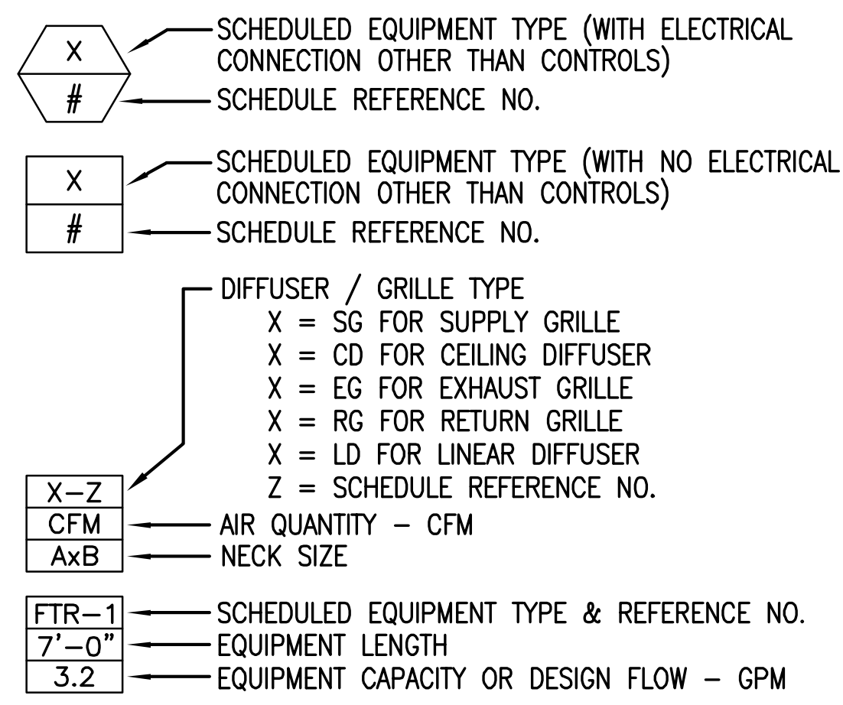
ABBREVIATION	DESCRIPTION
ACC	AIR COOLED CONDENSER
ACCU	AIR COOLED CONDENSING UNIT
AD	ACCESS DOOR
AFF	ABOVE FINISHED FLOOR
AFMS	AIR FLOW MEASURING STATION
AHU	AIR HANDLING UNIT
APD	AIR PRESSURE DROP
BAS	BUILDING AUTOMATION SYSTEM
BHP	BRAKE HORSEPOWER
BI	BACKWARD INCLINED
BTUH	BRITISH THERMAL UNIT
°C	DEGREES CELCIUS, CENTIGRADE
CC	COOLING COIL
CD	CEILING DIFFUSER, CONDENSATE DRAIN
CFM	CUBIC FEET PER MINUTE
CO	CLEAN OUT
CUH	CABINET UNIT HEATER
DB	DECIBELS
DBT	DRY BULB TEMPERATURE
DDC	DIRECT DIGITAL CONTROL
DIA	DIAMETER
DN	DOWN
DWG	DRAWING
DX	DIRECT EXPANSION
EAT	ENTERING AIR TEMPERATURE
EF	EXHAUST FAN
EFT	ENTERING FLUID TEMPERATURE
EG	EXHAUST GRILLE
EMS	ENERGY MANAGEMENT SYSTEM
ENT	ENTERING
ESP	EXTERNAL STATIC PRESSURE
ET	EXPANSION TANK
EWT	ENTERING WATER TEMPERATURE
EX	EXISTING
°F	DEGREES, FAHRENHEIT
FA	FACE AREA
FCU	FAN COIL UNIT
FPM	FEET PER MINUTE
FT	FEET
FV	FACE VELOCITY
GAL	GALLONS
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
H	HUMIDIFIER
HC	HEATING COIL
HD	HEAD
HOA	HAND, OFF, AUTO
HP	HORSEPOWER, HEAT PUMP
HZ	HERTZ
IN	INCHES
IN.WG	INCHES WATER GAUGE
KW	KILOWATT
LAT	LEAVING AIR TEMPERATURE
LBS	POUNDS
LBS/HR	POUNDS PER HOUR
LCP	LOCAL CONTROL PANEL
LD	LINEAR DIFFUSER
LF	LINEAR FOOT
LFT	LEAVING FLUID TEMPERATURE
LWT	LEAVING WATER TEMPERATURE
MAX	MAXIMUM
MBH	ONE THOUSAND BRITISH THERMAL UNIT
MCC	MOTOR CONTROL CENTER
MD	MOTORIZED DAMPER
MIN	MINIMUM
NC	NORMALLY CLOSED
ND	NOZZLE DIFFUSER
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NTS	NOT TO SCALE

ABBREVIATION	DESCRIPTION
OA	OUTSIDE AIR
OBD	OPPOSED BLADE DAMPER
P	PUMP
PD	PRESSURE DROP
PH	PHASE
PHC	PREHEAT COIL
PSI	POUNDS PER SQUARE INCH
PSID	POUNDS PER SQUARE INCH DIFFERENCE
PSIG	POUNDS PER SQUARE INCH GAUGE
PVC	POLYVINYL CHLORIDE
RA	RETURN AIR
RF	RETURN AIR FAN
RG	RETURN GRILLE
RH	RELATIVE HUMIDITY
RPM	REVOLUTIONS PER MINUTE
RTU	ROOFTOP UNIT
SA	SUPPLY AIR
SEF	SMOKE EXHAUST FAN
SF	SUPPLY AIR FAN
SG	SUPPLY GRILLE
SP	STATIC PRESSURE
TSTAT	THERMOSTAT
TYP	TYPICAL
UH	UNIT HEATER
V	VOLT
VAV	VARIABLE AIR VOLUME
VD	VOLUME DAMPER
VFD	VARIABLE FREQUENCY DRIVE
WBT	WET BULB TEMPERATURE
WG	WATER GAUGE
WMS	WIRE MESH SCREEN
WPD	WATER PRESSURE DROP

F1 HVAC ABBREVIATIONS

NO SCALE (NOT ALL ABBREVIATIONS ARE USED)

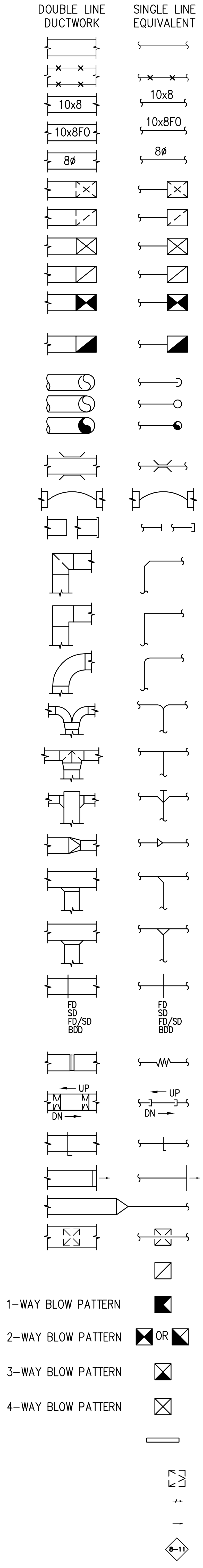


EQUIPMENT TYPES

AC	AIR CONDITIONING UNIT
ACC	AIR COOLED CONDENSER
AFMS	AIR FLOW MEASURING STATION
AF	AIR FILTER
AHU	AIR HANDLING UNIT
AS	AIR SEPARATOR
B	BOILER
CC	COOLING COIL
CD	CEILING DIFFUSER
CH	CHILLER
CP	CONDENSATE PUMP
CT	COOLING TOWER
CU	CONDENSING UNIT
CUH	CABINET UNIT HEATER
DC	DRY COOLER
DF	DESTRATIFICATION FAN
EC	EVAPORATIVE COOLER
ECU	EVAPORATIVE CONDENSING UNIT
EF	EXHAUST FAN
EG	EXHAUST GRILLE
EHC	ELECTRIC HEATING COIL
ERC	ENERGY RECOVERY COIL
ERV	EXHAUST ROOF VENT
ET	EXPANSION TANK
FCU	FAN COIL UNIT
FM	FLOW METER (HYDRONIC)
FBTU	FAN POWERED TERMINAL UNIT
FTR	FIN–TUBE RADIATION
GTHP	GEOTHERMAL HEAT PUMP
H	HUMIDIFIER
HC	HEATING COIL
HRW	HEAT RECOVERY (ENTHALPY) WHEEL
HV	HEATING AND VENTILATING UNIT
HVAC	HEATING, VENTILATING & AIR CONDITIONING UNIT
HEX	HEAT EXCHANGER
LD	LINEAR DIFFUSER
LV	LOUVER
ND	NOZZLE DIFFUSER
P–CW	PUMP – FOR CHILLED WATER SERVICE
P–GW	PUMP – FOR GEOTHERMAL WATER SERVICE
P–HW	PUMP – FOR HOT WATER SERVICE
P–WT	PUMP – FOR HVAC WATER TREATMENT SERVICE
RF	RETURN FAN
RG	RETURN GRILLE
RHC	REHEAT COIL
RP	RADIANT HEATING PANEL
SA	SOUND ATTENUATOR
SEF	SMOKE EXHAUST FAN
SF	SUPPLY FAN
SG	SUPPLY GRILLE
ST	HVAC HYDRONIC STORAGE TANK
TEF	TOILET EXHAUST FAN
UH	UNIT HEATER
VAV	VARIABLE AIR VOLUME TERMINAL UNIT

A1 HVAC EQUIPMENT TAGS

NO SCALE (SOME TAGS MAY NOT BE REFERENCED)



EXISTING DUCTWORK
EXISTING DUCTWORK TO BE REMOVED
RECTANGULAR DUCTWORK
FLAT OVAL DUCTWORK
ROUND DUCTWORK
SUPPLY DUCT DOWN
RETURN/EXHAUST DUCT DOWN
SUPPLY DUCT UP
RETURN/EXHAUST DUCT UP
SUPPLY DUCT UP (THROUGH FLOOR OR ROOF STRUCTURE ABOVE)
RETURN/EXHAUST DUCT UP (THROUGH FLOOR OR ROOF STRUCTURE ABOVE)
ROUND DUCT DN
ROUND DUCT UP
ROUND DUCT (UP THROUGH FLOOR OR ROOF STRUCTURE ABOVE)
BEAM PENETRATION BY DUCTWORK OR PIPING
FLEXIBLE DUCTWORK
END OF DUCT/DUCT CAP
MITERED ELBOW WITH TURNING VANES
MITERED ELBOW
RADIUS ELBOW (FULL RADIUS WHERE SPACE PERMITS)
RADIUS TEE
SQUARE–THROATED TEE
SQUARE–THROATED TEE
RECTANGULAR–TO–ROUND TRANSITION
TAKE–OFF TO RECTANGULAR DUCT
CONICAL TAKE–OFF (RECTANGULAR MAIN TO ROUND BRANCH)

SPECIAL DAMPER TYPES AND ABBREVIATIONS:
FD = FIRE DAMPER
SD = SMOKE DAMPER
FD/SD = COMBINATION FIRE/SMOKE DAMPER
BDD = BACKDRAFT DAMPER

FLEXIBLE CONNECTION
CHANGE IN ELEVATION (RELATIVE TO DIRECTION OF AIRFLOW)
VOLUME DAMPER
SIDE WALL REGISTER/GRILLE
DOUBLE LINE TO SINGLE LINE TRANSITION
DIFFUSER CONNECTED TO BOTTOM OF DUCT
RETURN REGISTER OR EXHAUST REGISTER

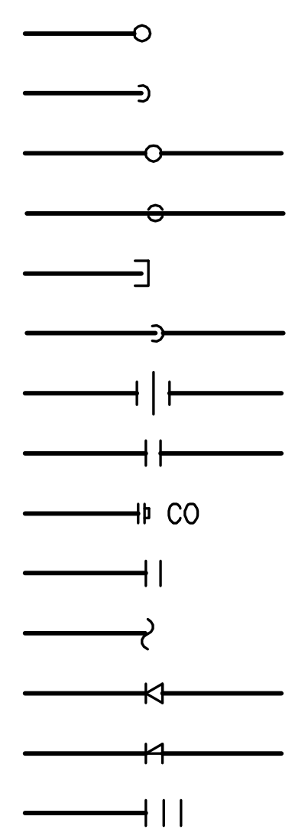
SUPPLY DIFFUSER:
SHADED PORTIONS INDICATE BLANKED OFF SECTIONS, OR DIRECTION OF NO AIR FLOW

NOTE:
AIR FLOW ARROWS ARE SHOWN ON LEGEND ONLY TO ILLUSTRATE INTENT – NOT SHOWN ON PLANS

LINEAR DIFFUSER
ACCESS DOOR
EXHAUST, RETURN, OR INTAKE AIR
SUPPLY AIR
DISTANCE TO FINISHED FLOOR (FT. AND INCH) FROM BOTTOM OF DUCT OR PIPE

A8 SHEETMETAL

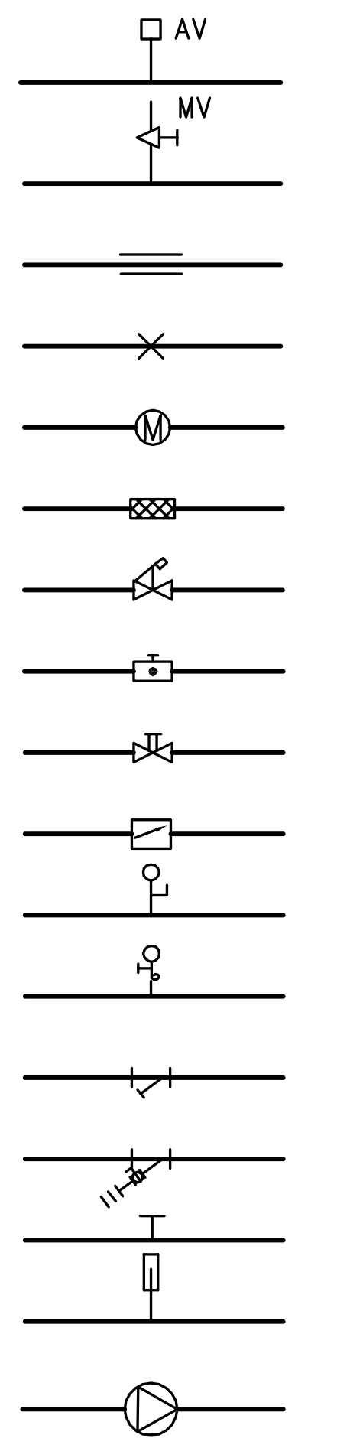
NO SCALE



ELBOW UP
ELBOW DOWN
TEE UP
TEE DOWN
CAP
RISE OR DROP IN PIPE
UNION
FLANGE
CLEANOUT WITH PLUG
BLIND FLANGE
PIPE CONTINUES
CONCENTRIC REDUCER / EXPANDER
ECCENTRIC REDUCER / EXPANDER
HOSE CONNECTION

N12 FITTINGS

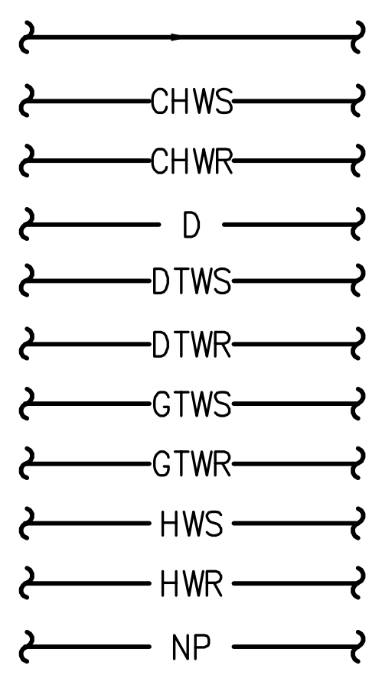
NO SCALE



AUTOMATIC AIR VENT
MANUAL AIR VENT
ALIGNMENT GUIDE
ANCHOR
TURBINE FLOWMETER
FLEXIBLE CONNECTOR
FUSIBLE LINK VALVE
VORTEX SHEDDING FLOWMETER
CALIBRATED BALANCING VALVE
AUTOMATIC FLOW CONTROL VALVE
PRESSURE GAUGE AND SHUT–OFF COCK
PRESSURE GAUGE WITH SYPHON
STRAINER
STRAINER WITH BLOW DOWN VALVE AND HOSE CONNECTION
TEMPERATURE AND PRESSURE TEST PORT
THERMOMETER
PUMP

H12 PIPING SPECIALTIES

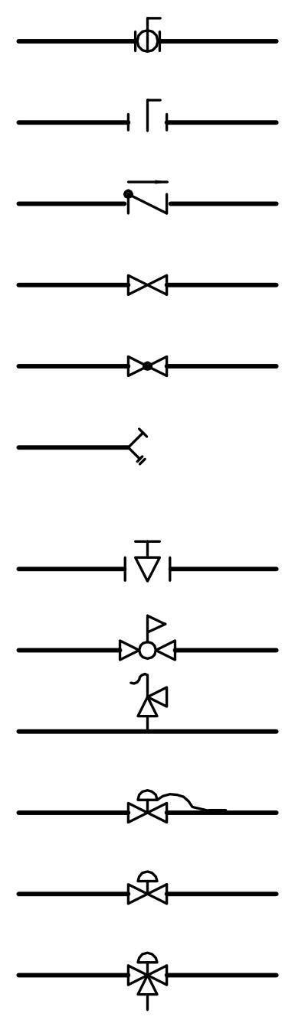
NO SCALE



FLOW DIRECTION WITHIN PIPE
HOT WATER SUPPLY
HOT WATER RETURN
DRAIN
HOT WATER SUPPLY
DUAL TEMPERATURE WATER RETURN
GEOTHERMAL WATER SUPPLY
GEOTHERMAL WATER RETURN
HOT WATER SUPPLY
HOT WATER RETURN
NON–POTABLE MAKEUP WATER

A12 PIPING

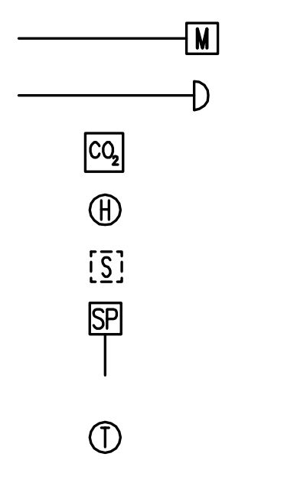
NO SCALE



BALL VALVE
BUTTERFLY VALVE
CHECK VALVE
GATE VALVE
GLOBE VALVE
HOSE END DRAIN VALVE WITH CHAIN AND CAP
PLUG VALVE
PRESSURE REDUCING VALVE
RELIEF VALVE
SELF–CONTAINED CONTROL VALVE
TWO WAY CONTROL VALVE
THREE WAY CONTROL VALVE

N15 VALVES

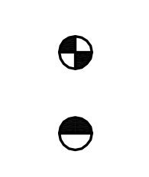
NO SCALE



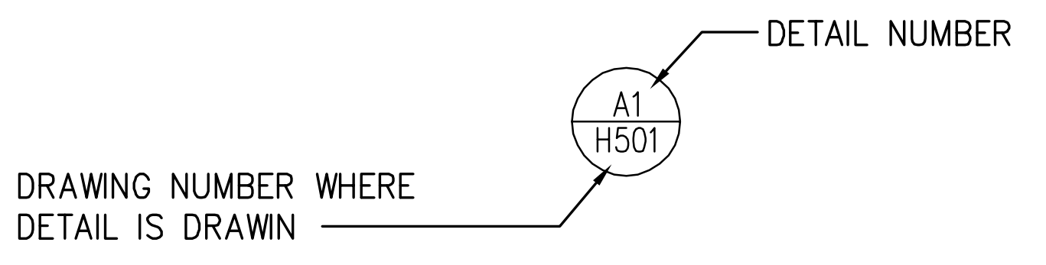
AUTOMATIC CONTROL DAMPER (ELECTRIC)
AUTOMATIC CONTROL DAMPER (PNEUMATIC)
CARBON DIOXIDE SENSOR
HUMIDITY SENSOR
SMOKE DETECTOR (DUCT)
STATIC PRESSURE SENSOR
THERMOSTAT OR TEMPERATURE SENSOR MOUNT 48" AFF UNLESS OTHERWISE NOTED

K15 CONTROLS

NO SCALE REFER TO H400 SERIES FOR CONTROLS LEGEND



CONNECT TO EXISTING
POINT OF DISCONNECTION



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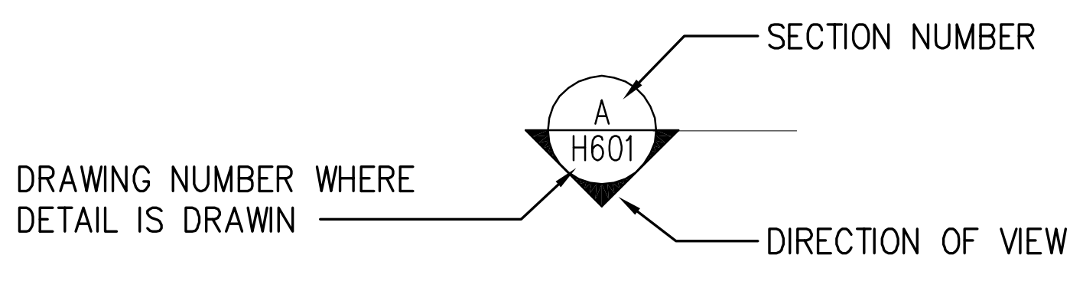
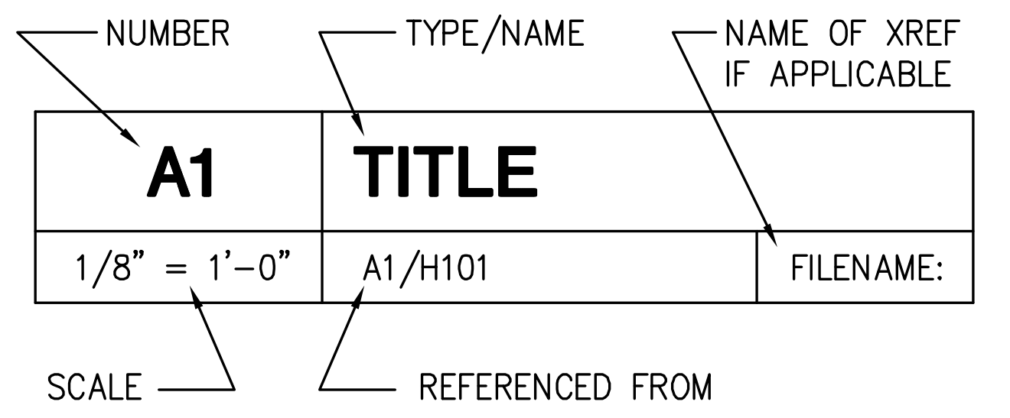
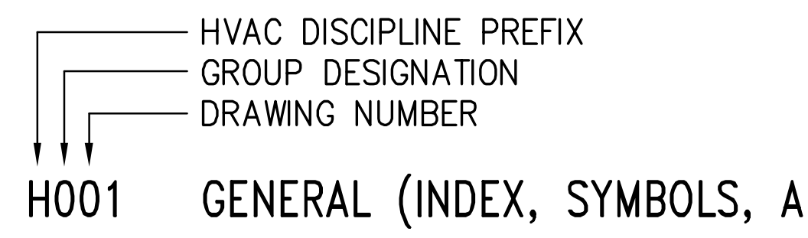


SECTION INDICATION



D15 GENERAL

NO SCALE



H001	GENERAL (INDEX, SYMBOLS, ABBREVIATIONS), SITE PLANS
HD101	FLOOR PLANS, DEMOLITION
H101	FLOOR PLANS, DUCTWORK
H201	FLOOR PLANS, PIPING
H301	LARGE SCALE PLANS & SECTIONS
H401	PIPING FLOW, RISER & CONTROL DIAGRAMS
H501	DETAILS & MISCELLANEOUS
H601	HVAC SCHEDULES

A15 DRAWING GROUPS

NO SCALE

GENERAL NOTES

1. HVAC WORK IS INDICATED DIAGRAMMATICALLY. EXACT LOCATIONS OF ALL COMPONENTS ARE TO BE DETERMINED IN THE FIELD AND BY THE ACTUAL BUILDING CONDITIONS. EXISTING DUCTS, PIPING OR EQUIPMENT INTERFERING WITH OTHER INSTALLATIONS SHALL BE RELOCATED AS REQUIRED AT NO ADDITIONAL COST TO THE OWNER. EXACT LOCATIONS MUST HAVE THE APPROVAL OF THE ARCHITECT.
2. INSTALLATION OF EQUIPMENT SHALL PERMIT ACCESSIBILITY FOR SERVICE AND/OR REPLACEMENT.
3. ALL DUCT SIZES SHOWN ARE INSIDE CLEAR DIMENSIONS.
4. PROVIDE VOLUME DAMPERS AT EACH NON VAV MAIN BRANCH TAKE–OFF AND IN OTHER SUCH LOCATIONS WHERE REQUIRED TO PROPERLY BALANCE THE SYSTEM.
5. ALL OPEN ENDED DUCTS LOCATED IN CEILING PLENUMS SHALL BE UNOBSTRUCTED FOR A MINIMUM DISTANCE OF 24" TO ALLOW FREE AIR FLOW AND SHALL HAVE 3/4" WIRE MESH SCREENING.
6. ALL MISCELLANEOUS STRUCTURAL SUPPORTS REQUIRED FOR HVAC EQUIPMENT INSTALLATION SHALL BE PROVIDED BY HVAC SUBCONTRACTOR.
7. ALL TRANSFER DUCTS SHALL BE INTERNALLY LINED.
8. EXACT LOCATION OF CEILING DIFFUSERS, GRILLES AND REGISTERS SHALL BE COORDINATED WITH ARCHITECTURAL REFLECTED CEILING PLAN. CONFLICTS SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT AND/OR HVAC ENGINEER.
9. SEE PLANS FOR QUANTITIES OF SAME TYPE EQUIPMENT SCHEDULED.
10. EXACT ELEVATION FOR SIDE WALL REGISTERS AND GRILLES SHALL BE APPROVED BY THE ARCHITECT PRIOR TO INSTALLATION.
11. UNLESS OTHERWISE NOTED, ALL PIPING RUNOUTS TO TERMINAL EQUIPMENT SHALL BE 3/4".
12. ALL EXPOSED EQUIPMENT (REGISTERS, UNIT HEATERS, ETC.) SHALL HAVE COLORS SELECTED BY ARCHITECT, UNLESS NOTED OTHERWISE.
13. HVAC SUBCONTRACTOR SHALL BLANK OFF ALL UNUSED LOUVER AREA AND INSULATE. PLENUM CONNECTION SIZED TO LOUVERS SHALL BE SHOWN ON PLANS.
14. EXACT LOCATION OF THERMOSTATS SHALL BE COORDINATED WITH FINAL LOCATION OF WALL MOUNTED ARCHITECTURAL AND ELECTRICAL EQUIPMENT.

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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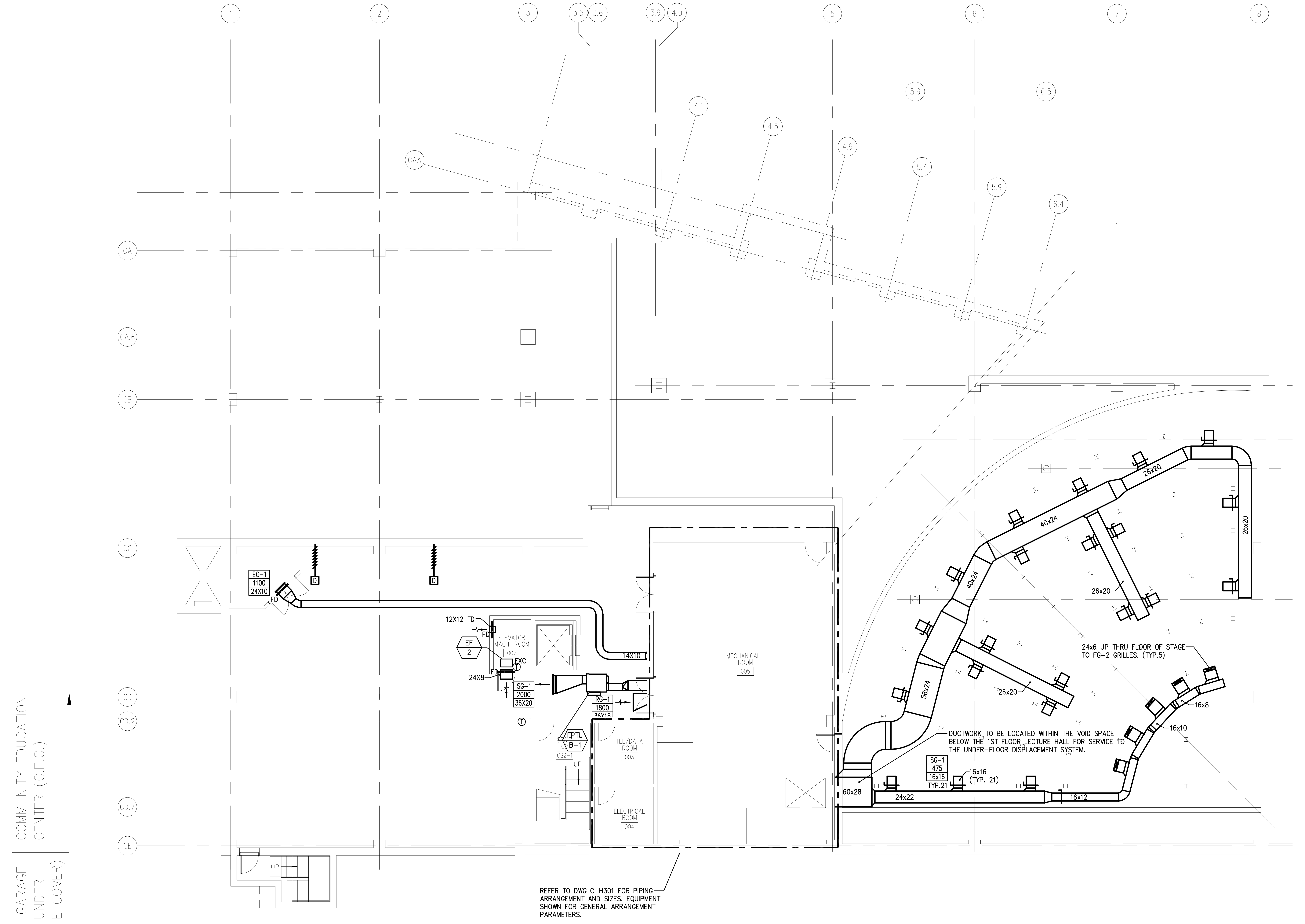
drawing title **HVAC LEGEND SHEET**

seal	designed by BOS	project no. 5001024.00
	drawn by DSC	CAD file no. C–H001.DWG
	checked by JMS	drawing no. **C-H001**
	date 1/19/2004	
	scale NONE	



DUCTWORK TO BE LOCATED WITHIN THE VOID SPACE BELOW THE 1ST FLOOR LECTURE HALL FOR SERVICE TO THE UNDER-FLOOR DISPLACEMENT SYSTEM.

24x6 UP THRU FLOOR OF STAGE TO FG-2 GRILLES. (TYP.5)

REFER TO DWG C-H301 FOR PIPING ARRANGEMENT AND SIZES. EQUIPMENT SHOWN FOR GENERAL ARRANGEMENT PARAMETERS.

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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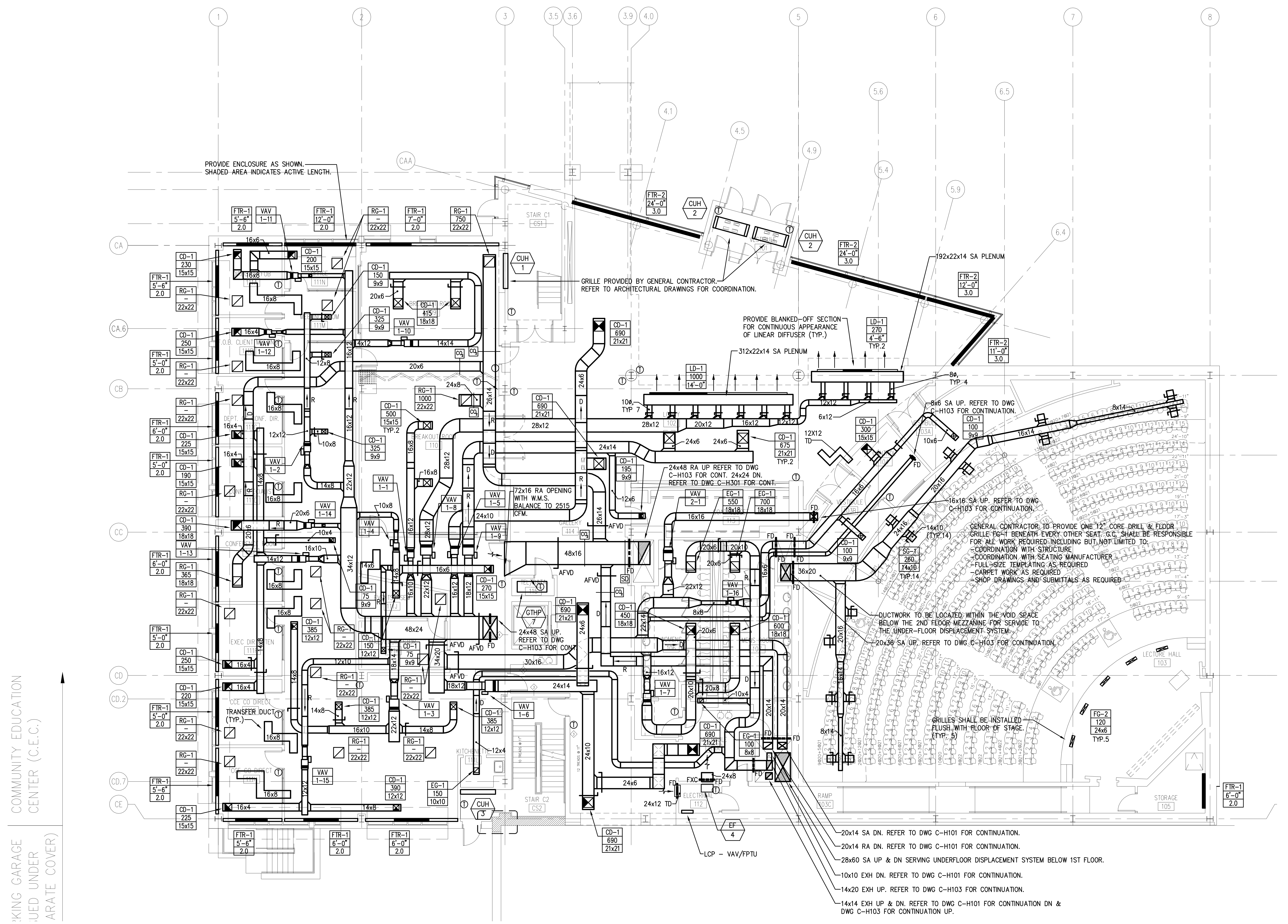
drawing title
C.E.C. BASEMENT PLAN- HVAC DUCTWORK

seal

designed by BOS
drawn by BOS
checked by JMS
date 1/19/2004
scale 1/8" = 1'-0"

project no. 5001024.00
CAD file no. C-H101.DWG
drawing no.
C-H101



GENERAL NOTES:

1. ALL VAV BOXES SHALL HAVE MANUFACTURER'S INTEGRATED SOUND ATTENUATORS.
2. ALL DIFFUSERS SHALL BE CONNECTED BY INSULATED FLEXIBLE DUCT – SHALL BE PRESTRETCHED BEFORE INSTALLATION. LENGTH NOT TO EXCEED 8 FEET AND NO LESS THAN 6 FEET. DIAMETER TO BE EQUAL TO DIFFUSER INLET SIZE.
3. EXACT LOCATION OF CEILING DIFFUSERS, GRILLES & REGISTERS SHALL BE COORDINATED WITH ARCHITECTURAL REFLECTED CEILING PLAN. CONFLICTS SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT AND/OR HVAC ENGINEER.

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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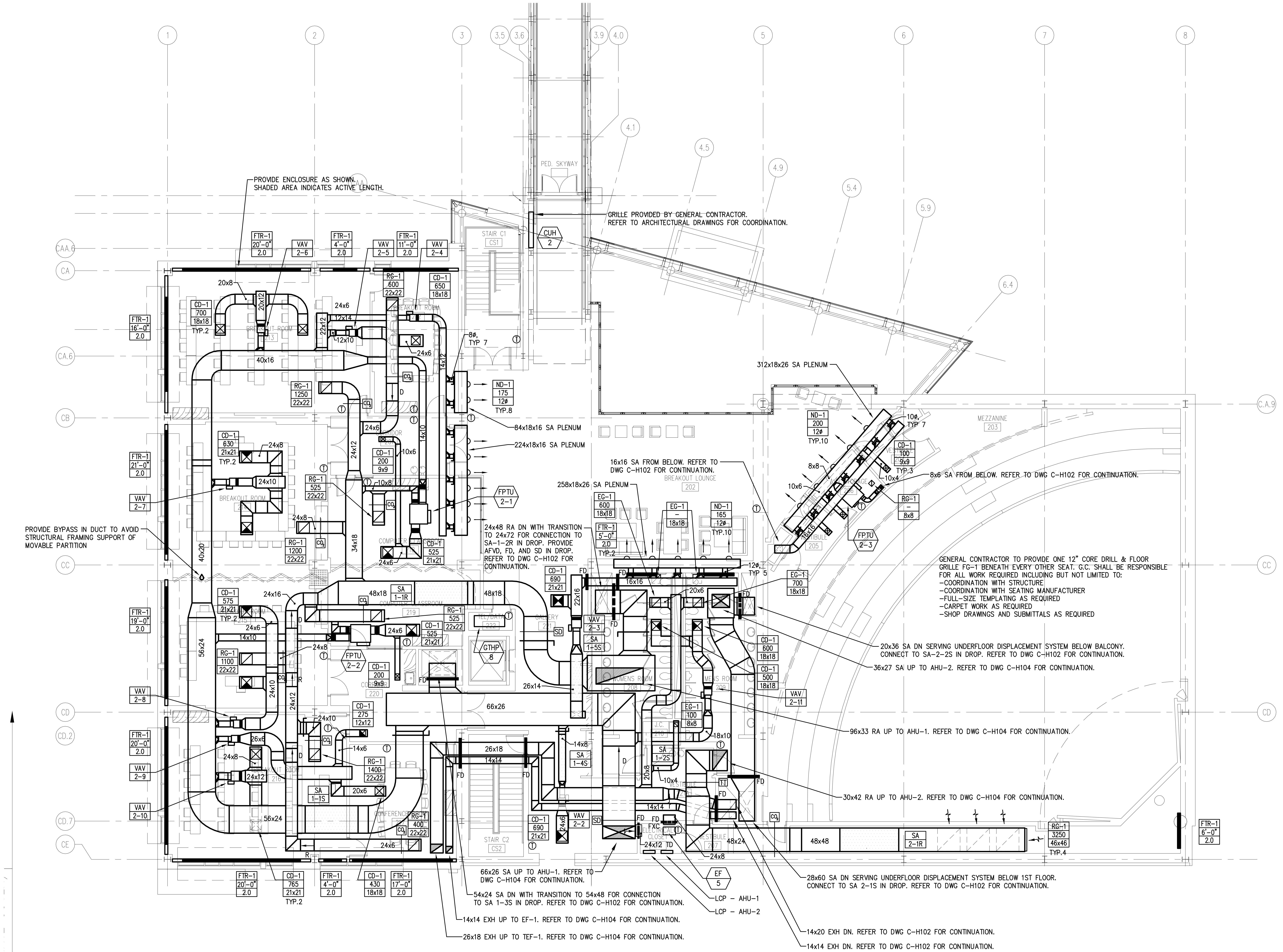
drawing title **C.E.C. FIRST FLOOR PLAN - HVAC DUCTWORK**

seal

designed by BOS	project no. 5001024.00
drawn by DSC	CAD file no. C-H102.DWG
checked by JMS	drawing no. C-H102
date 1/19/2004	
scale 1/8" = 1'-0"	

GENERAL NOTES:

1. ALL VAV BOXES SHALL HAVE MANUFACTURER'S INTEGRATED SOUND ATTENUATORS.
2. ALL DIFFUSERS SHALL BE CONNECTED BY INSULATED FLEXIBLE DUCT – SHALL BE PRESTRETCHED BEFORE INSTALLATION. LENGTH NOT TO EXCEED 8 FEET AND NO LESS THAN 6 FEET. DIAMETER TO BE EQUAL TO DIFFUSER INLET SIZE.
3. EXACT LOCATION OF CEILING DIFFUSERS, GRILLES & REGISTERS SHALL BE COORDINATED WITH ARCHITECTURAL REFLECTED CEILING PLAN. CONFLICTS SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT AND/OR HVAC ENGINEER.



PROVIDE ENCLOSURE AS SHOWN. SHADED AREA INDICATES ACTIVE LENGTH.

GRILLE PROVIDED BY GENERAL CONTRACTOR. REFER TO ARCHITECTURAL DRAWINGS FOR COORDINATION.

312x18x26 SA PLENUM

84x18x16 SA PLENUM

224x18x16 SA PLENUM

16x16 SA FROM BELOW. REFER TO DWG C-H102 FOR CONTINUATION.

258x18x26 SA PLENUM

8x6 SA FROM BELOW. REFER TO DWG C-H102 FOR CONTINUATION.

PROVIDE BYPASS IN DUCT TO AVOID STRUCTURAL FRAMING SUPPORT OF MOVABLE PARTITION

24x48 RA DN WITH TRANSITION TO 24x72 FOR CONNECTION TO SA-1-2R IN DROP. PROVIDE AFVD, FD, AND SD IN DROP. REFER TO DWG C-H102 FOR CONTINUATION.

GENERAL CONTRACTOR TO PROVIDE ONE 12" CORE DRILL & FLOOR GRILLE FG-1 BENEATH EVERY OTHER SEAT. G.C. SHALL BE RESPONSIBLE FOR ALL WORK REQUIRED INCLUDING BUT NOT LIMITED TO:
- –COORDINATION WITH STRUCTURE
- –COORDINATION WITH SEATING MANUFACTURER
- –FULL-SIZE TEMPLATING AS REQUIRED
- –CARPET WORK AS REQUIRED
- –SHOP DRAWINGS AND SUBMITTALS AS REQUIRED

20x36 SA DN SERVING UNDERFLOOR DISPLACEMENT SYSTEM BELOW BALCONY. CONNECT TO SA-2-2S IN DROP. REFER TO DWG C-H102 FOR CONTINUATION.

36x27 SA UP TO AHU-2. REFER TO DWG C-H104 FOR CONTINUATION.

96x33 RA UP TO AHU-1. REFER TO DWG C-H104 FOR CONTINUATION.

30x42 RA UP TO AHU-2. REFER TO DWG C-H104 FOR CONTINUATION.

66x26 SA UP TO AHU-1. REFER TO DWG C-H104 FOR CONTINUATION.

54x24 SA DN WITH TRANSITION TO 54x48 FOR CONNECTION TO SA 1-3S IN DROP. REFER TO DWG C-H102 FOR CONTINUATION.

14x14 EXH UP TO EF-1. REFER TO DWG C-H104 FOR CONTINUATION.

26x18 EXH UP TO TEF-1. REFER TO DWG C-H104 FOR CONTINUATION.

LCP – AHU-1

LCP – AHU-2

28x60 SA DN SERVING UNDERFLOOR DISPLACEMENT SYSTEM BELOW 1ST FLOOR. CONNECT TO SA 2-1S IN DROP. REFER TO DWG C-H102 FOR CONTINUATION.

14x20 EXH DN. REFER TO DWG C-H102 FOR CONTINUATION.

14x14 EXH DN. REFER TO DWG C-H102 FOR CONTINUATION.

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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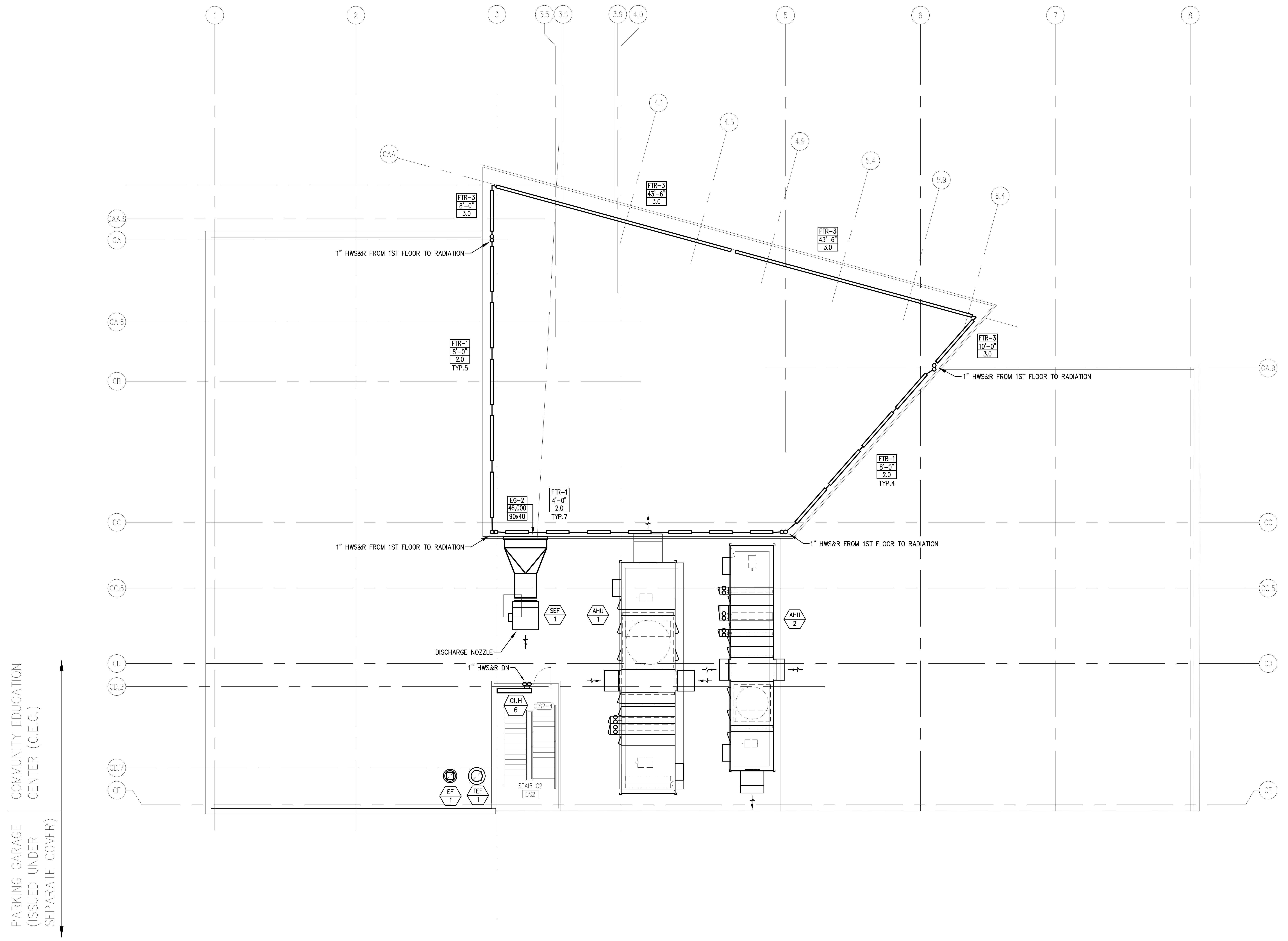
drawing title
C.E.C. SECOND FLOOR PLAN- HVAC DUCTWORK

seal

designed by BOS	project no. 5001024.00
drawn by DSC	CAD file no. C-H103.DWG
checked by JMS	drawing no.
date 1/19/2004	**C-H103**
scale 1/8" = 1'-0"	



GENERAL NOTE:
ALL HVAC PIPES SHALL BE ELECTRICALLY
HEAT TRACED (HWS&R, CHWS&R, CD)

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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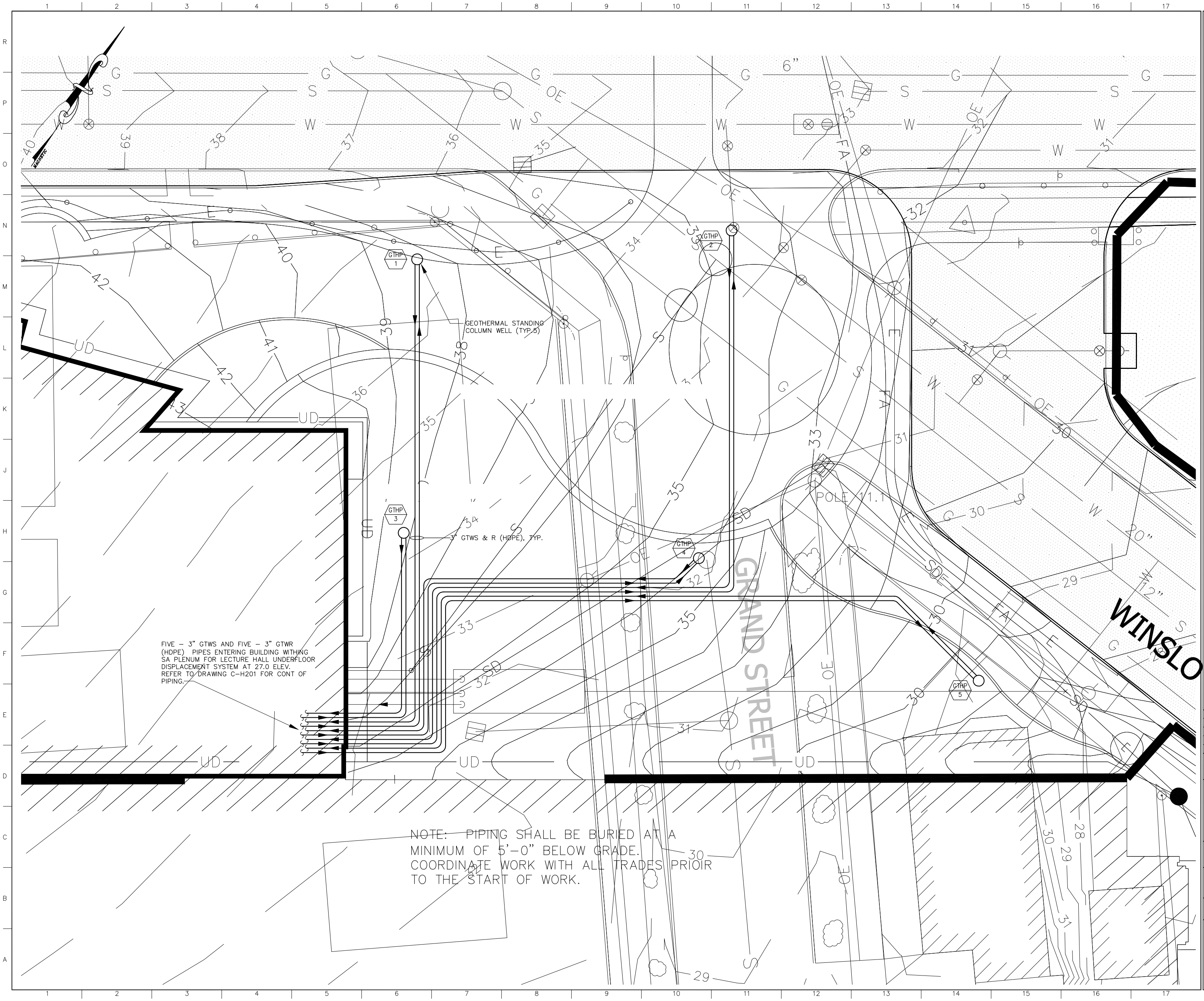
drawing title **C.E.C. HVAC ROOF PLAN**

seal

designed by BOS	project no. 5001024.00
drawn by BOS	CAD file no. C-H104.DWG
checked by JMS	drawing no.
date 1/19/2004	**C-H104**
scale 1/8" = 1'-0"	



GEOTHERMAL STANDING COLUMN WELL (TYP.5)

3" GTWS & R (HDPE), TYP.

FIVE – 3" GTWS AND FIVE – 3" GTWR (HDPE) PIPES ENTERING BUILDING WITHING SA PLENUM FOR LECTURE HALL UNDERFLOOR DISPLACEMENT SYSTEM AT 27.0 ELEV. REFER TO DRAWING C–H201 FOR CONT OF PIPING.

NOTE: PIPING SHALL BE BURIED AT A MINIMUM OF 5'-0" BELOW GRADE. COORDINATE WORK WITH ALL TRADES PRIOIR TO THE START OF WORK.

no.	revisions/submissions	date
	50% CONSTRUCTION DOCUMENTS	9/4/03

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UNIVERSITY OF SOUTHERN MAINE
COMMUNITY EDUCATION CENTER - PHASE 2
PORTLAND, MAINE

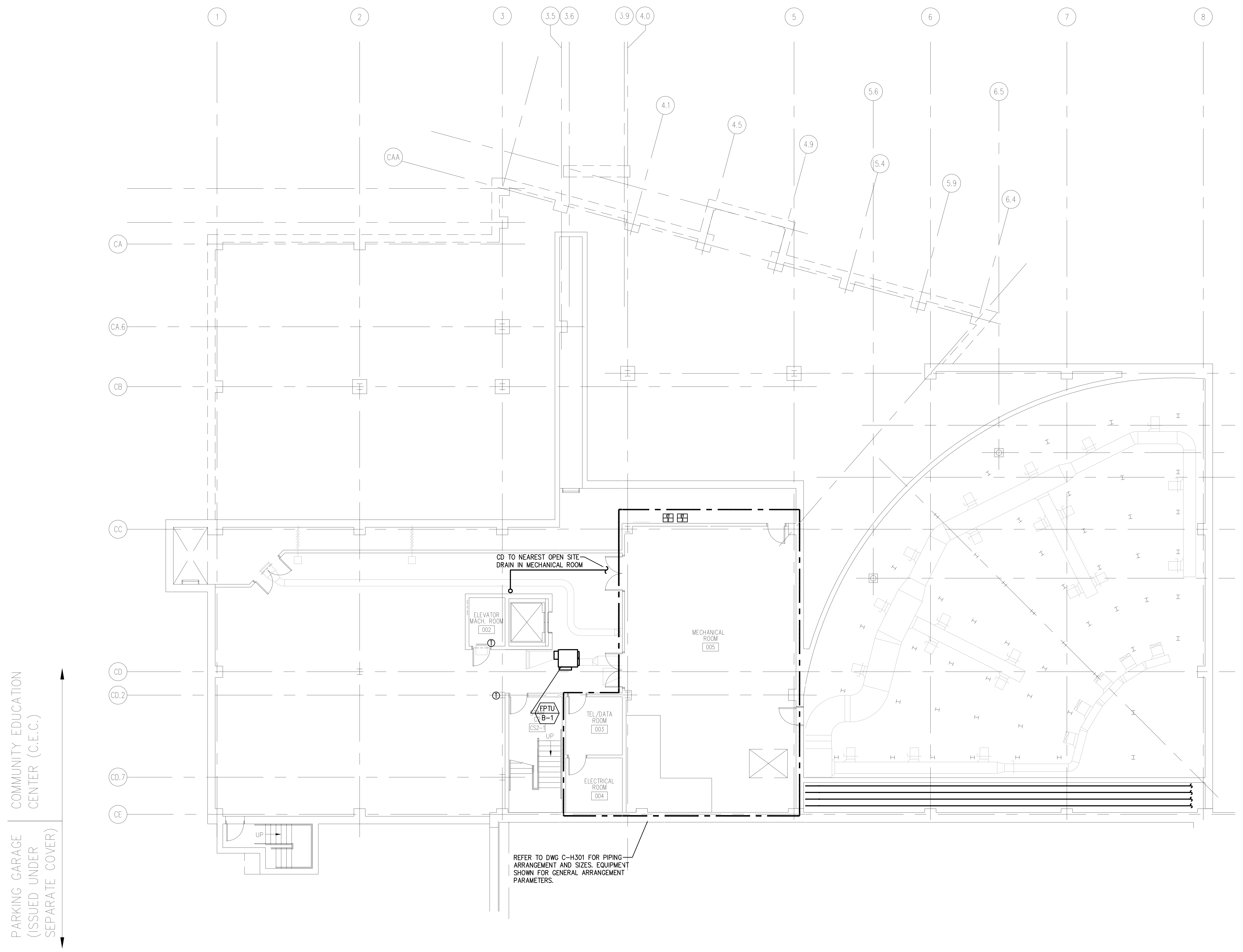
drawing title
LEEDS MECHANICAL SITE PLAN

seal

designed by BOS
drawn by DSC
checked by JMS
date 9/4/2003
scale 1/8" = 1'

project no. 5001024.00
CAD file no. C–HS01
drawing no. **C-H200**

GENERAL NOTE:
ALL BRANCH PIPING TO TERMINAL UNITS SHALL BE 3/4" UNLESS OTHERWISE NOTED.



CD TO NEAREST OPEN SITE DRAIN IN MECHANICAL ROOM

REFER TO DWG C-H301 FOR PIPING ARRANGEMENT AND SIZES. EQUIPMENT SHOWN FOR GENERAL ARRANGEMENT PARAMETERS.

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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UNIVERSITY OF SOUTHERN MAINE
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PORTLAND, MAINE

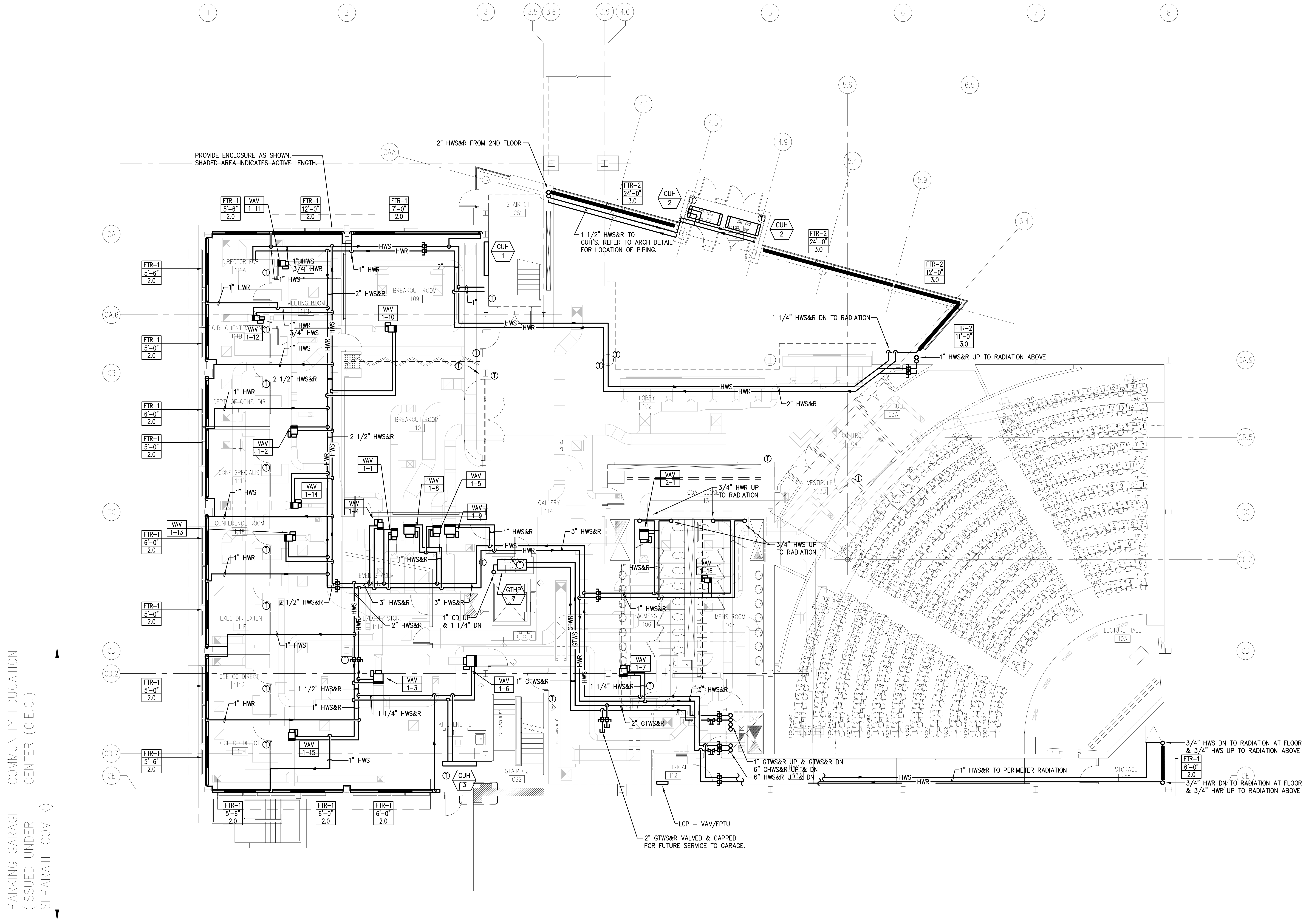
drawing title **C.E.C. BASEMENT PLAN- HVAC PIPING**

seal

designed by BOS
drawn by BOS
checked by JMS
date 1/19/2004
scale 1/8" = 1'-0"
project no. 5001024.00
CAD file no. C-H201.DWG
drawing no. C-H201

<u>GENERAL NOTES</u>:

1. ALL BRANCH PIPING TO TERMINAL UNITS SHALL BE 3/4" UNLESS OTHERWISE NOTED.
2. COORDINATE ALL PIPING RISES AND DROPS TO RADIATION, CABINET UNIT HEATERS, AND ALL OTHER TERMINAL UNITS WITH ARCHITECTS.



no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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PORTLAND, MAINE

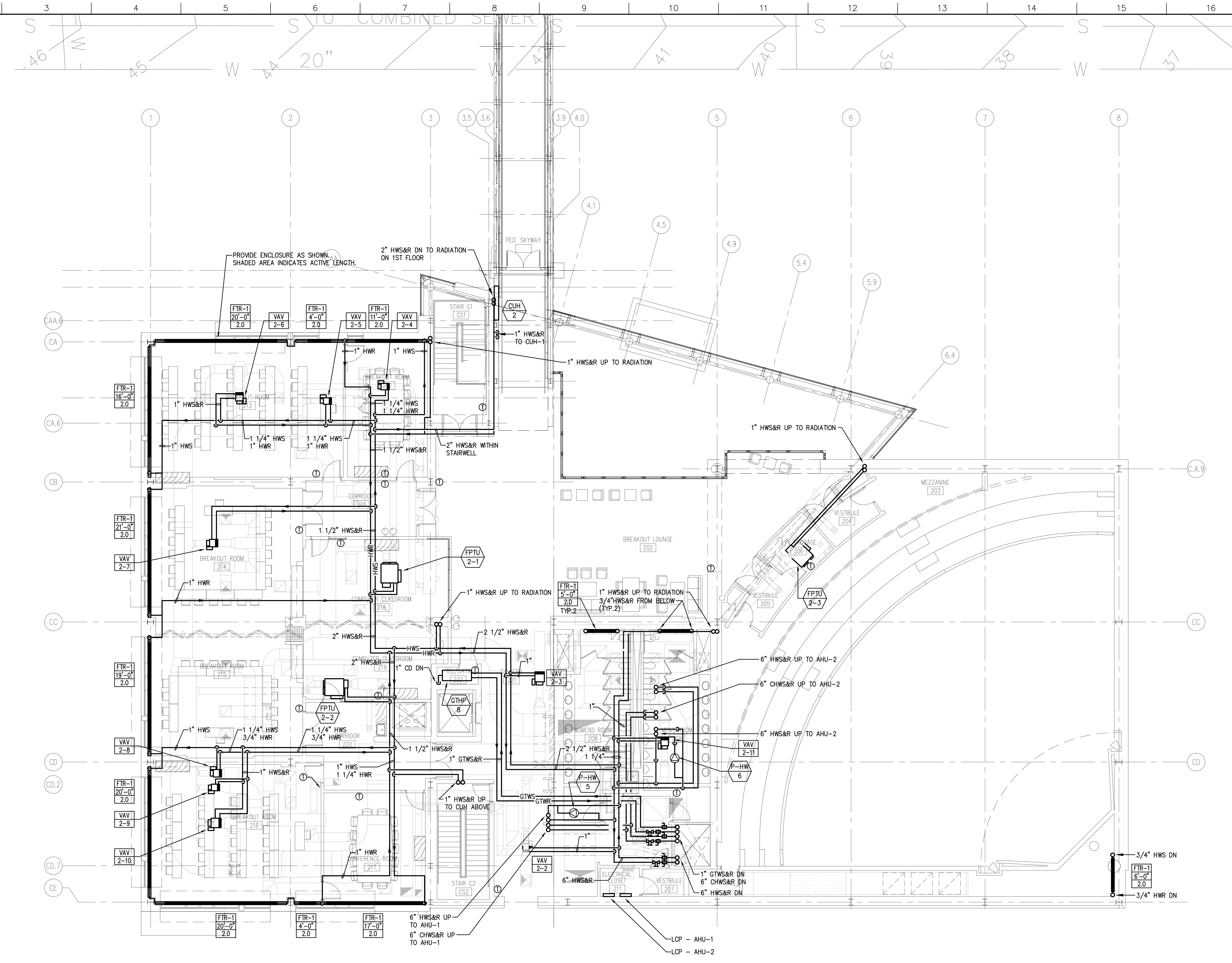
drawing title **C.E.C. FIRST FLOOR PLAN - HVAC PIPING**

seal

designed by BOS	project no. 5001024.00
drawn by DSC	CAD file no. C-H202.DWG
checked by JMS	drawing no.
date 1/19/2004	**C-H202**
scale 1/8" = 1'-0"	

GENERAL NOTES:

1. ALL BRANCH PIPING TO TERMINAL UNITS SHALL BE 3/4" UNLESS OTHERWISE NOTED.
2. COORDINATE ALL PIPING RISES AND DROPS TO RADIATION, CABINET UNIT HEATERS, AND ALL OTHER TERMINAL UNITS WITH ARCHITECTS.



no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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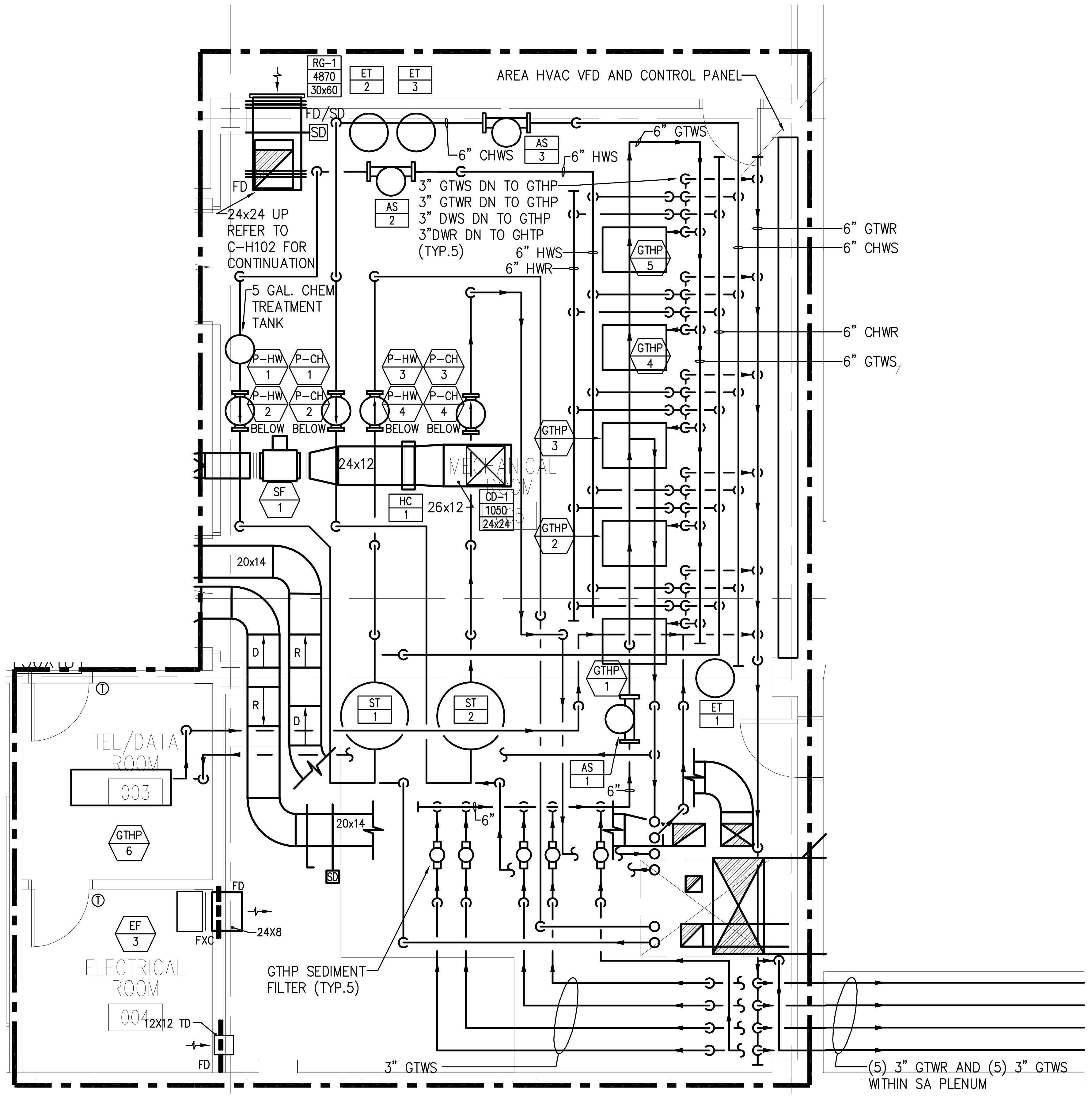
PORTLAND, MAINE

drawing title
C.E.C. SECOND FLOOR PLAN- HVAC PIPING

seal

designed by BOS
drawn by DSC
checked by JMS
date 1/19/2004
scale 1/8" = 1'-0"
project no. 5001024.00
CAD file no. C-H203.DWG
drawing no. C-H203



GENERAL NOTE:
DRAWING INDICATES GERNERAL ARRANGEMENT OF PIPING AND SYSTEMS. REFER TO DRAWING C-H401 FOR ALL VALVING, TRIM, AND ASSOCIATED APPURTENANCES.

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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PORTLAND, MAINE

drawing title **C.E.C. HVAC ENLARGED MECHANICAL ROOM PLAN**

seal

designed by BOS
drawn by BOS
checked by JMS
date 1/19/2004
scale 1/4" = 1'-0"
project no. 5001024.00
CAD file no.
drawing no.

C-H301

GEOTHERMAL HEAT PUMP, HOT AND CHILLED WATER SYSTEMS – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS:

HEAT PUMP MANUFACTURER SHALL PROVIDE A DRY CONTACT FOR GENERAL ALARMING PURPOSE IF ANY OF THE EQUIPMENT FAILS TO START OR FUNCTION AS DESCRIBED HEREIN.

ALL SET POINTS AND TIME DELAYS ARE ADJUSTABLE.

IN THE EVENT OF POWER FAILURE ALL CONTROL SHALL GO TO THEIR FAIL SAFE POSITIONS, NORMALLY OPEN OR NORMALLY CLOSED.

THE BAS SHALL MONITOR AND RECORD: ALL ALARMS DESCRIBED WITHIN; HEAT PUMPS STATUS'S AND RUNTIMES, PUMP STATUS'S AND RUNTIMES; VALVE POSITIONS; THE SPEED OF EACH PUMP'S VFD; THE GEOTHERMAL WATER SUPPLY PRESSURE; THE GEOTHERMAL SUPPLY WATER FLOW; THE GEOTHERMAL SUPPLY WATER TEMPERATURE, THE GEOTHERMAL RETURN WATER FLOW BACK TO THE WELLS; THE GEOTHERMAL RETURN WATER TEMPERATURE; THE GEOTHERMAL WATER FLOW TO THE CISTERN SYSTEM;

GEOTHERMAL WELL PUMPS, P-GW-1, P-GW-2, P-GW-3, P-GW-4 & P-GW-5

PUMPS SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

THE BAS SHALL MONITOR THE STATUS OF EACH PUMP THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL MONITOR THE SPEED OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLER.

THE BAS SHALL RECORD AND REPORT THE DURATION THAT EACH PUMP OPERATES AT A SPECIFIC SPEED ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HOURS AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLERS.

THE BAS SHALL CALCULATE AND MONITOR EACH PUMP'S ENERGY USAGE AT VARIOUS PUMP SPEEDS. THE BAS SHALL ALSO RECORD AND REPORT THE ENERGY USAGE AT VARIOUS PUMP SPEEDS FOR EACH OF THE PUMPS ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING ENERGY USAGE, IN KW, AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL: CALCULATE RECORD AND REPORT THE ELECTRICAL ENERGY USAGE FOR EACH PUMP ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

ANY OF THE PUMPS SHALL BE CAPABLE OF OPERATING AS THE LEAD OR LAG PUMP.

PUMPS ALTERNATE LEAD/LAG TO EQUALIZE RUNTIME. SELECTION OF THE LEAD/LAG PUMP IS EVALUATED ON A WEEKLY BASIS. THE PUMP WITH THE LEAST RUNTIME IS THE LEAD PUMP; THE NEXT PUMP WITH THE SECOND LEAD RUNTIME IN THE NEXT PUMP IN LEAD/LAG PUMP SEQUENCE AND SO FORTH. THE PUMP WITH THE MOST RUNTIME IS THE LAG PUMP. THE LEAD/LAG SCHEDULE FOR THE PUMPS AND FOR THE HEAT PUMPS SHALL BE INDEPENDENT OF EACH OTHER.

THE GEOTHERMAL WATER FLOW THROUGH EACH PUMP SHALL BE CONSTANT AND HARD BALANCED BY THE TAB CONTRACTOR. THE BAS SHALL NOT BE ABLE TO VARY THE FLOW TROUGH THE HEAT PUMPS.

DURING NORMAL PUMP OPERATION, THERE SHALL BE ONE PUMP ENERGIZED FOR EVERY HEAT PUMP THAT HAS BEEN ENERGIZED (A 1 TO 1 PUMP TO HEAT PUMP RATIO). DESIGN PUMP SPEED IS THE SPEED IN WHICH THE VFD MUST OPERATE AT IN ORDER TO MAINTAIN THE HEAT PUMP'S GEOTHERMAL WATER FLOW RATE AS SCHEDULED ON DRAWING C-H601.

UPON A SIGNAL FROM THE BAS FOR A HEAT PUMP TO ENERGIZE (EITHER IN COOLING OR HEATING MODE), PRIOR TO ENERGIZING THE HEAT PUMP, THE BAS SHALL: OPEN THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL RETURN BRANCH PIPING TO THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SEQUENCE; OPEN THE ISOLATION VALVE LOCATED IN GEOTHERMAL RETURN BRANCH PIPING TO THE WELL OF THE NEXT PUMP IN THE LEAD/LAG PUMP SCHEDULE; ENERGIZE THE NEXT PUMP IN THE LEAD/LAG PUMP SCHEDULE; AND MODULATE THE PUMP'S SPEED TO MAINTAIN A NORMAL CONSTANT GEOTHERMAL WATER SUPPLY OPERATING PRESSURE OF 40 PSI ± 3 PSI (ADJUSTABLE), AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN. THE HEAT PUMP SHALL BE ENERGIZED. UPON A SIGNAL FROM THE BAS TO DE-ENERGIZE A HEAT PUMP, THE REVERSE SHALL OCCUR.

IF MULTIPLE PUMPS ARE ENERGIZED, THE BAS SHALL ADJUST EACH OF THE PUMPS' SPEED THROUGH THE VFD CONTROL TO MAINTAIN EQUAL SPEEDS FOR EACH PUMP UNLESS OTHERWISE NOTED.

IF A PUMP HAS BEEN ENERGIZED AND FAILS TO OPERATE, AS SENSED BY ITS ASSOCIATED CURRENT SENSING RELAY, THE BAS SHALL: DE-ENERGIZE THE LEAD PUMP, CLOSE THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL RETURN BRANCH PIPING TO THE LEAD PUMP'S WELL, SIGNAL AND RECORD A PUMP FAILURE ALARM AT THE BAS FOR THAT PUMP, OPEN THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL RETURN BRANCH PIPING TO THE NEXT PUMP'S WELL IN THE LEAD/LAG PUMP SCHEDULING AND ENERGIZE THE NEXT PUMP IN THE LEAD/LAG SCHEDULING. THE PUMP FAILURE ALARM SHALL BE SILENCED BY THE OPERATOR ONLY.

IF THE PUMP(S) IS (ARE) NOT ABLE TO MAINTAIN THE GEOTHERMAL WATER SUPPLY PRESSURE ABOVE 32 PSI (ADJUSTABLE), AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN, AND THE PUMPS ARE OPERATING AT THEIR NORMAL MAXIMUM OPERATING SPEED FOR MORE THAN 10 MINUTES (ADJUSTABLE), THE BAS SHALL: SIGNAL A GEOTHERMAL PUMPING LOW PRESSURE ALARM; OPEN THE ISOLATION VALVE LOCATED IN GEOTHERMAL RETURN BRANCH PIPING TO THE WELL OF THE NEXT PUMP IN THE LEAD/LAG PUMP SCHEDULE; ENERGIZE THE NEXT PUMP IN THE LEAD/LAG PUMP SCHEDULE; AND INCREASE THE PUMP'S SPEED TO MAINTAIN THE NORMAL GEOTHERMAL WATER SUPPLY OPERATING PRESSURE, AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN. UPON THE SYSTEM PRESSURE REACHING THE NORMAL GEOTHERMAL WATER SUPPLY OPERATING PRESSURE, AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN, THE BAS SHALL: ADJUST EACH OF THE PUMPS' SPEEDS SO THAT THEY ARE EQUAL AND THAT THE GEOTHERMAL WATER SUPPLY PRESSURE, AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN, IS MAINTAINED. UPON THE SYSTEM OPERATING AT THE NORMAL GEOTHERMAL WATER SUPPLY OPERATING PRESSURE, AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN, WITH A PUMP TO HEAT PUMP RATIO GREATER THAN 1 (MORE PUMPS ARE RUNNING THAN HEAT PUMPS) FOR MORE THAN 10 MINUTES (ADJUSTABLE), THE BAS SHALL: EVALUATE CURRENT PUMPING OPERATION TO THE NORMAL PUMP OPERATION AND ADJUST THE OPERATION OF THE PUMPING SYSTEM ACCORDINGLY (E.G. IF 1 HEAT PUMP IS ENERGIZED AND 2 PUMPS ARE BOTH RUNNING AT A SPEED LESS THAN 50% OF THE PUMPS' MAXIMUM DESIGN SPEED, THE BAS SHALL DE-ENERGIZE THE PUMP WITH THE MOST RUNTIME. IF 2 HEAT PUMPS ARE ENERGIZED AND 3 PUMPS ARE ALL RUNNING AT A SPEED LESS THAN 66% OF THE PUMPS' MAXIMUM DESIGN SPEED. THE BAS SHALL: DE-ENERGIZE A PUMP. ETC...). UPON THE GEOTHERMAL WATER SYSTEM RETURNING TO THE NORMAL PUMP TO HEAT PUMP RATIO OF 1 TO 1, THE LOW GEOTHERMAL WATER PRESSURE ALARM SHALL BE AUTOMATICALLY SILENCED.

IF THE ALL OF THE PUMPS ARE HAVE BEEN INDEXED ON AND ARE OPERATING AT THEIR NORMAL PUMP OPERATING SPEED AND ARE NOT ABLE TO MAINTAIN THE GEOTHERMAL WATER SUPPLY PRESSURE ABOVE 32 PSI (ADJUSTABLE), AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN, THE BAS SHALL: SIGNAL A GEOTHERMAL PUMPING LOW PRESSURE ALARM, AND INCREASE ALL OF THE PUMPS' VFD SPEED TO 110% (ADJUSTABLE) OF THE PUMPS' NORMAL MAXIMUM DESIGN SPEED. UPON NO CIRCUMSTANCE SHALL ANY OF THE PUMPS' SPEEDS EXCEED THE VFD AND PUMP MANUFACTURERS WRITTEN RECOMMENDATIONS FOR MAXIMUM OPERATING CONDITIONS, PRODUCE A PUMP MOTOR OVERLOADING CONDITION OR OTHERWISE DAMAGE EQUIPMENT OR SYSTEMS.

NO PUMPS SHALL OPERATE WITHOUT AT LEAST ONE HEAT PUMP THAT BEING INDEXED ON BY THE BAS.

IF THE WATER SUPPLY PRESSURE RISES ABOVE 50 PSI (ADJUSTABLE), AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN, FOR MORE THAN 10 MINUTES (ADJUSTABLE), THE BAS SHALL: SIGNAL A GEOTHERMAL PUMPING OVER PRESSURE ALARM; REDUCE THE PUMP SPEED THROUGH THE VFD CONTROL BY 10% (ADJUSTABLE). UPON THE WATER SUPPLY PRESSURE RETURNING BACK TO ITS NORMAL OPERATING PRESSURE, AS MEASURED BY THE PRESSURE SENSOR LOCATED IN THE GEOTHERMAL SUPPLY MAIN, FOR MORE THAN 10 MINUTES (ADJUSTABLE) THE HIGH PRESSURE ALARM SHALL BE SILENCED AND NORMAL VFD CONTROL FOR THE PUMPS SHALL BE RE – ESTABLISHED.

THE BAS SHALL: MONITOR AND RECORD THE WATER FLOWS FOR THE GEOTHERMAL WATER SYSTEMS THROUGH THE FOLLOWING FLOW METERS:

FM-1: MEASURES THE GEOTHERMAL SUPPLY WATER FLOW INTO THE BUILDING.
FM-2: MEASURES THE GEOTHERMAL RETURN WATER FLOW BACK TO THE WELLS.
FM-3: MEASURES THE GEOTHERMAL BLEED WATER FLOW TO THE CISTERN SYSTEM.

UPON THE ARITHMETIC SUMMATION OF THE FLOW RATES BACK TO THE WELLS AND TO THE CISTERN SYSTEM, AS MEASURED BY THE FLOW METER IN THE GEOTHERMAL WATER RETURN HEADER AND THE GEOTHERMAL WATER DRAIN PIPING TO THE CISTERN SYSTEM (FM-2 & FM-3), RESPECTFULLY, BEING 10% (ADJUSTABLE) LESS THAN THE FLOW RATE OF THE GEOTHERMAL SUPPLY FLOW RATE, AS MEASURED BY THE FLOW METER LOCATED IN THE GEOTHERMAL SUPPLY HEADER (FM-1), THE BAS: SHALL SIGNAL AND RECORD A GEOTHERMAL WATER SYSTEM LEAK ALARM. UPON THE ARITHMETIC SUMMATION OF THE FLOW RATES BACK TO THE WELLS AND TO THE CISTERN SYSTEM, AS MEASURED BY THE FLOW METER IN THE GEOTHERMAL WATER RETURN HEADER AND THE GEOTHERMAL WATER DRAIN PIPING TO THE CISTERN SYSTEM (FM-2 & FM-3), RESPECTFULLY, BEING WITHIN 10% (ADJUSTABLE) OF THE FLOW RATE OF THE GEOTHERMAL SUPPLY FLOW RATE, AS MEASURED BY THE FLOW METER LOCATED IN THE GEOTHERMAL SUPPLY HEADER (FM-1), THE BAS SHALL: SILENCE THE ALARM.

THE BAS SHALL: CALCULATE THE ENERGY INPUT FROM THE GEOTHERMAL WATER SYSTEM, USING GEOTHERMAL WATER FLOW, AS MEASURED BY THE FLOW METER (FM-1) AND THE GEOTHERMAL WATER SUPPLY TEMPERATURE, AS MEASURED BY THE GEOTHERMAL SUPPLY WATER TEMPERATURE TRANSMITTER (GTWST), LOCATED ON THE GEOTHERMAL WATER SUPPLY HEADER.

THE BAS SHALL: CALCULATE THE ENERGY RETURNED TO THE GEOTHERMAL WATER SYSTEM, USING GEOTHERMAL WATER FLOW, AS MEASURED BY THE FLOW METER (FM-2), AND THE GEOTHERMAL WATER RETURN TEMPERATURE, AS MEASURED BY THE GEOTHERMAL RETURN WATER TEMPERATURE TRANSMITTER (GTWRT), LOCATED ON THE GEOTHERMAL WATER RETURN HEADER.

THE BAS SHALL: ARITHMETICALLY SUBTRACT THE THE ENERGY INPUT FROM THE GEOTHERMAL WATER SYSTEM FROM THE ENERGY RETURNED TO THE GEOTHERMAL WATER SYSTEM. A NEGATIVE VALUE DENOTES THE ENERGY REJECTED TO THE GEOTHERMAL WATER SYSTEM AND A POSITIVE VALUE DENOTES THE ENERGY ABSORBED BY THE GEOTHERMAL WATER SYSTEM. THE BAS SHALL MONITOR AND RECORD THIS DATA. THE BAS SHALL ALSO RECORD A RUNNING TOTAL OF THE GEOTHERMAL WATER SYSTEM ENERGY USAGE AND REPORT THE DAILY, WEEKLY, MONTHLY AND YEARLY NET ENERGY USED IN THE GEOTHERMAL SYSTEM.

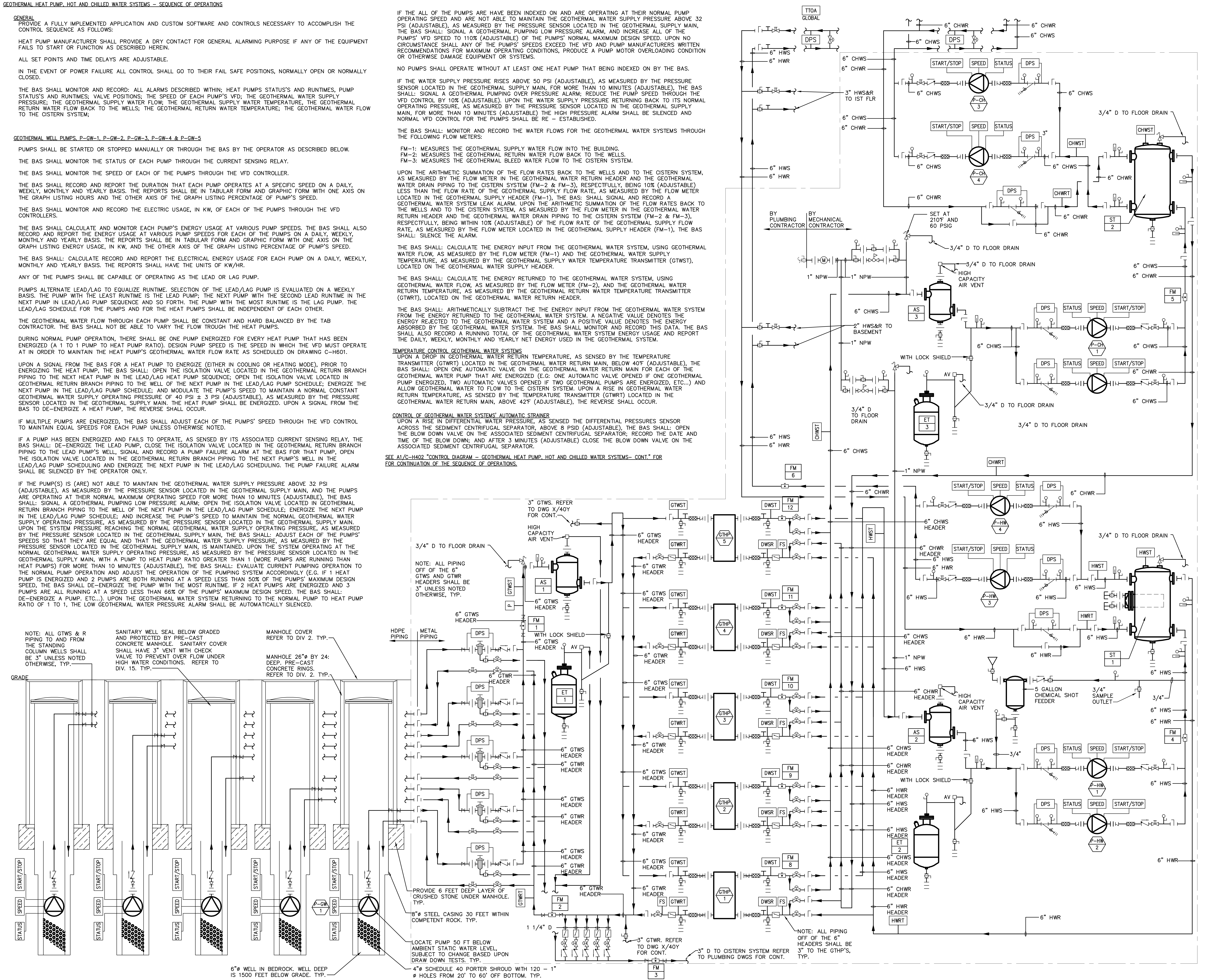
TEMPERATURE CONTROL GEOTHERMAL WATER SYSTEMS

UPON A DROP IN GEOTHERMAL WATER RETURN TEMPERATURE, AS SENSED BY THE TEMPERATURE TRANSMITTER (GTWRT) LOCATED IN THE GEOTHERMAL WATER RETURN MAIN, BELOW 40°F (ADJUSTABLE), THE BAS SHALL: OPEN ONE AUTOMATIC VALVE ON THE GEOTHERMAL WATER RETURN MAIN FOR EACH OF THE GEOTHERMAL WATER PUMP THAT ARE ENERGIZED (E.G: ONE AUTOMATIC VALVE OPENED IF ONE GEOTHERMAL PUMP ENERGIZED, TWO AUTOMATIC VALVES OPENED IF TWO GEOTHERMAL PUMPS ARE ENERGIZED, ETC...) AND ALLOW GEOTHERMAL WATER TO FLOW TO THE CISTERN SYSTEM. UPON A RISE IN GEOTHERMAL WATER RETURN TEMPERATURE, AS SENSED BY THE TEMPERATURE TRANSMITTER (GTWRT) LOCATED IN THE GEOTHERMAL WATER RETURN MAIN, ABOVE 42°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

CONTROL OF GEOTHERMAL WATER SYSTEMS' AUTOMATIC STRAINER

UPON A RISE IN DIFFERENTIAL WATER PRESSURE, AS SENSED THE DIFFERENTIAL PRESSURES SENSOR ACROSS THE SEDIMENT CENTRIFUGAL SEPARATOR, ABOVE 8 PSID (ADJUSTABLE), THE BAS SHALL: OPEN THE BLOW DOWN VALVE ON THE ASSOCIATED SEDIMENT CENTRIFUGAL SEPARATOR; RECORD THE DATE AND TIME OF THE BLOW DOWN; AND AFTER 3 MINUTES (ADJUSTABLE) CLOSE THE BLOW DOWN VALVE ON THE ASSOCIATED SEDIMENT CENTRIFUGAL SEPARATOR.

SEE A1/C-H402 "CONTROL DIAGRAM – GEOTHERMAL HEAT PUMP, HOT AND CHILLED WATER SYSTEMS– CONT." FOR FOR CONTINUATION OF THE SEQUENCE OF OPERATIONS.



A1 **CONTROL DIAGRAM - GEOTHERMAL HEAT PUMP, HOT AND CHILLED WATER SYSTEMS**

NONE

GENERAL NOTES:

1. THE BAS SHALL HAVE A SEQUENTIAL RESTART PROGRAM FOR THE RESTART OF ALL EQUIPMENT UPON RESTORATION OF NORMAL ELECTRICAL POWER AFTER A LOSS OF NORMAL POWER.
2. ALL BAS INFORMATION SHALL BE TRUE-TIME AND CONTINUOUS BY NATURE.
3. SPACE TEMPERATURE SETPOINTS SHALL BE ADJUSTABLE MANUALLY BY THE BAS OPERATOR ON A LOCAL (INDIVIDUAL ZONE) LEVEL OR ON A GLOBAL (WHOLE SYSTEM) LEVEL.
4. THE BAS SHALL MONITOR AND DISPLAY THE FOLLOWING:
   A. ALL ALARMS.
   B. ALL SETPOINTS.
   C. THE STATUS OF ALL EQUIPMENT AND DEVICES.
   D. ALL WATER FLOWS (GPM), AS MEASURED BY FLOW METERS (FM).
   E. ALL AIR FLOW (CFM), AS MEASURED BY AIR FLOW MEASURING STATIONS (AFMS) OR COMBINATION AIR FLOW MEASURING STATION / DAMPERS (AFMS/D).
   F. ALL VFD SPEED (% OF DESIGN), AS MEASURED BY THE VFD CONTROLLERS (VFD).
   G. ALL HVAC ELECTRICAL ENERGY USAGE (KW), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   H. ALL HVAC ELECTRICAL POWER USAGE (KH/Hr), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   I. ALL TEMPERATURES (°F), AS MEASURED BY TEMPERATURE TRANSMITTERS (TT).
   J. ALL HUMIDITY LEVELS (RH), AS MEASURED BY HUMIDITY TRANSMITTERS (HT).
   K. ALL CONTROL VALVE POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL VALVE POSITIONING SENSORS.
   L. ALL CONTROL DAMPER POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL DAMPER POSITIONING SENSORS.
   M. ALL PRESSURE READINGS (PSIG OR PSID), AS MEASURED BY PRESSURE SENSORS (PS) OR DIFFERENTIAL PRESSURE SENSORS (DPS).

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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PORTLAND, MAINE

drawing title
C.E.C. HVAC
CONTROL DIAGRAMS

seal

designed by	BOS	project no.	5001024.00
drawn by	BOS	CAD file no.	C-H401.DWG
checked by	JMS	drawing no.	C-H401
date	1/19/2004		
scale	NONE		

SEE A1/C-H401 "CONTROL DIAGRAM - GEOTHERMAL HEAT PUMP SYSTEM" FOR CONTINUATION OF THE SEQUENCE OF OPERATION.

WATER TO WATER GEOTHERMAL HEAT PUMPS, GTHP-1, GTHP-2, GTHP-3, GTHP-4 & & GTHP-5

GENERAL

HEAT PUMPS SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

ANY OF THE HEAT PUMPS SHALL BE CAPABLE OF OPERATING AS THE LEAD OR LAG PUMP.

HEAT PUMPS ALTERNATE LEAD/LAG TO EQUALIZE RUNTIME. SELECTION OF THE LEAD/LAG HEAT PUMP IS EVALUATED ON A WEEKLY BASIS. THE HEAT PUMP WITH THE LEAST RUNTIME IS THE LEAD HEAT PUMP; THE NEXT HEAT PUMP WITH THE SECOND LEAD RUNTIME IN THE NEXT HEAT PUMP IN LEAD/LAG HEAT PUMP SEQUENCE AND SO FORTH. THE HEAT PUMP WITH THE MOST RUNTIME IS THE LAG HEAT. THE LEAD/LAG SCHEDULE FOR THE PUMPS AND FOR THE HEAT PUMPS SHALL BE INDEPENDENT OF EACH OTHER.

IF A HEAT PUMP IS IN ALARM AS DESCRIBED HEREIN, THE BAS SHALL: REMOVE THE HEAT PUMP FROM THE LEAD/LAG HEAT PUMP SCHEDULE, UNTIL THE ALARM HAS BEEN SILENCED.

THE GEOTHERMAL AND BUILDING SIDE WATER FLOWS THROUGH EACH HEAT PUMP SHALL BE CONSTANT AND HARD BALANCED BY THE TAB CONTRACTOR. THE BAS SHALL NOT BE ABLE TO VARY THE FLOW TROUGH THE HEAT PUMP.

THE GEOTHERMAL HEAT PUMP MANUFACTURER SHALL PROVIDE THE FOLLOWING, AT MINIMUM, INTERNAL CONTROL FOR EACH HEAT PUMP:

1. LOW VOLTAGE PROTECTION.
2. HIGH VOLTAGE PROTECTION.
3. LOW GEOTHERMAL WATER TEMPERATURE PROTECTION.
4. LOW BUILDING SYSTEM WATER TEMPERATURE PROTECTION.
5. LOW REFRIGERANT PRESSURE PROTECTION (PROTECTION SHALL BE DISABLED FOR THE FIRST 2 MINUTES AFTER A COMPRESSOR START COMMAND TO PREVENT NUISANCE ALARMS).
6. HIGH REFRIGERANT PRESSURE PROTECTION.
7. COMPRESSOR LEAD/LAG OPERATION.
8. REVERSING VALVE SHALL FAIL IN THE HEATING MODE.
9. AUTOMATIC INTELLIGENT RESET (THE HEAT PUMP SHALL AUTOMATICALLY RESET FIVE MINUTES AFTER TRIP IF THE FAULT HAS CLEARED. SHOULD A FAULT REOCCUR THREE TIMES SEQUENTIALLY, THEN THE HEAT PUMP SHALL BE LOCKED OUT.

THE GEOTHERMAL HEAT PUMP MANUFACTURER SHALL PROVIDE A DRY CONTACT FOR EACH HEAT PUMP FOR BAS GENERAL ALARMING PURPOSES. THE FOLLOWING INTERNAL ALARMS, AT MINIMUM, SHALL PRODUCE A BAS GENERAL ALARM THE RESPECTIVE HEAT PUMP:

1. LOW VOLTAGE ALARM.
2. HIGH VOLTAGE ALARM.
3. LOW GEOTHERMAL WATER TEMPERATURE ALARM.
4. LOW BUILDING SYSTEM WATER TEMPERATURE ALARM.
5. LOW REFRIGERANT PRESSURE ALARM.
6. HIGH REFRIGERANT PRESSURE ALARM.
7. REVERSING VALVE FAILURE ALARM.
8. GENERAL FAULT LOCKOUT ALARM.

DURING NORMAL HEAT PUMP OPERATION, THERE SHALL BE ONE GEOTHERMAL WELL PUMP ENERGIZED FOR EVERY HEAT PUMP THAT HAS BEEN ENERGIZED (A 1 TO 1 PUMP TO HEAT PUMP RATIO).

THE BAS SHALL: MONITOR THE WATER TEMPERATURES FOR ALL OF THE CHILLED WATER TEMPERATURE TRANSMITTERS (CHWST's & CHWRT's) AND THE HOT WATER TRANMITTERS (HWST's & HWRT's).

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH THE HEAT PUMPS THROUGH AN ELECTRIC METER INSTALLED WITHIN EACH OF THE HEAT PUMP'S POWER WIRING. THE BAS SHALL: ALSO SEPARATELY TRACK THE ELECTRICAL USAGE FOR EACH OF THE HEAT PUMPS DURING THE HEATING OPERATING MODE AND THE COOLING OPERATING MODE.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENGERY USAGE FOR EACH HEATPUMP, FOR BOTH COOLING AND HEATING OPERATIONS, ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

THE BAS SHALL: MONITOR AND RECORD, THE WATER FLOWS FOR THE GEOTHERMAL WATER SYSTEMS THROUGH THE FOLLOWING FLOW METERS (FM):

FM-8: MEASURES WATER FLOW (BOTH CHILLED AND HOT WATER) OUT OF HEAT PUMP GTHP-1.
FM-9: MEASURES WATER FLOW (BOTH CHILLED AND HOT WATER) OUT OF HEAT PUMP GTHP-2.
FM-10: MEASURES WATER FLOW (BOTH CHILLED AND HOT WATER) OUT OF HEAT PUMP GTHP-3.
FM-11: MEASURES WATER FLOW (BOTH CHILLED AND HOT WATER) OUT OF HEAT PUMP GTHP-4.
FM-12: MEASURES WATER FLOW (BOTH CHILLED AND HOT WATER) OUT OF HEAT PUMP GTHP-5.

THE BAS SHALL: CALCULATE THE ENERGY OUTPUT FROM EACH OF HEAT PUMPS, USING WATER FLOW, AS MEASURED BY THE FLOW METER (FM) FOR EACH HEAT PUMP AND ARITHMETICALLY DIFFERENCE BETWEEN THE DUAL TEMPERATURE WATER RETURN TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER IN THE DUAL TEMPERATURE WATER RETURN BRANCH PIPING TO THE RESPECTIVE HEAT PUMP (DTWRT) AND THE DUAL TEMPERATURE WATER SUPPLY TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER IN THE DUAL TEMPERATURE WATER SUPPLY BRANCH PIPING TO THE RESPECTIVE HEAT PUMP (DTWST), E.G. THE TEMPERATURE DIFFERENCE = (DTWST-DTWRT). ALL ENERGY VALUES SHALL BE IN MBH. A NEGATIVE ENERGY OUTPUT VALUE DENOTES COOLING ENERGY AND A POSITIVE ENERGY OUTPUT VALUE DENOTES HEATING ENERGY. THE BAS SHALL: CALCULATE THE NET HEATING AND THE NET COOLING ENERGY OF THE BUILDING BY ARITHMETICAL TOTALING THE ENERGY OUTPUTS FROM EACH OF THE HEAT PUMPS. THE BAS SHALL: MONITOR AND RECORD THIS DATA. THE BAS SHALL: ALSO RECORD A RUNNING TOTAL OF THE COOLING AND THE HEATING ENERGY USAGE, BOTH FOR EACH HEAT PUMP AND ON A TOTAL BUILDING BASIS, AND REPORT THE DAILY, WEEKLY, MONTHLY AND YEARLY HEATING AND COOLING ENERGIES USED. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HEATING OR COOLING ENERGY USAGE IN THOUSANDS OF BTU'S PER HOUR (MBH) AND THE OTHER AXIS OF THE GRAPH LISTING TIME (E.G. HOURS FOR A DAILY REPORT, DAYS FOR A WEEKLY REPORT, ETC...).

THE BAS SHALL: CALCULATE EACH OF THE HEAT PUMPS' COOLING EFFICIENCIES AT FULL AND PART LOADING BY USING THE ARITHMETICALLY DIVIDING THE ABSOLUTE VALUE OF THE COOLING ENERGY AS CALCULATED BY THE BAS ABOVE, BY THE ELECTRICAL INPUT, AS MEASURED BY THE ELECTRICAL METER FOR EACH HEAT PUMP. THE EFFICIENCY VALVES SHALL HAVE THE UNITS OF TONS/KW. THE BAS SHALL: MONITOR AND RECORD THIS DATA. THE BAS SHALL: ALSO RECORD AN AVERAGE HEAT PUMP COOLING EFFICIENCY, FOR EACH OF THE HEAT PUMPS AND ON A TOTAL BUILDING BASIS, AND REPORT THE DAILY, WEEKLY, MONTHLY AND YEARLY COOLING EFFICIENCIES. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING COOLING EFFICIENCY IN TONS/KW AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF HEAT PUMP LOADING.

THE BAS SHALL: CALCULATE EACH OF THE HEAT PUMPS' HEATING EFFICIENCIES AT FULL AND PART LOADING BY USING THE ARITHMETICALLY DIVIDING THE ABSOLUTE VALUE OF THE HEATING ENERGY AS CALCULATED BY THE BAS ABOVE, BY THE ELECTRICAL INPUT, AS MEASURED BY THE ELECTRICAL METER FOR EACH HEAT PUMP. THE EFFICIENCY VALVES SHALL HAVE THE UNITS OF MBH/KW. THE BAS SHALL: MONITOR AND RECORD THIS DATA. THE BAS SHALL: ALSO RECORD AN AVERAGE HEAT PUMP HEATING EFFICIENCY, FOR EACH OF THE HEAT PUMPS AND ON A TOTAL BUILDING BASIS, AND REPORT THE DAILY, WEEKLY, MONTHLY AND YEARLY HEATING EFFICIENCIES. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HEATING EFFICIENCY IN MBH/KW AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF HEAT PUMP LOADING.

UPON REFRIGERANT BEING DETECTED BY REFRIGERANT SENSORS, AS DESCRIBED ON DRAWING A1/C-H403 "CONTROL DIAGRAM - MECHANICAL ROOM VENTILATION", THE HEAT PUMPS SHALL DE-ENERGIZE AND NORMAL OPERATION AS DESCRIBED HEREIN SHALL BE LOCKED OUT, UNTIL THE REFRIGERANT LEAK ALARM HAS BEEN SILENCED.

HEATING OPERATION

UNOCCUPIED MODE

IF THE BUILDING IS OPERATING IN AN UNOCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE; AND UPON A RISE IN THE OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA), ABOVE 65°F (ADJUSTABLE), THE BAS SHALL: LOCK OUT ALL HOT WATER OPERATION (E.G. HEAT PUMPS SHALL NOT BE ABLE TO BE ENERGIZED, HOT WATER PUMPS SHALL NOT BE ALLOWED TO OPERATE, HOT WATER TEMPERATURE CONTROLS SHALL BE DISABLE, ISOLATION VALVES TO HEAT PUMP SHALL NOT BE ALLOWED TO OPEN, ETC...). IF THE BUILDING IS OPERATING IN AN OCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE; UPON A DROP IN THE OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA), BELOW 65°F (ADJUSTABLE); OR UPON A DROP IN HOT WATER TEMPERATURE BELOW THE SETPOINT OF 70°F (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (HWRT) LOCATED IN THE HOT WATER RETURN PIPING FROM THE HOT WATER STORAGE TANK (ST-1), THE BAS SHALL: ALLOW NORMAL HEATING OPERATION AS DESCRIBED HEREIN.

OCCUPIED MODE

UPON A DROP IN HOT WATER TEMPERATURE BELOW THE SETPOINT OF 105°F (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (HWRT) LOCATED IN THE HOT WATER RETURN PIPING FROM THE HOT WATER STORAGE TANK (ST-1), THE BAS SHALL: OPEN THE ISOLATION VALVES LOCATED IN THE HOT WATER SUPPLY AND RETURN BRANCH PIPING FOR THE LEAD HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE; INCREASE THE PRIMARY HOT WATER FLOW, AS DESCRIBED IN "PRIMARY HOT WATER PUMPS, P-HW-1, P-HW-2 & P-HW-3" SECTION OF THE SEQUENCE OF OPERATION; AND ENERGIZE THE LEAD HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE FOR HEATING OPERATION, ONCE WATER FLOW HAS BEEN PROVEN THROUGH FLOW SWITCHES (FS's) LOCATED IN BOTH THE GEOTHERMAL WATER AND DUAL TEMPERATURE WATER RETURN BRANCH PIPING TO THE LEAD HEAT PUMP. AFTER 10 MINUTES (ADJUSTABLE) OF THE LEAD HEAT PUMP OPERATING, AND THE HOT WATER RETURN TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (HWRT) LOCATED IN THE HOT WATER RETURN PIPING FROM THE HOT WATER STORAGE TANK (ST-1), IS STILL BELOW THE SETPOINT OF 105°F (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (HWST), LOCATED IN THE HOT WATER RETURN PIPING FROM THE HOT WATER STORAGE TANK (ST-1), THE BAS SHALL: REPEAT THE SAME SEQUENCE OF OPERATION ABOVE FOR THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE. UPON A RISE IN HOT WATER RETURN TEMPERATURE ABOVE THE SETPOINT OF 105°F (ADJUSTABLE) FOR MORE THAN 5 MINUTES (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (HWRT), LOCATED IN THE HOT WATER RETURN PIPING FROM THE HOT WATER STORAGE TANK (ST-1), THE REVERSE SHALL OCCUR.

IF A HEAT PUMP FAILS TO START AFTER 1 MINUTE (ADJUSTABLE) AFTER THE BAS COMMAND FOR THE ISOLATION VALVES LOCATED IN THE HOT WATER SUPPLY AND RETURN BRANCH PIPING TO OPEN FOR A SPECIFIC HEAT PUMP, AS A RESULT OF THE FLOW NOT BEING PROVEN BY THE FLOW SWITCH (FS) LOCATED IN THE DUAL TEMPERATURE WATER RETURN BRANCH PIPING FOR THE RESPECTIVE HEAT PUMP, THE BAS SHALL: CLOSE THE ISOLATION VALVES LOCATED IN THE HOT WATER SUPPLY AND RETURN BRANCH PIPING FOR THE SPECIFIC HEAT PUMP; CLOSE THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE SPECIFIC HEAT PUMP; OPEN THE ISOLATION VALVES LOCATED IN THE HOT WATER SUPPLY, HOT WATER RETURN AND GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE; UPON PROOF OF WATER FLOW THROUGH FLOW SWITCHES (FS's) LOCATED IN BOTH THE GEOTHERMAL WATER AND DUAL TEMPERATURE WATER RETURN BRANCH PIPING TO NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE, ENERGIZE THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE FOR HEATING OPERATION; AND PRODUCE A NO WATER FLOW - BUILDING WATER FLOW ALARM FOR THE RESPECTIVE HEAT PUMP.

IF A HEAT PUMP FAILS TO START AFTER 1 MINUTE (ADJUSTABLE) AFTER THE BAS COMMAND FOR THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL WATER RETURN BRANCH PIPING TO OPEN FOR A SPECIFIC HEAT PUMP, AS A RESULT OF THE FLOW NOT BEING PROVEN BY THE FLOW SWITCH (FS) LOCATED IN THE GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE RESPECTIVE HEAT PUMP, THE BAS SHALL: CLOSE THE ISOLATION VALVES LOCATED IN THE HOT WATER SUPPLY AND RETURN BRANCH PIPING FOR THE SPECIFIC HEAT PUMP; CLOSE THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE SPECIFIC HEAT PUMP; OPEN THE ISOLATION VALVES LOCATED IN THE HOT WATER SUPPLY, HOT WATER RETURN AND GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE; UPON PROOF OF WATER FLOW THROUGH FLOW SWITCHES (FS's) LOCATED IN BOTH THE GEOTHERMAL WATER AND DUAL TEMPERATURE WATER RETURN BRANCH PIPING TO NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE, ENERGIZE THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE FOR HEATING OPERATION; AND PRODUCE A NO WATER FLOW - GEOTHERMAL WATER FLOW ALARM FOR THE RESPECTIVE HEAT PUMP.

IF THE DUAL TEMPERATURE WATER SUPPLY TEMPERATURE TO A HEAT PUMP IS LESS THAN 80°F (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (DTWST), LOCATED IN THE DUAL TEMPERATURE WATER SUPPLY BRANCH PIPING TO A HEAT PUMP, FOR MORE THAN 3 MINUTES (ADJUSTABLE) OF HEAT PUMP OPERATION, THE BAS SHALL: DE-ENERGIZE THE RESPECTIVE HEAT PUMP' CLOSE THE HOT WATER ISOLATION VALVES; ENERGIZE THE NEXT HEAT PUMP IN THE HEAT PUMP LEAD / LAG SCHEDULE; AND REGISTER A HEAT PUMP TEMPERATURE OPERATION FAILURE ALARM.

COOLING OPERATION

UNOCCUPIED MODE

IF THE BUILDING IS OPERATING IN AN UNOCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE, OR UPON A DROP IN OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (OATT), BELOW 48°F (ADJUSTABLE) THE BAS SHALL: LOCK OUT ALL CHILLED WATER OPERATION (E.G. HEAT PUMPS SHALL NOT BE ABLE TO OPERATE IN THE COOLING MODE, CHILLED WATER PUMPS SHALL NOT BE ALLOWED TO OPERATE, CHILLED WATER TEMPERATURE CONTROLS SHALL BE DISABLE, CHILLED WATER ISOLATION VALVES TO HEAT PUMP SHALL NOT BE ALLOWED TO OPEN, ETC...). IF THE BUILDING IS OPERATING IN AN OCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE AND UPON A RISE IN OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (OATT), ABOVE 48°F (ADJUSTABLE) THE BAS SHALL: ALLOW NORMAL OPERATION OF THE CHILLED WATER SYSTEMS AS DESCRIBED HEREIN.

OCCUPIED MODE

UPON A RISE IN CHILLED WATER RETURN TEMPERATURE ABOVE THE SETPOINT OF 55°F (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (CHWRT) LOCATED IN THE CHILLED WATER RETURN PIPING FROM THE CHILLED WATER STORAGE TANK (ST-2), THE BAS SHALL: OPEN THE ISOLATION VALVES LOCATED IN THE CHILLED WATER SUPPLY AND RETURN BRANCH PIPING FOR THE LEAD HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE; INCREASE THE PRIMARY CHILLED WATER FLOW, AS DESCRIBED IN "PRIMARY CHILLED WATER PUMPS, P-CH-1 & P-CH-2" SECTION OF THE SEQUENCE OF OPERATION; AND ENERGIZE THE LEAD HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE FOR COOLING OPERATION, ONCE WATER FLOW HAS BEEN PROVEN THROUGH FLOW SWITCHES (FS's) LOCATED IN BOTH THE GEOTHERMAL WATER AND DUAL TEMPERATURE WATER RETURN BRANCH PIPING TO THE LEAD HEAT PUMP. AFTER 10 MINUTES (ADJUSTABLE) OF THE LEAD HEAT PUMP OPERATING, AND THE CHILLED WATER RETURN TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (CHWRT) LOCATED IN THE CHILLED WATER RETURN PIPING FROM THE CHILLED WATER STORAGE TANK (ST-2), IS STILL ABOVE THE SETPOINT OF 55°F (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (CHWRT), LOCATED IN THE CHILLED WATER RETURN PIPING FROM THE CHILLED WATER STORAGE TANK (ST-2), THE BAS SHALL: REPEAT THE SAME SEQUENCE OF OPERATION ABOVE FOR THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE. UPON A DROP IN CHILLED WATER RETURN TEMPERATURE BELOW THE SETPOINT OF 55°F (ADJUSTABLE) FOR MORE THAN 5 MINUTES (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (CHWRT), LOCATED IN THE CHILLED WATER RETURN PIPING FROM THE CHILLED WATER STORAGE TANK (ST-2), THE REVERSE SHALL OCCUR.

IF A HEAT PUMP FAILS TO START AFTER 1 MINUTE (ADJUSTABLE) AFTER THE BAS COMMAND FOR THE ISOLATION VALVES LOCATED IN THE CHILLED WATER SUPPLY AND RETURN BRANCH PIPING TO OPEN FOR A SPECIFIC HEAT PUMP, AS A RESULT OF THE FLOW NOT BEING PROVEN BY THE FLOW SWITCH (FS) LOCATED IN THE DUAL TEMPERATURE WATER RETURN BRANCH PIPING FOR THE RESPECTIVE HEAT PUMP, THE BAS SHALL: CLOSE THE ISOLATION VALVES LOCATED IN THE CHILLED WATER SUPPLY AND RETURN BRANCH PIPING FOR THE SPECIFIC HEAT PUMP; CLOSE THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE SPECIFIC HEAT PUMP; OPEN THE ISOLATION VALVES LOCATED IN THE CHILLED WATER SUPPLY, CHILLED WATER RETURN AND GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE; UPON PROOF OF WATER FLOW THROUGH FLOW SWITCHES (FS's) LOCATED IN BOTH THE GEOTHERMAL WATER AND DUAL TEMPERATURE WATER RETURN BRANCH PIPING TO NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE, ENERGIZE THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE FOR COOLING OPERATION; AND PRODUCE A NO WATER FLOW - BUILDING WATER FLOW ALARM FOR THE RESPECTIVE HEAT PUMP.

IF A HEAT PUMP FAILS TO START AFTER 1 MINUTE (ADJUSTABLE) AFTER THE BAS COMMAND FOR THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL WATER RETURN BRANCH PIPING TO OPEN FOR A SPECIFIC HEAT PUMP, AS A RESULT OF THE FLOW NOT BEING PROVEN BY THE FLOW SWITCH (FS) LOCATED IN THE GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE RESPECTIVE HEAT PUMP, THE BAS SHALL: CLOSE THE ISOLATION VALVES LOCATED IN THE CHILLED WATER SUPPLY AND RETURN BRANCH PIPING FOR THE SPECIFIC HEAT PUMP; CLOSE THE ISOLATION VALVE LOCATED IN THE GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE SPECIFIC HEAT PUMP; OPEN THE ISOLATION VALVES LOCATED IN THE CHILLED WATER SUPPLY, CHILLED WATER RETURN AND GEOTHERMAL WATER RETURN BRANCH PIPING FOR THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE; UPON PROOF OF WATER FLOW THROUGH FLOW SWITCHES (FS's) LOCATED IN BOTH THE GEOTHERMAL WATER AND DUAL TEMPERATURE WATER RETURN BRANCH PIPING TO NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE, ENERGIZE THE NEXT HEAT PUMP IN THE LEAD/LAG HEAT PUMP SCHEDULE FOR COOLING OPERATION; AND PRODUCE A NO WATER FLOW - GEOTHERMAL WATER FLOW ALARM FOR THE RESPECTIVE HEAT PUMP.

IF THE DUAL TEMPERATURE WATER SUPPLY TEMPERATURE FROM A HEAT PUMP IS MORE THAN 80°F (ADJUSTABLE), AS MEASURED BY THE TEMPERATURE TRANSMITTER (DTWST), LOCATED IN THE DUAL TEMPERATURE WATER SUPPLY BRANCH PIPING TO A HEAT PUMP, FOR MORE THAN 3 MINUTES (ADJUSTABLE) OF HEAT PUMP OPERATION, THE BAS SHALL: DE-ENERGIZE THE RESPECTIVE HEAT PUMP' CLOSE THE CHILLED WATER ISOLATION VALVES; ENERGIZE THE NEXT HEAT PUMP IN THE HEAT PUMP LEAD / LAG SCHEDULE; AND REGISTER A HEAT PUMP TEMPERATURE OPERATION FAILURE ALARM.

PRIMARY HEATING LOOP PUMPS, P-HW-1 & P-HW-2

PUMPS SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

THE BAS SHALL MONITOR THE STATUS OF EACH PUMP THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL MONITOR THE SPEED OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLER.

THE BAS SHALL RECORD AND REPORT THE DURATION THAT EACH PUMP OPERATES AT A SPECIFIC SPEED ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HOURS AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLER.

THE BAS SHALL: CALCULATE AND MONITOR EACH PUMP'S ENERGY USAGE AT VARIOUS PUMP SPEEDS. THE BAS SHALL ALSO RECORD AND REPORT THE ENERGY USAGE AT VARIOUS PUMP SPEEDS FOR EACH OF THE PUMPS ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING ENERGY USAGE, IN KW, AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENGERY USAGE FOR EACH PUMP ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

ANY OF THE PUMPS SHALL BE CAPABLE OF OPERATING AS THE LEAD OR LAG PUMP.

PUMPS ALTERNATE LEAD/LAG TO EQUALIZE RUNTIME. SELECTION OF THE LEAD/LAG PUMP IS EVALUATED ON A WEEKLY BASIS. THE PUMP WITH THE LEAST RUNTIME IS THE LEAD PUMP; THE NEXT PUMP WITH THE SECOND LEAD RUNTIME IN THE NEXT PUMP IN LEAD/LAG PUMP SEQUENCE AND SO FORTH. THE PUMP WITH THE MOST RUNTIME IS THE LAG PUMP.

UPON A SIGNAL FROM THE BAS FOR A HEAT PUMP TO ENERGIZE IN THE HEATING OPERATION MODE, PRIOR TO ENERGIZING THE HEAT PUMP, THE BAS SHALL: ENERGIZE OR INCREASE THE PUMP(S) SPEED(S) AS FOLLOWS:

NUMBER OF HEAT PUMPS	LEAD PUMP'S SPEED	FLOW METER FM-4 READING IN GPM
1	20%	90
2	40%	180
3	60%	270
4	80%	360
5	100%	450

IF THE FLOW RATE DEVIATES MORE THAN ±2% FROM THE SCHEDULED VALUES ABOVE, AS MEASURED BY THE FLOW METER LOCATED DOWNSTREAM OF THE PRIMARY HOT WATER PUMPS' HEADER (FM-4), THE BAS SHALL: ADJUST THE PUMP'S SPEED ACCORDINGLY.

IF MULTIPLE PUMPS ARE ENERGIZED, THE BAS SHALL ADJUST EACH OF THE PUMPS' SPEED THROUGH THE VFD CONTROL TO MAINTAIN EQUAL SPEEDS FOR EACH PUMP UNLESS OTHERWISE NOTED.

IF A PUMP HAS BEEN ENERGIZED AND FAILS TO OPERATE, AS SENSED BY ITS ASSOCIATED CURRENT SENSING RELAY, THE BAS SHALL: DE-ENERGIZE THE LEAD PUMP, SIGNAL AND RECORD A PUMP FAILURE ALARM AT THE BAS FOR THAT PUMP, REMOVE THE PUMP THAT FAILED FROM THE PUMP LEAD/LAG SCHEDULING AND ENERGIZE THE NEXT PUMP IN THE LEAD/LAG SCHEDULE. THE PUMP FAILURE ALARM SHALL BE SILENCED BY THE OPERATOR ONLY.

UPON A RISE IN DIFFERENTIAL WATER PRESSURE, AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRIMARY HOT WATER PUMP'S INLET STRAINER, ABOVE 5 PSID (ADJUSTABLE), THE BAS SHALL: SIGNAL A DIRTY STRAINER ALARM FOR THE RESPECTIVE PUMP; DE-ENERGIZE THE ASSOCIATED PUMP AND MOVE THE ASSOCIATED PUMP TO THE LAST PUMP IN THE PRIMARY HOT WATER LEAD/LAG PUMP SCHEDULE; AND ENERGIZE THE NEXT PUMP IN THE PRIMARY HOT WATER LEAD/LAG PUMP SCHEDULE. UPON A DROP IN DIFFERENTIAL WATER PRESSURE, AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRIMARY HOT WATER PUMP'S INLET STRAINER, BELOW 5 PSID (ADJUSTABLE), THE BAS SHALL: SILENCE THE DIRTY STRAINER ALARM FOR THE ASSOCIATED PUMP.

PRIMARY CHILLED WATER LOOP PUMPS, P-CH-1 & P-CH-2

PUMPS SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

UPON A DROP IN OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA) BELOW 48°F (ADJUSTABLE), THE BAS SHALL: LOCKOUT THE NORMAL OPERATION OF THE PRIMARY CHILLED WATER PUMPS. UPON A RISE IN OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA) ABOVE 48°F (ADJUSTABLE), THE BAS SHALL: ALLOW NORMAL OPERATION OF THE PRIMARY CHILLED WATER PUMPS AS DESCRIBED HEREIN.

THE BAS SHALL MONITOR THE STATUS OF EACH PUMP THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL MONITOR THE SPEED OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLER.

THE BAS SHALL RECORD AND REPORT THE DURATION THAT EACH PUMP OPERATES AT A SPECIFIC SPEED ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ONTHE GRAPH LISTING HOURS AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLER.

THE BAS SHALL CALCULATE AND MONITOR EACH PUMP'S ENERGY USAGE AT VARIOUS PUMP SPEEDS. THE BAS SHALL ALSO RECORD AND REPORT THE ENERGY USAGE AT VARIOUS PUMP SPEEDS FOR EACH OF THE PUMPS ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING ENERGY USAGE, IN KW, AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENGERY USAGE FOR EACH PUMP ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

ANY OF THE PUMPS SHALL BE CAPABLE OF OPERATING AS THE LEAD OR LAG PUMP.

PUMPS ALTERNATE LEAD/LAG TO EQUALIZE RUNTIME. SELECTION OF THE LEAD/LAG PUMP IS EVALUATED ON A WEEKLY BASIS. THE PUMP WITH THE LEAST RUNTIME IS THE LEAD PUMP; THE NEXT PUMP WITH THE SECOND LEAD RUNTIME IN THE NEXT PUMP IN LEAD/LAG PUMP SEQUENCE AND SO FORTH. THE PUMP WITH THE MOST RUNTIME IS THE LAG PUMP.

UPON A SIGNAL FROM THE BAS FOR A HEAT PUMP TO ENERGIZE IN THE COOLING OPERATION MODE, PRIOR TO ENERGIZING THE HEAT PUMP, THE BAS SHALL: ENERGIZE OR INCREASE THE PUMP(S) SPEED(S) AS FOLLOWS:

NUMBER OF HEAT PUMPS	LEAD PUMP'S SPEED	FLOW METER FM-5 READING IN GPM
1	20%	90
2	40%	180
3	60%	270
4	80%	360
5	100%	450

IF THE FLOW RATE DEVIATES MORE THAN ±2% FROM THE SCHEDULED VALUES ABOVE, AS MEASURED BY THE FLOW METER LOCATED DOWNSTREAM OF THE PRIMARY CHILLED WATER PUMPS' HEADER (FM-5), THE BAS SHALL: ADJUST THE PUMP'S SPEED ACCORDINGLY.

IF MULTIPLE PUMPS ARE ENERGIZED, THE BAS SHALL ADJUST EACH OF THE PUMPS' SPEED THROUGH THE VFD CONTROL TO MAINTAIN EQUAL SPEEDS FOR EACH PUMP UNLESS OTHERWISE NOTED.

IF A PUMP HAS BEEN ENERGIZED AND FAILS TO OPERATE, AS SENSED BY ITS ASSOCIATED CURRENT SENSING RELAY, THE BAS SHALL: DE-ENERGIZE THE LEAD PUMP, SIGNAL AND RECORD A PUMP FAILURE ALARM AT THE BAS FOR THAT PUMP, REMOVE THE PUMP THAT FAILED FROM THE PUMP LEAD/LAG SCHEDULING AND ENERGIZE THE NEXT PUMP IN THE LEAD/LAG SCHEDULE. THE PUMP FAILURE ALARM SHALL BE SILENCED BY THE OPERATOR ONLY.

UPON A RISE IN DIFFERENTIAL WATER PRESSURE, AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRIMARY CHILLED WATER PUMP'S INLET STRAINER, ABOVE 5 PSID (ADJUSTABLE), THE BAS SHALL: SIGNAL A DIRTY STRAINER ALARM FOR THE RESPECTIVE PUMP; DE-ENERGIZE THE ASSOCIATED PUMP AND MOVE THE ASSOCIATED PUMP TO THE LAST PUMP IN THE PRIMARY CHILLED WATER LEAD/LAG PUMP SCHEDULE; AND ENERGIZE THE NEXT PUMP IN THE PRIMARY CHILLED WATER LEAD/LAG PUMP SCHEDULE. UPON A DROP IN DIFFERENTIAL WATER PRESSURE, AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRIMARY CHILLED WATER PUMP'S INLET STRAINER, BELOW 5 PSID (ADJUSTABLE), THE BAS SHALL: SILENCE THE DIRTY STRAINER ALARM FOR THE ASSOCIATED PUMP.

SECONDARY HEATING LOOP PUMPS, P-HW-3, & P-HW-4

PUMPS SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

IF THE BUILDING IS OPERATING IN AN UNOCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE, AND UPON A RISE IN THE OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA), ABOVE 65°F (ADJUSTABLE), THE BAS SHALL: LOCK OUT THE NORMAL OPERATION OF THE SECONDARY HOT WATER PUMP CONTROL. IF THE BUILDING IS OPERATING IN AN OCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE, OR UPON A DROP IN THE OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA), BELOW 65°F (ADJUSTABLE), THE BAS SHALL: ALLOW NORMAL SECONDARY HOT WATER LOOP PUMP OPERATION AS DESCRIBED HEREIN.

THE BAS SHALL MONITOR THE STATUS OF EACH PUMP THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL MONITOR THE SPEED OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLER.

THE BAS SHALL RECORD AND REPORT THE DURATION THAT EACH PUMP OPERATES AT A SPECIFIC SPEED ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HOURS AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLER.

THE BAS SHALL CALCULATE AND MONITOR EACH PUMP'S ENERGY USAGE AT VARIOUS PUMP SPEEDS. THE BAS SHALL ALSO RECORD AND REPORT THE ENERGY USAGE AT VARIOUS PUMP SPEEDS FOR EACH OF THE PUMPS ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING ENERGY USAGE, IN KW, AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENGERY USAGE FOR EACH PUMP ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

ANY OF THE PUMPS SHALL BE CAPABLE OF OPERATING AS THE LEAD OR LAG PUMP.

PUMPS ALTERNATE LEAD/LAG TO EQUALIZE RUNTIME. SELECTION OF THE LEAD/LAG PUMP IS EVALUATED ON A WEEKLY BASIS. THE PUMP WITH THE LEAST RUNTIME IS THE LEAD PUMP; THE NEXT PUMP WITH THE SECOND LEAD RUNTIME IN THE NEXT PUMP IN LEAD/LAG PUMP SEQUENCE AND SO FORTH. THE PUMP WITH THE MOST RUNTIME IS THE LAG PUMP.

THE BAS SHALL: ADJUST THE LEAD PUMP'S SPEED, THROUGH THE PUMP'S VFD CONTROLLER TO MAINTAIN A CONSTANT DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE HOT WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS), OF 15 PSID (ADJUSTABLE). IF THE LEAD PUMP IS OPERATING AT 100% OF ITS MAXIMUM SCHEDULED SPEED AND THE DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE HOT WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS), DROPS BELOW 10 PSID (ADJUSTABLE) FOR MORE THAN 5 MINUTES (ADJUSTABLE), THE BAS SHALL: ENERGIZE THE LAG SECONDARY HOT WATER LOOP PUMP; MODULATE BOTH THE LEAD AND LAG PUMPS' SPEEDS, IN UNISON, TO MAINTAIN THE DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE HOT WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS) OF 15 PSID (ADJUSTABLE); AND REGISTER A SECONDARY HOT WATER PUMPING SYSTEM LOW PRESSURE ALARM. UPON BOTH THE LEAD AND LAG SECONDARY HOT WATER PUMPS EACH OPERATING AT LESS THAN 49% (ADJUSTABLE) OF THE PUMP'S MAXIMUM SCHEDULED SPEED FOR MORE THAN 10 MINUTES (ADJUSTABLE), THE BAS SHALL: DE-ENERGIZE THE LAG PUMP; ADJUST THE LEAD PUMP'S SPEED, THROUGH IT'S VFD CONTROLLER; AND SILENCE THE SECONDARY HOT WATER PUMPING LOW PRESSURE ALARM.

UPON A DROP IN THE PUMP'S SPEED BELOW 35% (ADJUSTABLE) OF THE MAXIMUM SCHEDULED PUMP'S SPEED, AS MEASURED BY THE PUMP'S VFD CONTROLLER AND A RISE IN DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE HOT WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS), ABOVE 17 PSID (ADJUSTABLE), THE BAS SHALL: MODULATE THE DIFFERENTIAL BYPASS VALVE OPEN TO MAINTAIN A DIFFERENTIAL PRESSURE OF 15 PSID (ADJUSTABLE), AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE HOT WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS). UPON A DROP IN DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE HOT WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS), BELOW 13 PSID (ADJUSTABLE), THE BAS SHALL: CLOSE THE DIFFERENTIAL BYPASS VALVE.

UPON A RISE IN DIFFERENTIAL WATER PRESSURE, AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE SECONDARY HOT WATER PUMP'S INLET STRAINER, ABOVE 5 PSID (ADJUSTABLE), THE BAS SHALL: SIGNAL A DIRTY STRAINER ALARM FOR THE RESPECTIVE PUMP; DE-ENERGIZE THE ASSOCIATED PUMP AND MOVE THE ASSOCIATED PUMP TO THE LAST PUMP IN THE SECONDARY HOT WATER LEAD/LAG PUMP SCHEDULE; AND ENERGIZE THE NEXT PUMP IN THE SECONDARY HOT WATER LEAD/LAG PUMP SCHEDULE. UPON A DROP IN DIFFERENTIAL WATER PRESSURE, AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE SECONDARY HOT WATER PUMP'S INLET STRAINER, BELOW 5 PSID (ADJUSTABLE), THE BAS SHALL: SILENCE THE DIRTY STRAINER ALARM FOR THE ASSOCIATED PUMP.

SECONDARY CHILLED WATER LOOP PUMPS, P-CH-4, & P-CH-5

PUMPS SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

IF THE BUILDING IS OPERATING IN AN UNOCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE; UPON A DROP IN THE OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA), BELOW 48°F (ADJUSTABLE); OR UPON A RISE IN THE WATER TEMPERATURE IN THE CHILLED WATER STORAGE TANK (ST-2), AS MEASURED BY THE TEMPERATURE TRANSMITTER LOCATED IN THE CHILLED WATER STORAGE TANK (CHWST), ABOVE 60°F (ADJUSTABLE); THE BAS SHALL: LOCK OUT THE NORMAL OPERATION OF THE SECONDARY CHILLED WATER PUMP CONTROL. IF THE BUILDING IS OPERATING IN AN OCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE; UPON A RISE IN THE OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA), ABOVE 48°F (ADJUSTABLE); AND UPON A DROP CHILLED WATER TEMPERATURE IN THE CHILLED WATER STORAGE TANK (ST-2), AS MEASURED BY THE TEMPERATURE TRANSMITTER LOCATED IN THE CHILLED WATER STORAGE TANK (CHWST), DROPS BELOW 60°F (ADJUSTABLE), THE BAS SHALL: ALLOW NORMAL SECONDARY CHILLED WATER LOOP PUMP OPERATION AS DESCRIBED HEREIN.

THE BAS SHALL MONITOR THE STATUS OF EACH PUMP THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL MONITOR THE SPEED OF EACH OF THE PUMPS THROUGH THE VFD CONTROLLER.

THE BAS SHALL RECORD AND REPORT THE DURATION THAT EACH PUMP OPERATES AT A SPECIFIC SPEED ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HOURS AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE PUMPS THROUGH AN ELECTRIC METER INSTALLED WITHIN EACH OF THE PUMP'S POWER WIRING.

THE BAS SHALL CALCULATE AND MONITOR EACH PUMP'S ENERGY USAGE AT VARIOUS PUMP SPEEDS. THE BAS SHALL ALSO RECORD AND REPORT THE ENERGY USAGE AT VARIOUS PUMP SPEEDS FOR EACH OF THE PUMPS ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING ENERGY USAGE, IN KW, AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF PUMP'S SPEED.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENGERY USAGE FOR EACH PUMP ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

ANY OF THE PUMPS SHALL BE CAPABLE OF OPERATING AS THE LEAD OR LAG PUMP.

PUMPS ALTERNATE LEAD/LAG TO EQUALIZE RUNTIME. SELECTION OF THE LEAD/LAG PUMP IS EVALUATED ON A WEEKLY BASIS. THE PUMP WITH THE LEAST RUNTIME IS THE LEAD PUMP; THE NEXT PUMP WITH THE SECOND LEAD RUNTIME IN THE NEXT PUMP IN LEAD/LAG PUMP SEQUENCE AND SO FORTH. THE PUMP WITH THE MOST RUNTIME IS THE LAG PUMP.

THE BAS SHALL: ADJUST THE LEAD PUMP'S SPEED, THROUGH THE PUMP'S VFD CONTROLLER TO MAINTAIN A CONSTANT DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE CHILLED WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS), OF 15 PSID (ADJUSTABLE). IF THE LEAD PUMP IS OPERATING AT 100% OF ITS MAXIMUM SCHEDULED SPEED AND THE DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE CHILLED WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS), DROPS BELOW 10 PSID (ADJUSTABLE) FOR MORE THAN 5 MINUTES (ADJUSTABLE), THE BAS SHALL: ENERGIZE THE LAG SECONDARY CHILLED WATER LOOP PUMP; MODULATE BOTH THE LEAD AND LAG PUMPS' SPEEDS, IN UNISON, TO MAINTAIN THE DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE CHILLED WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS) OF 15 PSID (ADJUSTABLE); AND REGISTER A SECONDARY CHILLED WATER PUMPING SYSTEM LOW PRESSURE ALARM. UPON BOTH THE LEAD AND LAG SECONDARY CHILLED WATER PUMPS EACH OPERATING AT LESS THAN 49% (ADJUSTABLE) OF THE PUMPS' MAXIMUM SCHEDULED SPEEDS FOR MORE THAN 10 MINUTES (ADJUSTABLE), THE BAS SHALL: DE-ENERGIZE THE LAG PUMP; ADJUST THE LEAD PUMP'S SPEED, THROUGH IT'S VFD CONTROLLER; AND SILENCE THE SECONDARY CHILLED WATER PUMPING LOW PRESSURE ALARM.

UPON A DROP IN THE PUMP'S SPEED BELOW 35% (ADJUSTABLE) OF THE MAXIMUM SCHEDULED PUMP'S SPEED, AS MEASURED BY THE PUMP'S VFD CONTROLLER AND A RISE IN DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE CHILLED WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS), ABOVE 17 PSID (ADJUSTABLE), THE BAS SHALL: MODULATE THE DIFFERENTIAL BYPASS VALVE OPEN TO MAINTAIN A DIFFERENTIAL PRESSURE OF 15 PSID (ADJUSTABLE), AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE CHILLED WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS). UPON A DROP IN DIFFERENTIAL PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR LOCATED ACROSS THE CHILLED WATER SUPPLY AND RETURN MAINS ON THE SECOND FLOOR (DPS), BELOW 13 PSID (ADJUSTABLE), THE BAS SHALL: CLOSE THE DIFFERENTIAL BYPASS VALVE.

UPON A RISE IN DIFFERENTIAL WATER PRESSURE, AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE SECONDARY CHILLED WATER PUMP'S INLET STRAINER, ABOVE 5 PSID (ADJUSTABLE), THE BAS SHALL: SIGNAL A DIRTY STRAINER ALARM FOR THE RESPECTIVE PUMP; DE-ENERGIZE THE ASSOCIATED PUMP AND MOVE THE ASSOCIATED PUMP TO THE LAST PUMP IN THE SECONDARY CHILLED WATER LEAD/LAG PUMP SCHEDULE; AND ENERGIZE THE NEXT PUMP IN THE SECONDARY CHILLED WATER LEAD/LAG PUMP SCHEDULE. UPON A DROP IN DIFFERENTIAL WATER PRESSURE, AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE SECONDARY CHILLED WATER PUMP'S INLET STRAINER, BELOW 5 PSID (ADJUSTABLE), THE BAS SHALL: SILENCE THE DIRTY STRAINER ALARM FOR THE ASSOCIATED PUMP.

A1 CONTROL DIAGRAM - GEOTHERMAL HEAT PUMP, HOT AND CHILLED WATER SYSTEMS - CONT.

NONE

GENERAL NOTES:

1. THE BAS SHALL HAVE A SEQUENTIAL RESTART PROGRAM FOR THE RESTART OF ALL EQUIPMENT UPON RESTORATION OF NORMAL ELECTRICAL POWER AFTER A LOSS OF NORMAL POWER.
2. ALL BAS INFORMATION SHALL BE TRUE-TIME AND CONTINUOUS BY NATURE.
3. SPACE TEMPERATURE SETPOINTS SHALL BE ADJUSTABLE MANUALLY BY THE BAS OPERATOR ON A LOCAL (INDIVIDUAL ZONE) LEVEL OR ON A GLOBAL (WHOLE SYSTEM) LEVEL.
4. THE BAS SHALL MONITOR AND DISPLAY THE FOLLOWING:
   - A. ALL ALARMS.
   - B. ALL SETPOINTS.
   - C. THE STATUS OF ALL EQUIPMENT AND DEVICES.
   - D. ALL WATER FLOWS (GPM), AS MEASURED BY FLOW METERS (FM).
   - E. ALL AIR FLOW (CFM), AS MEASURED BY AIR FLOW MEASURING STATIONS (AFMS) OR COMBINATION AIR FLOW MEASURING STATION / DAMPERS (AFMS/D).
   - F. ALL VFD SPEED (% OF DESIGN), AS MEASURED BY THE VFD CONTROLLERS (VFD).
   - G. ALL HVAC ELECTRICAL ENERGY USAGE (KW), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   - H. ALL HVAC ELECTRICAL POWER USAGE (KH/Hr), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   - I. ALL TEMPERATURES (°F), AS MEASURED BY TEMPERATURE TRANSMITTERS (TT).
   - J. ALL HUMIDITY LEVELS (RH), AS MEASURED BY HUMIDITY TRANSMITTERS (HT).
   - K. ALL CONTROL VALVE POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL VALVE POSITIONING SENSORS.
   - L. ALL CONTROL DAMPER POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL DAMPER POSITIONING SENSORS.
   - M. ALL PRESSURE READINGS (PSIG OR PSID), AS MEASURED BY PRESSURE SENSORS (PS) OR DIFFERENTIAL PRESSURE SENSORS (DPS).

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MECHANICAL ROOM VENTILATION – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

ALL SET POINTS AND TIME DELAYS ARE FULLY ADJUSTABLE.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

THE BAS SHALL: MONITOR THE STATUS OF EACH FAN THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL: MONITOR THE SPEED OF EACH OF THE FANS THROUGH THE VFD CONTROLLER.

THE BAS SHALL: MONITOR THE AIR VOLUME FLOW RATES, IN CFM, OF THE SUPPLY FAN (SF–1) AND EXHAUST FAN (EF–1) THROUGH AIR FLOW MEASURING STATIONS LOCATED IN EACH OF THE FANS' INLETS.

THE BAS SHALL: RECORD AND REPORT THE DURATION THAT EACH FAN OPERATES AT A SPECIFIC SPEED ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HOURS AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF FAN'S SPEED.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE FANS THROUGH AN ELECTRIC METER INSTALLED WITHIN EACH OF THE FAN'S POWER WIRING.

THE BAS SHALL: CALCULATE AND MONITOR EACH FAN'S ENERGY USAGE AT VARIOUS FAN SPEEDS. THE BAS SHALL ALSO RECORD AND REPORT THE ENERGY USAGE AT VARIOUS FAN SPEEDS FOR EACH OF THE FANS ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING ENERGY USAGE, IN KW, AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF FAN'S SPEED.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS FOR EACH FAN. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

WHEN THE EXHAUST FAN (EF–1) IS INDEXED ON, THE BAS SHALL: ENERGIZE OPEN THE DAMPER ON THE INLET OF THE EXHAUST FAN (EF–1); ENERGIZE OPEN THE DAMPER ON THE INLET SIDE OF THE SUPPLY FAN (SF–1); ENERGIZE OPEN THE DAMPER THE NORMAL OPERATION DAMPER LOCATED DOWNSTREAM OF THE SUPPLY FAN (SF–1) AND UPSTREAM OF THE HEATING COIL (HC–1); AND POWER CLOSE THE EMERGENCY BYPASS DAMPER. UPON THE DAMPERS BEING PROVED OPEN VIA AN END SWITCH CLOSURE, THE EXHAUST FAN (EF–1) SHALL BE ENERGIZED. SUPPLY FAN (SF–1) SHALL BE ENERGIZED AFTER EXHAUST FAN (EF–1) IS ENERGIZED.

THE BAS SHALL: MAINTAIN A CONSTANT EXHAUST AIR AND SUPPLY FLOW RATE DIFFERENTIAL OF 100 CFM (ADJUSTABLE), AS MEASURED BY THE AIR FLOW MEASURING STATIONS (AFMS–5 & 6) LOCATED IN EACH OF THE FANS' INLETS, BY ADJUSTING EACH OF FANS' VFD SPEED ACCORDINGLY TO PRODUCE THE EXHAUST AND SUPPLY AIR DIFFERENTIAL.

NORMAL FAN AND TEMPERATURE CONTROL

FANS SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1) SHALL BE STARTED OR STOPPED THRU THE BAS BY THE OPERATOR AS DESCRIBED BELOW, EXCEPT WHEN THE MECHANICAL ROOM IS IN AN EMERGENCY REFRIGERANT LEAK PURGE MODE.

SUMMER OPERATION

SUMMER OPERATION SHALL OCCUR UPON A RISE IN OUTSIDE AIR TEMPERATURE (TTOA), AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER, ABOVE 50°F (ADJUSTABLE).

UPON A RISE IN SPACE TEMPERATURE, AS MEASURED BY THE WALL MOUNTED SPACE TEMPERATURE SENSOR (TT) LOCATED WITHIN THE MECHANICAL ROOM, ABOVE 80°F (ADJUSTABLE), THE BAS SHALL: INCREASE THE SPEEDS OF THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1) THROUGH EACH OF THE FANS' VFD CONTROLLERS TO MAINTAIN THE EXHAUST AND SUPPLY AIR DIFFERENTIAL, AS MEASURED BY THE AIR FLOW MEASURING STATIONS (AFMS–5 & 6) LOCATED IN THE SUPPLY FAN (SF–1) AND IN THE EXHAUST FAN INLETS, AS DESCRIBED ABOVE. UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL MOUNTED SPACE TEMPERATURE SENSOR (TT) LOCATED WITHIN THE MECHANICAL ROOM, BELOW 65°F (ADJUSTABLE), THE BAS SHALL: DECREASE THE SPEEDS OF THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1) THROUGH EACH OF THE FANS' VFD CONTROLLERS TO MAINTAIN THE EXHAUST AND SUPPLY AIR DIFFERENTIAL, AS MEASURED BY THE AIR FLOW MEASURING STATIONS (AFMS–5 & 6) LOCATED IN THE SUPPLY FAN (SF–1) AND IN THE EXHAUST FAN INLETS, AS DESCRIBED ABOVE, UNTIL THE FAN ARE OPERATING AT THEIR SCHEDULED MINIMUM AIR FLOW RATES.

WINTER OPERATION

WINTER OPERATION SHALL OCCUR UPON A DROP IN OUTSIDE AIR TEMPERATURE (TTOA), AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER, BELOW 60°F (ADJUSTABLE).

UPON A RISE IN SPACE TEMPERATURE, AS MEASURED BY THE WALL MOUNTED SPACE TEMPERATURE TRANSMITTER (TT) LOCATED WITHIN THE MECHANICAL ROOM, ABOVE 75°F (ADJUSTABLE), THE BAS SHALL: INCREASE THE SPEEDS OF THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1) THROUGH EACH OF THE FANS' VFD CONTROLLERS TO MAINTAIN THE EXHAUST AND SUPPLY AIR DIFFERENTIAL, AS MEASURED BY THE AIR FLOW MEASURING STATIONS (AFMS–5 & 6) LOCATED IN THE SUPPLY FAN (SF–1) AND IN THE EXHAUST FAN INLETS, AS DESCRIBED ABOVE. UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL MOUNTED SPACE TEMPERATURE SENSOR (TT) LOCATED WITHIN THE MECHANICAL ROOM, BELOW 65°F (ADJUSTABLE), THE BAS SHALL: DECREASE THE SPEEDS OF THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1) THROUGH EACH OF THE FANS' VFD CONTROLLERS TO MAINTAIN THE EXHAUST AND SUPPLY AIR DIFFERENTIAL, AS MEASURED BY THE AIR FLOW MEASURING STATIONS (AFMS–5 & 6) LOCATED IN THE SUPPLY FAN (SF–1) AND IN THE EXHAUST FAN INLETS, AS DESCRIBED ABOVE, UNTIL THE FAN ARE OPERATING AT THEIR SCHEDULED MINIMUM AIR FLOW RATES.

UPON A DROP IN SUPPLY AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT) LOCATED DOWNSTREAM OF THE HEAT COIL (HC–1) BELOW 48°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE LOCATED ON THE HOT WATER RETURN PIPING TO THE HEATING COIL (HC–1) TO MAINTAIN A SUPPLY AIR TEMPERATURE OF 50°F (ADJUSTABLE). UPON A RISE INN SUPPLY AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT) LOCATED DOWNSTREAM OF THE HEAT COIL (HC–1) ABOVE 48°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

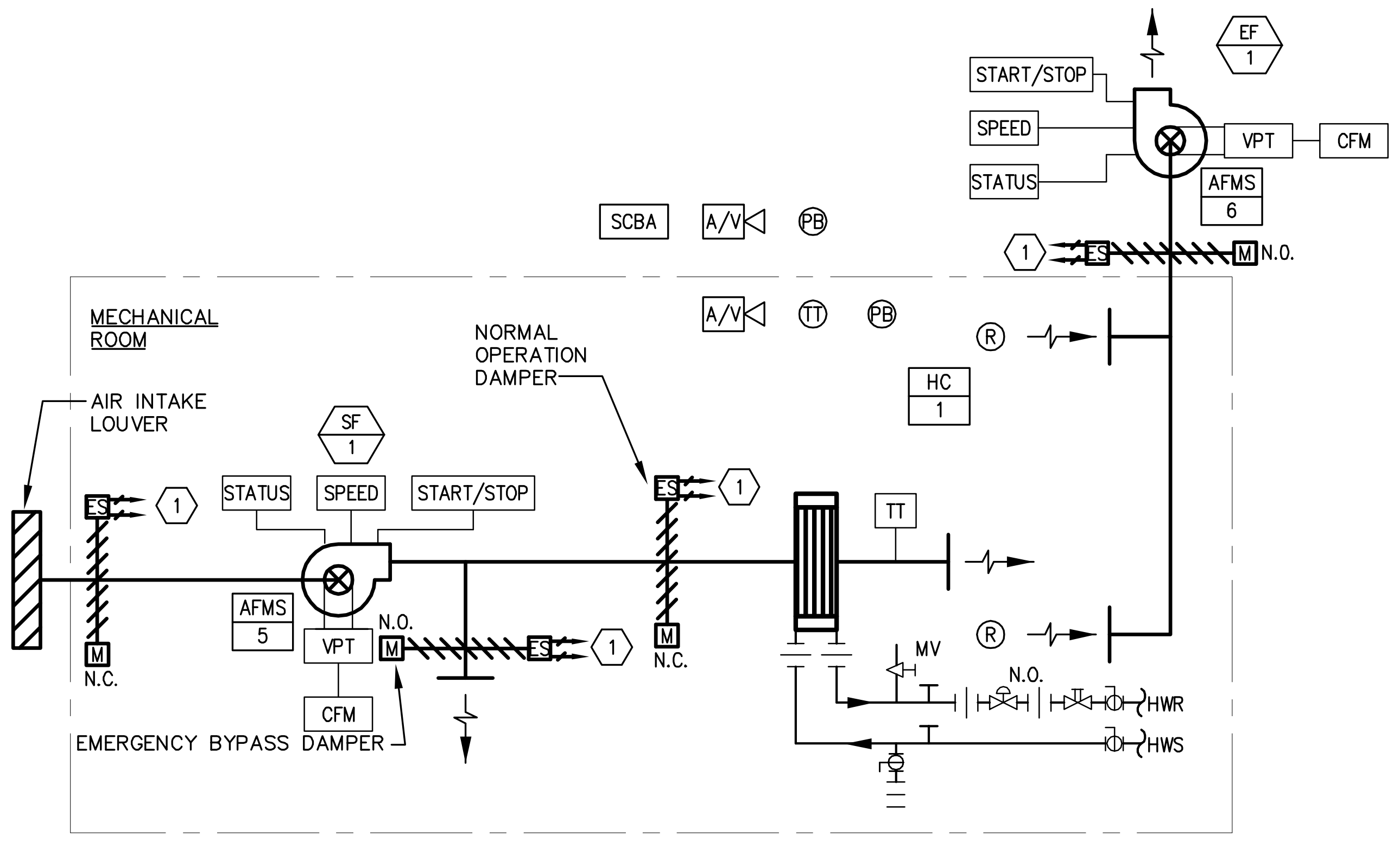
UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL MOUNTED TEMPERATURE, BELOW 62°F (ADJUSTABLE) AND THE SUPPLY FAN (SF–1) IS OPERATING AT ITS MINIMUM AIR FLOW RATE, THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE LOCATED ON THE HOT WATER RETURN PIPING TO THE HEATING COIL (HC–1). UPON A RISE IN SPACE TEMPERATURE, AS MEASURED BY THE WALL MOUNTED TEMPERATURE, ABOVE 65°F (ADJUSTABLE) AND THE SUPPLY FAN (SF–1) IS OPERATING AT ITS MINIMUM AIR FLOW RATE, THE REVERSE SHALL OCCUR.

UPON A DROP IN SUPPLY AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT) LOCATED DOWNSTREAM OF THE HEAT COIL (HC–1) BELOW 38°F (ADJUSTABLE), THE BAS SHALL: FULLY OPEN THE CONTROL VALVE LOCATED ON THE HOT WATER RETURN PIPING TO THE HEATING COIL (HC–1); DE–ENERGIZE THE SUPPLY FAN SF–1); DE–ENERGIZE THE EXHAUST FAN (EF–1); CLOSE THE DAMPER IN THE INLET OF THE EXHAUST FAN (EF–1); CLOSE THE NORMAL OPERATION DAMPER LOCATED DOWNSTREAM OF THE SUPPLY FAN (SF–1) AND UPSTREAM OF THE HEATING COIL (HC–1); CLOSE THE DAMPER LOCATED IN THE INLET OF THE SUPPLY FAN (SF–1) AND SIGNAL A FREEZING ALARM FOR THE MECHANICAL ROOM / HC–1. UPON A RISE IN SUPPLY AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT) LOCATED DOWNSTREAM OF THE HEAT COIL (HC–1) ABOVE 42°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

EMERGENCY OPERATION FAN AND TEMPERATURE CONTROL

UPON ANY OF THE REFRIGERANT SENSORS (R) DETECTING 40,000 (ADJUSTABLE) PARTS PER MILLION (BY VOLUME) OF REFRIGERANT, UPON AN OPERATOR MANUALLY PRESSING THE EMERGENCY REFRIGERANT LEAK ALARM PUSH BUTTON (PB) LOCATED WITHIN THE MECHANICAL ROOM, OR AN OPERATOR MANUALLY PRESSING THE EMERGENCY REFRIGERANT LEAK ALARM PUSH BUTTON (PB) LOCATED NEAR THE EGRESS DOOR OUTSIDE OF THE MECHANICAL ROOM, THE BAS SHALL: SIGNAL AUDIO/VISUAL ALARMS (A/V) WITHIN THE MECHANICAL ROOM AND OUTSIDE OF THE EGRESS FROM THE MECHANICAL ROOM; THE BAS SHALL REGISTER A REFRIGERANT LEAK ALARM AND THE TIME OF THE INCIDENT; DE–ENERGIZE ALL OF THE HEAT PUMPS AND LOCK OUT THEIR NORMAL OPERATION; SUSPEND THE NORMAL OPERATIONS AS DESCRIBE ABOVE AND INCREASE THE SPEEDS OF THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1) THROUGH THEIR VFD CONTROLLERS TO THEIR MAXIMUM DESIGN VALUES. THE ALARM SHALL NOT BE AUTOMATICALLY RESET BY THE BAS. THE ALARM SHALL ONLY BE SILENCED MANUALLY BY AN OPERATOR AT THE REFRIGERANT SENSORS (R) ONLY. A SELF–CONTAINED BREATHING APPARATUS (SCBA) KIT SHALL BE PROVIDED NEAR THE EGRESS DOOR OUTSIDE OF THE MECHANICAL ROOM. ONCE THE ALARM HAS BEEN SILENCED, THE BAS SHALL; ALLOW THE NORMAL OPERATION OF THE HEAT PUMPS (GTHP), THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1).

UPON A DROP IN SUPPLY AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT) LOCATED DOWNSTREAM OF THE HEAT COIL (HC–1) BELOW 38°F (ADJUSTABLE) AND THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1) ARE OPERATING IN EMERGENCY EXHAUST MODE, THE BAS SHALL: FULLY OPEN THE CONTROL VALVE LOCATED ON THE HOT WATER RETURN PIPING TO THE HEATING COIL (HC–1); CLOSE THE NORMAL OPERATION DAMPER LOCATED DOWNSTREAM OF THE SUPPLY FAN (SF–1) AND UPSTREAM OF THE HEATING COIL (HC–1); OPEN THE EMERGENCY BYPASS DAMPER LOCATED DOWNSTREAM OF THE SUPPLY FAN (SF–1); SIGNAL A FREEZING CONDITION FOR HEATING COIL (HC–1) AND THE MECHANICAL ROOM AND THE TIME OF THE INCIDENT. UPON A RISE IN SUPPLY AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT) LOCATED DOWNSTREAM OF THE HEAT COIL (HC–1) ABOVE 44°F (ADJUSTABLE) AND THE SUPPLY FAN (SF–1) AND THE EXHAUST FAN (EF–1) ARE OPERATING IN EMERGENCY EXHAUST MODE, THE REVERSE SHALL OCCUR.



A1	CONTROL DIAGRAM - MECHANICAL ROOM VENTIALTION
NONE	FOR SF–1, EF–1 & HC–1

TOILET EXHAUST FAN – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

ALL SET POINTS AND TIME DELAYS ARE FULLY ADJUSTABLE.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

THE BAS SHALL: MONITOR THE STATUS OF THE FAN THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE FANS THROUGH AN ELECTRIC METER INSTALLED WITHIN THE FAN'S POWER WIRING.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE OF THE FAN ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

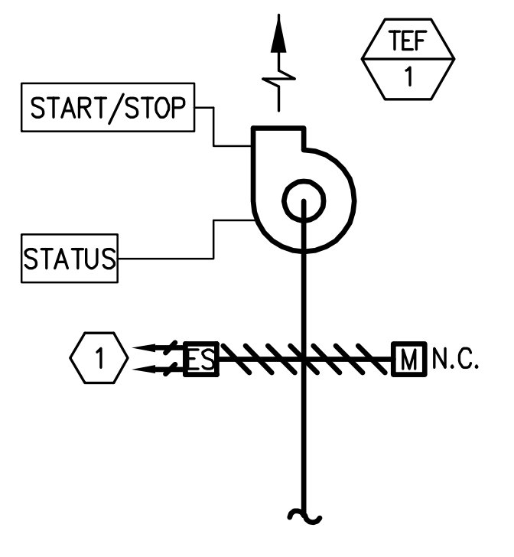
THE TOILET EXHAUST FAN (TEF–1) SHALL BE HARD BALANCED TO A CONSTANT AIR FLOW RATE BY THE TAB CONTRACTOR. THE BAS SHALL: NOT BE ABLE TO ADJUST THE AIR FLOW RATE.

WHEN THE TOILET EXHAUST FAN (TEF–1) IS INDEXED ON, EITHER MANUALLY BY THE BAS OPERATOR OR AUTOMATICALLY BY THE BAS SCHEDULE, THE BAS SHALL: PLACE FPTU–2–1 IN THE OCCUPIED MODE OF OPERATION, ENERGIZE OPEN THE DAMPER ON THE INLET OF THE TOILET EXHAUST FAN (TEF–1); UPON THE DAMPER BEING PROVED OPEN VIA AN END SWITCH CLOSURE, THE TOILET EXHAUST FAN (TEF–1) SHALL BE ENERGIZED.

FAN CONTROL

FAN SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

UPON THE BUILDING OPERATING IN THE OCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE, THE BAS SHALL: CONTINUOUSLY ENERGIZE THE TOILET EXHAUST FAN (TEF–1). UPON THE BUILDING OPERATING IN THE UNOCCUPIED MODE, AS DETERMINED BY THE BAS OPERATOR OR BAS SCHEDULE, THE BAS SHALL: DE–ENERGIZE THE TOILET EXHAUST FAN (TEF–1).



N8	CONTROL DIAGRAM - TOILET EXHAUST FAN
NONE	FOR TEF–1

COOLING EXHAUST FAN – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

ALL SET POINTS AND TIME DELAYS ARE FULLY ADJUSTABLE.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

THE BAS SHALL: MONITOR THE STATUS OF THE FAN THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE FANS THROUGH AN ELECTRIC METER INSTALLED WITHIN THE FAN'S POWER WIRING.

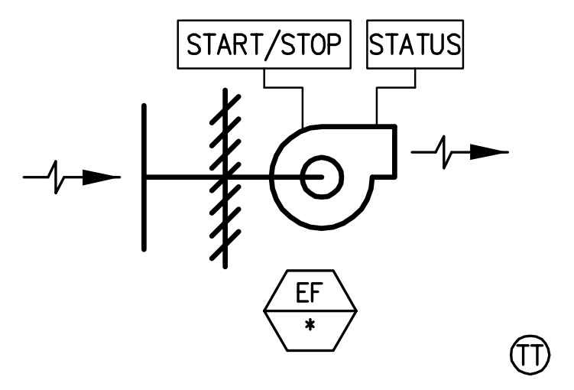
THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE OF THE FAN ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

THE EXHAUST FAN (EF–2, EF–3, EF–4 OR EF–5) SHALL BE HARD BALANCED TO A CONSTANT AIR FLOW RATE BY THE TAB CONTRACTOR. THE BAS SHALL: NOT BE ABLE TO ADJUST THE AIR FLOW RATE.

FAN CONTROL

FAN SHALL BE STARTED OR STOPPED MANUALLY OR THROUGH THE BAS BY THE OPERATOR AS DESCRIBED BELOW.

UPON THE RISE IN SPACE TEMPERATURE, AS MEASURED BY THE WALL MOUNTED TEMPERATURE TRANSMITTER (TT), ABOVE 75°F (ADJUSTABLE) , THE BAS SHALL: ENERGIZE THE EXHAUST FAN (EF–*). UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL MOUNTED TEMPERATURE TRANSMITTER (TT), BELOW 70°F (ADJUSTABLE) THE EXHAUST FAN (EF–*), THE BAS SHALL: DE–ENERGIZE THE EXHAUST AIR FAN (EF–*).



K8	CONTROL DIAGRAM - COOLING EXHUAST EXHAUST FAN
NONE	FOR EF–2, EF–3, EF–4 & EF–5

VAV BOX WITHOUT PERIMETER HEATING – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

ALL SET POINTS AND TIME DELAYS ARE FULLY ADJUSTABLE.

THE OCCUPIED / UNOCCUPIED MODE OF OPERATION SHALL BE DETERMINED EITHER MANUALLY BY THE BAS OPERATOR OR AUTOMATICALLY BY THE BAS SCHEDULE.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

THE BAS SHALL: MONITOR THE AIR VOLUME FLOW RATE, IN CFM, THRU AIR FLOW MEASURING STATION (AFMS) LOCATED IN EACH OF THE VAV BOX'S INLET.

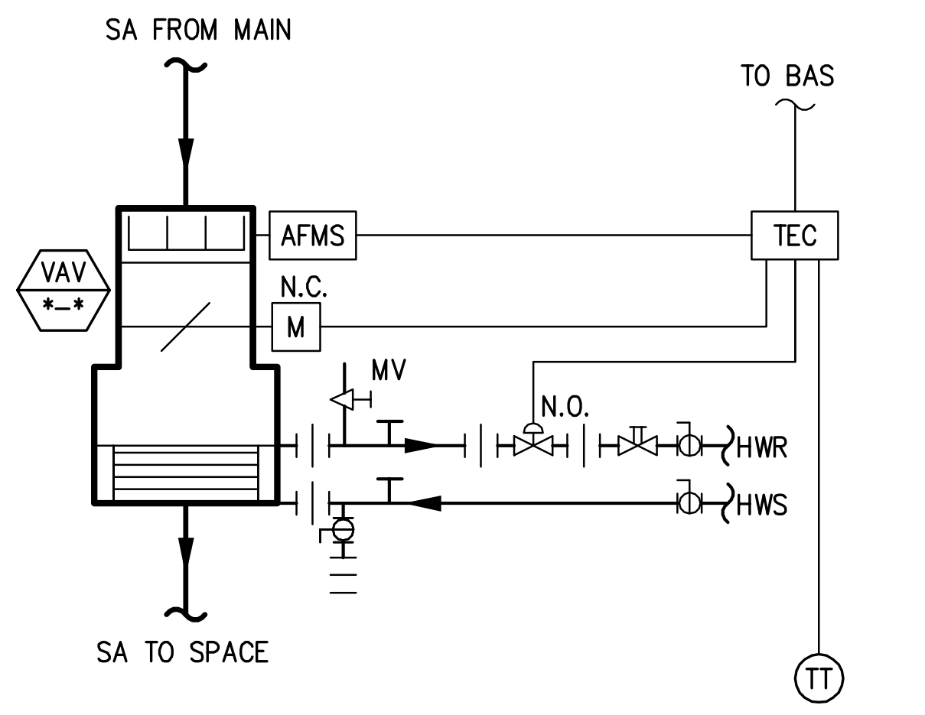
OCCUPIED MODE OF OPERATION

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 75°F (ADJUSTABLE), THE BAS SHALL: MODULATE CLOSE THE VAV BOX'S INTEGRAL CONTROL DAMPER (D), LOCATED IN THE VAV BOX'S INLET. UPON A RISE IN SPACE TEMPERATURE ABOVE 75°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 72°F (ADJUSTABLE) AND THE VAV BOX OPERATING AT ITS SCHEDULED MINIMUM AIR, AS MEASURED BY THE AIR FLOW MEASURING STATION (AFMS), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE ON THE HOT WATER RETURN PIPING. UPON A RISE IN SPACE TEMPERATURE ABOVE 72°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UNOCCUPIED MODE OF OPERATION

THE BAS SHALL: CLOSE THE VAV BOX'S INTEGRAL CONTROL DAMPER (D), AND THE OCCUPIED MODE TEMPERATURE CONTROLS SHALL BE SUSPENDED.



F8	CONTROL DIAGRAM - VAV BOXES WITHOUT RADIATORS
NONE	REFER TO PLANS AND SCHDEULES FOR OCCURANCES

CABINET UNIT HEATER – SEQUENCE OF OPERATIONS

GENERAL

THIS SEQUENCE APPLIES TO BOTH PROPELLER TYPE UNIT HEATERS AND CABINET TYPE UNIT HEATERS.

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

ALL SET POINTS AND TIME DELAYS ARE FULLY ADJUSTABLE.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

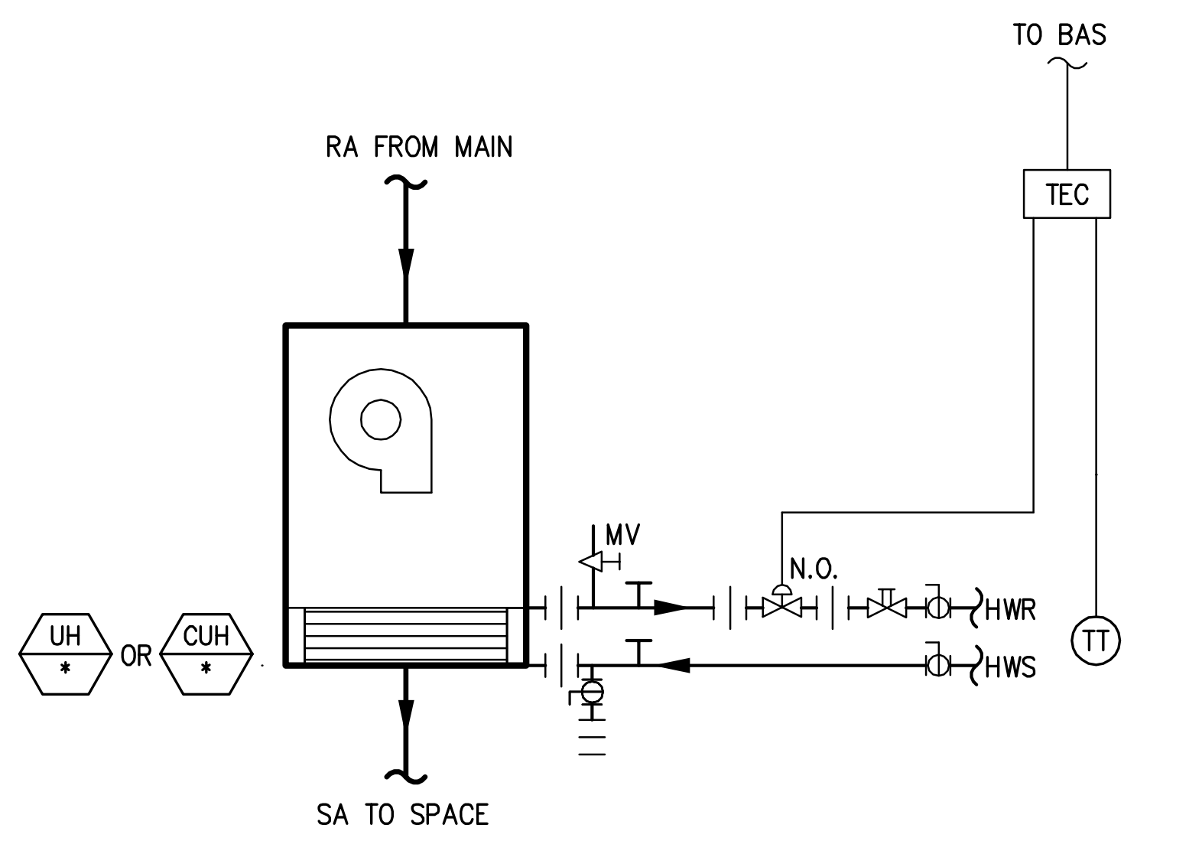
THE UNIT HEATER'S INTEGRAL FAN AIR FLOW RATE SHALL BE HARD BALANCED TO A CONSTANT AIR FLOW RATE BY THE TAB CONTRACTOR. THE BAS SHALL: NOT BE ABLE TO ADJUST THE AIR FLOW RATE.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE FANS THROUGH AN ELECTRIC METER INSTALLED WITHIN THE FAN'S POWER WIRING.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE OF THE FAN ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

TEMPERATURE CONTROL

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 60°F (ADJUSTABLE), THE BAS: SHALL MODULATE OPEN THE CONTROL VALVE ON THE HOT WATER RETURN PIPING AND ENERGIZE THE UNIT HEATER'S INTEGRAL FAN. UPON A RISE IN SPACE TEMPERATURE ABOVE 65°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.



A8	CONTROL DIAGRAM - CABINET UNIT HEATER
NONE	

GENERAL NOTES:

1. THE BAS SHALL HAVE A SEQUENTIAL RESTART PROGRAM FOR THE RESTART OF ALL EQUIPMENT UPON RESTORATION OF NORMAL ELECTRICAL POWER AFTER A LOSS OF NORMAL POWER.
2. ALL BAS INFORMATION SHALL BE TRUE–TIME AND CONTINUOUS BY NATURE.
3. SPACE TEMPERATURE SETPOINTS SHALL BE ADJUSTABLE MANUALLY BY THE BAS OPERATOR ON A LOCAL (INDIVIDUAL ZONE) LEVEL OR ON A GLOBAL (WHOLE SYSTEM) LEVEL.
4. THE BAS SHALL MONITOR AND DISPLAY THE FOLLOWING:
   A. ALL ALARMS.
   B. ALL SETPOINTS.
   C. THE STATUS OF ALL EQUIPMENT AND DEVICES.
   D. ALL WATER FLOWS (GPM), AS MEASURED BY FLOW METERS (FM).
   E. ALL AIR FLOW (CFM), AS MEASURED BY AIR FLOW MEASURING STATIONS (AFMS) OR COMBINATION AIR FLOW MEASURING STATION / DAMPERS (AFMS/D).
   F. ALL VFD SPEED (% OF DESIGN), AS MEASURED BY THE VFD CONTROLLERS (VFD).
   G. ALL HVAC ELECTRICAL ENERGY USAGE (KW), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   H. ALL HVAC ELECTRICAL POWER USAGE (KH/Hr), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   I. ALL TEMPERATURES (°F), AS MEASURED BY TEMPERATURE TRANSMITTERS (TT).
   J. ALL HUMIDITY LEVELS (RH), AS MEASURED BY HUMIDITY TRANSMITTERS (HT).
   K. ALL CONTROL VALVE POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL VALVE POSITIONING SENSORS.
   L. ALL CONTROL DAMPER POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL DAMPER POSITIONING SENSORS.
   M. ALL PRESSURE READINGS (PSIG OR PSID), AS MEASURED BY PRESSURE SENSORS (PS) OR DIFFERENTIAL PRESSURE SENSORS (DPS).

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CONTROL DIAGRAMS

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VAV BOX WITH PERIMETER HEATING – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

THE OCCUPIED / UNOCCUPIED MODE OF OPERATION SHALL BE DETERMINED EITHER MANUALLY BY THE BAS OPERATOR OR AUTOMATICALLY BY THE BAS SCHEDULE.

ALL SET POINTS AND TIME DELAYS ARE FULLY ADJUSTABLE.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

THE BAS SHALL: MONITOR THE AIR VOLUME FLOW RATE, IN CFM, THRU AIR FLOW MEASURING STATION (AFMS) LOCATED IN EACH OF THE VAV BOX'S INLET.

OCCUPIED MODE OF OPERATION

IF THE SPACE IS OPERATING IN AN OCCUPIED MODE AND ANY OF THE WINDOWS WITHIN THE SPACE ARE OPEN, AS MEASURED BY THE OPENING OF THE CONTACT FOR THE WINDOW SENSOR (WS), THE BAS SHALL: SUSPEND NORMAL ATC OPERATION AND CLOSE THE VAV BOX'S INTEGRAL CONTROL DAMPER (D). UPON THE CLOSURE OF ALL OF THE WINDOWS, AS MEASURED BY THE CLOSING OF THE CONTACTS FOR THE WINDOWS SENSOR (WS), THE BAS SHALL: RESTORE NORMAL ATC CONTROL AND OPEN THE VAV BOX'S INTEGRAL CONTROL DAMPER (D) TO ITS MINIMUM SCHEDULED POSITION.

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 75°F (ADJUSTABLE), THE BAS SHALL: MODULATE CLOSE THE VAV BOX'S INTEGRAL CONTROL DAMPER (D), LOCATED IN THE VAV BOX'S INLET. UPON A RISE IN SPACE TEMPERATURE ABOVE 75°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 72°F (ADJUSTABLE); THE VAV BOX OPERATING AT ITS SCHEDULED MINIMUM AIR, AS MEASURED BY THE AIR FLOW MEASURING STATION (AFMS); AND THE OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA), IS ABOVE 55°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE ON THE HOT WATER RETURN PIPING SERVING TEH VAV BOX'S INTEGRAL REHEAT COIL. UPON A RISE IN SPACE TEMPERATURE ABOVE 72°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.

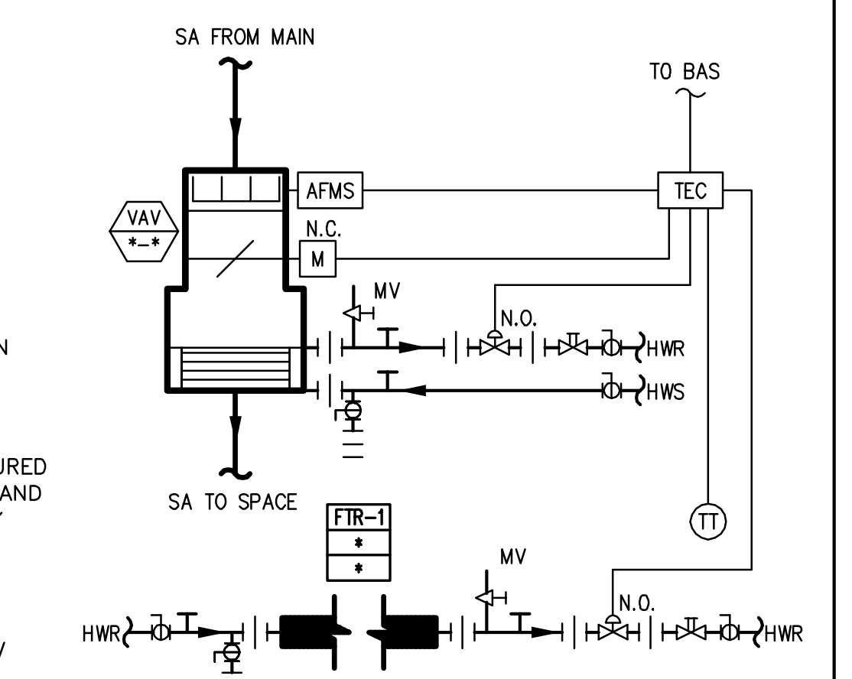
UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 72°F (ADJUSTABLE); THE VAV BOX OPERATING AT ITS SCHEDULED MINIMUM AIR, AS MEASURED BY THE AIR FLOW MEASURING STATION (AFMS); AND THE OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (TTOA), IS BELOW 45°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVES ON THE HOT WATER RETURN PIPING SERVING TEH VAV BOX'S INTEGRAL REHEAT COIL AND THE FIN TUBE RADIATOR IN UNISON. UPON A RISE IN SPACE TEMPERATURE ABOVE 72°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.

UNOCCUPIED MODE OF OPERATION

IF THE SPACE IS OPERATING IN AN UNOCCUPIED MODE AND ANY OF THE WINDOWS WITHIN THE SPACE ARE OPEN, AS MEASURED BY THE OPENING OF THE CONTACT FOR THE WINDOW SENSOR (WS), THE BAS SHALL: REGISTER A WINDOW OPEN / UNOCCUPIED ALARM FOR THE SPECIFIC ROOM AND RECORD THE TIME OF THE ALARM. UPON PROOF THAT ALL OF THE WINDOWS ARE CLOSED, AS MEASURED BY THE CLOSING OF THE CONTACT FOR ALL OF THE WINDOW SENSORS (WS) WITHIN THE SPACE, THE BAS SHALL: SILENCE THE ALARM.

THE BAS SHALL: CLOSE THE VAV BOX'S INTEGRAL CONTROL DAMPER (D).

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 60°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE ON THE HOT WATER RETURN PIPING SERVING THE FIN TUBE RADIATOR (FTR). UPON A RISE IN SPACE TEMPERATURE ABOVE 60°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.



M1 CONTROL DIAGRAM - VAV BOX W/ PERIMETER HEATING

NONE | REFER TO PLANS FOR OCCURANCES

FAN POWERED TERMINAL UNITS – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

ALL SET POINTS AND TIME DELAYS ARE FULLY ADJUSTABLE.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

THE OCCUPIED / UNOCCUPIED MODE OF OPERATION SHALL BE DETERMINED EITHER MANUALLY BY THE BAS OPERATOR OR AUTOMATICALLY BY THE BAS SCHEDULE.

THE FPTU'S INTEGRAL FAN AIR FLOW RATE SHALL BE HARD BALANCED TO A CONSTANT AIR FLOW RATE BY THE TAB CONTRACTOR. THE BAS SHALL: NOT BE ABLE TO ADJUST THE AIR FLOW RATE.

THE BAS SHALL: MONITOR THE PRIMARY AIR VOLUME FLOW RATE, IN CFM, THRU AIR FLOW MEASURING STATION (AFMS) LOCATED IN EACH OF THE FPTU BOX'S PRIMARY AIR INLET.

THE BAS SHALL: MONITOR THE STATUS OF THE FAN THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, OF EACH OF THE FANS THROUGH AN ELECTRIC METER INSTALLED WITHIN THE FAN'S POWER WIRING.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE OF THE FAN ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

OCCUPIED MODE OF OPERATION

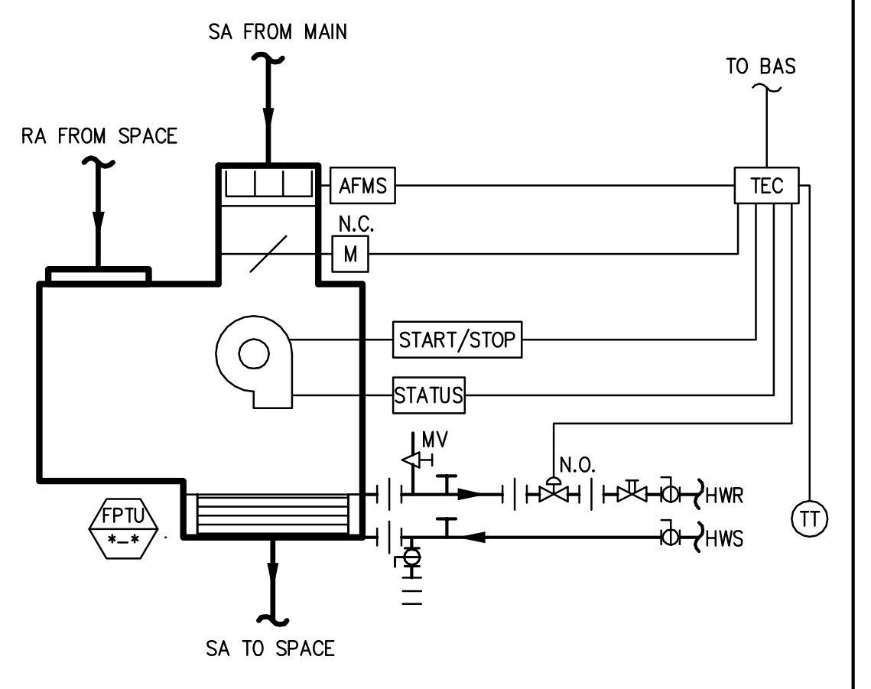
UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 75°F (ADJUSTABLE), THE BAS SHALL: MODULATE CLOSE THE FPTU BOX'S INTEGRAL CONTROL DAMPER (D), LOCATED IN THE FPTU BOX'S PRIMARY AIR INLET. UPON A RISE IN SPACE TEMPERATURE ABOVE 75°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 72°F (ADJUSTABLE) AND THE FPTU BOX OPERATING AT ITS SCHEDULED MINIMUM AIR, AS MEASURED BY THE AIR FLOW MEASURING STATION (AFMS), LOCATED IN THE FPTU BOX'S PRIMARY AIR INLET, THE BAS: SHALL MODULATE OPEN THE CONTROL VALVE ON THE HOT WATER RETURN PIPING. UPON A RISE IN SPACE TEMPERATURE ABOVE 72°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.

UNOCCUPIED MODE OF OPERATION

THE BAS SHALL: CLOSE THE FPTU BOX'S INTEGRAL CONTROL DAMPER (D), LOCATED IN THE FPTU BOX'S PRIMARY AIR INLET.

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 60°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE ON THE HOT WATER RETURN PIPING AND ENERGIZE THE FPTU BOX'S INTEGRAL FAN. UPON A RISE IN SPACE TEMPERATURE ABOVE 60°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.



G1 CONTROL DIAGRAM - FPTU BOX

NONE | DOES NOT APPLY TO FPTU–2–1

FIN TUBE RADIATORS SERVING BREAKOUT LOUNGES (FRT–*) – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

ALL SET POINTS AND TIME DELAYS ARE FULLY ADJUSTABLE.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

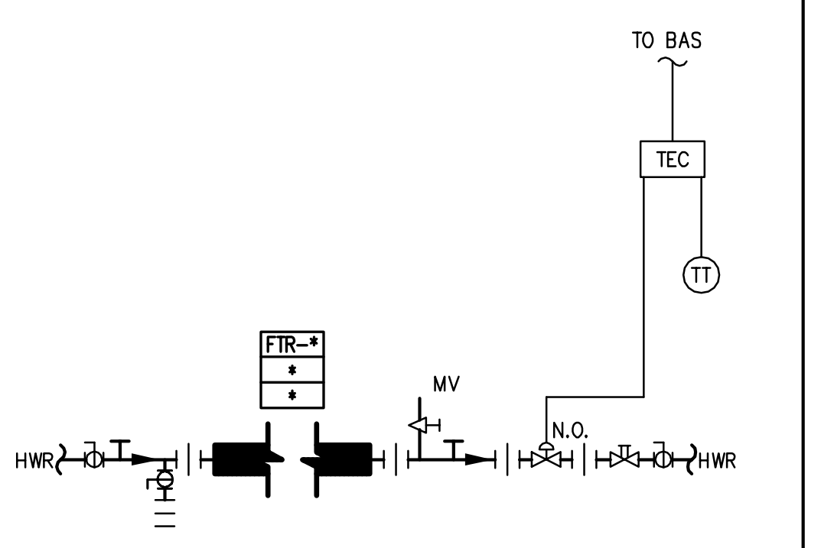
THE OCCUPIED / UNOCCUPIED MODE OF OPERATION SHALL BE DETERMINED EITHER MANUALLY BY THE BAS OPERATOR OR AUTOMATICALLY BY THE BAS SCHEDULE.

OCCUPIED MODE OF OPERATION

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 65°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE ON THE HOT WATER RETURN PIPING SERVING THE FIN TUBE RADIATION (FTR). UPON A RISE IN SPACE TEMPERATURE ABOVE 65°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.

UNOCCUPIED MODE OF OPERATION

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE WALL TEMPERATURE TRANSMITTER (TT), BELOW 60°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE ON THE HOT WATER RETURN PIPING SERVING THE FIN TUBE RADIATOR. UPON A RISE IN SPACE TEMPERATURE ABOVE 60°F (ADJUSTABLE) THE REVERSE SHALL OCCUR.



D1 CONTROL DIAGRAM - RADIATION

NONE | FOR BREAKOUT LOUNGE RADIATION

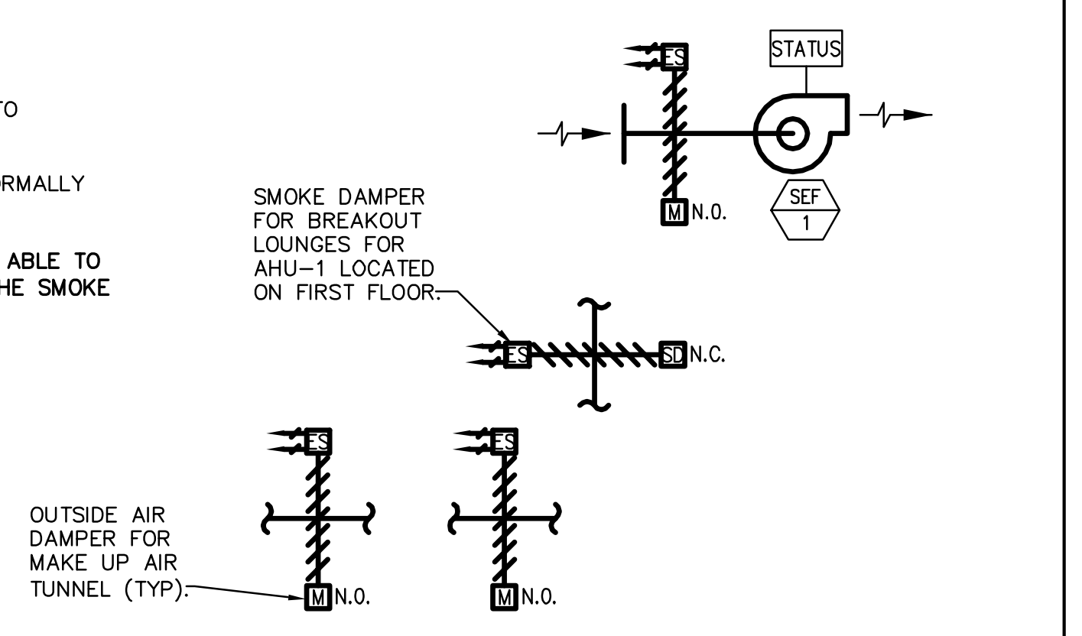
SMOKE EXHAUST FAN (SEF–1) – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS.

IN THE EVENT OF A POWER FAILURE, ALL CONTROLS SHALL GO TO THEIR FAIL–SAFE POSITIONS (NORMALLY OPEN OR NORMALLY CLOSED).

THE BAS SHALL: ONLY MONITOR STATUS SMOKE EXHAUST FAN (SEF–1). THE BAS SHALL: NOT BE ABLE TO CONTROL THE OPERATION OF THE SMOKE EXHAUST FAN (SEF–1). SEQUENCE OF OPERATION FOR THE SMOKE EXHAUST FAN SHALL BE UNDER DIVISION 16, FIRE ALARM SYSTEM.



A1 CONTROL DIAGRAM - SMOKE EXHAUST FAN

NONE | SEF–1

AIR HANDLING UNIT SERVING VAV AND FPTU BOXES – AHU–1 – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS:

THE AIR HANDLING UNIT SYSTEM SHALL BE ENERGIZED OR DE–ENERGIZED EITHER MANUALLY BY THE BAS OPERATOR OR AUTOMATICALLY BY THE BAS SCHEDULE.

AIR HANDLING UNIT MANUFACTURER SHALL PROVIDE A DRY CONTACT FOR GENERAL ALARMING PURPOSE IF ANY OF THE EQUIPMENT FAILS TO START OR FUNCTION AS DESCRIBED HEREIN.

ALL SET POINTS AND TIME DELAYS ARE ADJUSTABLE.

IN THE EVENT OF POWER FAILURE ALL CONTROL SHALL GO TO THEIR FAIL SAFE POSITIONS, NORMALLY OPEN OR NORMALLY CLOSED.

UPON AHU–2 BEING DE–ENERGIZED, THE BAS SHALL: STOP POWER TO ALL MOTORS, CLOSE ALL DAMPERS AND CLOSE ALL VALVES. UPON AHU–2 BEING ENERGIZED. THE BAS SHALL: COMPLETE THE SEQUENCES AS DESCRIBED WITHIN.

THE BAS OPERATOR SHALL BE ABLE TO SCHEDULE THE MODE OF OPERATION OF THE AHU SYSTEM (OCCUPIED OR UNOCCUPIED MODES OF OPERATION) THROUGH THE BAS USING A GRAPHIC INTERFACE SIMILAR TO A DAILY PLANNER FOR UP TO ONE CALENDAR YEAR. THE SCHEDULE SHALL BE ABLE TO BE OVER RIDDEN BY THE BAS OPERATOR AS THE OCCASION ARISES.

OCCUPIED MODE

FAN CONTROL

THE BAS SHALL: MONITOR THE STATUS OF EACH OF THE FANS (SUPPLY AND EXHAUST) THROUGH EACH OF THE CURRENT SENSING RELAYS.

THE BAS SHALL: MONITOR THE SPEED OF EACH OF THE FANS (SUPPLY AND EXHAUST) THROUGH EACH OF THE VFD CONTROLLERS.

THE BAS SHALL: RECORD AND REPORT THE DURATION THAT EACH OF THE FANS (SUPPLY AND EXHAUST) OPERATES AT A SPECIFIC SPEED ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HOURS AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF FAN'S SPEED.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, FOR EACH OF THE FANS (SUPPLY AND EXHAUST) THROUGH AN ELECTRIC METER INSTALLED WITHIN EACH FAN'S POWER WIRING.

THE BAS SHALL CALCULATE AND MONITOR EACH OF THE FAN'S (SUPPLY AND EXHAUST) ENERGY USAGE AT VARIOUS FAN SPEEDS. THE BAS SHALL ALSO RECORD AND REPORT THE ENERGY USAGE AT VARIOUS FAN SPEEDS FOR EACH OF THE FANS (SUPPLY AND EXHAUST) ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING ENERGY USAGE, IN KW, AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF FAN'S SPEED.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE FOR EACH FAN (SUPPLY AND EXHAUST) ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

THE EXHAUST FAN SHALL BE BE ELECTRICALLY INTERLOCKED WITH THE SUPPLY FAN.

UPON AHU–1 BEING ENERGIZED, THE BAS SHALL: OPEN THE SMOKE DAMPERS (SD) LOCATED ON THE SUPPLY RETURN MAINS, AND OPEN THE INTEGRAL RETURN AIR CONTROL DAMPER (D). UPON THE DAMPERS BEING PROVEN OPEN VIA END SWITCH CLOSURES, THE BAS SHALL: ENERGIZE THE SUPPLY FAN. UPON AHU–1 BEING DE–ENERGIZED, THE REVERSE SHALL OCCUR.

UPON EITHER THE DUCT MOUNTED SMOKE DETECTORS (SD), LOCATED IN THE RETURN AIR MAIN OR IN THE SUPPLY AIR MAIN DETECT THE PRODUCTS OF COMBUSTION, THE BAS SHALL: DE–ENERGIZE THE SUPPLY AND EXHAUST AIR FANS, CLOSE ALL OF ITS CONTROL DAMPERS (M or SD), REGISTER AND RECORD A SMOKE ALARM FOR AIR HANDLING UNIT–1, AND THE DEVICE THAT CAUSED THE ALARM (EITHER THE SUPPLY OR RETURN AIR SYSTEM).

UPON A RISE IN DUCT DIFFERENTIAL PRESSURE, AS MEASURED BY THE DUCT MOUNT DIFFERETIAL PRESSURE SENSOR, LOCATED ON THE FIRST FLOOR, ABOVE 1.0" W.G. (ADJUSTABLE), THE BAS SHALL: INCREASE THE SPEED OF THE SUPPLY FAN THROUGH ITS VFD CONTROLLER. UPON A DROP IN DUCT DIFFERENTIAL PRESSURE, AS MEASURED BY THE DUCT MOUNT DIFFERETIAL PRESSURE SENSOR, LOCATED ON THE FIRST FLOOR, BELOW 0.85" W.G. (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A RISE IN THE EXHAUST AIR FLOW RATE, AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE INLET OF THE EXHAUST FAN (AFMS–2), OF MORE THAN THE SUM OF THE OUTSIDE AIR INTAKES, AS MEASURED BY THE COMBINATION AIR FLOW MEASURING STATION / CONTROL DAMPERS (AFMS/D) MINUS 5,000 CFM (ADJUSTABLE), THE BAS SHALL: DECREASE THE EXHAUST FAN'S SPEED THROUGH ITS VFD CONTROLLER. UPON A DROP IN THE EXHAUST AIR FLOW RATE, AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE INLET OF THE EXHAUST FAN (AFMS–4), OF LESS THAN THE SUM OF THE OUTSIDE AIR INTAKES, AS MEASURED BY THE COMBINATION AIR FLOW MEASURING STATION/CONTROL DAMPERS (AFMS/D's) MINUS 4500 CFM (ADJUSTABLE), THE REVERSE SHALL OCCUR.

RETURN DAMPER, RELIEF DAMPER, COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR INTAKE DAMPERS, OUTSIDE AIR BYPASS DAMPER AND ENTALPHY WHEEL CONTROL

THE BAS SHALL: MONITOR THE STATUS THE ENTHALPY WHEEL'S MOTOR THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, FOR THE ENTHALPY WHEEL'S MOTOR THROUGH AN ELECTRIC METER INSTALLED WITHIN THE POWER WIRING.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE FOR THE ENTHALPY WHEEL'S MOTOR ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE THE AMOUNT OF OUTSIDE AIR INTRODUCED INTO AHU–2, AS MEASURED BY THE COMBINATION AIR FLOW MEASURING STATION / DAMPERS (AFMS/D) ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL PRODUCE AN AVERAGE AMOUNT OF OUTSIDE AIR FOR THE PERIOD AND HAVE THE UNITS OF CUBIC FEET OF OUTSIDE AIR / MINUTE (AVERAGE)

THE ENTHALPY WHEEL'S SPEED SHALL BE CONSTANT AND HARD BALANCED BY THE TAB CONTRACTOR. THE BAS SHALL NOT BE ABLE TO VARY THE SPEED OF THE ENTHALPY WHEEL.

THE AHU HAS TWO OUTSIDE AIR LOUVERS (ONE ON THE LEFT HAND SIDE AND ONE ON THE RIGHT). EACH OUTSIDE LOUVER SHALL HAVE A MINIMUM CAPACITY OF 50% OF THE UNIT'S MAXIMUM SUPPLY AIR FLOW RATE (CFM). EACH LOUVER SHALL HAVE TWO – COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) THAT ARE SIZED TO PROVIDE 1/3 – 2/3 CONTROL FOR EACH LOUVER. THE BAS SHALL: ALTERNATE LEAD/LAG OPERATION (BETWEEN THE LEFT AND RIGHT HAND SIDE OF THE AHU) TO EQUALIZE THE USAGE OF THE LOUVERS AND COMBINATION AIR FLOW MEASURING STATIONS / OUTSIDE AIR DAMPERS (AFMS/D's); THE LEAD/LAG SELECTION SHALL BE EVALUATED ON A WEEKLY BASIS (ADJUSTABLE); THE LOUVER WITH THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPER (AFMS/D) ASSOCIATED WITH THE 1/3 AIR FLOW CONTROL THAT HAS THE LEAST TIME IN OPERATION SHALL DICTATE THE LEAD LOUVER. THE BAS SHALL: OPERATE THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS./D's) AS DESCRIBED IN THE MATRIX BELOW:

% OF MAX OA FLOW	OPERATION OF 2/3 AFMS/D ON LEAD LOUVER	OPERATION OF 1/3 AFMS/D ON LEAD LOUVER	OPERATION OF 2/3 AFMS/D ON LAG LOUVER	OPERATION OF 1/3 AFMS/D ON LAG LOUVER
0–17	CLOSED	MODULATING	CLOSED	CLOSED
18–50	CLOSED	MODULATING	MODULATING	CLOSED
50–67	CLOSED	OPEN	OPEN	MODULATING
68–100	MODULATING	OPEN	OPEN	MODULATING
83–100	OPEN	OPEN	OPEN	MODULATING

UPON A DROP IN THE AIR FLOW RATE (CFM), AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE INLET OF THE SUPPLY FAN (AFMS–1), BELOW 5% (ADJUSTABLE) THE SCHEDULED AIR FLOW RATE, AS DESCRIBED ABOVE, THE BAS SHALL: MODULATE THE RETURN AIR DAMPER OPEN.

UPON A RISE IN THE AIR FLOW RATE (CFM), AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE INLET OF THE SUPPLY FAN (AFMS–1), ABOVE 5% (ADJUSTABLE) THE SCHEDULED AIR FLOW RATE, AS DESCRIBED ABOVE, THE REVERSE SHALL OCCUR.

UPON THE AHU–1 BEING ENERGIZED AND THE SUPPLY FAN HAS BEEN ENERGIZED FOR 5 MINUTES (ADJUSTABLE), THE BAS SHALL: OPEN THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's)TO THEIR MINIMUM SCHEDULED AIR FLOW RATE POSITIONS, AS MEASURED BY THE COMBINATION AIR FLOW FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's).

AFTER THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) ARE OPERATING AT THEIR MINIMUM SCHEDULED AIR FLOW RATE POSITIONS FOR 5 MINUTES (ADJUSTABLE), THE BAS SHALL: COMPARE THE CONCENTRATION OF CARBON DIOXIDE IN THE RETURN AIR, AS MEASURED BY THE CO2 MONITORS LOCATED IN THE THE RETURN AIR DUCTWORK (CO2), TO THE OUTSIDE AIR'S CONCENTRATION OF CARBON DIOXIDE, AS MEASURED BY THE GLOBAL OUTSIDE AIR CARBON DIOXIDE MONITOR (CO2–OA). IF THE ABSOLUTE DIFFERENCE IN THE CONCENTRATION OF CARBON DIOXIDE BETWEEN THE OUTSIDE AND RETURN AIR, FOR THE CARBON DIOXIDE MONITOR (CO2)WITH THE HIGHEST CONCENTRATION CARBON DIOXIDE, IS LESS THAN 500 PART PER MILLION (ADJUSTABLE), THE BAS SHALL: REDUCE THE OUTSIDE AIR AIR FLOW RATE (CFM) SETPOINTS FOR THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) BY 5% (ADJUSTABLE), UNLESS THE AHU IS OPERATION WITHIN AN ENTHALPY ECONOMIZER (FREE COOLING) MODE. IF THE ABSOLUTE DIFFERENCE IN THE CONCENTRATION OF CARBON DIOXIDE BETWEEN THE OUTSIDE AND ANY OF THE CARBON DIOXIDE MONITORS (CO2) IN RETURN AIR DUCTWORK IS MORE THAN 530 PART PER MILLION (ADJUSTABLE), THE BAS SHALL: INCREASE THE OUTSIDE AIR AIR FLOW RATE (CFM) SETPOINTS FOR THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) BY 5% (ADJUSTABLE).

THE BAS SHALL: CONTROL THE DAMPERS AND ENTHALPY WHEEL, AS DESCRIBE IN THE MATRIX BELOW:

OA AIR TEMP	OA AIR RH	MIXED AIR TEMP	MIX AIR RH	EXH AIR TEMP	ENTHALPY WHEEL MOTOR	OUTSIDE AIR DAMPERS	OUTSIDE AIR BYPASS DAMPER	RETURN AIR DAMPER	RELIEF AIR BYPASS DAMPER
>62°F	>61%	N.A.	N.A.	N.A.	ON	MIN	CLOSED	MAX	CLOSED
<62°F, >44°F	<65% ①	>62°F	<61%	N.A.	OFF	MODULATING TO MAX	OPEN	MODULATING TO MIN	OPEN
<62°F, >44°F	<65% ①	<62°F	<61%	N.A.	OFF	MODULATING TO MIN	OPEN	MODULATING TO MAX	OPEN
<42°F	N.A.	>62°F	>62°F	N.A.	ON	MIN	CLOSED	MAX	CLOSED
<25°F	<100%	N.A.	N.A.	<25°F	OFF	MIN	OPEN	MAX	OPEN

NOTE ① : FOR THE ECONOMIZER (FREE COOLING) MODE OF OPERATION.

FILTER CONTROL

UPON A RISE IN DIFFERENTIAL AIR PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRE–FILTER, ABOVE 0.50" WG (ADJUSTABLE), THE BAS SHALL: PRODUCE A PRE–FILTER DIRTY ALARM FOR THE SPECIFIC AHU SYSTEM. UPON A DROP IN DIFFERENTIAL AIR PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRE–FILTER, BELOW 0.40" WG (ADJUSTABLE), THE REVERSE SHALL OCCUR AND THE ALARM SILENCED.

UPON A RISE IN DIFFERENTIAL AIR PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE FINAL–FILTER, ABOVE 2.00" WG (ADJUSTABLE), THE BAS SHALL: PRODUCE A FINAL–FILTER DIRTY ALARM FOR THE SPECIFIC AHU SYSTEM. UPON A DROP IN DIFFERENTIAL AIR PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRE–FILTER, BELOW 1.75" WG (ADJUSTABLE), THE REVERSE SHALL OCCUR AND THE ALARM SILENCED.

PREHEAT COIL CONTROL

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 49°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL. UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, ABOVE 50°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 42°F (ADJUSTABLE), THE BAS SHALL: FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL AND PRODUCE A FREEZING CONDITION ALARM WARNING FOR THE SPECIFIC AHU SYSTEM. UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, ABOVE 45°F (ADJUSTABLE), THE REVERSE SHALL OCCUR AND THE WARNING SHALL BE SILENCED.

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY EITHER THE TEMPERATURE TRANSMITTER (TT) OR THE FREEZSTAT (FZ), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 38°F (ADJUSTABLE), THE BAS SHALL: FULLY CLOSE THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL; ENERGIZE THE FREEZE PROTECTION PUMP (P–HW–6); FULLY OPEN THE RETURN AIR DAMPER, FULLY CLOSE ALL EXHAUST AND OUTSIDE AIR DAMPERS; AND PRODUCE A FREEZING CONDITION ALARM FOR THE SPECIFIC AHU SYSTEM. THE NORMAL OPERATION OF THE PREHEAT COIL CONTROL SHALL ONLY BE RESET AT THE LOCAL CONTROL PANEL (LCP) FOR THE AHU SYSTEM AND UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY EITHER THE TEMPERATURE TRANSMITTER (TT) OR THE FREEZSTAT (FZ), LOCATED DOWNSTREAM OF THE PREHEAT COIL, ABOVE 45°F (ADJUSTABLE). THE BAS SHALL MONITOR THE STATUS OF THE FREEZE PROTECTION PUMP (P–HW–6) THROUGH THE CURRENT SENSING RELAY.

COOLING COIL CONTROL

UPON A DROP IN OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (OATT), THE BAS SHALL LOCKOUT THE NORMAL CONTROL FOR THE COOLING COIL AS DESCRIBE HEREIN AND THE COOLING COIL SHALL BE DRAINED AND WINTERIZED BY MAINTENANCE STAFF TO PREVENT FREEZING OF THE COIL.

UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE COOLING COIL, ABOVE 62°F (ADJUSTABLE) AND A RISE IN AIR RELATIVE HUMIDITY, AS MEASURED BY THE HUMIDITY TRANSMITTER (HT), LOCATED DOWNSTREAM OF THE COOLING COIL ABOVE 65% (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE LOCATED IN THE CHILLED WATER RETURN PIPING TO THE COOLING COIL. UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE COOLING COIL, BELOW 60°F (ADJUSTABLE) AND A BELOW IN AIR RELATIVE HUMIDITY, AS MEASURED BY THE HUMIDITY TRANSMITTER (HT), LOCATED DOWNSTREAM OF THE COOLING COIL BELOW 69% (ADJUSTABLE), THE BAS SHALL: MODULATE CLOSED THE CONTROL VALVE LOCATED IN THE CHILLED WATER RETURN PIPING TO THE COOLING COIL.

ELECTRIC HEAT TRACE CONTROL

ALL PIPING LOCATED ABOVE THE ROOF (HOT WATER, CHILLED WATER AND DRAINS), INCLUDING PIPING WITHIN THE AHU'S PIPING VESTIBULES, SHALL BE ELECTRICALLY HEAT TRACE. EACH PIPE SHALL BE CONTROLLED AND CIRCUITED INDEPENDENT OF EACH OTHER. PIPING SHALL BE HEAT TRACED AFTER THE PIPING SECTION HAS BEEN PRESSURE TESTED AND PRIOR TO THE INSTALLATION OF THE INSULATION.

UPON A DROP IN PIPE SURFACE TEMPERATURE, AS MEASURED INTEGRAL TEMPERATURE CONTROLLER FOR THE HEAT TRACE, LOCATED ON THE PIPE SURFACE BUT BELOW THE PIPE INSULATION, BELOW 40°F (ADJUSTABLE AT THE PIPING), THE HEAT TRACE SHALL BE ENERGIZED. UPON A RISE IN PIPE SURFACE TEMPERATURE, AS MEASURED INTEGRAL TEMPERATURE CONTROLLER FOR THE HEAT TRACE, LOCATED ON THE PIPE SURFACE BUT BELOW THE PIPE INSULATION, ABOVE 40°F (ADJUSTABLE AT THE PIPING), THE REVERSE SHALL OCCUR.

FOR EACH PIPE, A TEMPERATURE TRANSMITTER (TT), WHICH IS INDEPENDENT OF THE HEAT TRACE CONTROLLER DESCRIBE ABOVE, SHALL BE INSTALLED ON THE PIPE SURFACE AND BELOW THE PIPE INSULATION. THE HEAT TRACE PIPING SHALL ALLOW THE BAS TO MONITOR THE PIPING SURFACE TEMPERATURE.

UPON A DROP IN PIPE SURFACE TEMPERATURE, AS MEASURED INDEPENDENT TEMPERATURE TRANSMITTER (TT), LOCATED ON THE PIPE SURFACE BUT BELOW THE PIPE INSULATION, BELOW 36°F (ADJUSTABLE AT THE BAS), THE BAS SHALL: PRODUCE A PIPE FREEZING ALARM FOR THE SPECIFIC PIPE. THE ALARM SHALL BE SILENCE ONLY AT THE AHU'S LOCAL CONTROL PANEL (LCP) BY THE MAINTENANCE STAFF AND UPON A RISE IN PIPE SURFACE TEMPERATURE, AS MEASURED INDEPENDENT TEMPERATURE TRANSMITTER (TT), LOCATED ON THE PIPE SURFACE BUT BELOW THE PIPE INSULATION, BELOW 40°F (ADJUSTABLE AT THE BAS).

UNOCCUPIED MODE

GENERAL

DURING THE UNOCCUPIED MODE OF OPERATION, THE AHU SYSTEM SHALL BE DE–ENERGIZED (ALL MOTORS OFF), ALL AUTOMATIC CONTROL DAMPERS, (SD's AND M's), COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) AND AUTOMATIC VALVES SHALL BE CLOSED; UNLESS OTHER WISE DESCRIBED BELOW. THE BAS SHALL: MONITOR AND RECORD ALL DATA AS DESCRIBED WITHIN THE OCCUPIED MODE OF OPERATION.

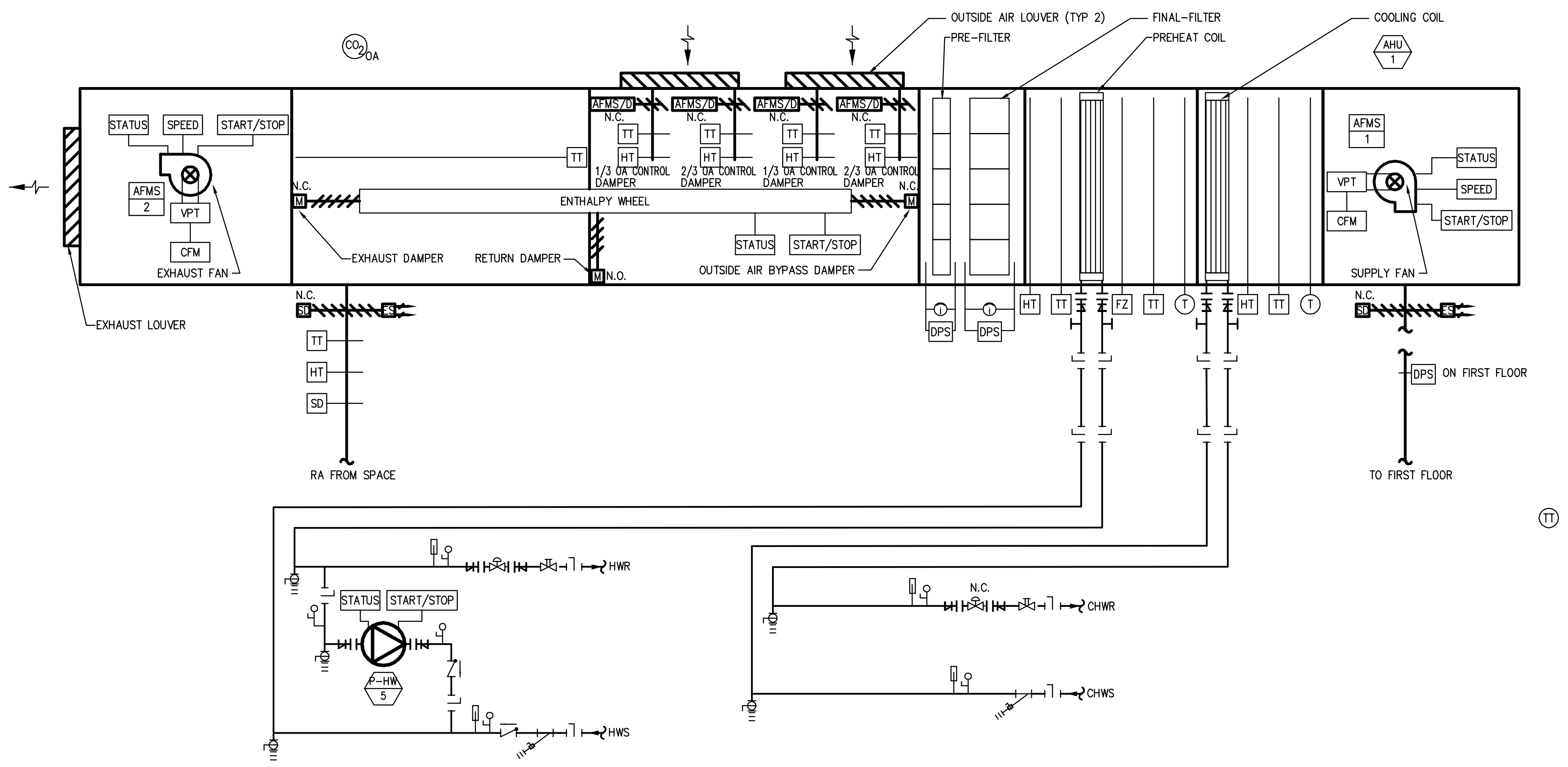
TEMPERATURE CONTROL

UPON A DROP IN TEMPERATURE WITHIN THE AHU CASING, AS MEASURED BY THE ANY OF TEMPERATURE TRANSMITTERS (TT's), LOCATED DOWNSTREAM OF ANY OF THE COILS, BELOW 45°F (ADJUSTABLE), THE BAS SHALL: FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL. UPON A RISE IN TEMPERATURE WITHIN THE AHU CASING, AS MEASURED BY ALL OF THE TEMPERATURE TRANSMITTERS, LOCATED DOWNSTREAM OF THE COILS, ABOVE 50°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A DROP IN TEMPERATURE WITHIN THE AHU CASING, AS MEASURED BY THE ANY OF TEMPERATURE TRANSMITTERS (TT's), LOCATED DOWNSTREAM OF ANY OF THE COILS, BELOW 42°F (ADJUSTABLE), THE BAS SHALL: FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL; OPEN FULLY OPEN THE RETURN AIR DAMPER; AND ENERGIZE THE SUPPLY AIR FAN. UPON A RISE IN TEMPERATURE WITHIN THE AHU CASING, AS MEASURED BY ALL OF THE TEMPERATURE TRANSMITTERS, LOCATED DOWNSTREAM OF THE COILS, ABOVE 50°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY ANY OF THE TEMPERATURE TRANSMITTER (TT's) LOCATED DOWNSTREAM OF THE COILS OR THE FREEZSTAT (FZ), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 38°F (ADJUSTABLE), THE BAS SHALL: FULLY CLOSE THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL; ENERGIZE THE FREEZE PROTECTION PUMP (P–HW–6) AND PRODUCE A FREEZING CONDITION ALARM FOR THE SPECIFIC AHU SYSTEM. THE NORMAL OPERATION OF THE PREHEAT COIL CONTROL SHALL ONLY BE RESET AT THE LOCAL CONTROL PANEL (LCP) FOR THE AHU AND UPON A RISE IN TEMPERATURE, AS MEASURED BY ALL OF THE TEMPERATURE TRANSMITTERS (TT's), LOCATED DOWNSTREAM OF THE COILS AND THE FREEZSTAT (FZ), LOCATED DOWNSTREAM OF THE PREHEAT COIL, ABOVE 45°F (ADJUSTABLE).

THE OPERATION OF THE ELECTRIC HEAT TRACE, AS DESCRIBE WITHIN THE OCCUPIED MODE OF OPERATION SHALL ALSO BE OPERATION DURING THE UNOCCUPIED MODE OF OPERATION.



A7 AHU-1 CONTROL SEQUENCE

NO SCALE

GENERAL NOTES:

1. THE BAS SHALL HAVE A SEQUENTIAL RESTART PROGRAM FOR THE RESTART OF ALL EQUIPMENT UPON RESTORATION OF NORMAL ELECTRICAL POWER AFTER A LOSS OF NORMAL POWER.
2. ALL BAS INFORMATION SHALL BE TRUE–TIME AND CONTINUOUS BY NATURE.
3. SPACE TEMPERATURE SETPOINTS SHALL BE ADJUSTABLE MANUALLY BY THE BAS OPERATOR ON A LOCAL (INDIVIDUAL ZONE) LEVEL OR ON A GLOBAL (WHOLE SYSTEM) LEVEL.
4. THE BAS SHALL MONITOR AND DISPLAY THE FOLLOWING:
   A. ALL ALARMS.
   B. ALL SETPOINTS.
   C. THE STATUS OF ALL EQUIPMENT AND DEVICES.
   D. ALL WATER FLOWS (GPM), AS MEASURED BY FLOW METERS (FM).
   E. ALL AIR FLOW (CFM), AS MEASURED BY AIR FLOW MEASURING STATIONS (AFMS) OR COMBINATION AIR FLOW MEASURING STATION / DAMPERS (AFMS/D).
   F. ALL VFD SPEED (% OF DESIGN), AS MEASURED BY THE VFD CONTROLLERS (VFD).
   G. ALL HVAC ELECTRICAL ENERGY USAGE (KW), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   H. ALL HVAC ELECTRICAL POWER USAGE (KH/Hr), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   I. ALL TEMPERATURES (°F), AS MEASURED BY TEMPERATURE TRANSMITTERS (TT).
   J. ALL HUMIDITY LEVELS (RH), AS MEASURED BY HUMIDITY TRANSMITTERS (HT).
   K. ALL CONTROL VALVE POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL VALVE POSITIONING SENSORS.
   L. ALL CONTROL DAMPER POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL DAMPER POSITIONING SENSORS.
   M. ALL PRESSURE READINGS (PSIG OR PSID), AS MEASURED BY PRESSURE SENSORS (PS) OR DIFFERENTIAL PRESSURE SENSORS (DPS).

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CONTROL DIAGRAMS

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A1 **NOT USED**

NONE

AIR HANDLING UNIT SERVING LECTURE HALL – AHU-2 – SEQUENCE OF OPERATIONS

GENERAL

PROVIDE A FULLY IMPLEMENTED APPLICATION AND CUSTOM SOFTWARE AND CONTROLS NECESSARY TO ACCOMPLISH THE CONTROL SEQUENCE AS FOLLOWS:

THE AIR HANDLING UNIT SYSTEM SHALL BE ENERGIZED OR DE–ENERGIZED EITHER MANUALLY BY THE BAS OPERATOR OR AUTOMATICALLY BY THE BAS SCHEDULE.

AIR HANDLING UNIT MANUFACTURER SHALL PROVIDE A DRY CONTACT FOR GENERAL ALARMING PURPOSE IF ANY OF THE EQUIPMENT FAILS TO START OR FUNCTION AS DESCRIBED HEREIN.

ALL SET POINTS AND TIME DELAYS ARE ADJUSTABLE.

IN THE EVENT OF POWER FAILURE ALL CONTROL SHALL GO TO THEIR FAIL SAFE POSITIONS, NORMALLY OPEN OR NORMALLY CLOSED.

UPON AHU–2 BEING DE–ENERGIZED, THE BAS SHALL: STOP POWER TO ALL MOTORS, CLOSE ALL DAMPERS AND CLOSE ALL VALVES. UPON AHU–2 BEING ENERGIZED. THE BAS SHALL: COMPLETE THE SEQUENCES AS DESCRIBED WITHIN.

THE BAS OPERATOR SHALL BE ABLE TO SCHEDULE THE MODE OF OPERATION OF THE AHU SYSTEM (OCCUPIED OR UNOCCUPIED MODES OF OPERATION) THROUGH THE BAS USING A GRAPHIC INTERFACE SIMILAR TO A DAILY PLANNER FOR UP TO ONE CALENDAR YEAR. THE SCHEDULE SHALL BE ABLE TO BE OVER RIDDEN BY THE BAS OPERATOR AS THE OCCASION ARISES.

OCCUPIED MODE

FAN CONTROL

THE BAS SHALL: MONITOR THE STATUS OF EACH OF THE FANS (SUPPLY AND EXHAUST) THROUGH EACH OF THE CURRENT SENSING RELAYS.

THE BAS SHALL: MONITOR THE SPEED OF EACH OF THE FANS (SUPPLY AND EXHAUST) THROUGH EACH OF THE VFD CONTROLLERS.

THE BAS SHALL: RECORD AND REPORT THE DURATION THAT EACH OF THE FANS (SUPPLY AND EXHAUST) OPERATES AT A SPECIFIC SPEED ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING HOURS AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF FAN'S SPEED.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, FOR EACH OF THE FANS (SUPPLY AND EXHAUST) THROUGH AN ELECTRIC METER INSTALLED WITHIN EACH FAN'S POWER WIRING.

THE BAS SHALL CALCULATE AND MONITOR EACH OF THE FAN'S (SUPPLY AND EXHAUST) ENERGY USAGE AT VARIOUS FAN SPEEDS. THE BAS SHALL ALSO RECORD AND REPORT THE ENERGY USAGE AT VARIOUS FAN SPEEDS FOR EACH OF THE FANS (SUPPLY AND EXHAUST) ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL BE IN TABULAR FORM AND GRAPHIC FORM WITH ONE AXIS ON THE GRAPH LISTING ENERGY USAGE, IN KW, AND THE OTHER AXIS OF THE GRAPH LISTING PERCENTAGE OF FAN'S SPEED.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE FOR EACH FAN (SUPPLY AND EXHAUST) ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

THE EXHAUST FAN SHALL BE BE ELECTRICALLY INTERLOCKED WITH THE SUPPLY FAN.

UPON AHU–2 BEING ENERGIZED, THE BAS SHALL: OPEN THE SMOKE DAMPERS (SD) LOCATED ON THE SUPPLY RETURN MAINS, AND OPEN THE INTEGRAL RETURN AIR CONTROL DAMPER (D). UPON THE DAMPERS BEING PROVEN OPEN VIA END SWITCH CLOSURES, THE BAS SHALL: ENERGIZE THE SUPPLY FAN. UPON AHU–2 BEING DE–ENERGIZED, THE REVERSE SHALL OCCUR.

UPON EITHER THE DUCT MOUNTED SMOKE DETECTORS (SD), LOCATED IN THE RETURN AIR MAIN OR IN THE SUPPLY AIR MAIN DETECT THE PRODUCTS OF COMBUSTION, THE BAS SHALL: DE–ENERGIZE THE SUPPLY AND EXHAUST AIR FANS, CLOSE ALL OF ITS CONTROL DAMPERS (M or SD), REGISTER AND RECORD A SMOKE ALARM FOR AIR HANDLING UNIT–2, AND THE DEVICE THAT CAUSED THE ALARM (EITHER THE SUPPLY OR RETURN AIR SYSTEM).

THE SUPPLY FAN AIR FLOW RATE SHALL BE ADJUSTED AUTOMATICALLY THROUGH THE BAS SCHEDULE, MANUALLY BY THE BAS OPERATOR, OR FROM THE MANUAL SPEED CONTROLLER SELECTOR SWITCH LOCATED IN THE CONTROL ROOM WITHIN THE LECTURE HALL. THE PREPROGRAM SPEEDS SHALL BE: 100% OF SCHEDULED AIR FLOW; 75% (ADJUSTABLE) OF THE SCHEDULED AIR SPEED; AND 50% (ADJUSTABLE) OF THE SCHEDULED AIR FLOW. UPON A SPEED BE DETERMINED EITHER AUTOMATICALLY OR MANUALLY, THE BAS SHALL: ADJUST THE SUPPLY FAN'S SPEED THROUGH ITS VFD CONTROLLER TO MAINTAIN THE SELECTED AIR FLOW RATE, AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE SUPPLY FAN'S INLET (AFMS–3).

UPON A RISE IN THE EXHAUST AIR FLOW RATE, AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE INLET OF THE EXHAUST FAN (AFMS–4), OF MORE THAN THE SUM OF THE OUTSIDE AIR INTAKES, AS MEASURED BY THE COMBINATION AIR FLOW MEASURING STATION / CONTROL DAMPERS (AFMS/D) MINUS 1,000 CFM (ADJUSTABLE), THE BAS SHALL: DECREASE THE EXHAUST FAN'S SPEED THROUGH ITS VFD CONTROLLER. UPON A DROP IN THE EXHAUST AIR FLOW RATE, AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE INLET OF THE EXHAUST FAN (AFMS–4), OF LESS THAN THE SUM OF THE OUTSIDE AIR INTAKES, AS MEASURED BY THE COMBINATION AIR FLOW MEASURING STATION/CONTROL DAMPERS (AFMS/D's) MINUS 700 CFM (ADJUSTABLE), THE REVERSE SHALL OCCUR.

RETURN DAMPER, RELIEF DAMPER, COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR INTAKE DAMPERS, OUTSIDE AIR BYPASS DAMPER AND ENTALPHY WHEEL CONTROL

THE BAS SHALL: MONITOR THE STATUS THE ENTHALPY WHEEL'S MOTOR THROUGH THE CURRENT SENSING RELAY.

THE BAS SHALL: MONITOR AND RECORD THE ELECTRIC USAGE, IN KW, FOR THE ENTHALPY WHEEL'S MOTOR THROUGH AN ELECTRIC METER INSTALLED WITHIN THE POWER WIRING.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE ELECTRICAL ENERGY USAGE FOR THE ENTHALPY WHEEL'S MOTOR ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL HAVE THE UNITS OF KW/HR.

THE BAS SHALL: CALCULATE, RECORD AND REPORT THE THE AMOUNT OF OUTSIDE AIR INTRODUCED INTO AHU–2, AS MEASURED BY THE COMBINATION AIR FLOW MEASURING STATION / DAMPERS (AFMS/D) ON A DAILY, WEEKLY, MONTHLY AND YEARLY BASIS. THE REPORTS SHALL PRODUCE AN AVERAGE AMOUNT OF OUTSIDE AIR FOR THE PERIOD AND HAVE THE UNITS OF CUBIC FEET OF OUTSIDE AIR / MINUTE (AVERAGE)

THE ENTHALPY WHEEL'S SPEED SHALL BE CONSTANT AND HARD BALANCED BY THE TAB CONTRACTOR. THE BAS SHALL NOT BE ABLE TO VARY THE SPEED OF THE ENTHALPY WHEEL.

THE AHU HAS TWO OUTSIDE AIR LOUVERS (ONE ON THE LEFT HAND SIDE AND ONE ON THE RIGHT). EACH OUTSIDE LOUVER SHALL HAVE A MINIMUM CAPACITY OF 50% OF THE UNIT'S MAXIMUM SUPPLY AIR FLOW RATE (CFM). EACH LOUVER SHALL HAVE TWO – COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) THAT ARE SIZED TO PROVIDE 1/3 – 2/3 CONTROL FOR EACH LOUVER. THE BAS SHALL: ALTERNATE LEAD/LAG OPERATION (BETWEEN THE LEFT AND RIGHT HAND SIDE OF THE AHU) TO EQUALIZE THE USAGE OF THE LOUVERS AND COMBINATION AIR FLOW MEASURING STATIONS / OUTSIDE AIR DAMPERS (AFMS/D's); THE LEAD/LAG SELECTION SHALL BE EVALUATED ON A WEEKLY BASIS (ADJUSTABLE); THE LOUVER WITH THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPER (AFMS/D) ASSOCIATED WITH THE 1/3 AIR FLOW CONTROL THAT HAS THE LEAST TIME IN OPERATION SHALL DICTATE THE LEAD LOUVER. THE BAS SHALL: OPERATE THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS./D's) AS DESCRIBED IN THE MATRIX BELOW:

% OF MAX OA FLOW	OPERATION OF 2/3 AFMS/D ON LEAD LOUVER	OPERATION OF 1/3 AFMS/D ON LEAD LOUVER	OPERATION OF 2/3 AFMS/D ON LAG LOUVER	OPERATION OF 1/3 AFMS/D ON LAG LOUVER
0–17	CLOSED	MODULATING	CLOSED	CLOSED
18–50	CLOSED	MODULATING	MODULATING	CLOSED
50–67	CLOSED	OPEN	OPEN	MODULATING
68–100	MODULATING	OPEN	OPEN	MODULATING
83–100	OPEN	OPEN	OPEN	MODULATING

UPON A DROP IN THE AIR FLOW RATE (CFM), AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE INLET OF THE SUPPLY FAN (AFMS–3), BELOW 5% (ADJUSTABLE) THE SCHEDULED AIR FLOW RATE, AS DESCRIBED ABOVE, THE BAS SHALL: MODULATE THE RETURN AIR DAMPER OPEN.

UPON A RISE IN THE AIR FLOW RATE (CFM), AS MEASURED BY THE AIR FLOW MEASURING STATION LOCATED IN THE INLET OF THE SUPPLY FAN (AFMS–3), ABOVE 5% (ADJUSTABLE) THE SCHEDULED AIR FLOW RATE, AS DESCRIBED ABOVE, THE REVERSE SHALL OCCUR.

UPON THE AHU–2 BEING ENERGIZED AND THE SUPPLY FAN HAS BEEN ENERGIZED FOR 5 MINUTES (ADJUSTABLE), THE BAS SHALL: OPEN THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's)TO THEIR MINIMUM SCHEDULED AIR FLOW RATE POSITIONS, AS MEASURED BY THE COMBINATION AIR FLOW FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's).

AFTER THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) ARE OPERATING AT THEIR MINIMUM SCHEDULED AIR FLOW RATE POSITIONS FOR 5 MINUTES (ADJUSTABLE), THE BAS SHALL: COMPARE THE CONCENTRATION OF CARBON DIOXIDE IN THE RETURN AIR, AS MEASURED BY THE CO2 MONITOR LOCATED IN THE RETURN AIR MAIN (CO2), TO THE OUTSIDE AIR'S CONCENTRATION OF CARBON DIOXIDE, AS MEASURED BY THE GLOBAL OUTSIDE AIR CARBON DIOXIDE MONITOR (CO2–OA). IF ABSOLUTE DIFFERENCE IN THE CONCENTRATION OF CARBON DIOXIDE BETWEEN THE OUTSIDE AND RETURN AIR IS LESS THAN 500 PART PER MILLION (ADJUSTABLE), THE BAS SHALL: REDUCE THE OUTSIDE AIR AIR FLOW RATE (CFM) SETPOINTS FOR THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) BY 5% (ADJUSTABLE), UNLESS THE AHU IS OPERATION WITHIN AN ENTHALPY ECONOMIZER (FREE COOLING) MODE. IF ABSOLUTE DIFFERENCE IN THE CONCENTRATION OF CARBON DIOXIDE BETWEEN THE OUTSIDE AND RETURN AIR IS MORE THAN 530 PART PER MILLION (ADJUSTABLE), THE BAS SHALL: INCREASE THE OUTSIDE AIR AIR FLOW RATE (CFM) SETPOINTS FOR THE COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) BY 5% (ADJUSTABLE).

THE BAS SHALL: CONTROL THE DAMPERS AND ENTHALPY WHEEL, AS DESCRIBE IN THE MATRIX BELOW:

OA AIR TEMP	OA AIR RH	MIXED AIR TEMP	MIX AIR RH	EXH AIR TEMP	ENTHALPY WHEEL MOTOR	OUTSIDE AIR DAMPERS	OUTSIDE AIR BYPASS DAMPER	RETURN AIR DAMPER	RELIEF AIR BYPASS DAMPER
>62°F	>61%	N.A.	N.A.	N.A.	ON	MIN	CLOSED	MAX	CLOSED
<62°F, >44°F	<65% ①	>62°F	<61%	N.A.	OFF	MODULATING TO MAX	OPEN	MODULATING TO MIN	OPEN
<62°F, >44°F	<65% ①	<62°F	<61%	N.A.	OFF	MODULATING TO MIN	OPEN	MODULATING TO MAX	OPEN
<42°F	N.A.	>62°F	>62°F	N.A.	ON	MIN	CLOSED	MAX	CLOSED
<25°F	<100%	N.A.	N.A.	<25°F	OFF	MIN	OPEN	MAX	OPEN

NOTE ① : FOR THE ECONOMIZER (FREE COOLING) MODE OF OPERATION.

FILTER CONTROL

UPON A RISE IN DIFFERENTIAL AIR PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRE–FILTER, ABOVE 0.50" WG (ADJUSTABLE), THE BAS SHALL: PRODUCE A PRE–FILTER DIRTY ALARM FOR THE SPECIFIC AHU SYSTEM. UPON A DROP IN DIFFERENTIAL AIR PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRE–FILTER, BELOW 0.40" WG (ADJUSTABLE), THE REVERSE SHALL OCCUR AND THE ALARM SILENCED.

UPON A RISE IN DIFFERENTIAL AIR PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE FINAL–FILTER, ABOVE 2.00" WG (ADJUSTABLE), THE BAS SHALL: PRODUCE A FINAL–FILTER DIRTY ALARM FOR THE SPECIFIC AHU SYSTEM. UPON A DROP IN DIFFERENTIAL AIR PRESSURE, AS MEASURED BY THE DIFFERENTIAL PRESSURE SENSOR (DPS) ACROSS THE PRE–FILTER, BELOW 1.75" WG (ADJUSTABLE), THE REVERSE SHALL OCCUR AND THE ALARM SILENCED.

PREHEAT COIL CONTROL

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 49°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL. UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, ABOVE 50°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 42°F (ADJUSTABLE), THE BAS SHALL: FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL AND PRODUCE A FREEZING CONDITION ALARM WARNING FOR THE SPECIFIC AHU SYSTEM. UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, ABOVE 45°F (ADJUSTABLE), THE REVERSE SHALL OCCUR AND THE WARNING SHALL BE SILENCED.

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY EITHER THE TEMPERATURE TRANSMITTER (TT) OR THE FREEZSTAT (FZ), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 38°F (ADJUSTABLE), THE BAS SHALL: FULLY CLOSE THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL; ENERGIZE THE FREEZE PROTECTION PUMP (P–HW–6); FULLY OPEN THE RETURN AIR DAMPER, FULLY CLOSE ALL EXHAUST AND OUTSIDE AIR DAMPERS; AND PRODUCE A FREEZING CONDITION ALARM FOR THE SPECIFIC AHU SYSTEM. THE NORMAL OPERATION OF THE PREHEAT COIL CONTROL SHALL ONLY BE RESET AT THE LOCAL CONTROL PANEL (LCP) FOR THE AHU SYSTEM AND UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY EITHER THE TEMPERATURE TRANSMITTER (TT) OR THE FREEZSTAT (FZ), LOCATED DOWNSTREAM OF THE PREHEAT COIL, ABOVE 45°F (ADJUSTABLE). THE BAS SHALL MONITOR THE STATUS OF THE FREEZE PROTECTION PUMP (P–HW–6) THROUGH THE CURRENT SENSING RELAY.

COOLING COIL CONTROL

UPON A DROP IN OUTSIDE AIR TEMPERATURE, AS MEASURED BY THE GLOBAL OUTSIDE AIR TEMPERATURE TRANSMITTER (OATT), THE BAS SHALL LOCKOUT THE NORMAL CONTROL FOR THE COOLING COIL AS DESCRIBE HEREIN AND THE COOLING COIL SHALL BE DRAINED AND WINTERIZED BY MAINTENANCE STAFF TO PREVENT FREEZING OF THE COIL.

UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE COOLING COIL, ABOVE 62°F (ADJUSTABLE) AND A RISE IN AIR RELATIVE HUMIDITY, AS MEASURED BY THE HUMIDITY TRANSMITTER (HT), LOCATED DOWNSTREAM OF THE COOLING COIL ABOVE 65% (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE LOCATED IN THE CHILLED WATER RETURN PIPING TO THE COOLING COIL. UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE COOLING COIL, BELOW 60°F (ADJUSTABLE) AND A BELOW IN AIR RELATIVE HUMIDITY, AS MEASURED BY THE HUMIDITY TRANSMITTER (HT), LOCATED DOWNSTREAM OF THE COOLING COIL BELOW 69% (ADJUSTABLE), THE BAS SHALL: MODULATE CLOSED THE CONTROL VALVE LOCATED IN THE CHILLED WATER RETURN PIPING TO THE COOLING COIL.

REHEAT COIL CONTROL

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 63°F (ADJUSTABLE), THE BAS SHALL: MODULATE OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE REHEAT COIL. UPON A RISE IN AIR TEMPERATURE, AS MEASURED BY THE TEMPERATURE TRANSMITTER (TT), LOCATED DOWNSTREAM OF THE REHEAT COIL, ABOVE 65°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE ANY OF THE 10 WALL TEMPERATURE TRANSMITTER (TT), LOCATED WITHIN THE LECTURE HALL, BELOW 66°F (ADJUSTABLE) FOR MORE THAN 10 MINUTES (ADJUSTABLE), THE BAS SHALL: INCREASE THE SUPPLY AIR TEMPERATURE SETPOINT FOR THE REHEAT COIL BY 2°F (ADJUSTABLE). UPON A RISE IN SPACE TEMPERATURE, AS MEASURED BY THE ALL OF THE 10 WALL TEMPERATURE TRANSMITTER (TT), LOCATED WITHIN THE LECTURE HALL, ABOVE 73°F FOR WINTER AND 76°F FOR SUMMER (ADJUSTABLE) FOR MORE THAN 10 MINUTES (ADJUSTABLE), THE REVERSE SHALL OCCUR.

ELECTRIC HEAT TRACE CONTROL

ALL PIPING LOCATED ABOVE THE ROOF (HOT WATER, CHILLED WATER AND DRAINS), INCLUDING PIPING WITHIN THE AHU'S PIPING VESTIBULES, SHALL BE ELECTRICALLY HEAT TRACE. EACH PIPE SHALL BE CONTROLLED AND CIRCUITED INDEPENDENT OF EACH OTHER. PIPING SHALL BE HEAT TRACED AFTER THE PIPING SECTION HAS BEEN PRESSURE TESTED AND PRIOR TO THE INSTALLATION OF THE INSULATION.

UPON A DROP IN PIPE SURFACE TEMPERATURE, AS MEASURED INTEGRAL TEMPERATURE CONTROLLER FOR THE HEAT TRACE, LOCATED ON THE PIPE SURFACE BUT BELOW THE PIPE INSULATION, BELOW 40°F (ADJUSTABLE AT THE PIPING), THE HEAT TRACE SHALL BE ENERGIZED. UPON A RISE IN PIPE SURFACE TEMPERATURE, AS MEASURED INTEGRAL TEMPERATURE CONTROLLER FOR THE HEAT TRACE, LOCATED ON THE PIPE SURFACE BUT BELOW THE PIPE INSULATION, ABOVE 40°F (ADJUSTABLE AT THE PIPING), THE REVERSE SHALL OCCUR.

FOR EACH PIPE, A TEMPERATURE TRANSMITTER (TT), WHICH IS INDEPENDENT OF THE HEAT TRACE CONTROLLER DESCRIBE ABOVE, SHALL BE INSTALLED ON THE PIPE SURFACE AND BELOW THE PIPE INSULATION. THE HEAT TRACE PIPING SHALL ALLOW THE BAS TO MONITOR THE PIPING SURFACE TEMPERATURE.

UPON A DROP IN PIPE SURFACE TEMPERATURE, AS MEASURED INDEPENDENT TEMPERATURE TRANSMITTER (TT), LOCATED ON THE PIPE SURFACE BUT BELOW THE PIPE INSULATION, BELOW 36°F (ADJUSTABLE AT THE BAS), THE BAS SHALL: PRODUCE A PIPE FREEZING ALARM FOR THE SPECIFIC PIPE. THE ALARM SHALL BE SILENCE ONLY AT THE AHU'S LOCAL CONTROL PANEL (LCP) BY THE MAINTENANCE STAFF AND UPON A RISE IN PIPE SURFACE TEMPERATURE, AS MEASURED INDEPENDENT TEMPERATURE TRANSMITTER (TT), LOCATED ON THE PIPE SURFACE BUT BELOW THE PIPE INSULATION, BELOW 40°F (ADJUSTABLE AT THE BAS).

UNOCCUPIED MODE

GENERAL

DURING THE UNOCCUPIED MODE OF OPERATION, THE AHU SYSTEM SHALL BE DE–ENERGIZED (ALL MOTORS OFF), ALL AUTOMATIC CONTROL DAMPERS, (SD's AND M's), COMBINATION AIR FLOW MEASURING STATION / OUTSIDE AIR DAMPERS (AFMS/D's) AND AUTOMATIC VALVES SHALL BE CLOSED; UNLESS OTHER WISE DESCRIBED BELOW. THE BAS SHALL: MONITOR AND RECORD ALL DATA AS DESCRIBED WITHIN THE OCCUPIED MODE OF OPERATION.

TEMPERATURE CONTROL

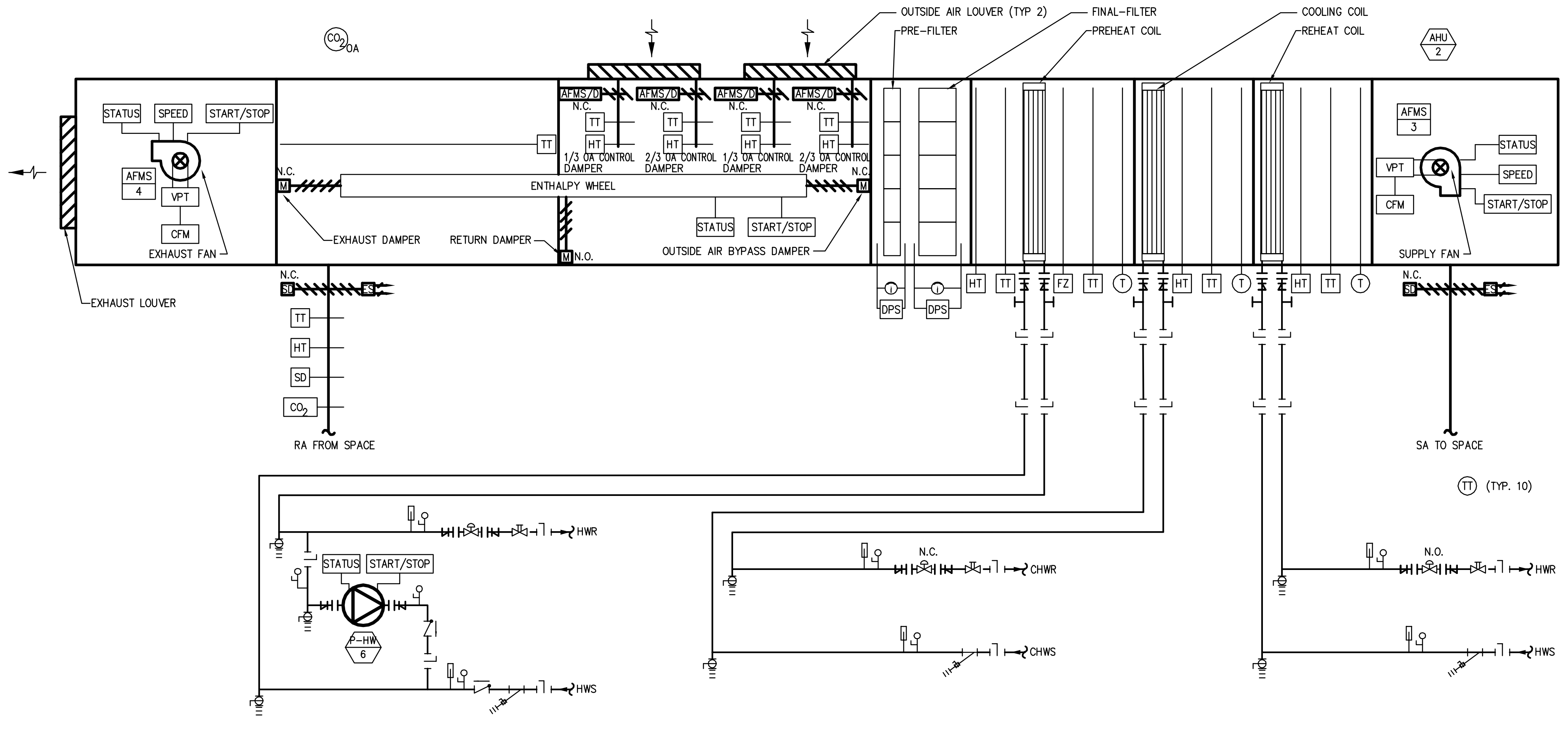
UPON A DROP IN SPACE TEMPERATURE, AS MEASURED BY THE ANY OF THE 10 WALL TEMPERATURE TRANSMITTER (TT), LOCATED WITHIN THE LECTURE HALL, BELOW 60°F (ADJUSTABLE) FOR MORE THAN 10 MINUTES (ADJUSTABLE), THE BAS SHALL: OPEN THE RETURN AIR DAMPER TO ITS FULL OPEN POSITION; FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL; FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE REHEAT COIL; AND ENERGIZE THE SUPPLY AIR FAN. UPON A RISE IN AIR TEMPERATURE, AS MEASURED SPACE TEMPERATURE, AS MEASURED BY THE ALL OF THE 10 WALL TEMPERATURE TRANSMITTER (TT), LOCATED WITHIN THE LECTURE HALL, BELOW 72°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A DROP IN TEMPERATURE WITHIN THE AHU CASING, AS MEASURED BY THE ANY OF TEMPERATURE TRANSMITTERS (TT's), LOCATED DOWNSTREAM OF ANY OF THE COILS, BELOW 45°F (ADJUSTABLE), THE BAS SHALL: FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL; AND FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE REHEAT COIL. UPON A RISE IN TEMPERATURE WITHIN THE AHU CASING, AS MEASURED BY ALL OF THE TEMPERATURE TRANSMITTERS, LOCATED DOWNSTREAM OF THE COILS, ABOVE 50°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A DROP IN TEMPERATURE WITHIN THE AHU CASING, AS MEASURED BY THE ANY OF TEMPERATURE TRANSMITTERS (TT's), LOCATED DOWNSTREAM OF ANY OF THE COILS, BELOW 42°F (ADJUSTABLE), THE BAS SHALL: FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL; FULLY OPEN THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE REHEAT COIL; OPEN FULLY OPEN THE RETURN AIR DAMPER; AND ENERGIZE THE SUPPLY AIR FAN. UPON A RISE IN TEMPERATURE WITHIN THE AHU CASING, AS MEASURED BY ALL OF THE TEMPERATURE TRANSMITTERS, LOCATED DOWNSTREAM OF THE COILS, ABOVE 50°F (ADJUSTABLE), THE REVERSE SHALL OCCUR.

UPON A DROP IN AIR TEMPERATURE, AS MEASURED BY ANY OF THE TEMPERATURE TRANSMITTER (TT's) LOCATED DOWNSTREAM OF THE COILS OR THE FREEZSTAT (FZ), LOCATED DOWNSTREAM OF THE PREHEAT COIL, BELOW 38°F (ADJUSTABLE), THE BAS SHALL: FULLY CLOSE THE CONTROL VALVE LOCATED IN THE HOT WATER RETURN PIPING TO THE PREHEAT COIL; ENERGIZE THE FREEZE PROTECTION PUMP (P–HW–6) AND PRODUCE A FREEZING CONDITION ALARM FOR THE SPECIFIC AHU SYSTEM. THE NORMAL OPERATION OF THE PREHEAT COIL CONTROL SHALL ONLY BE RESET AT THE LOCAL CONTROL PANEL (LCP) FOR THE AHU AND UPON A RISE IN TEMPERATURE, AS MEASURED BY ALL OF THE TEMPERATURE TRANSMITTERS (TT's), LOCATED DOWNSTREAM OF THE COILS AND THE FREEZSTAT (FZ), LOCATED DOWNSTREAM OF THE PREHEAT COIL, ABOVE 45°F (ADJUSTABLE).

THE OPERATION OF THE ELECTRIC HEAT TRACE, AS DESCRIBE WITHIN THE OCCUPIED MODE OF OPERATION SHALL ALSO BE OPERATION DURING THE UNOCCUPIED MODE OF OPERATION.



A7 **AHU-2 CONTROL SEQUENCE**

NO SCALE

GENERAL NOTES:

1. THE BAS SHALL HAVE A SEQUENTIAL RESTART PROGRAM FOR THE RESTART OF ALL EQUIPMENT UPON RESTORATION OF NORMAL ELECTRICAL POWER AFTER A LOSS OF NORMAL POWER.
2. ALL BAS INFORMATION SHALL BE TRUE–TIME AND CONTINUOUS BY NATURE.
3. SPACE TEMPERATURE SETPOINTS SHALL BE ADJUSTABLE MANUALLY BY THE BAS OPERATOR ON A LOCAL (INDIVIDUAL ZONE) LEVEL OR ON A GLOBAL (WHOLE SYSTEM) LEVEL.
4. THE BAS SHALL MONITOR AND DISPLAY THE FOLLOWING:
   A. ALL ALARMS.
   B. ALL SETPOINTS.
   C. THE STATUS OF ALL EQUIPMENT AND DEVICES.
   D. ALL WATER FLOWS (GPM), AS MEASURED BY FLOW METERS (FM).
   E. ALL AIR FLOW (CFM), AS MEASURED BY AIR FLOW MEASURING STATIONS (AFMS) OR COMBINATION AIR FLOW MEASURING STATION / DAMPERS (AFMS/D).
   F. ALL VFD SPEED (% OF DESIGN), AS MEASURED BY THE VFD CONTROLLERS (VFD).
   G. ALL HVAC ELECTRICAL ENERGY USAGE (KW), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   H. ALL HVAC ELECTRICAL POWER USAGE (KH/Hr), AS MEASURED BY ELECTRICAL METERS OR THRU VFD CONTROLLERS (VFD).
   I. ALL TEMPERATURES (°F), AS MEASURED BY TEMPERATURE TRANSMITTERS (TT).
   J. ALL HUMIDITY LEVELS (RH), AS MEASURED BY HUMIDITY TRANSMITTERS (HT).
   K. ALL CONTROL VALVE POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL VALVE POSITIONING SENSORS.
   L. ALL CONTROL DAMPER POSITIONS (% OF OPEN), AS MEASURED BY INTEGRAL DAMPER POSITIONING SENSORS.
   M. ALL PRESSURE READINGS (PSIG OR PSID), AS MEASURED BY PRESSURE SENSORS (PS) OR DIFFERENTIAL PRESSURE SENSORS (DPS).

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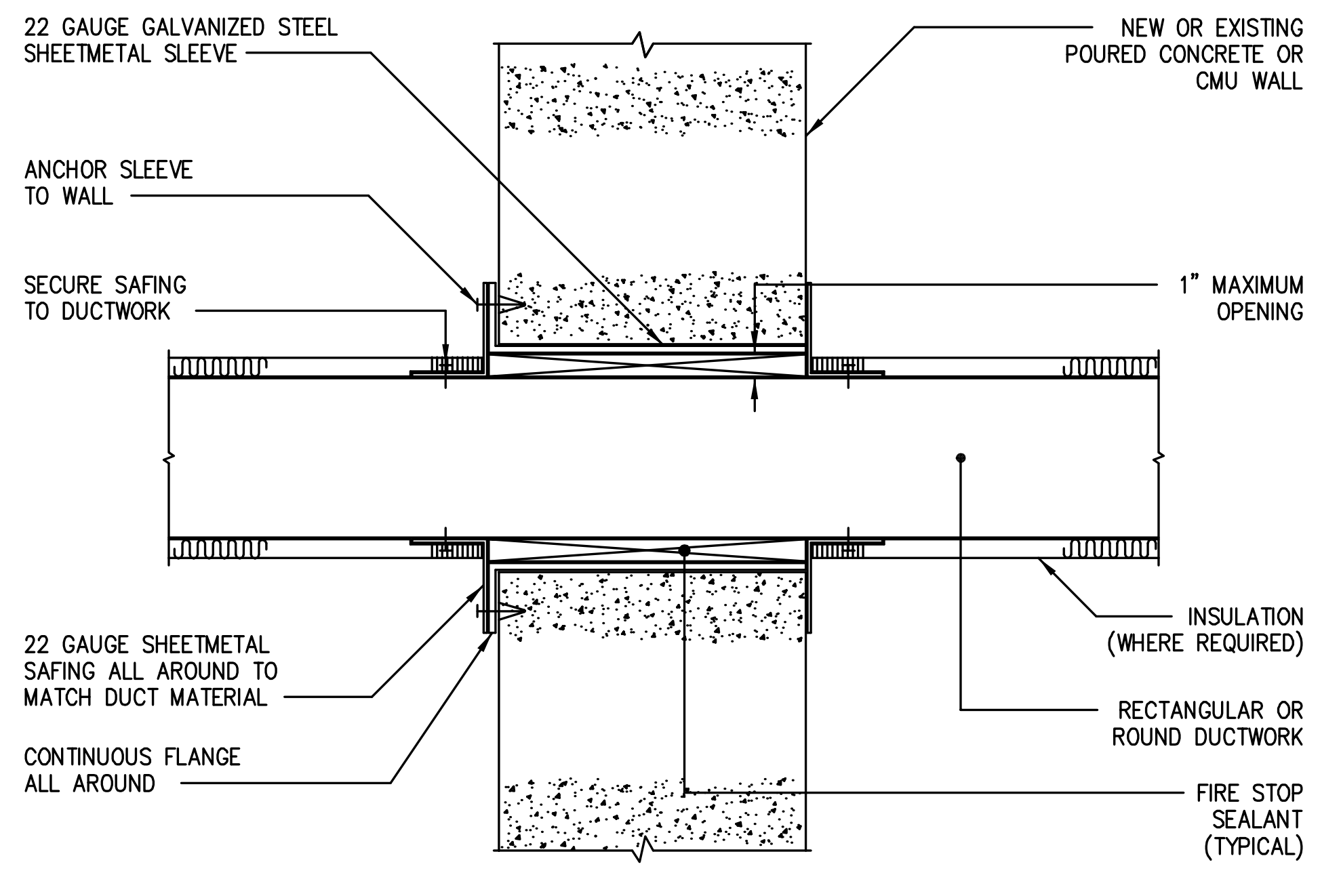
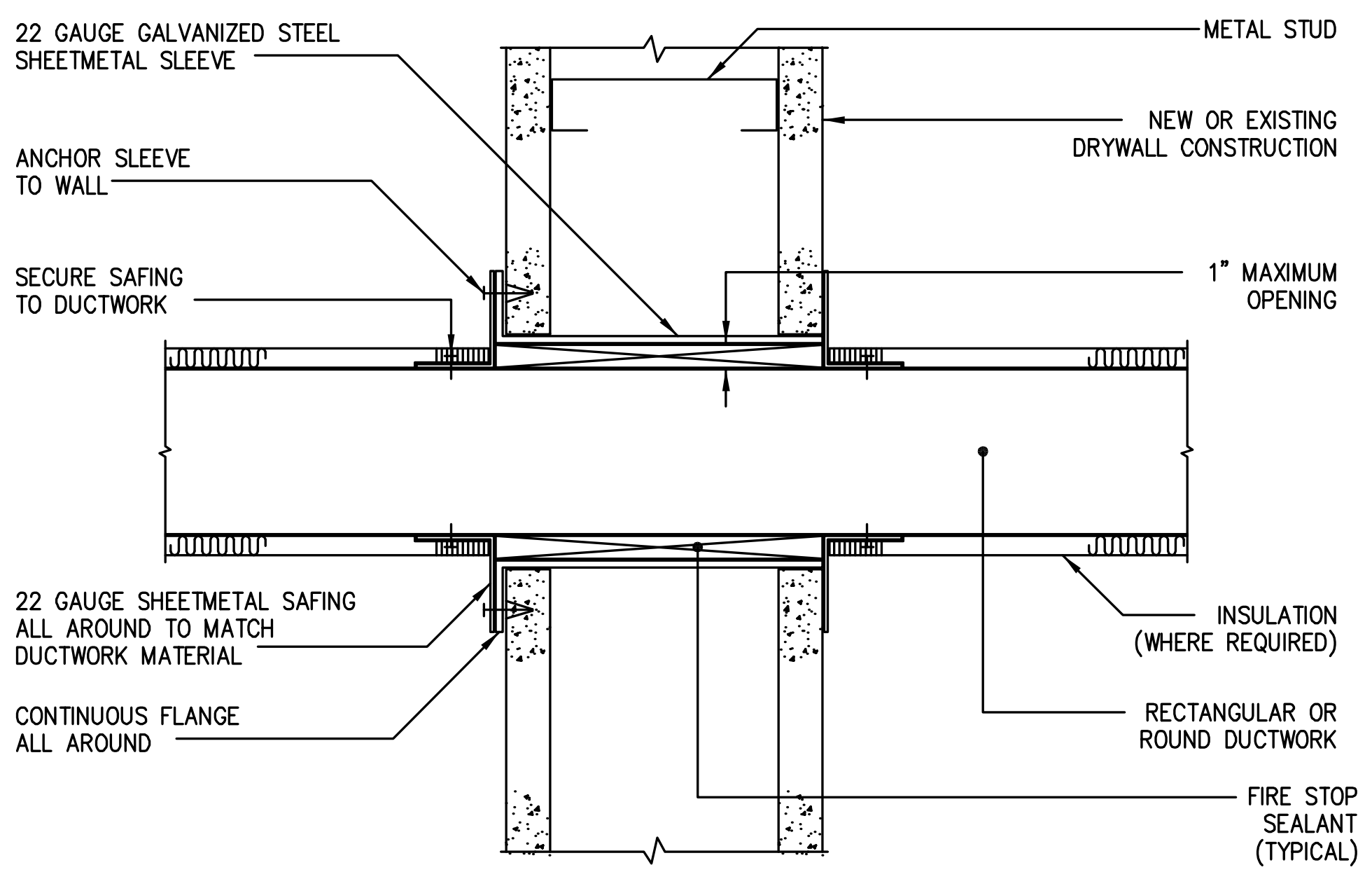


NOTE

FIRE STOP SEALANTS AND FIRE STOP PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE DIRECTORY.

M1 DUCT PENETRATION

NONE | 1-HOUR RATED WALLS



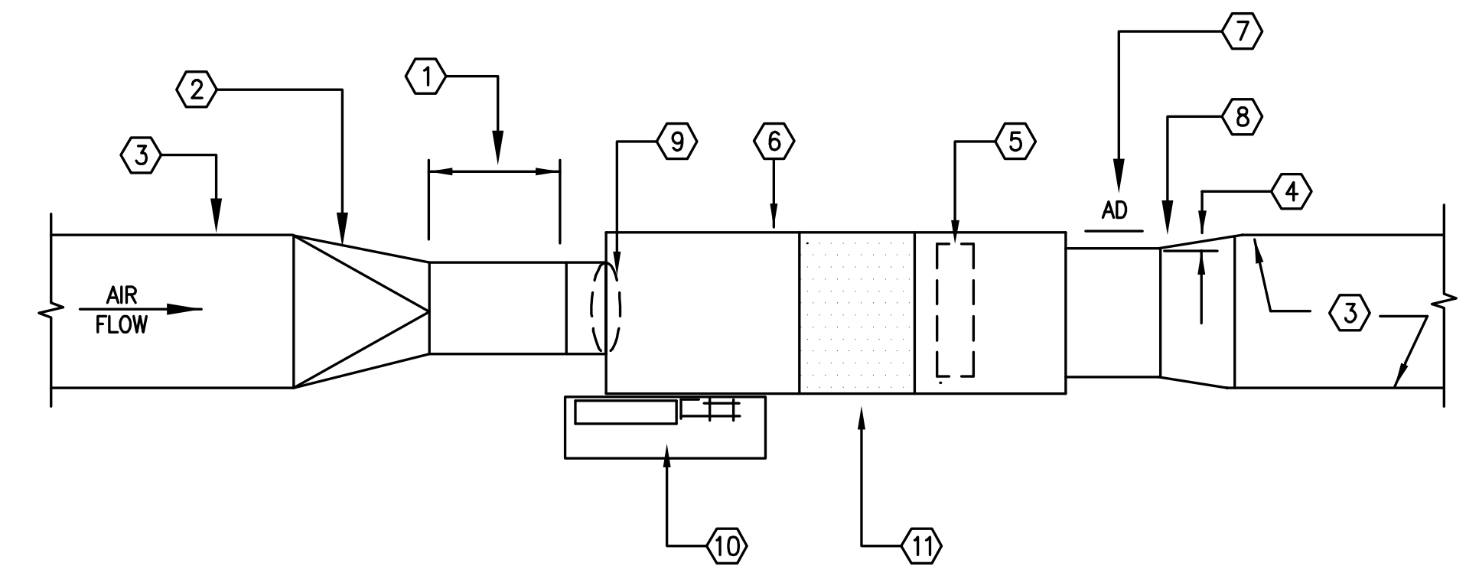
NOTE

FIRE STOP SEALANTS AND FIRE STOP PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE DIRECTORY.

M5 DUCT PENETRATION

NONE | 1-HOUR RATED WALLS

① 2 INLET DIAMETERS
② TRANSITION TO TERMINAL INLET DIAMETER
③ DUCT SIZE SHOWN ON PLANS
④ 15° MAXIMUM
⑤ REHEAT COIL
⑥ AIR TERMINAL UNIT
⑦ ACCESS DOORS, BOTTOM OR SIDE, BOTH SIDES OF COIL, AS SPECIFIED.
⑧ TRANSITION FROM TERMINAL OUTLET DIAMETER
⑨ CONTROL DAMPER
⑩ DAMPER ACTUATOR AND CONTROL BOX
⑪ MANUFACTURER'S INTEGRATED SOUND ATTENUATOR



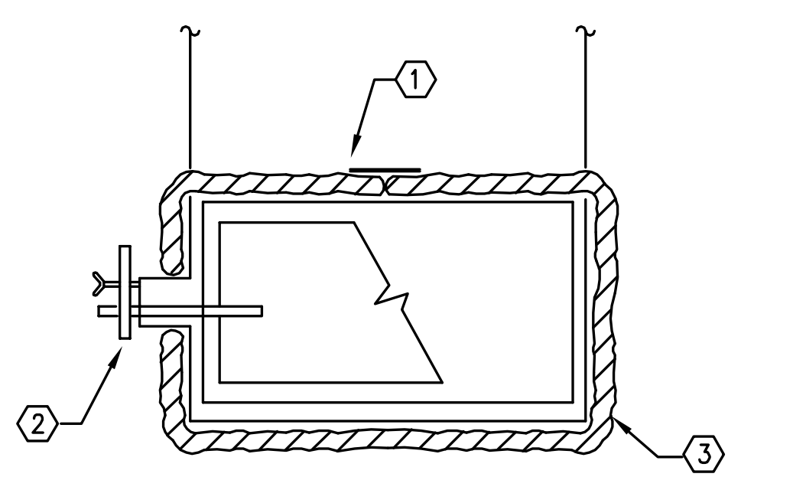
NOTE:

1. THE EXACT LOCATION OF AIR TERMINAL TO BE COORDINATED WITH ALL TRADES TO ASSURE NO CONFLICTS AND TO PROVIDE ACCESS TO CONTROLS, COIL, DAMPER, ACCESS DOORS AND ALL OTHER POINTS REQUIRING SERVICE AND MAINTANCE.

M9 AIR TERMINAL INSTALLATION

NONE | DETAIL

① PROVIDE 2" OVERLAP
② PROVIDE LOCKING QUADRANT ARM STANDOFF
③ PROVIDE EXTRA LENGTH TO AVOID "PINCHING" OF INSULATION AT CORNERS

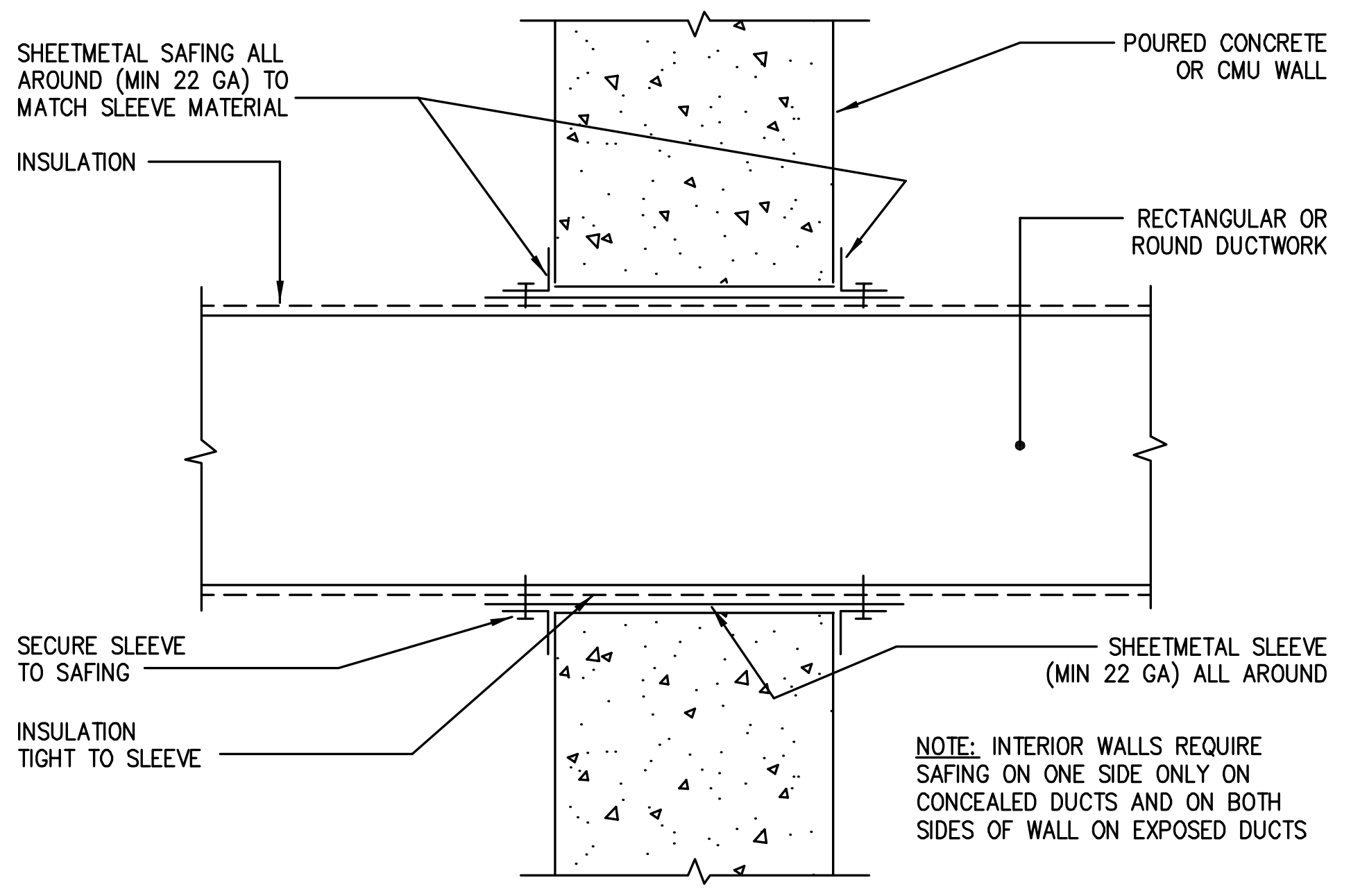


NOTE:

1. FOR HANGING DUCT: TRAPEZE DUCT OR STRAP HANGER AROUND THE DUCT COMPLETELY. DO NOT USE ANY SCREWS.
2. PLEASE REFER TO STRUCTURAL DWG S2.01, DETAIL 'N', FOR ATTACHING TO PRE-CAST "TEE".

M13 TYPICAL DUCT INSULATION

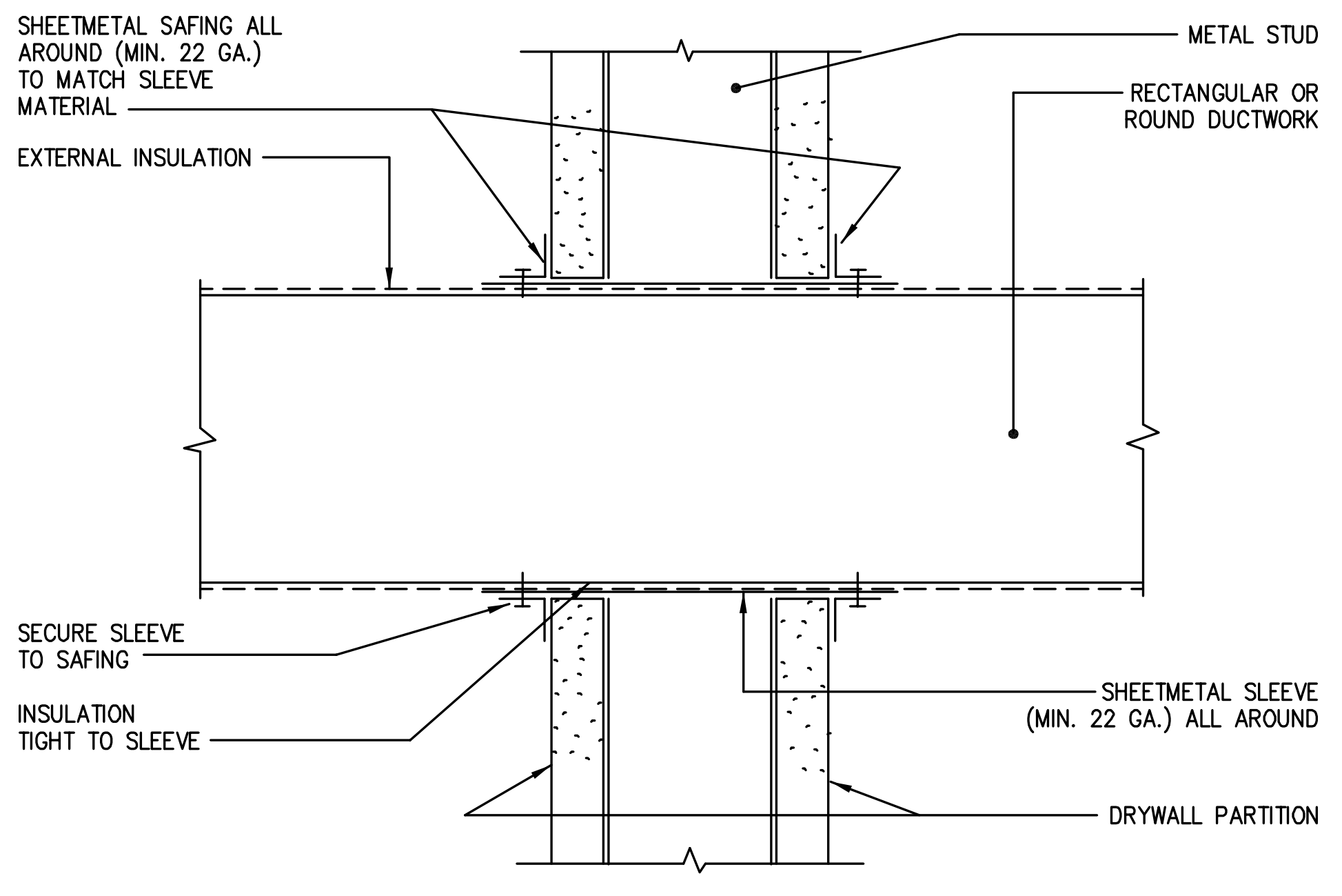
NONE | & SUPPORTS NEAR VOLUME DAMPERS DETAIL



NOTE: INTERIOR WALLS REQUIRE SAFING ON ONE SIDE ONLY ON CONCEALED DUCTS AND ON BOTH SIDES OF WALL ON EXPOSED DUCTS

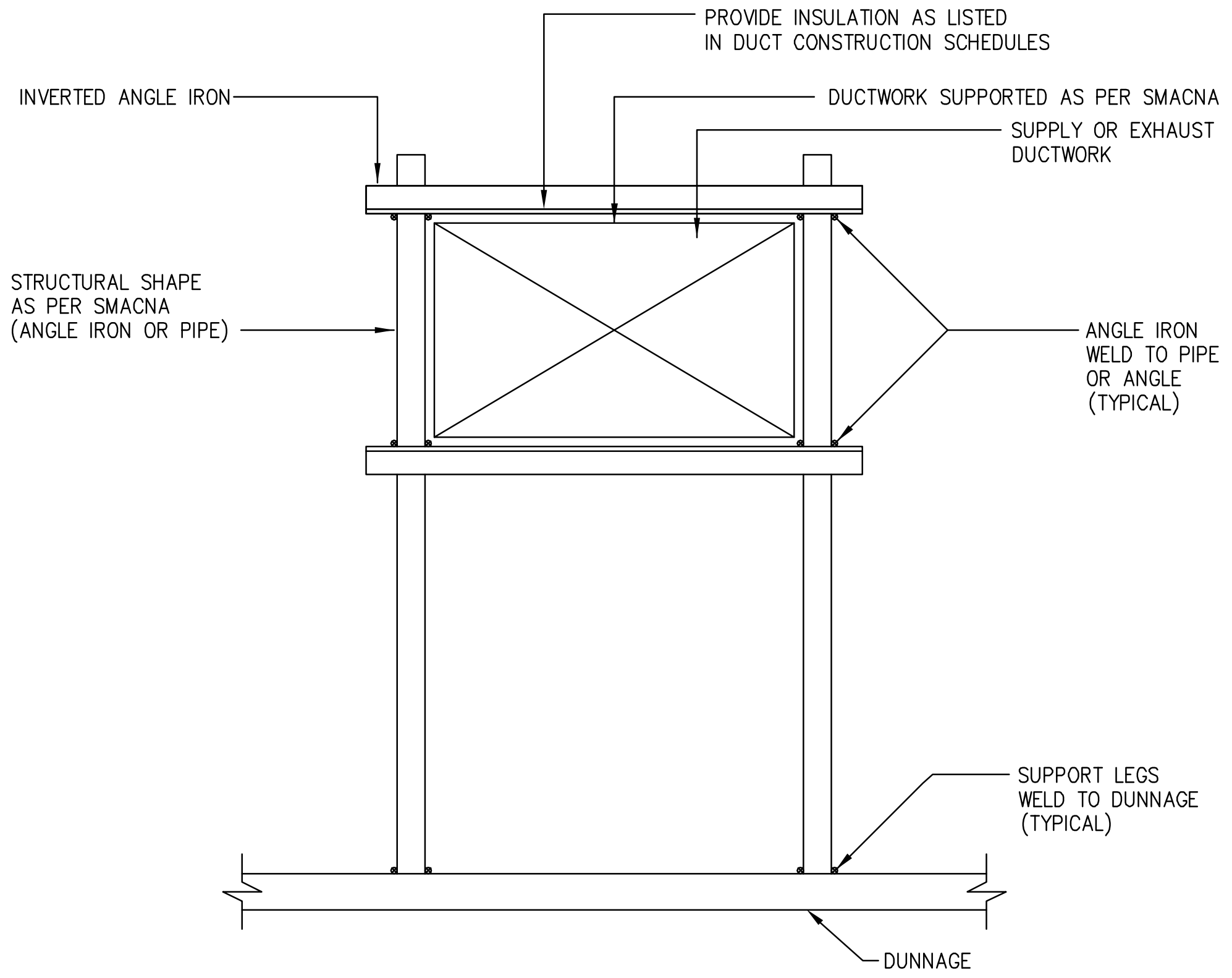
G1 DUCT PENETRATION

NONE | NON-FIRE RATED WALLS



G5 DUCT PENETRATION

NONE | NON-FIRE RATED WALLS



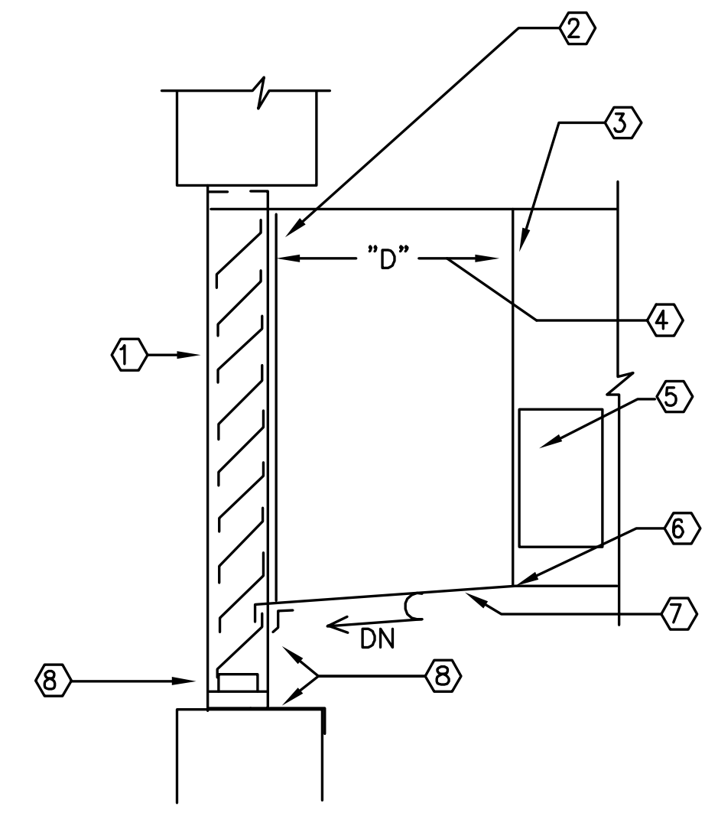
NOTES:

1. PROVIDE HEIGHTS TO ALLOW PROPER CLEARANCES FOR SERVICE, PERSONNEL, AND EQUIPMENT.
2. PROVIDE CROSS BRACING, AS REQUIRED, FOR RIGIDITY.

G9 RECTANGULAR DUCT SUPPORT

NONE | DUNNAGE

① STORM-PROOF LOUVER
② 1/2" BIRDSCREEN
③ LOUVER PLENUM: INSULATE ALL EXPOSED PARTS W/ 2" RIGID BOARD INSULATION. (ALSO INSULATE UNUSED LOUVER AREA)
④ WHEN "D" IS OVER 24" PROVIDE 3/4" DRAIN AT 5'-0" CENTERS (IF DEPTH INTO PAPER IS GREATER THAN 5'-0"), 6" FROM LOUVER WITH TRAP.
⑤ ACCESS DOOR HALF OF HEIGHT OF DUCT. 12"x12" MIN. (UNLESS SHOWN OTHERWISE ON PLANS.)
⑥ SOLDER BOTTOM JOINT & UP TO 12"
⑦ PITCH TO OUTSIDE
⑧ SEAL AND CAULK ALL AROUND

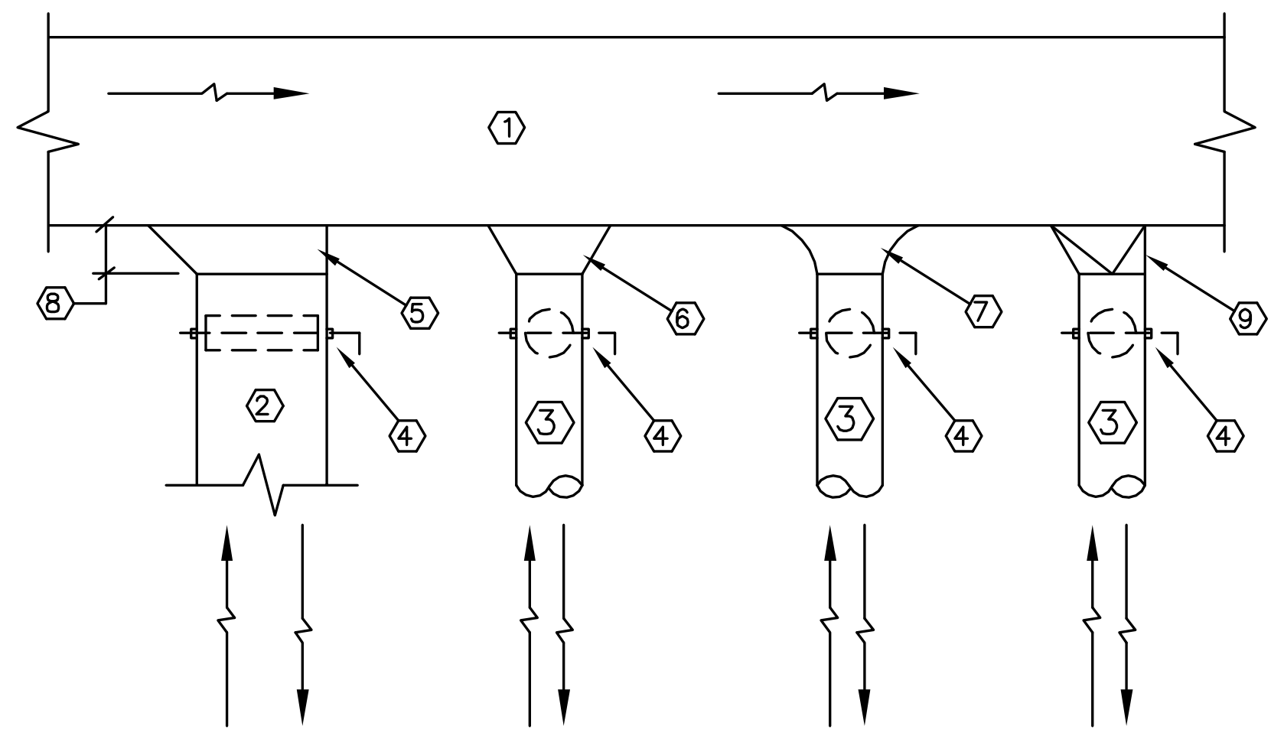


G13 LOUVER CONNECTION DETAIL

NONE

① MAIN SUPPLY OR EXHAUST DUCT (LOW OR MEDIUM PRESS.)
② RECTANGULAR BRANCH TAKE-OFF DUCT (LOW OR MEDIUM PRESS.)
③ ROUND BRANCH TAKE-OFF DUCT (LOW OR MEDIUM PRESS.)
④ VOLUME DAMPER AS INDICATED ON PLANS
⑤ 45 DEGREE ENTRY FITTING
⑥ CONICAL DUCT TAKE-OFF FITTING
⑦ BELLMOUTH DUCT TAKE-OFF FITTING
⑧ DISTANCE = (1/4) x (DUCT WIDTH); 4" MINIMUM DISTANCE
⑨ CONTOUR TEE FITTING

NOTE: SPIN-IN DUCT TAKE-OFF FITTINGS MAY BE USED IN LIEU OF CONICAL OR BELLMOUTH FITTINGS ONLY WHERE MAIN DUCT DIMENSIONS ARE NOT SUFFICIENT TO ALLOW THE USE OF A CONICAL OR BELLMOUTH. SEAL ALL TAKE-OFF & OTHER DUCT FITTINGS AIR TIGHT AS PER SPEC. FABRICATE BRANCH DUCT TAKE-OFF FITTINGS PER LATEST EDITION OF SMACNA DUCT CONSTRUCTION MANUAL, AS INDICATED ON PLANS, OR AS DESCRIBED IN SPECIFICATION.

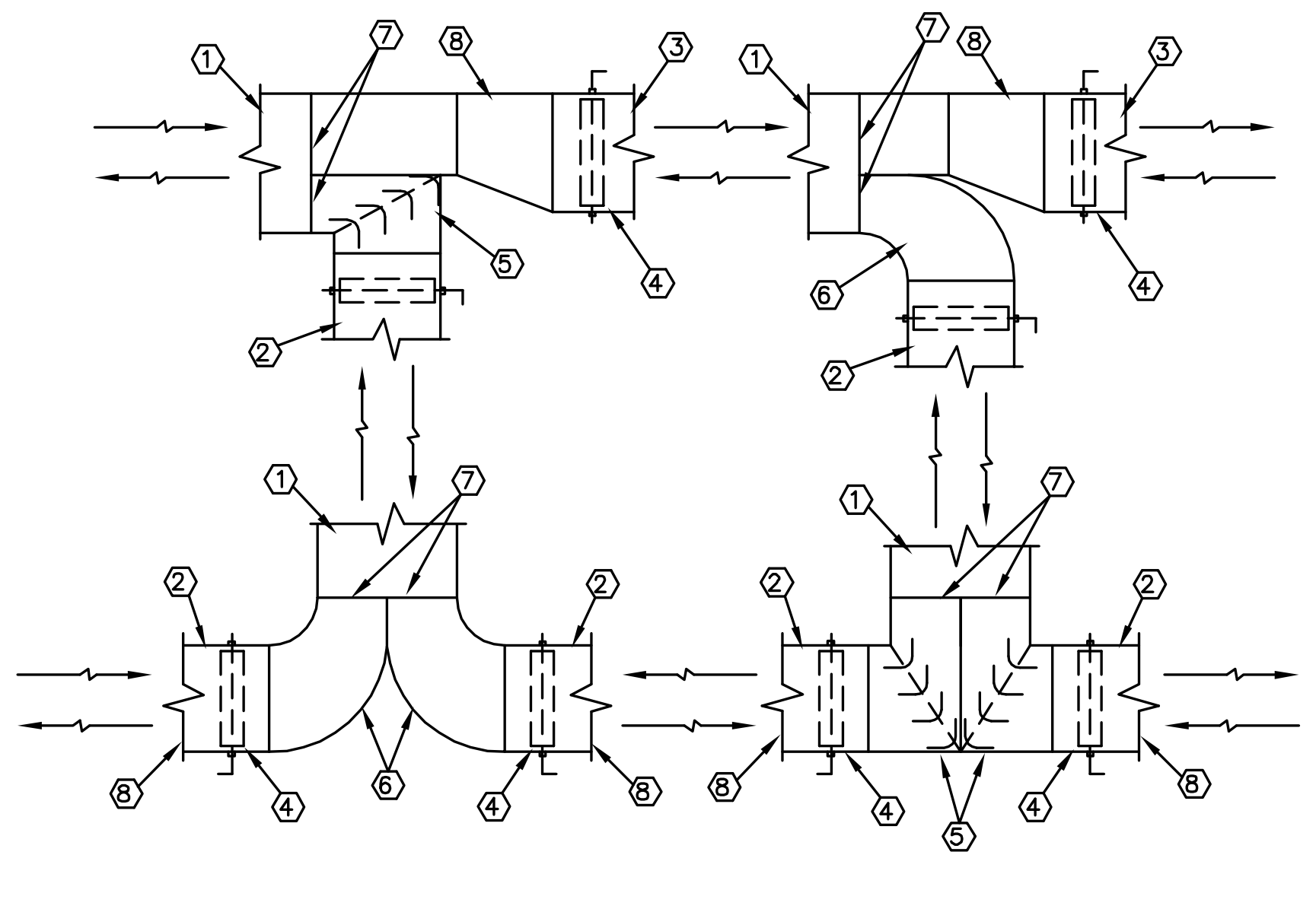


A1 BRANCH TAKE-OFF DETAIL

NONE

① MAIN SUPPLY, RETURN OR EXHAUST DUCT (LOW OR MEDIUM PRESS.)
② RECTANGULAR BRANCH DUCT (DIVERGING OR CONVERGING FLOW)
③ MAIN OR BRANCH DUCT W/ DIVERGING OR CONVERGING FLOW
④ VOLUME DAMPER AS INDICATED ON PLANS (TYP)
⑤ RECTANGULAR ELBOW TRANSITION W/ TURNING VANES
⑥ RADIUSED ELBOW TRANSITION
⑦ DIMENSIONS OF SPLIT PER SMACNA DUCT MANUAL OR AS ON PLANS
⑧ TRANSITION AS REQUIRED

NOTE: FABRICATE SPLIT FITTINGS, ELBOWS, TRANSITIONS, ETC. PER LATEST EDITION OF SMACNA DUCT CONSTRUCTION MANUAL, AS INDICATED ON PLANS, OR AS DESCRIBED IN SPECIFICATION.
PROVIDE DUCT SPLIT ARRANGEMENT AS SHOWN ON PLANS.

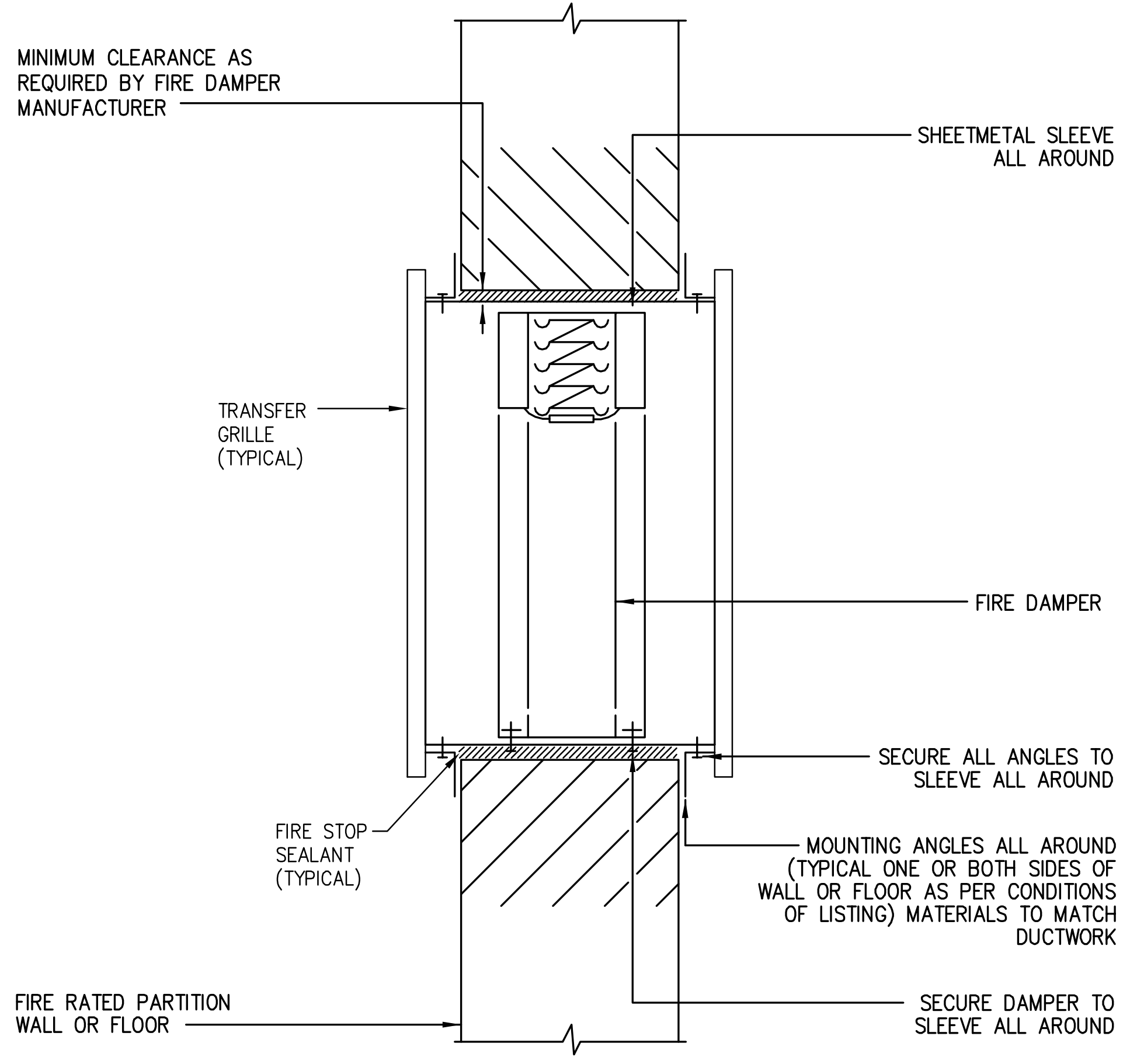


A5 SPLIT DUCT DETAIL

NONE

NOTES:

1. GENERAL ARRANGEMENT SHOWN. INSTALL ALL FIRE DAMPERS IN STRICT ACCORDANCE WITH ALL CONDITIONS OF THEIR LISTING, THE MANUFACTURERS' INSTALLATION INSTRUCTIONS AND AUTHORITIES HAVING JURISDICTION. SEE SPECIFICATIONS
2. WHERE FIRE DAMPER IS TO BE MOUNTED WITHIN EXISTING WALL OR FLOOR, CUT OPENING AS REQUIRED TO MAINTAIN CLEARANCES STIPULATED BY THE MANUFACTURER BETWEEN WALL OR FLOOR AND SLEEVE.
3. GAUGE OF SHEETMETAL SLEEVE, MOUNTING ANGLES, METHOD OF ATTACHMENT, ETC. AS PER CONDITIONS OF LISTING AND AS DIRECTED BY FIRE DAMPER MANUFACTURER.
4. FIRE STOP SEALANTS AND DUCT PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE DIRECTORY.

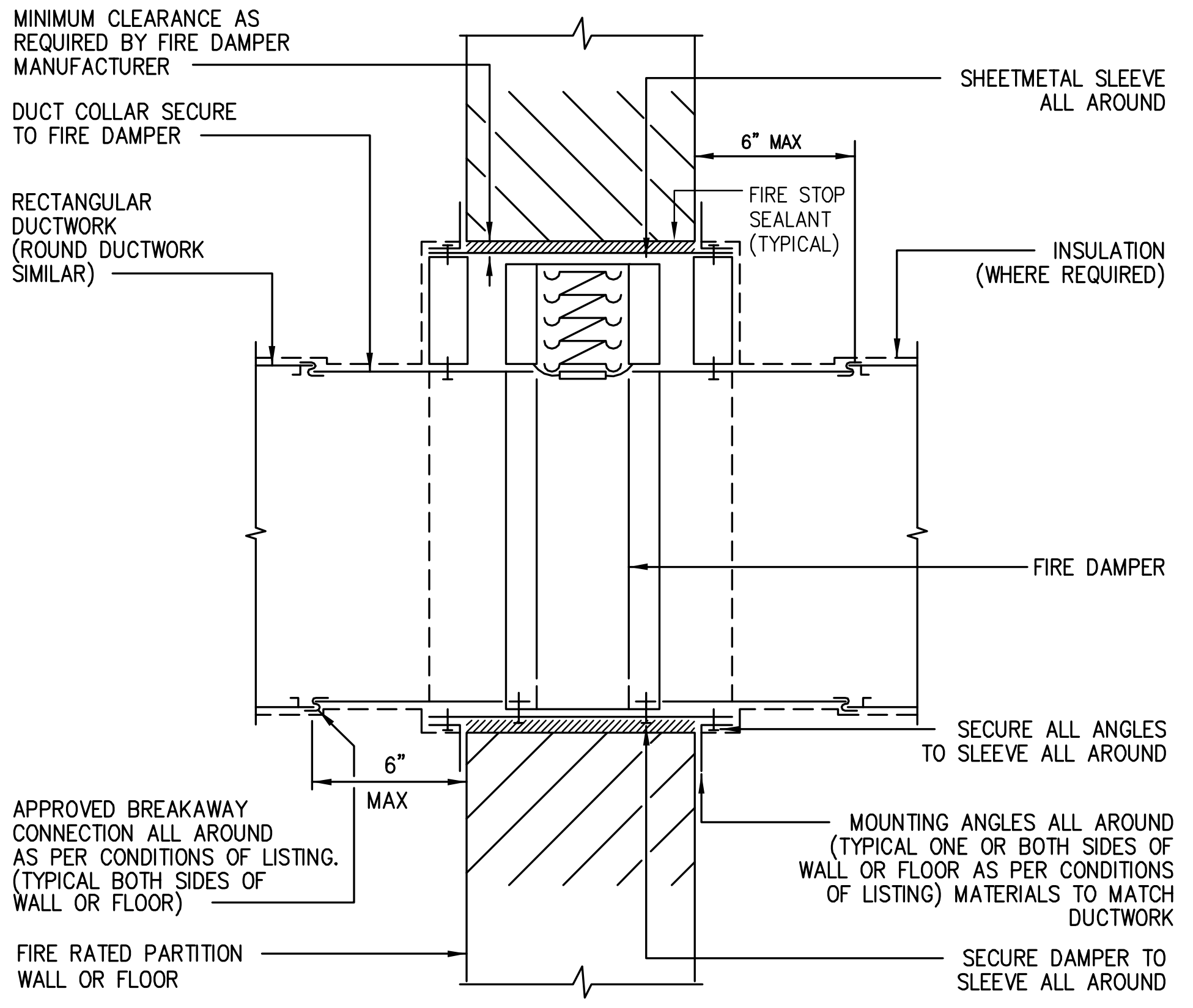


A9 FIRE DAMPER INSTALLATION

NONE | TRANSFER AIR

NOTES:

1. GENERAL ARRANGEMENT SHOWN. INSTALL ALL FIRE DAMPERS IN STRICT ACCORDANCE WITH ALL CONDITIONS OF THEIR LISTING, THE MANUFACTURERS' INSTALLATION INSTRUCTIONS AND AUTHORITIES HAVING JURISDICTION. SEE SPECIFICATIONS
2. WHERE FIRE DAMPER IS TO BE MOUNTED WITHIN EXISTING WALL OR FLOOR, CUT OPENING AS REQUIRED TO MAINTAIN CLEARANCES STIPULATED BY THE MANUFACTURER BETWEEN WALL OR FLOOR AND SLEEVE.
3. ACCESS DOORS SHALL BE AS LARGE AS POSSIBLE, UP TO 18"x12" MAXIMUM. LOCATE ON MOST ACCESSIBLE SIDE OF DAMPER.
4. GAUGE OF SHEETMETAL SLEEVE, MOUNTING ANGLES, METHOD OF ATTACHMENT, ETC. AS PER CONDITIONS OF LISTING AND AS DIRECTED BY FIRE DAMPER MANUFACTURER.
5. FIRE STOP SEALANTS AND DUCT PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE DIRECTORY.



A13 FIRE DAMPER INSTALLATION

NONE

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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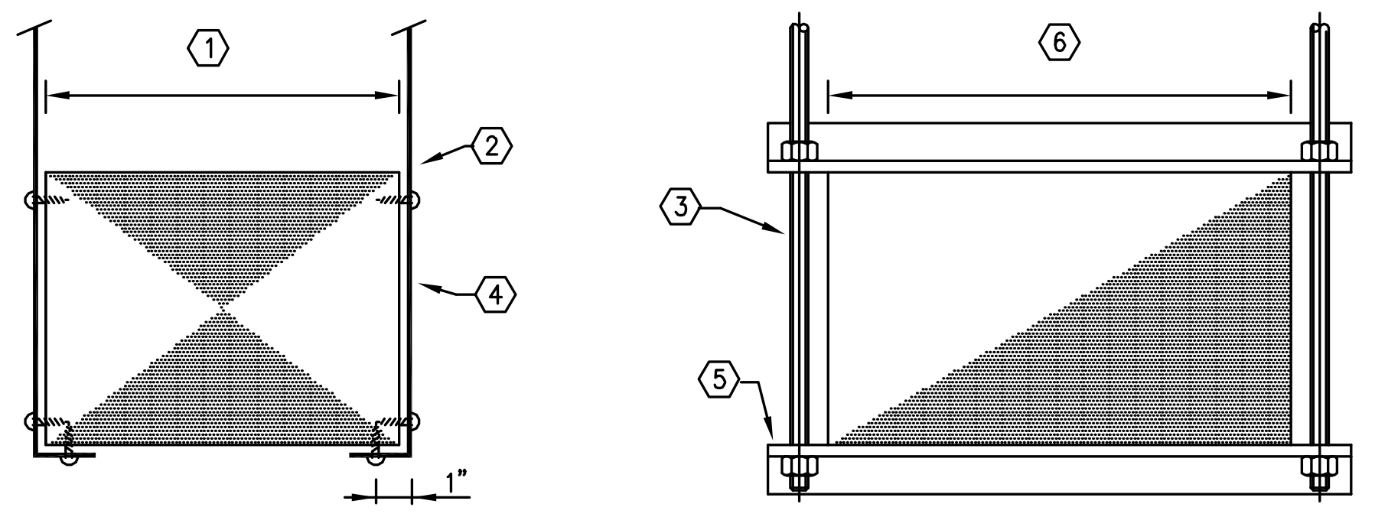
PORTLAND, MAINE

drawing title
C.E.C. HVAC DETAILS

seal

designed by BOS
drawn by DSC
checked by JMS
date 1/19/2004
scale NONE
project no. 5001024.00
CAD file no. C-H501.DWG
drawing no. **C-H501**

① MAX. 60"
② GALVANIZED HANGER
③ THREADED HANGER ROD
④ HANGER STRAP
⑤ UNISTRUT OR ANGLE IRON
⑥ OVER 60"



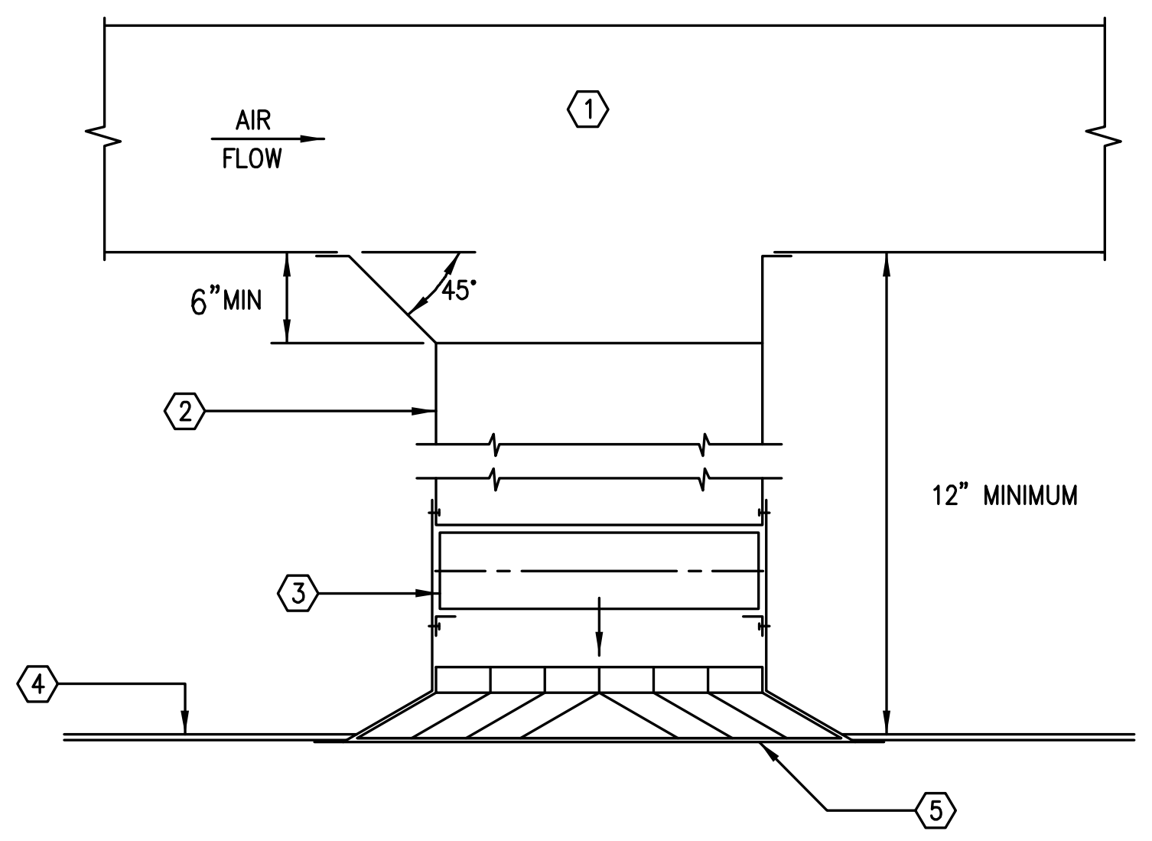
NOTES:

1. ON DUCTS OVER 48" WIDE, BOTTOM SHALL BE BRACED BY ANGLE. FOR CROSS SECTION AREA MORE THAN 8 SQ FT, DUCT SHALL BE BRACED BY ANGLES ON ALL FOUR SIDES.
2. CUTTING AND PATCHING SHALL BE LIMITED TO A MINIMUM AS REQUIRED FOR PROPER INSTALLATION.
3. SUPPORTS SHALL BE SPACED AND SIZED AS PER SMACNA.
4. PLEASE REFER TO STRUCTURAL DWG S2.01, DETAIL 'N', FOR ATTACHING TO PRE-CAST "TEE".

M1 DUCT HANGER SUPPORT DETAIL

NONE

① SUPPLY AIR DUCT. INSULATED AS SCHEDULED
② DUCT DROP. INSULATED AS SCHEDULED
③ OPPOSED BLADE DAMPER IF SCHEDULED. INSTALL AS PER MANUFACTURER'S RECOMMENDATIONS
④ CEILING, WHERE APPLICABLE
⑤ DIFFUSER



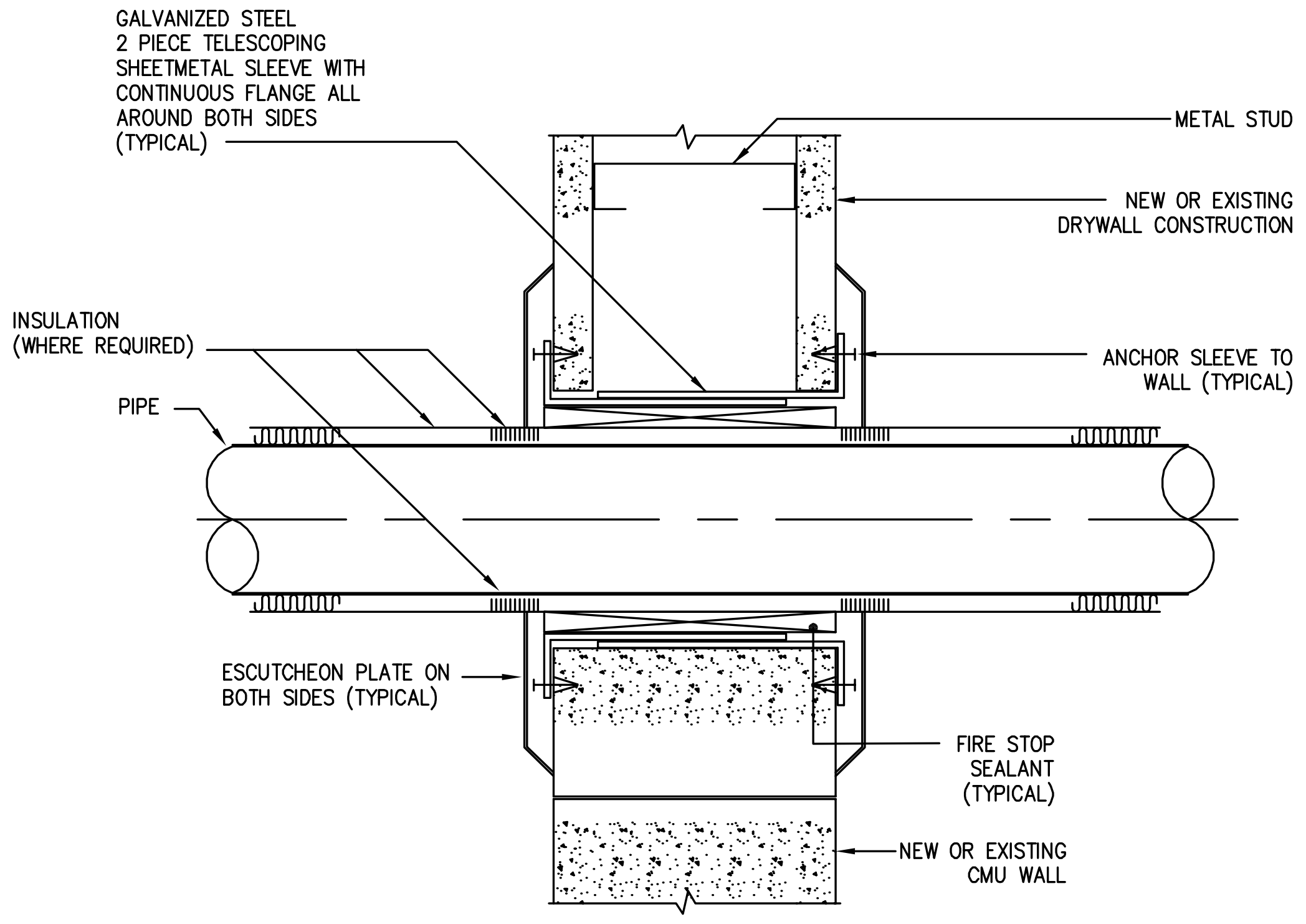
NOTE:

SPACES MAY OR MAY NOT HAVE FINISHED CEILING; USE SAME METHOD IN BOTH CASES

M6 TYPICAL SUPPLY DIFFUSER

NONE

DUCTWORK AND CONNECTION



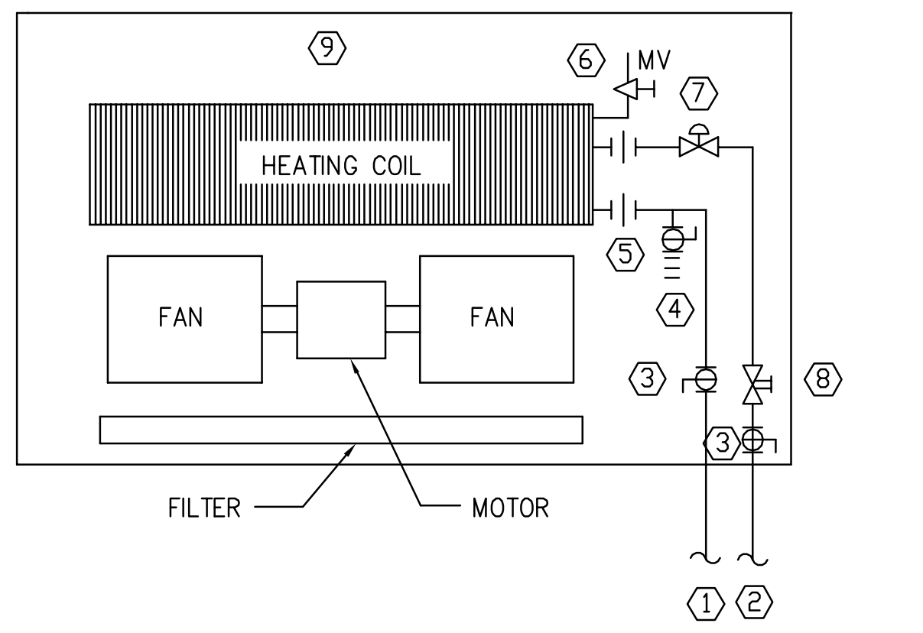
NOTE

FIRE STOP SEALANTS AND FIRE STOP PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE DIRECTORY.

M11 PIPING SLEEVE

NONE

① SUPPLY PIPING
② RETURN PIPING
③ SHUT-OFF VALVE
④ DRAIN VALVE W/ HOSE END
⑤ UNION (TYPICAL)
⑥ MANUAL AIR VENT
⑦ TWO-POSITION CONTROL VALVE
⑧ CALIBRATED BALANCING VALVE
⑨ CABINET UNIT HEATER

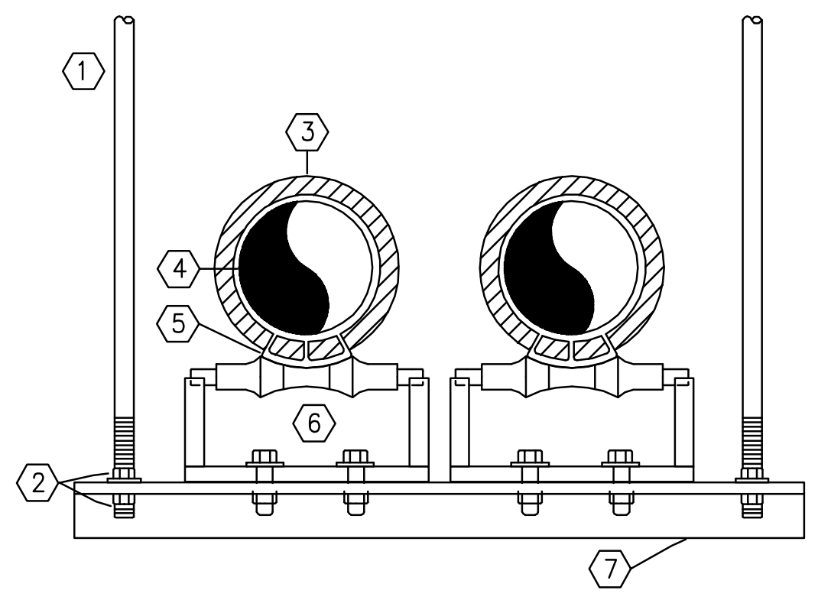


G1 CABINET UNIT HEATER PIPING

NONE

DETAIL

① THREADED HANGER ROD
② LOCKING/SUPPORT NUT
③ PIPE INSULATION
④ CHILLED/HOT WATER PIPING
⑤ PIPE SADDLE (MIN. 12" LONG)
⑥ SINGLE PIPE ROLLER
⑦ 6" CHANNEL



NOTES:

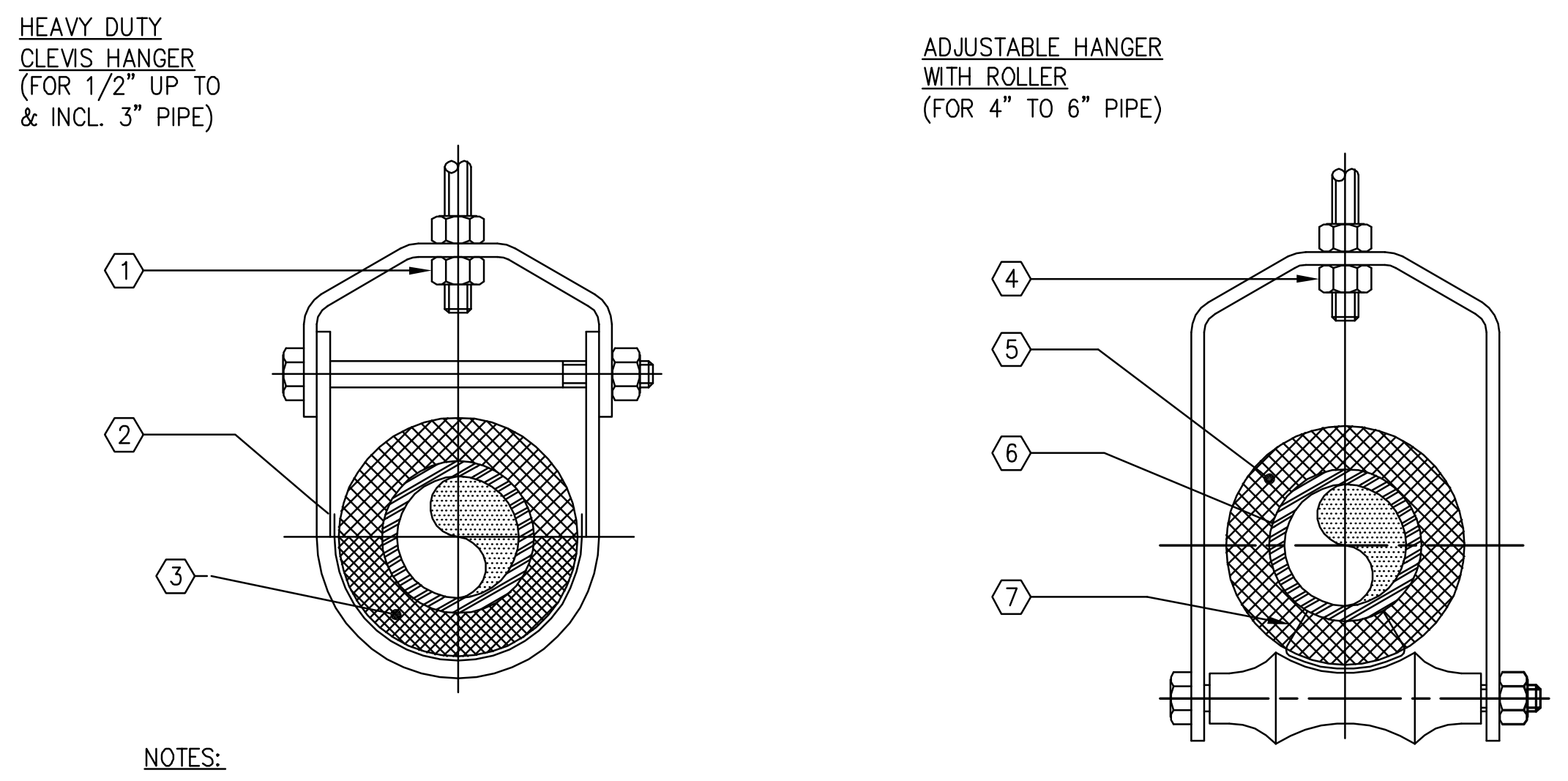
1. REFER TO STRUCTURAL DWG S2.01, DETAIL 'N', FOR ATTACHING TO PRE-CAST "TEE".

G5 PIPE HANGER SUPPORT DETAIL

NONE

(MULTIPLE PIPES)

① SUPPORT NUT
② GALVANIZED INSULATION SHIELD 12" LONG
③ MINIMUM 9 LB/CFT DENSITY RIGID INSULATION AT SHIELD
④ LOCKING NUT
⑤ INSULATION
⑥ PIPE
⑦ PIPE COVERING PROTECTION – 16 GAUGE SADDLE


HEAVY DUTY CLEVIS HANGER (FOR 1/2" UP TO & INCL. 3" PIPE)

ADJUSTABLE HANGER WITH ROLLER (FOR 4" TO 6" PIPE)

NOTES:

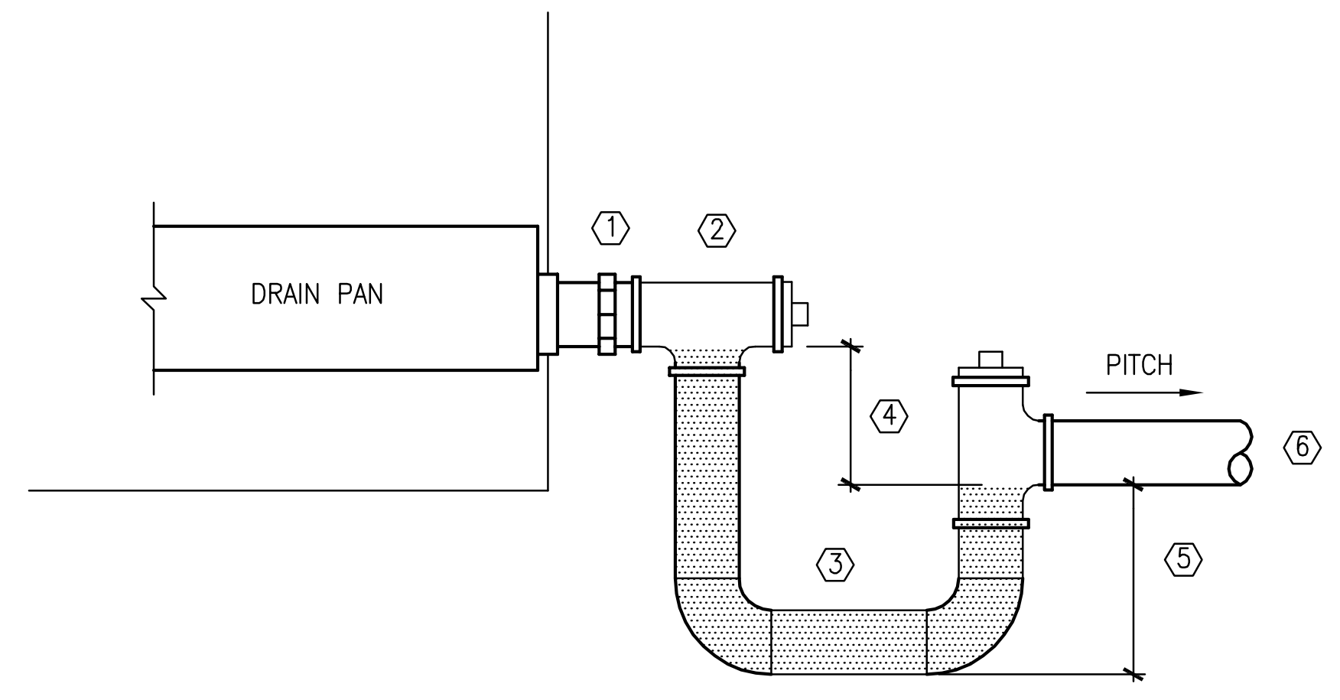
1. SEE SPECIFICATION FOR HANGER SIZES.
2. PIPE 8" AND LARGER SHALL HAVE ROLLER SUPPORTED WITH DUAL RODS.
3. FOR CHW SERVICE OVER 3" REPLACE SADDLE WITH 12" LONG 14 GA SHIELD WITH RIGID INSULATION BETWEEN PIPE AND SHIELD.
4. REFER TO STRUCTURAL DWG S2.01, DETAIL 'N', FOR ATTACHING TO PRE-CAST "TEE".

G9 PIPE HANGER SUPPORT DETAIL

NONE

(SINGLE PIPES)

① UNION OR FLANGE. COORDINATE WITH UNIT MANUFACTURER
② TEE WITH CLEANOUT PLUG (TYPICAL)
③ TRAP
④ FAN STATIC PRESSURE (FSP) + 1"
⑤ (FSP/2) + 1"
⑥ PITCH PIPE TO NEAREST FLOOR DRAIN



NOTES:

1. ALLOW SUFFICIENT SPACE BELOW DRAIN PAN FOR TRAP.
2. PITCH DRAIN FOR PROPER RUNOFF.
3. MANUALLY PRIME FILL TRAP BEFORE STARTUP TO FORM INITIAL DRAIN SEAL.
4. SUPPORT LENGTHY DRAIN LINES TO PREVENT SAG AND CONDENSATE OVERFLOW.
5. THE COOLING COILS FOR AHU-1 & 2 AND ASSOCIATED PIPING EXPOSED TO WEATHER SHALL BE WINTERIZED TO PREVENT FREEZING.

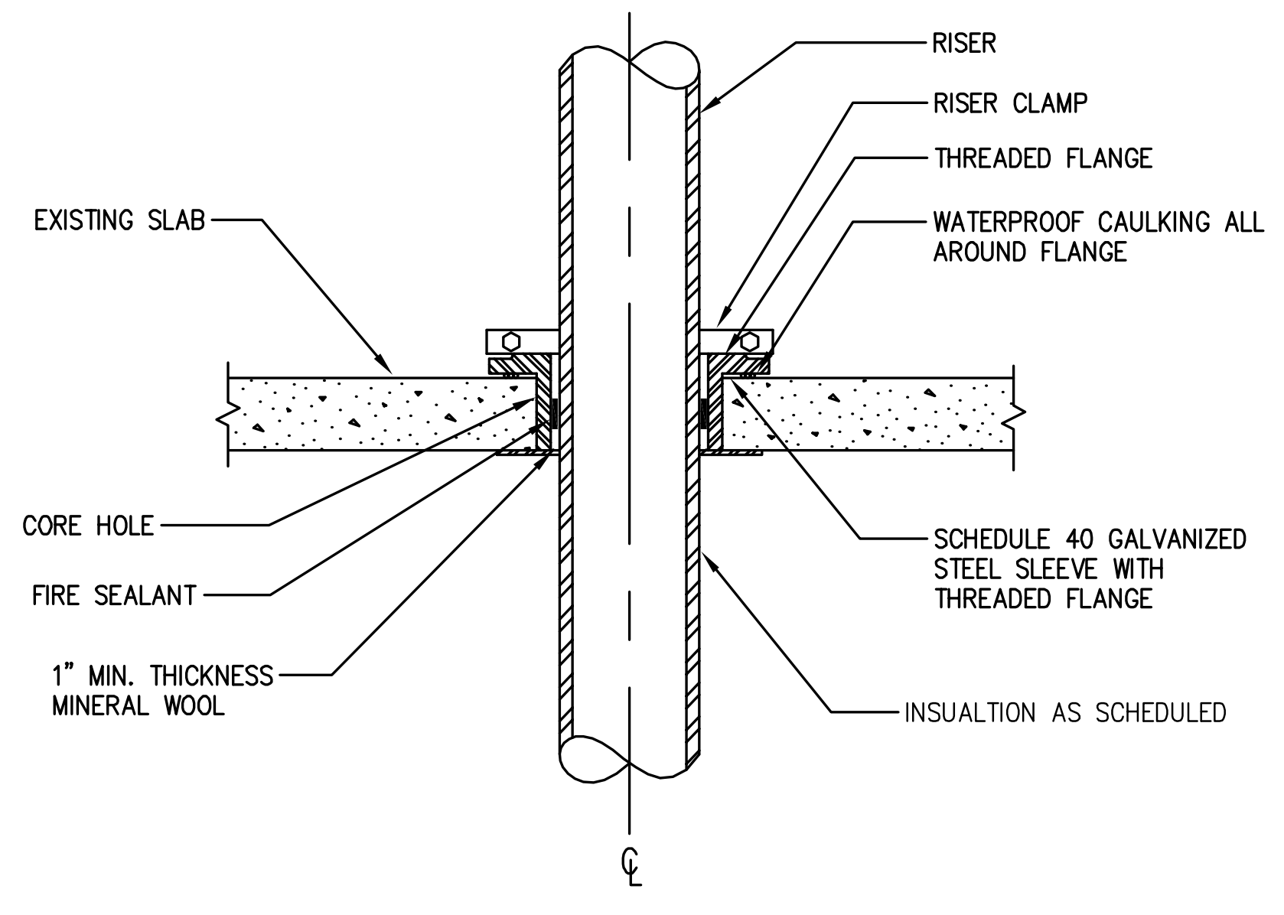
G14 DRAW-THRU CONDENSATE TRAP

NONE

DETAIL

NOTE:

FIRE STOP SEALANTS AND PIPING PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE DIRECTORY. REFER TO DIVISION 7

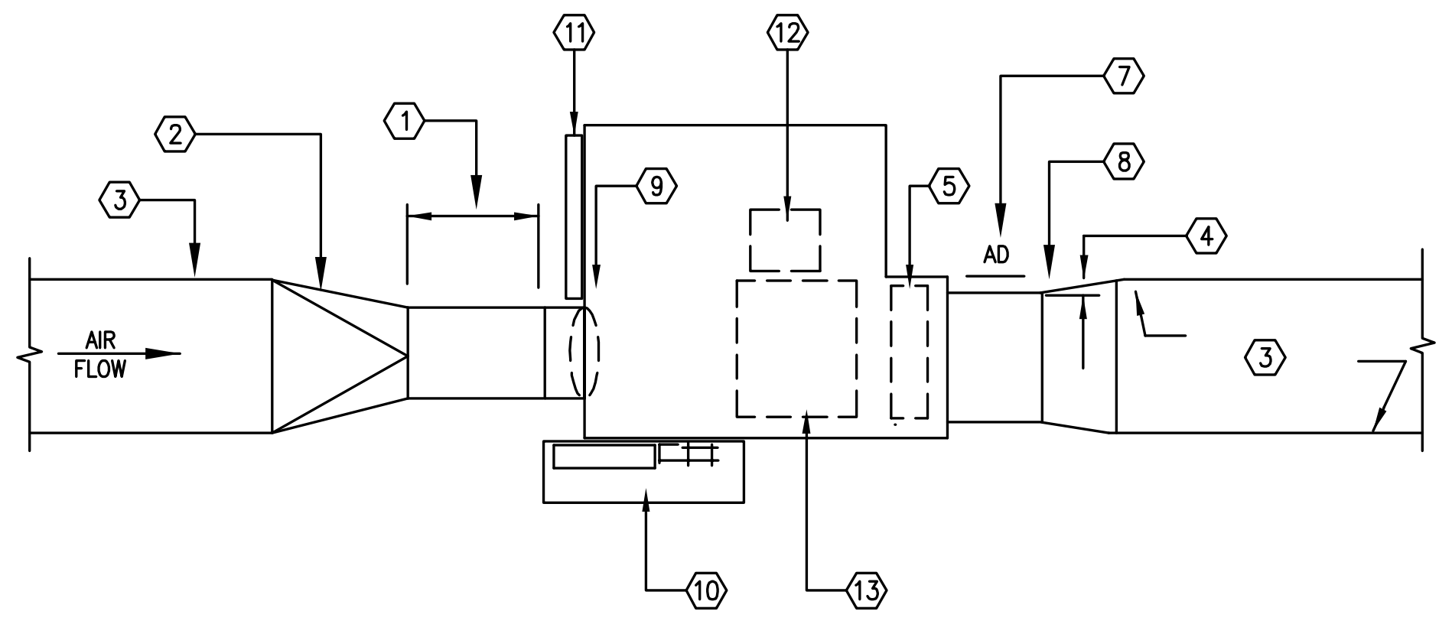


B1 PIPE PENETRATION

NONE

THROUGH EXISTING SLAB

① 2 INLET DIAMETERS – MINIMUM
② TRANSITION TO TERMINAL INLET DIAMETER
③ DUCT SIZE SHOWN ON PLANS
④ 15° MAXIMUM
⑤ REHEAT COIL
⑥ FAN POWERED TERMINAL UNIT (FPTU)
⑦ ACCESS DOORS, BOTTOM OR SIDE, BOTH SIDES OF COIL, AS SPECIFIED.
⑧ TRANSITION FROM TERMINAL OUTLET DIAMETER
⑨ CONTROL DAMPER
⑩ DAMPER ACTUATOR AND CONTROL BOX
⑪ FILTER
⑫ FAN MOTOR
⑬ FAN



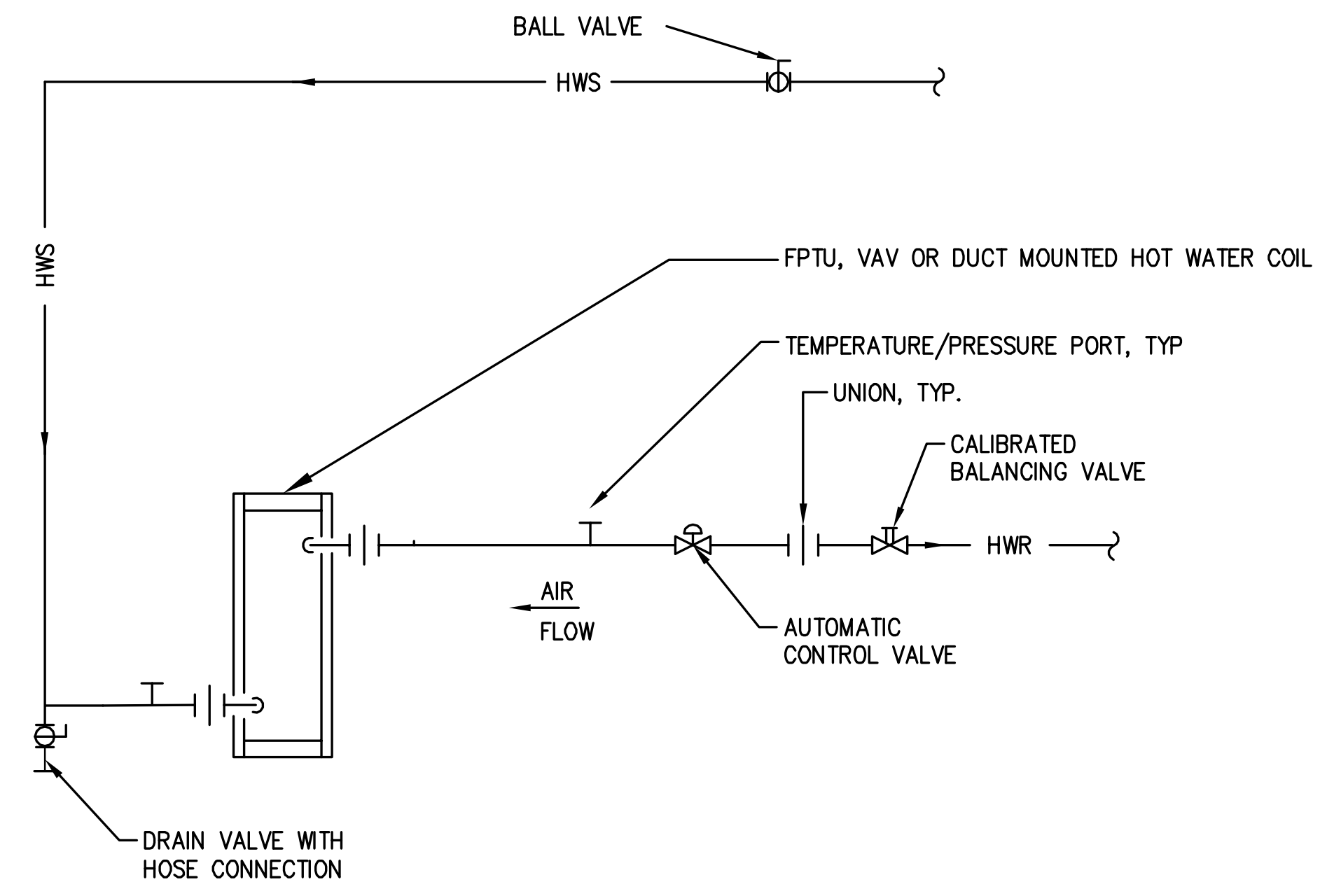
NOTE:

1. THE EXACT LOCATION OF AIR TERMINAL TO BE COORDINATED WITH ALL TRADES TO ASSURE NO CONFLICTS AND TO PROVIDE ACCESS TO COIL, FILTER, FAN, MOTOR, CONTROLS, ACCESS DOORS AND ALL OTHER POINTS OF SERVICE AND MAINTENANCE.

B5 FAN POWERED TERMINAL UNIT

NONE

B9 NOT USED



B13 TERMINAL UNIT HOT WATER COIL DETAIL

NONE

FOR FPTU's, VAV UNITS AND DUCT MOUNTED AIR COILS.

no.	revisions/submissions	date
	GMP DOCUMENTS	1/19/04

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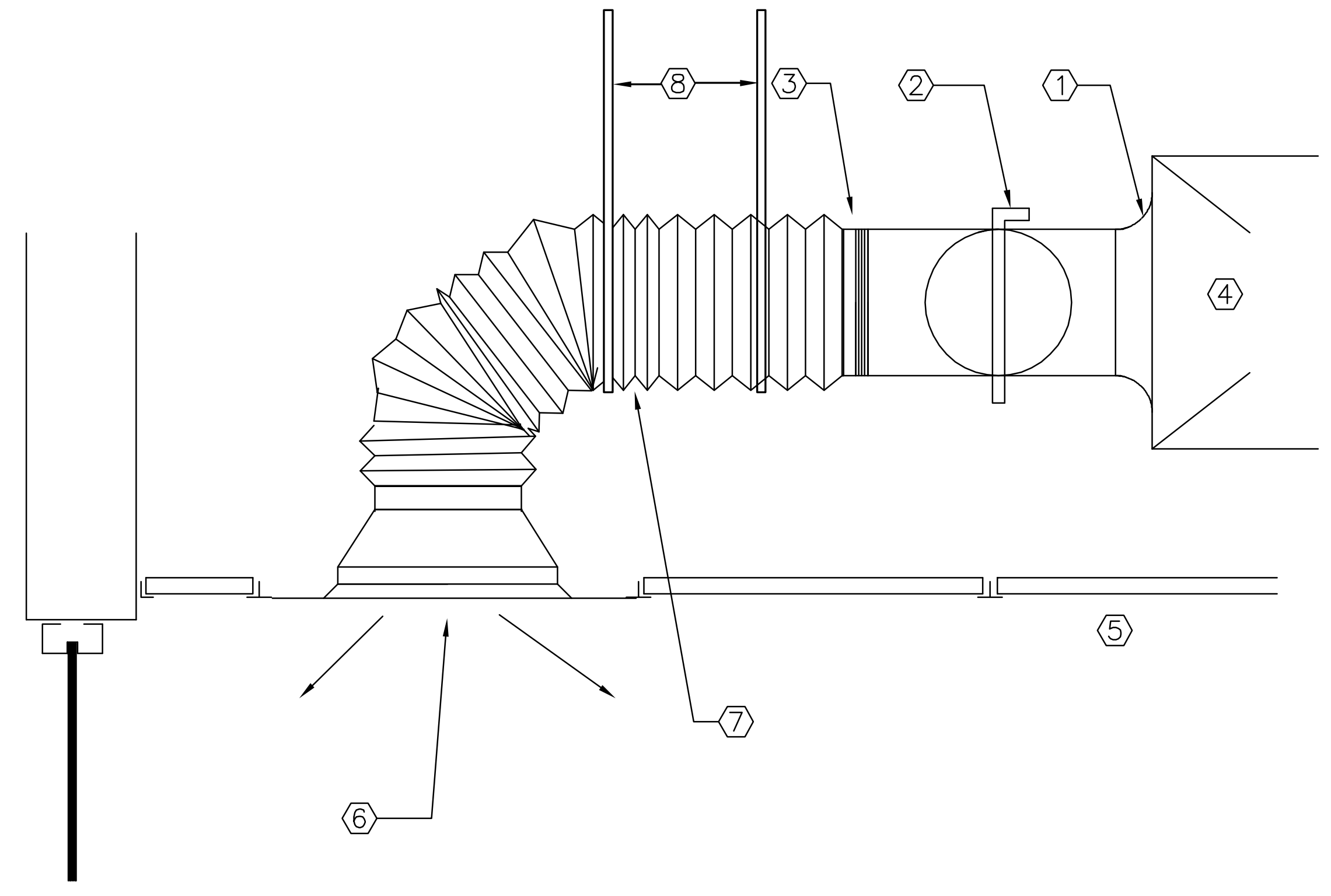
PORTLAND, MAINE

drawing title
C.E.C. HVAC DETAILS

seal

designed by BOS	project no. 5001024.00
drawn by DSC	CAD file no. C-H502.DWG
checked by JMS	drawing no. C-H502
date 1/19/2004	
scale NONE	

① BELLMOUTH FITTING
② VOLUME DAMPER WITH LOCKING QUADRANT
③ DRAWBAND CONNECTION
④ DUCT
⑤ CEILING
⑥ TYPICAL CEILING SUPPLY DIFFUSER (ADJUST VANES TO BLOW INTO SPACE ALONG CEILING)
⑦ INSULATED FLEXIBLE DUCT – SHALL BE PRESTRETCHED BEFORE INSTALLATION. LENGTH NOT TO EXCEED 8 FEET AND NO LESS THAN 6 FEET. DIA. TO BE EQUAL TO DIFFUSER INLET SIZE.
⑧ HANGER

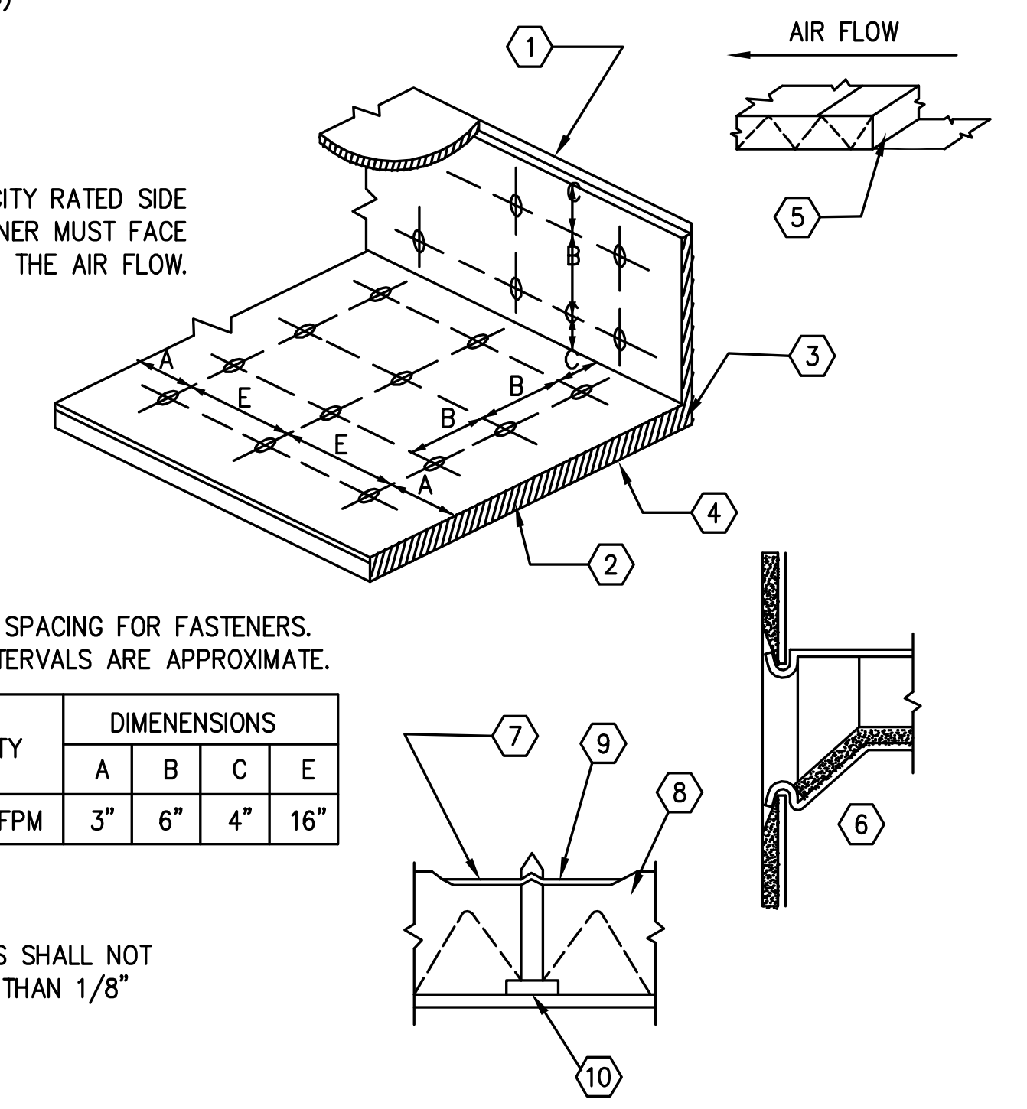


G1 TYPICAL DIFFUSER TAKE-OFF

NONE

① LAPPED & BUTTED CORNER
② 1" THICK DUCT LINER OR AS SPECIFIED.
③ ALTERNATIVE FOLDED CORNER
④ ALL TRANSVERSE EDGES TO BE COATED WITH ADHESIVE LINER ADHERED TO THE DUCT WITH A 100% AREA COVERAGE OF ADHESIVE.
⑤ USE METAL NOSING ON INITIAL LEADING EDGE. NOSING MAY BE FORMED OF DUCT OR BE CHANNEL OR ZEE ATTATCHED BY SCREWS, RIVETS, OR WELDS.
⑥ LINED DUCT CONNECTION (NO EXPOSED LINER EDGES)
⑦ INTEGRAL OR PRESSED ON HEAD.
⑧ LINER
⑨ WASHER
⑩ WELDED PINS ONLY.

THE VELOCITY RATED SIDE OF THE LINER MUST FACE THE AIR FLOW.



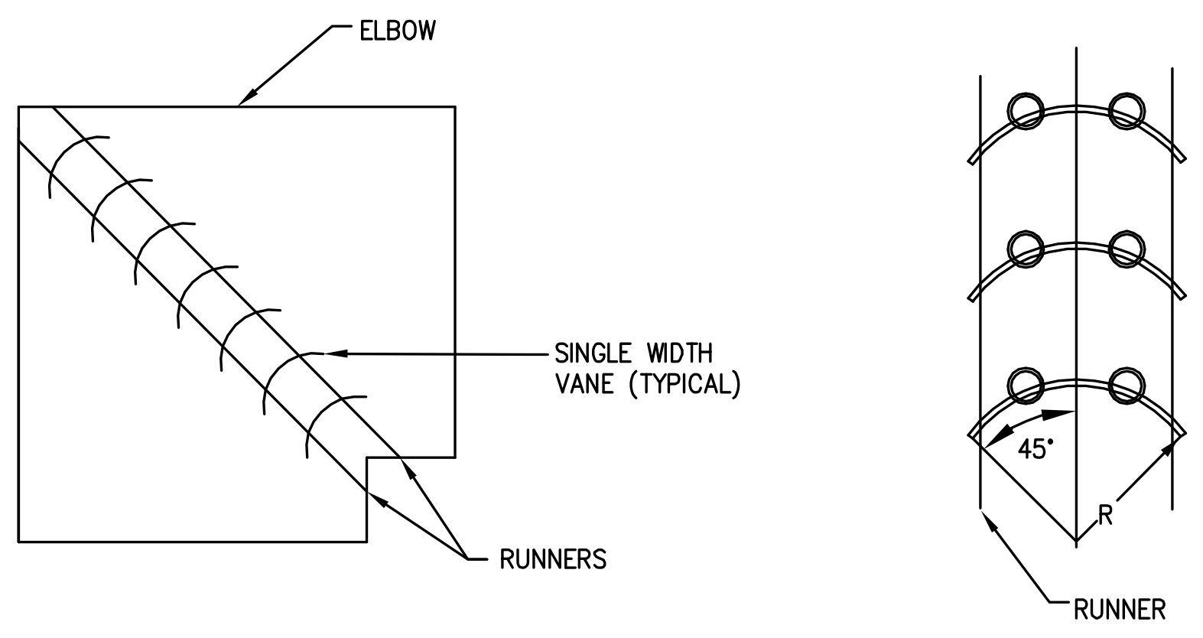
MAXIMUM SPACING FOR FASTENERS.
ACTUAL INTERVALS ARE APPROXIMATE.

VELOCITY	DIMENENSIONS			
	A	B	C	E
0–6000 FPM	3"	6"	4"	16"

NOTE: MECHANICAL FASTENERS SHALL NOT COMPRESS LINING MORE THAN 1/8"

M6 ACOUSTICAL LINING

NONE



SINGLE VANE SCHEDULE			
SIZE	R	SP	GA
ELBOWS LESS THAN 12" WIDE	2" (51mm)	1–1/2" (38mm)	24 (0.7mm)
ELBOWS 12" AND LARGER	4–1/2" (114mm)	3–1/4" (83mm)	22 (0.85mm)

NOTE:

1. LOCKING LUGS INTEGRAL WITH VANES
2. RUNNERS: BOLTED, OR WELDED
3. VANES AND FRAMES : SAME GAUGE AS ELBOW

G6 SINGLE WIDTH TURNING VANE

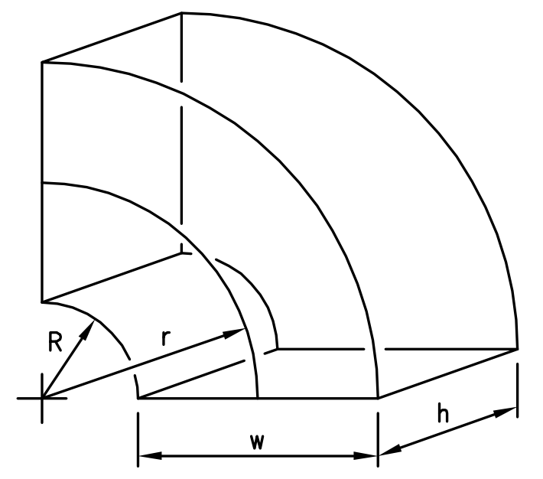
NONE

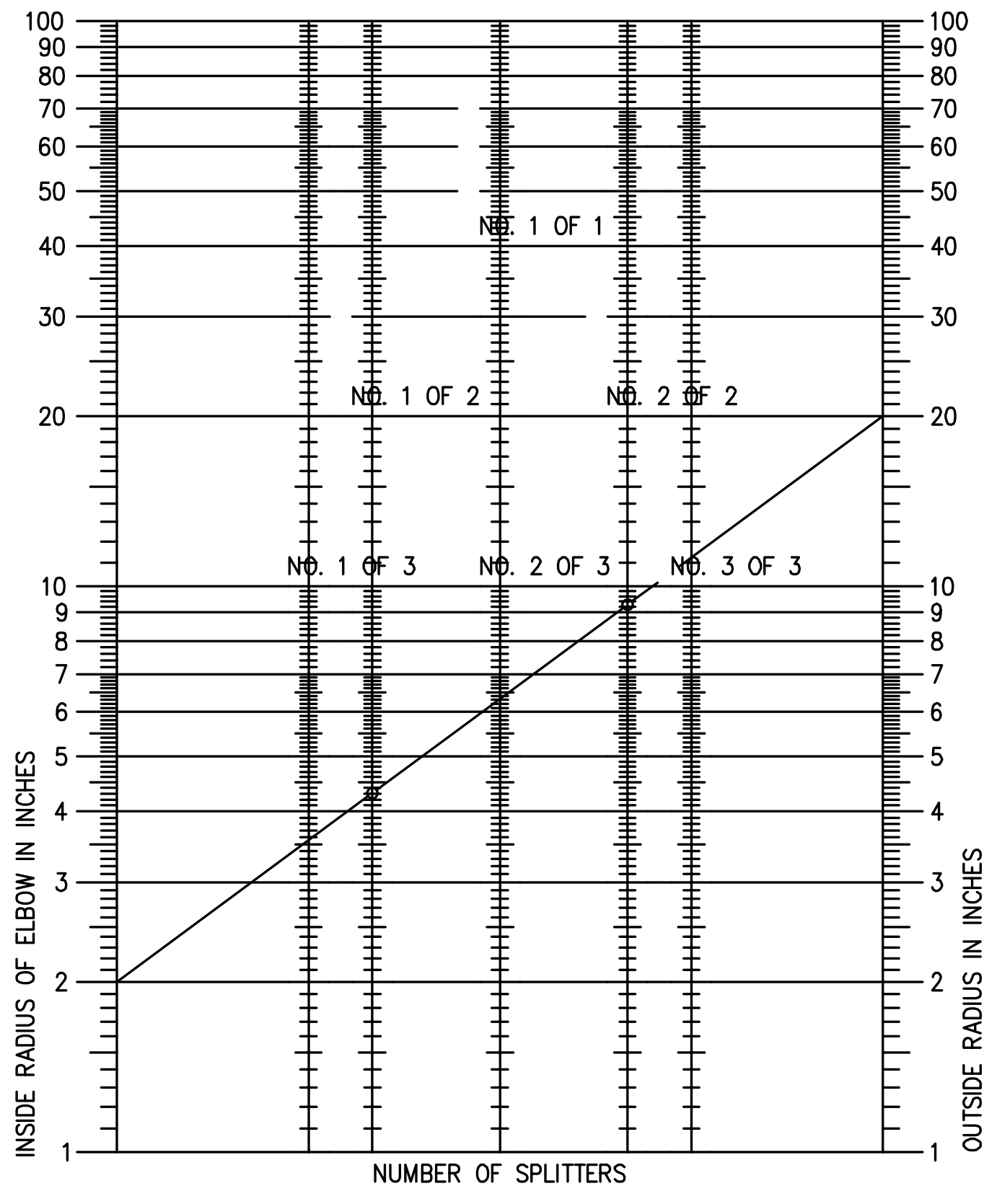
RADIUS ELBOW AND SPLITTER VANE REQUIREMENTS

r/w RATIO:	NO. OF VANES FOR 1 ELBOW:	NO. OF VANES WHEN 2 ELBOWS ARE WITHIN 2 EQUIV. DIA.:
r/w >= 1.50	0	1
1.5 > r/w >= 0.70	1	2
0.7 > r/w >= 0.60	2	3
0.6 > r/w >= 0.55	3	3

EQUIVALENT DIAMETER = (w+h)/2

NOTE: r/w = 0.5 IS A SQUARE THROAT ELBOW! HOWEVER, MINIMUM INSIDE RADIUS R SHOULD BE 2".





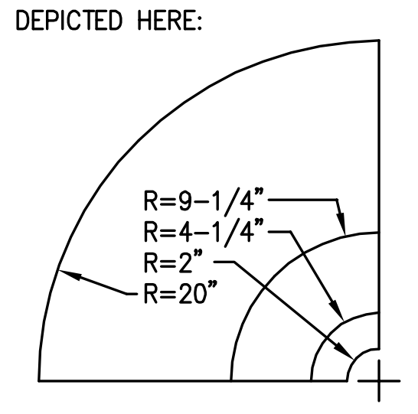
r = CENTERLINE RADIUS
R = INSIDE RADIUS
w = DUCT WIDTH
h = DUCT HEIGHT

TERMINOLOGY:

"NO. 1 OF 3" = NO. 1 VANE OF A TOTAL OF 3 VANES.

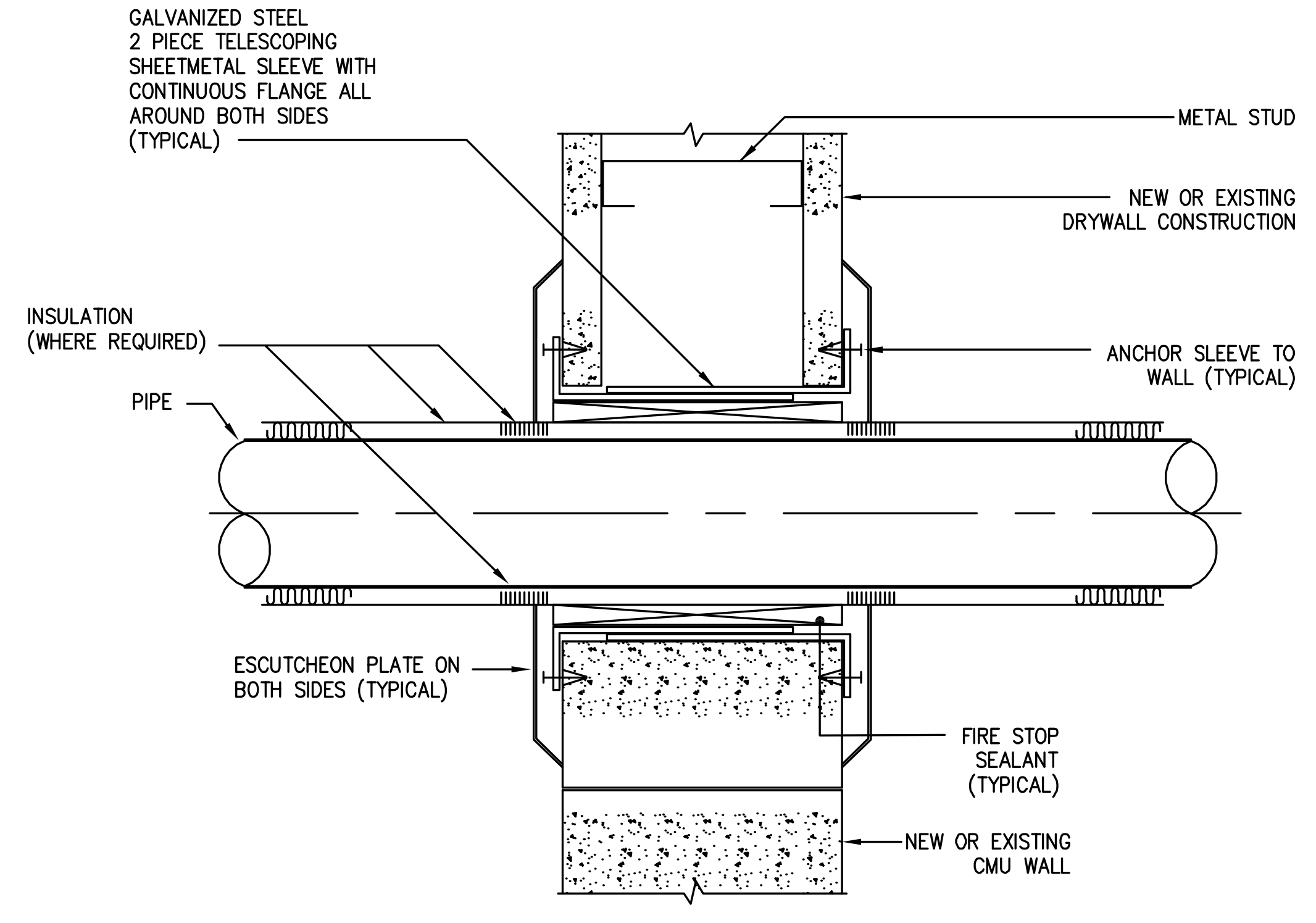
"NO. 2 OF 3" = NO. 2 VANE OF A TOTAL OF 3 VANES.

EXAMPLE AT LEFT IS DEPICTED HERE:



G11 NO. & SPACING OF DUCT SPLITTER VANES

NONE

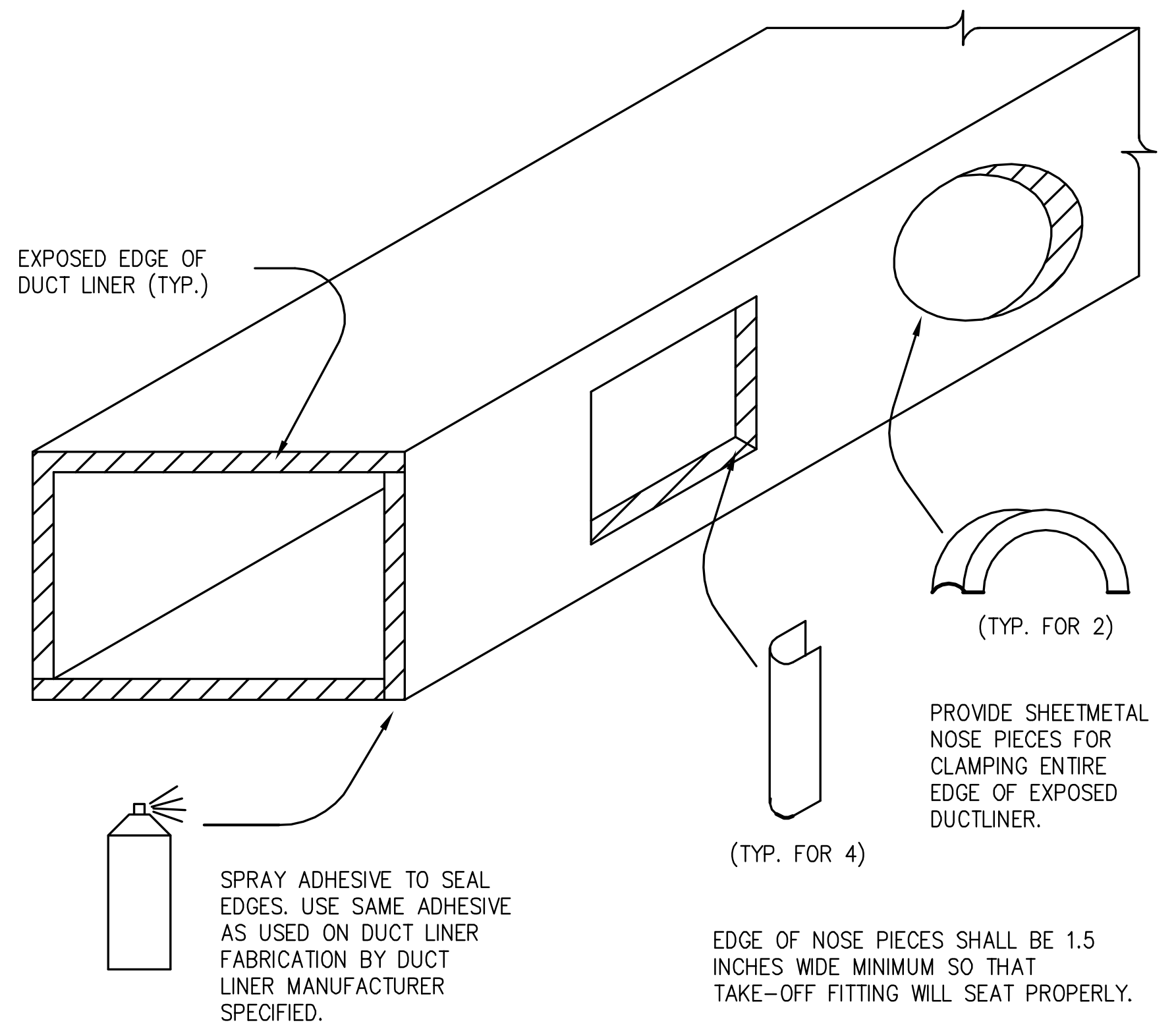


NOTE

FIRE STOP SEALANTS AND FIRE STOP PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE DIRECTORY.

A1 PIPING SLEEVE

NONE



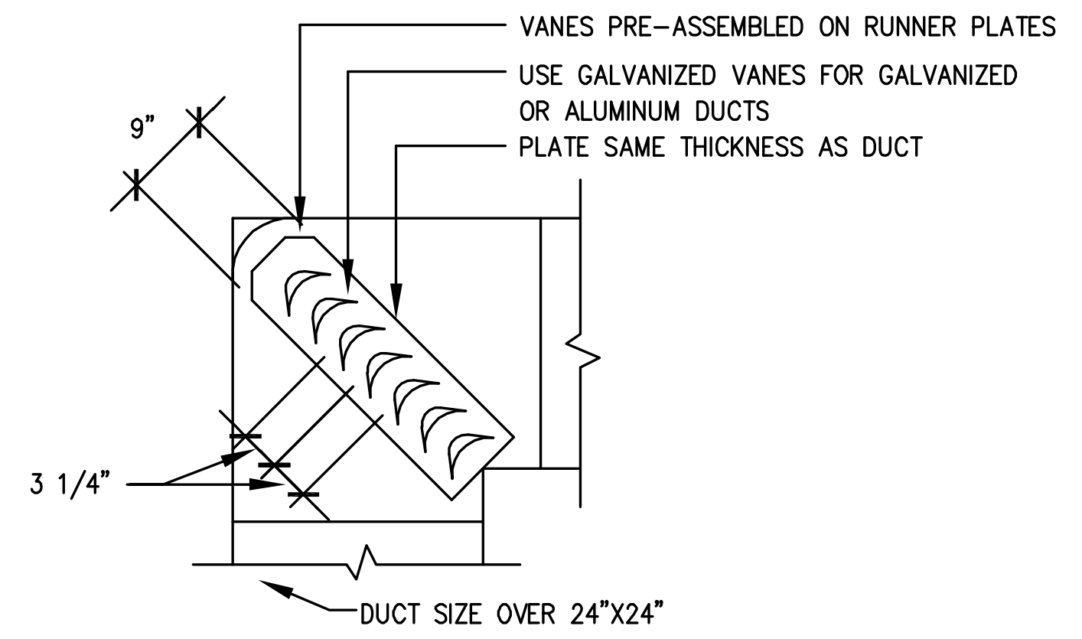
SPRAY ADHESIVE TO SEAL EDGES. USE SAME ADHESIVE AS USED ON DUCT LINER FABRICATION BY DUCT LINER MANUFACTURER SPECIFIED.

PROVIDE SHEETMETAL NOSE PIECES FOR CLAMPING ENTIRE EDGE OF EXPOSED DUCTLINER.

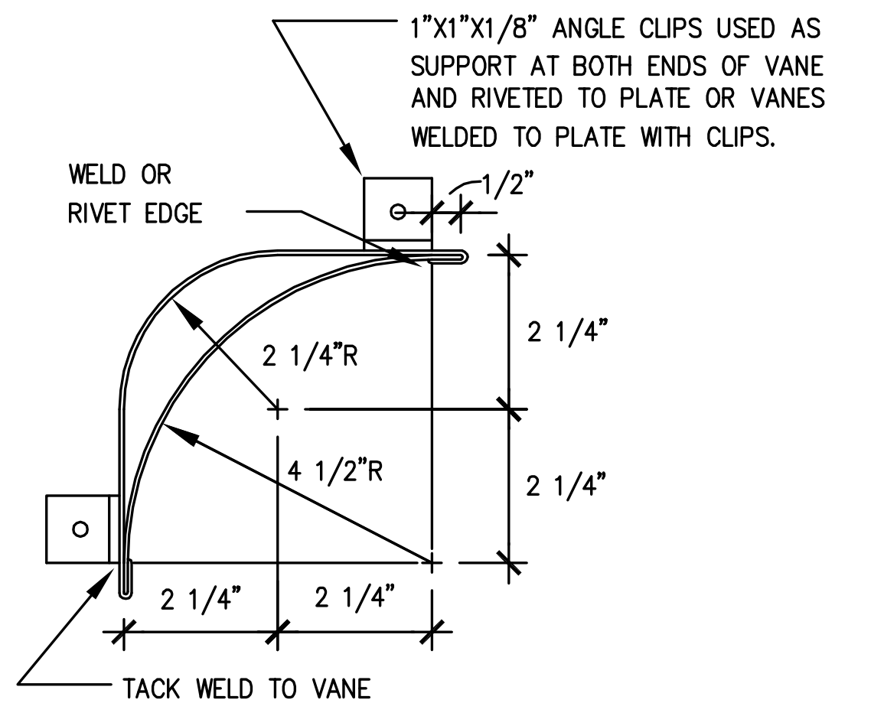
EDGE OF NOSE PIECES SHALL BE 1.5 INCHES WIDE MINIMUM SO THAT TAKE-OFF FITTING WILL SEAT PROPERLY.

A6 SEALING AND SECURING DUCTLINER

NONE



SQ. ELBOW WITH TYPE "A" DOUBLE THIKNESS VANES



TYPE "A" VANE USED IN DUCTS OVER 24"X24" SAME GAGE THICKNESS AS DUCT NOT TO EXCEED 20 U.S. GAGE.

TYPE "B" VANE CONSTRUCTION

A11 DOUBLE WIDTH TURNING VANE

NONE

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COMMUNITY EDUCATION CENTER - PHASE 2
PORTLAND, MAINE

drawing title **C.E.C. HVAC DETAILS**

seal

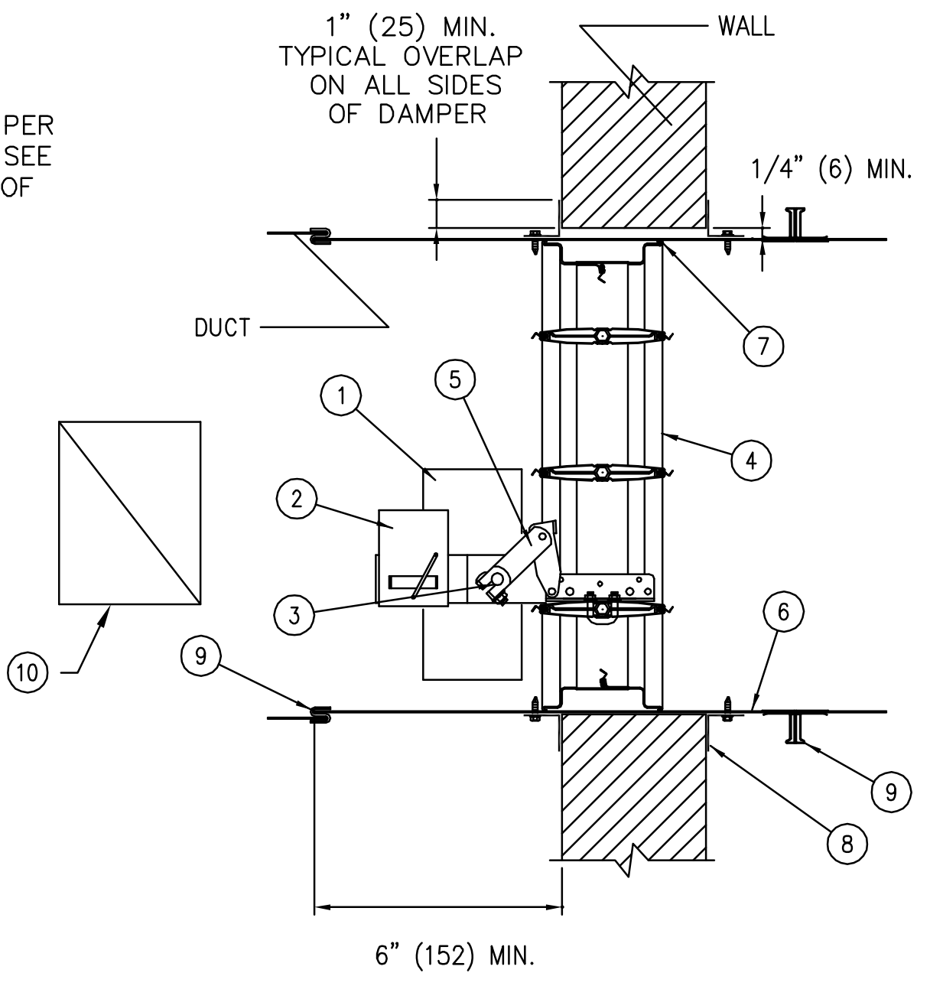
designed by BOS
drawn by DSC
checked by JMS
date 1/19/2004
scale NONE

project no. 5001024.00
CAD file no. C–H503.DWG
drawing no. **C-H503**

VERTICAL INSTALLATION

ITEM. DESCRIPTION
1. ACTUATOR (LOCATION MAY VARY). DAMPER MAY BE SUPPLIED WITHOUT ACTUATOR INSTALLED. RUSKIN'S UL LISTED FIRE DAMPER ACTUATORS MAY BE FIELD INSTALLED IF PROPERLY LABELED. SEE ACTUATOR INSTALLATION INSTRUCTIONS FOR FIELD MOUNTING OF DAMPER ACTUATORS.
2. FIRESTAT OR SP100
3. AUXILIARY OPERATING JACK SHAFT
4. DAMPER
5. OVER CENTER LOCK
6. SLEEVE
7. CAULKING MATERIAL (MAY BE ON EITHER SIDE OF DAMPER FRAME)
8. PFMA OR CONVENTIONAL MOUNTING ANGLES
9. S-JOINT/DUCT MATE, SLEEVE TO DUCT
10. ACCESS DOORS SHALL BE SQUARE AND 2" LESS THAN THE WIDTH OR HEIGHT OF THE DUCT UP TO 18"x18" MAXIMUM. LOCATE ON THE MOST ACCESSIBLE SIDE OF THE DAMPER.

NOTE: FIRE STOP SEALANTS AND FIRE STOP PENETRATIONS THROUGH RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE AND SMOKE DIRECTORY. REFER TO DIVISION 7.

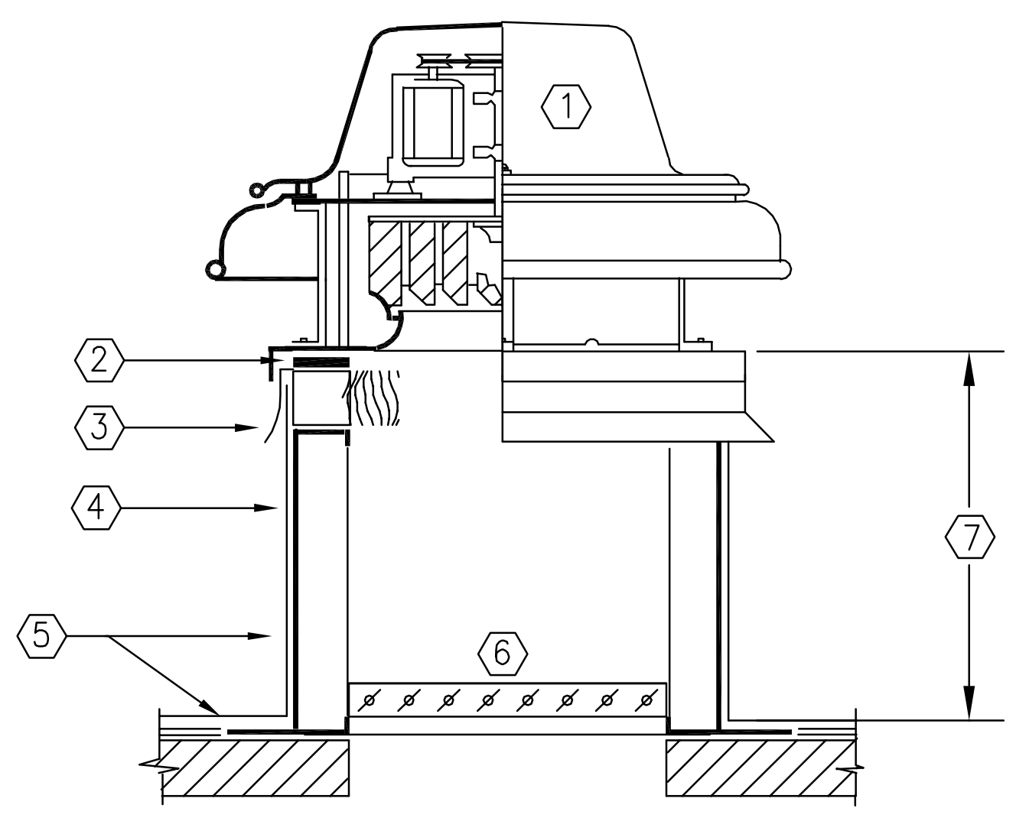


TYPICAL AIRFOIL INSTALLATION

L1 SMOKE DAMPER INSTALLATION

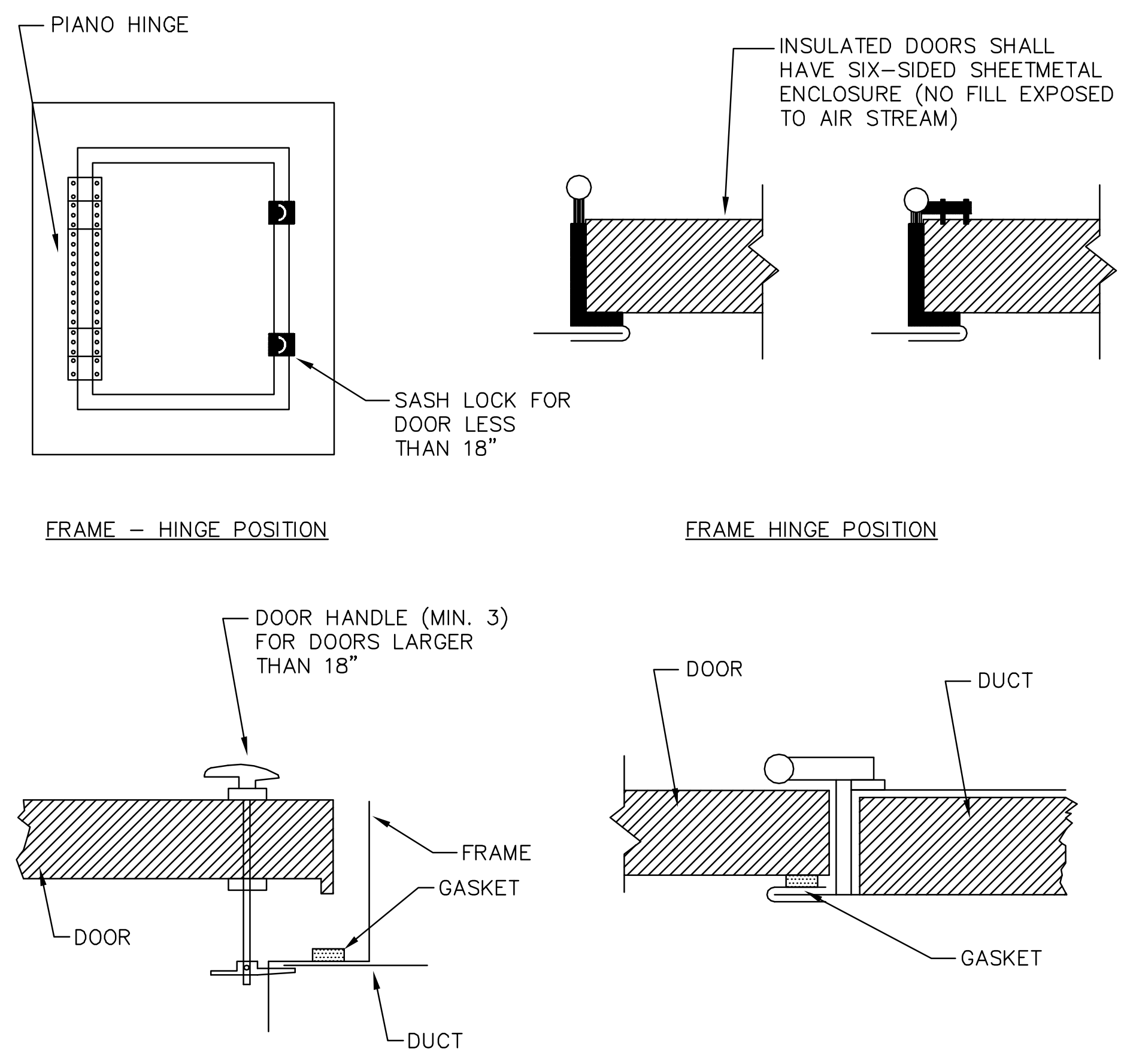
NONE

⟨1⟩ CENTRIFUGAL EXHAUST FAN
⟨2⟩ GASKET
⟨3⟩ FLASHING
⟨4⟩ PREFABRICATED INSULATED ROOF CURB
⟨5⟩ ROOFING – REFER TO ARCH. DRAWINGS
⟨6⟩ CONTROL DAMPER
⟨7⟩ 12" MINIMUM



L7 CENTRIFUGAL ROOF EXHAUST FAN DETAIL

NONE



FRAME – HINGE POSITION

FRAME HINGE POSITION

NOTES:

① LABEL ALL ACCESSES CLEARLY STATING ITS PURPOSE WITH MIN. OF 2" HIGH LETTERS.

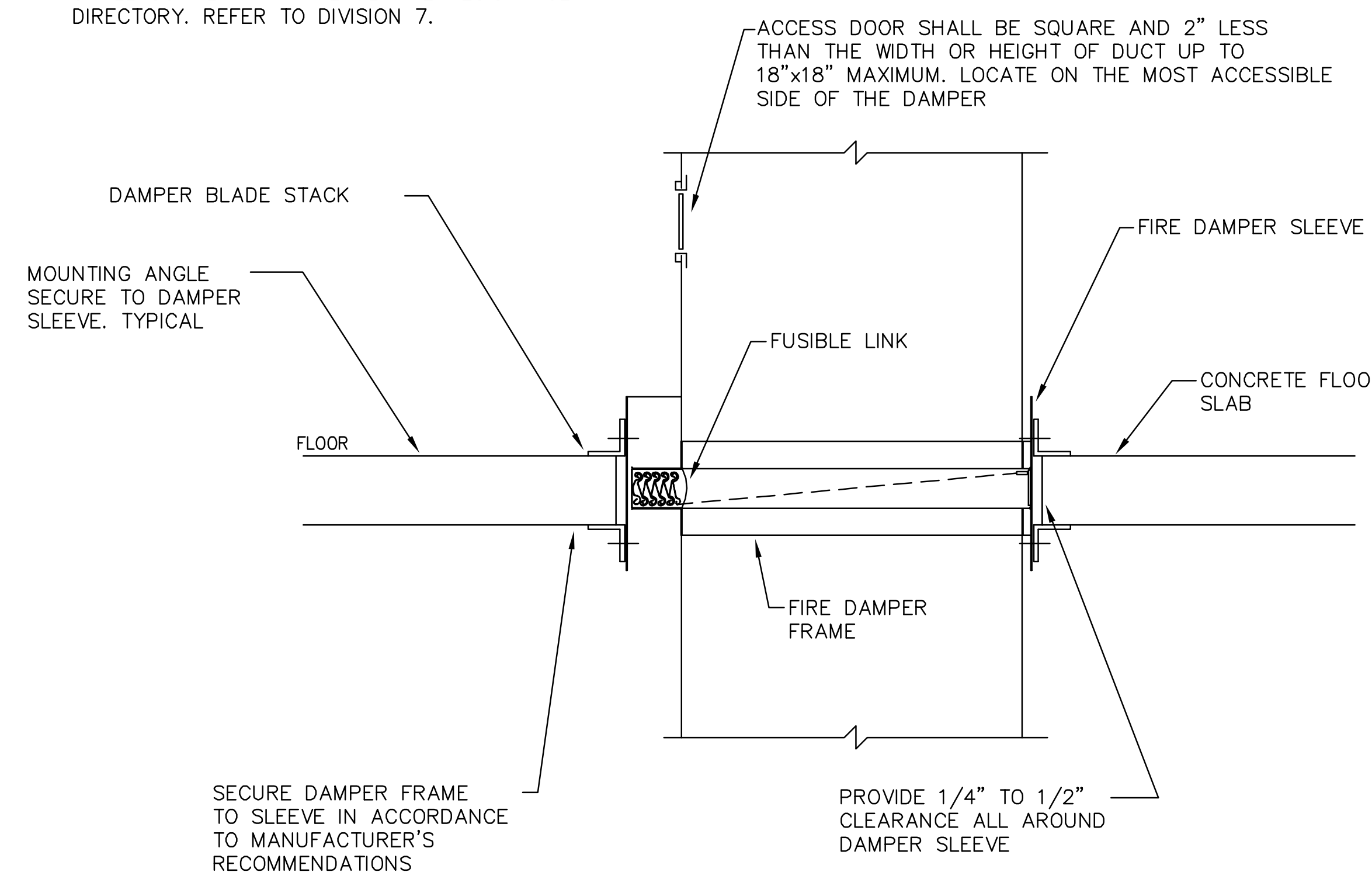
② ACCESS DOOR DOWN STREAM OF FIRE DAMPERS, SMOKE DAMPERS AND/OR AUTOMATIC DAMPERS SHALL BE OF THE PRESSURE RELIEF TYPE THAT AUTOMATICALLY RESETS. THE DAMPERS SHALL ALLOW AIR TO FLOW INTO THE DUCT UNDER HIGH NEGATIVE STATIC.

③ ACCESS DOOR SHALL BE SQUARE AND 2" LESS THAN THE HEIGHT, WIDTH OR DIAMETER OF OF THE DUCT UP TO 18"x18" MAXIMUM.

L12 DUCT ACCESS DOORS

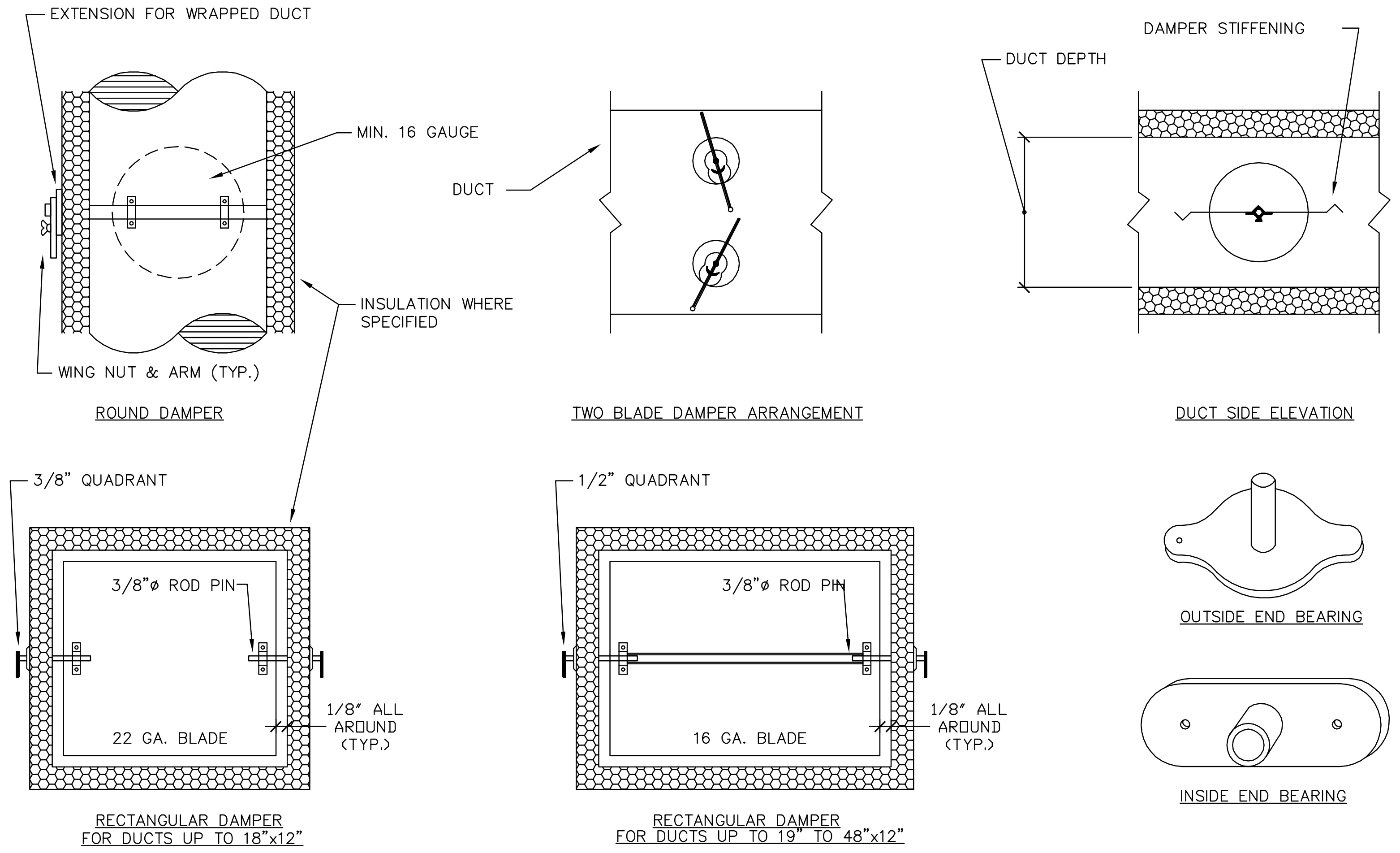
NONE

NOTE: FIRE DAMPER SLEEVE MOUNTING ANGLES SHALL BE SECURED TO SLEEVE ONLY. MOUNTING ANGLES SHALL OVERLAP SLAB CONSTRUCTION AND SHALL FIT SNUG ON BOTH TOP AND BOTTOM. FIRESTOP SEALANTS AND FIRESTOP PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL COMPLY WITH THE UL FIRE RESISTANCE DIRECTORY. REFER TO DIVISION 7.



E1 HORIZONTAL FIRE DAMPER

NONE



ROUND DAMPER

TWO BLADE DAMPER ARRANGEMENT

DUCT SIDE ELEVATION

RECTANGULAR DAMPER FOR DUCTS UP TO 18"x12"

RECTANGULAR DAMPER FOR DUCTS UP TO 19" TO 48"x12"

OUTSIDE END BEARING

INSIDE END BEARING

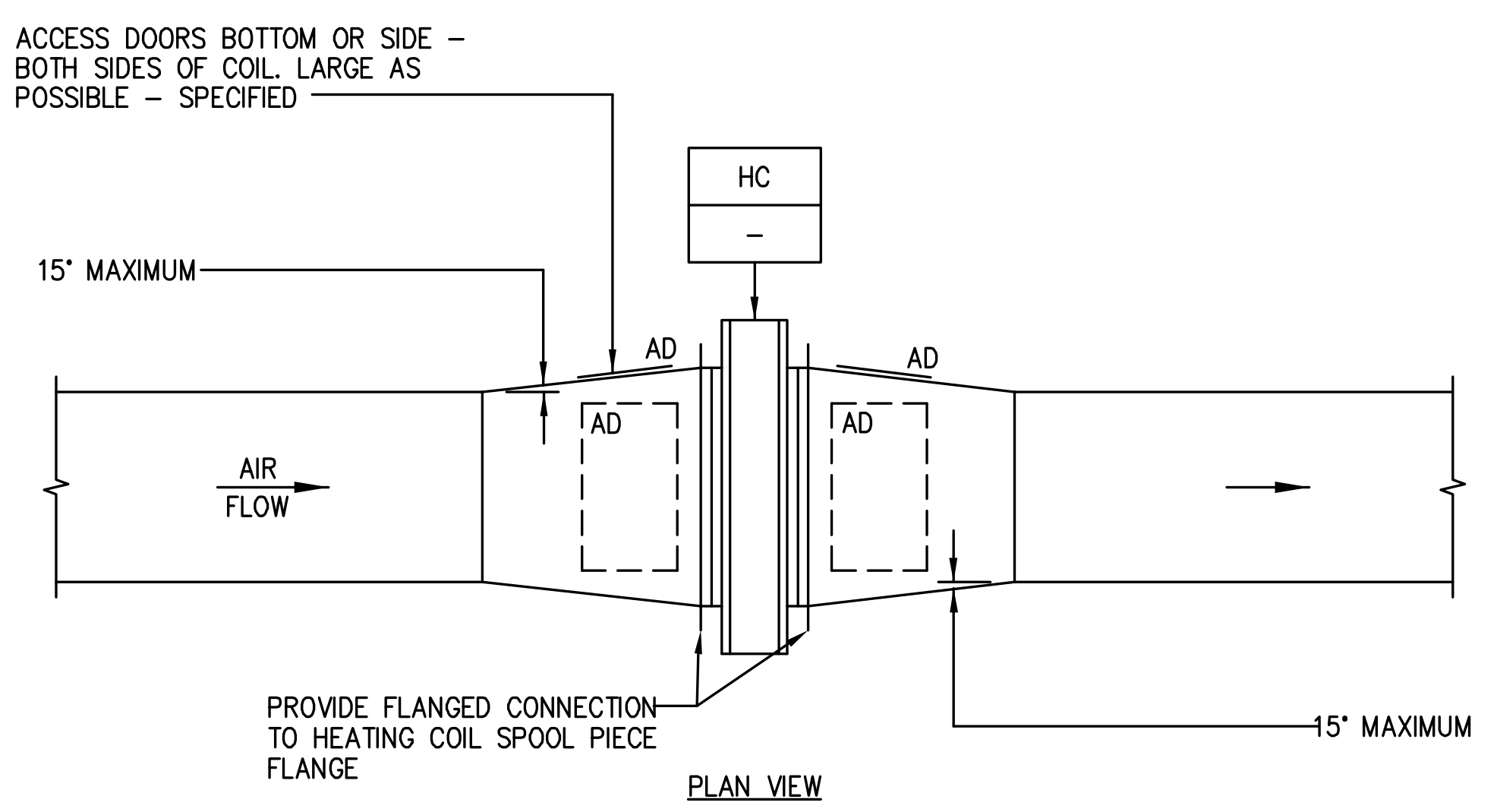
NOTES:

① FOR RECTANGULAR DUCTS OVER 12" HIGH, PROVIDE MULTIPLE OPPOSED BLADE DAMPER.

② ALL QUADRANT OPERATORS SHALL BE EXTENDED TO OUTSIDE OF INSULATION.

E7 VOLUME DAMPER (SINGLE BLADE)

NONE



PLAN VIEW

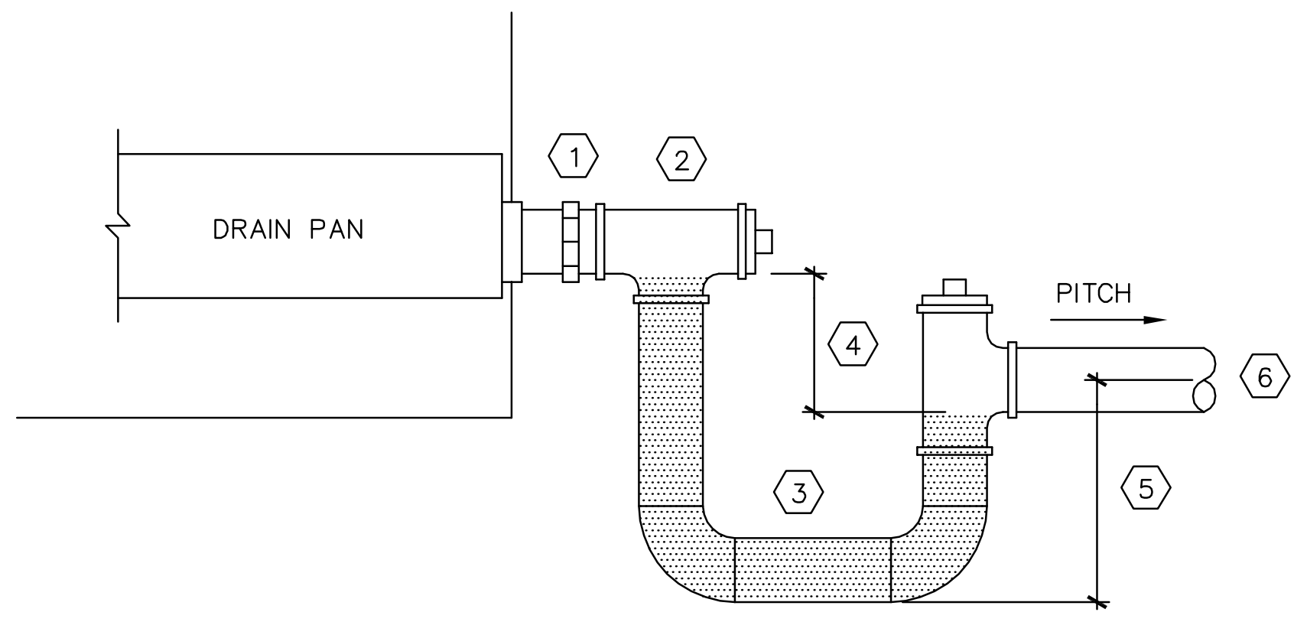
NOTE:

INSTALL HEATING COIL IN FLANGED SPOOL PIECE OF SHEET METAL TO FACILITATE THE REMOVAL OF COIL FLANGED DUCTWORK WITH A MINIMUM OF DISTURBANCE TO THE DUCTWORK SYSTEM.

A1 DUCT MOUNTED HEATING COIL

NONE

⟨1⟩ UNION
⟨2⟩ TEE WITH CLEANOUT PLUG (TYPICAL)
⟨3⟩ TRAP
⟨4⟩ FAN STATIC PRESSURE (FSP) + 1"
⟨5⟩ (FSP/2) + 1"
⟨6⟩ PITCH PIPE TO NEAREST FLOOR DRAIN



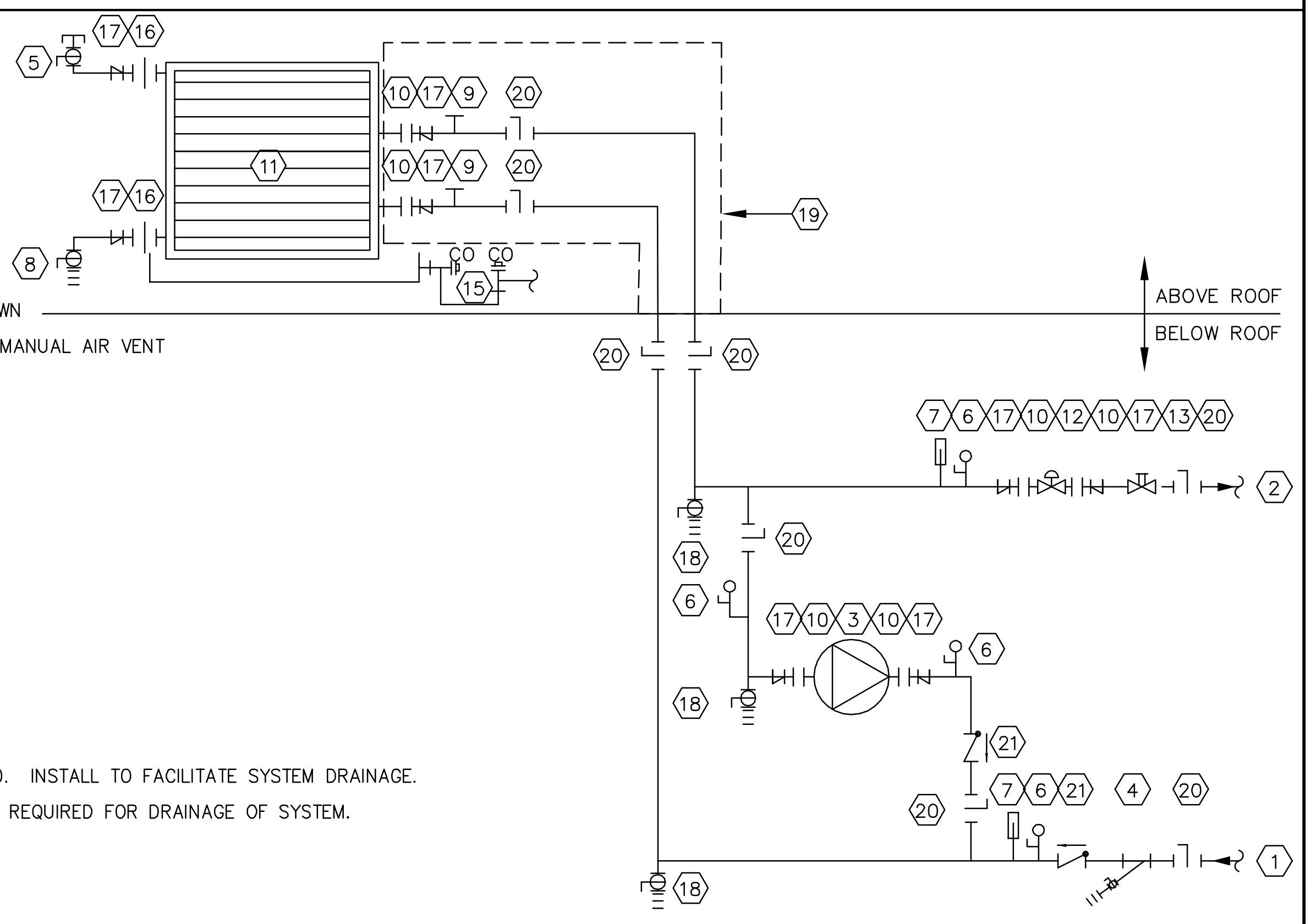
NOTES:

1. ALLOW SUFFICIENT SPACE BELOW DRAIN PAN FOR TRAP.
2. PITCH DRAIN FOR PROPER RUNOFF.
3. MANUALLY PRIME FILL TRAP BEFORE STARTUP TO FORM INITIAL DRAIN SEAL.
4. SUPPORT LENGTHY DRAIN LINES TO PREVENT SAG AND CONDENSATE OVERFLOW.

A7 CONDENSATE PAN TRAP

NONE

⟨1⟩ SUPPLY PIPING
⟨2⟩ RETURN PIPING
⟨3⟩ FREEZE PROTECTION PUMP
⟨4⟩ STRAINER WITH BALL VALVE, CHAIN AND CAP FOR BLOW DOWN
⟨5⟩ 3/4" PIPE WITH BALL VALVE, CHAIN AND CAP TO SERVE A MANUAL AIR VENT
⟨6⟩ PRESSURE GAUGE (TYPICAL)
⟨7⟩ THERMOMETER (TYPICAL)
⟨8⟩ 3/4" COIL DRAIN VALVE W/ HOSE END CONNECTION
⟨9⟩ PRESSURE/TEMPERATURE PORT
⟨10⟩ FLANGE (TYPICAL)
⟨11⟩ HYDRONIC COIL
⟨12⟩ CONTROL VALVE
⟨13⟩ CALIBRATED BALANCING VALVE
⟨14⟩ DRAIN PAN (COOLING ONLY)
⟨15⟩ CONDENSATE TRAP SEAL (COOLING ONLY
⟨16⟩ UNION (TYPICAL)
⟨17⟩ PROVIDE PIPE ECCENTRIC REDUCER/ EXPANDER AS REQUIRED. INSTALL TO FACILITATE SYSTEM DRAINAGE.
⟨18⟩ 3/4" DRAIN VALVE W/ HOSE END CONNECTION. PROVIDE AS REQUIRED FOR DRAINAGE OF SYSTEM.
⟨19⟩ AHU's COIL PIPE CHASE BY AHU MANUFACTURER.
⟨20⟩ BUTTERFLY VALVE (TYPICAL)
⟨21⟩ CHECK VALVE (TYPICAL)



A11 AHU HYDRONIC COIL PIPING DETAIL

NONE

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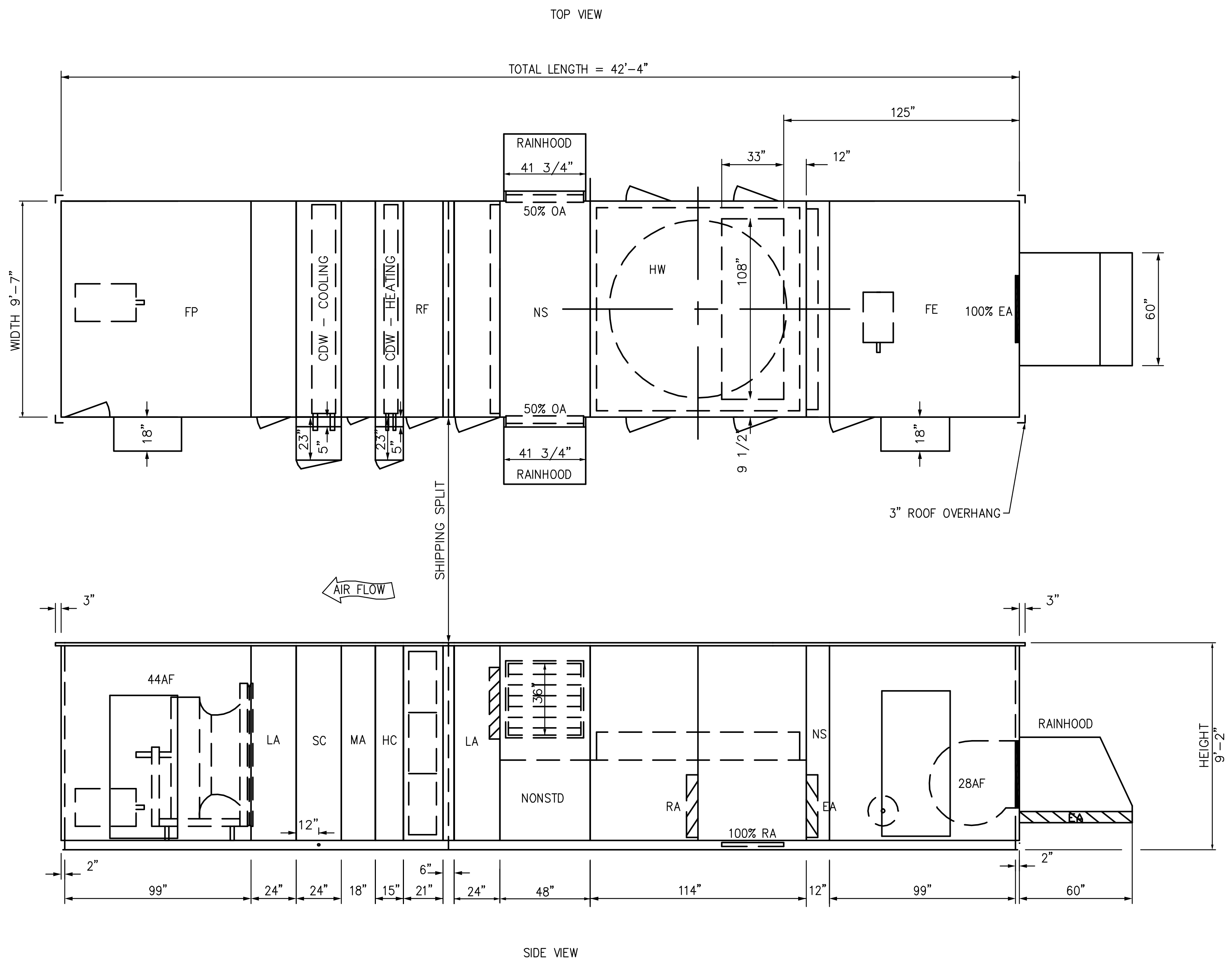
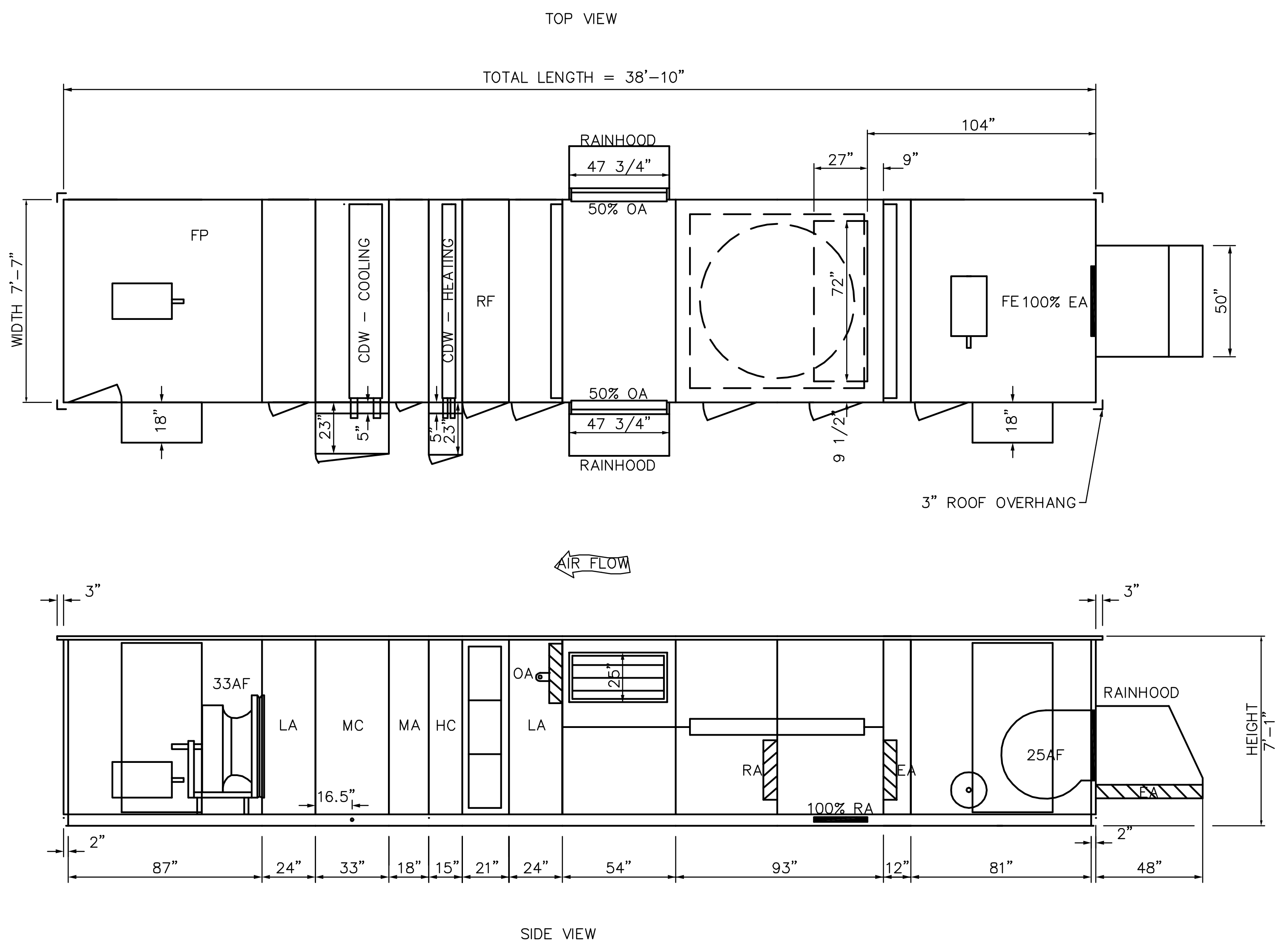


A1 **AHU-1**

N.T.S.



A9 **AHU-2**

N.T.S.

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CAD file no. C-H505.DWG
drawing no. **C-H505**

AIR HANDLING UNIT SCHEDULE

TAG	AREA SERVED	UNIT LOCATION	MIN OA CFM	SUPPLY FAN					EXHAUST FAN					WINTER DATA								SUMMER DATA								WHEEL DATA				
														SUPPLY EAT		SUPPLY LAT		EXHAUST EAT		EXHAUST LAT		SUPPLY EAT		SUPPLY LAT		EXHAUST EAT		EXHAUST LAT						
				CFM	ESP (IN. WG)	RPM	BHP	HP	CFM	ESP (IN. WG)	RPM	BHP	HP	DB (°F)	WB (°F)	DB (°F)	WB (°F)	DB (°F)	WB (°F)	DB (°F)	WB (°F)	DB (°F)	WB (°F)	DB (°F)	WB (°F)	DB (°F)	WB (°F)	DB (°F)	WB (°F)	HP	TYPE OF CONTROL	SPEED RANGE (RPM)	DIA. (IN.)	MEDIA MATERIAL
AHU–1	REFER TO PLANS	ROOF	17,000	24,000	3.0	–	–	50	20,100	2.0	–	–	30	–3.0	–4.0	38.8	35.0	78.6	63.6	–	–	83	73	79	65.4	83.0	75.0	–	–	1/2	VFD	61.6	99	POLYMER W/ SILICA GEL DESICCANT
AHU–2	LECTURE HALL	ROOF	7,500	14,000	3.0	–	–	25	10,000	2.0	–	–	20	–3.0	–4.0	38.8	35.0	78.6	63.6	–	–	83	73	79	65.4	83.0	75.0	–	–	1/3	VFD	61.6	74	POLYMER W/ SILICA GEL DESICCANT

AIR HANDLING UNIT SCHEDULE (CONT.)

AHU
XX

TAG	PRE HEATING COIL										COOLING COIL										HEATING COIL										FILTER DATA		BASIS OF DESIGN	REMARKS
	ROWS	FINS/ IN	FACE VEL. (FT/MIN)	MBH	EAT DB (°F)	LAT DB (°F)	ENTERING WATER (°F)	LEAVING WATER (°F)	GPM	P.D. (FT. WG)	ROWS	FINS/ IN	FACE VEL. (FT/MIN)	MBH	EAT DB (°F)	LAT DB (°F)	ENTERING WATER (°F)	LEAVING WATER (°F)	GPM	P.D. (FT. WG)	ROWS	FINS/ IN	FACE VEL. (FT/MIN)	MBH	EAT DB (°F)	LAT DB (°F)	ENTERING WATER (°F)	LEAVING WATER (°F)	GPM	P.D. (FT. WG)	PRE FILTER DEPTH / EFFICIENCY	FINAL FILTER DEPTH / EFFICIENCY		
AHU–1	2	13	368	298.3	38.7	50.1	115	105	60.3	10	8	12	368	1316.6	78.3	50	45	55	261.3	10	2	8	368	792.2	50	85	115	105	158.9	10	2"/30%	12"/95%	YORK CP 680	–
AHU–2	2	12	345	138.6	41.0	50.1	115	105	30.2	10	8	9	345	731.0	78.1	51.0	45	55	145.5	10											2"/30%	12"/95%	YORK CP 400	–

DUCT MATERIAL, CONSTRUCTION AND INSULATION SCHEDULE

SYSTEM	SECTION	MATERIAL	DUCT PRESSURE CLASS	INSULATION		JACKET	VAPOR BARRIER	REMARKS
				TYPE	THICK (IN.)			
AHU–1	SA DUCTWORK FROM AHU DISCH. TO SMOKE DAMPER	GALV. STEEL	+10	WRAP	1.5	FOIL	YES	–
AHU–1	SA DUCTWORK FROM SMOKE DAMPER TO VAV OR FPTU BOX INLET	GALV. STEEL	+3	WRAP	1.5	FOIL	YES	NOTE 2
AHU–1	SA DUCTWORK FIRST FLOOR SLAB TO FPTU–B–1	GALV. STEEL	+3	BOARD	1.5	FOIL	YES	–
AHU–1	SA DUCTWORK FROM VAV OR FPTU BOX OUTLET TO DIFFUSER, REGISTER OR GRILLE	GALV. STEEL	+2	A.L	1.0	–	YES	NOTE 1
AHU–1	RE DUCTWORK REGISTER OR GRILLE TO SOUND ATTENUATOR	GALV. STEEL	–2	A.L.	1.0	–	YES	NOTE 1
AHU–1	RA DUCTWORK FROM SMOKE DAMPER TO AHU INLET	GALV. STEEL	–6	WRAP	1.5	FOIL	YES	–
AHU–2	SA DUCTWORK FROM AHU DISCH. TO SMOKE DAMPER	GALV. STEEL	+10	WRAP	1.5	FOIL	YES	–
AHU–2	SA DUCTWORK FROM SMOKE DAMPER TO SOUND ATTENUATOR	GALV. STEEL	+3	A.L.	2.0	–	YES	NOTE 1
AHU–2	SA DUCTWORK FROM SOUND ATTENUATOR TO SA DISCHARGE TO SPACE	GALV. STEEL	+2	A.L.	2.0	–	YES	NOTE 1
AHU–2	RE DUCTWORK REGISTER OR GRILLE TO SOUND ATTENUATOR	GALV. STEEL	–2	A.L.	2.0	–	YES	NOTE 1
AHU–2	RA DUCTWORK FROM SMOKE DAMPER TO AHU INLET	GALV. STEEL	–6	WRAP	1.5	FOIL	YES	–
SF–1	SA DUCTWORK FROM LOUVER TO FAN INLET	GALV. STEEL	–2	BOARD	1.5	FOIL	YES	–
SF–1	SA DUCTWORK FROM FAN DISCHARGE TO DIFFUSER	GALV. STEEL	+2	BOARD	1.5	FOIL	YES	–
SEF–1	EXH DUCTWORK FROM GRILLE TO FAN INLET	GALV. STEEL	–3	–	–	–	–	–
SEF–1	EXH DUCTWORK FROM FAN DISCHARGE TO OUTLET	GALV. STEEL	+3	–	–	–	–	NOTE 3
TEF–1	EXH DUCTWORK FROM GRILLE TO FAN INLET	GALV. STEEL	–2	–	–	–	–	–
EF–1	EXH DUCTWORK FROM GRILLE TO FAN INLET	GALV. STEEL	–2	–	–	–	–	–
EF–2,3,4&5	EXH DUCTWORK FROM GRILLE TO FAN INLET	GALV. STEEL	–2	–	–	–	–	–
EF–2,3,4&5	EXH DUCTWORK FROM FAN DISCHARGE TO OUTLET	GALV. STEEL	+2	–	–	–	–	–
CUH's	SUPPLY DUCTWORK FROM CUH TO GRILLE	GALV. STEEL	+2	–	–	–	–	–
CUH's	RA DUCTWORK FROM GRILLE TO CUH	GALV. STEEL	–2	–	–	–	–	–
GTHP–6,7&8	SA DUCTWORK FROM GTHP DISCHARGE TO DIFFUSER OR GRILLE	GALV. STEEL	+2	BOARD	1.5	FOIL	YES	–
GTHP–6,7&8	RA DUCTWORK FROM GRILLE TO GTHP INLET	GALV. STEEL	–2	BOARD	1.5	FOIL	YES	–
ALL	TRANSFER DUCT WORK	GALV. STEEL	–2	A.L.	1.0	–	–	NOTE 1

NOTE 1: A.L. = ACOUSTICAL LINING.
NOTE 2: EXCLUDES DUCTWORK IN BASEMENT.
NOTE 3: DUCTWORK SHALL BE SEALED WEATHER TIGHT.

VAV BOX SCHEDULE (W/ HW REHEAT)

VAV
NO.

TAG	AREA SERVED	UNIT LOCATION	INLET SIZE (IN)	AIRFLOW RANGE		MAXIMUM APD (IN. WG)	NC LEVEL		HOT WATER HEATING COIL								BASIS OF DESIGN	REMARKS
				MAX CFM	MIN CFM		RAD	DISCH.	CAP (MBH)	EAT (°F)	LAT (°F)	GPM	EWT (°F)	LWT (°F)	WPD (FT)	ROWS		
VAV–1–1	BREAKOUT RM 110	OPEN OFFICE 111	12	1000	350	0.39	25	20	12.4	55	95.6	2.4	115.0	102.0	0.9	3	NAILOR 30RW	–
VAV–1–2	NORTH END OF OPEN OFFICE 111	OPEN OFFICE 111	08	800	200	0.25	25	20	6.7	55	88.1	1.4	115.0	105.0	0.4	2	NAILOR 30RW	–
VAV–1–3	SOUTH END OF OPEN OFFICE 111	DIRECTOR FOB 111A	12	1200	400	0.53	25	20	13.7	55	94.3	2.7	115.0	102.0	1.1	3	NAILOR 30RW	–
VAV–1–4	RECEPTION & RMS 111K & 111J	OPEN OFFICE 111	07	495	200	0.12	25	20	6.7	55	88.1	1.4	115.0	105.0	0.4	2	NAILOR 30RW	–
VAV–1–5	LOBBY 102	OPEN OFFICE 111	12	1380	450	0.67	25	20	18.6	55	93.2	3.0	115.0	103.0	1.3	3	NAILOR 30RW	–
VAV–1–6	LOBBY 102	OPEN OFFICE 111	16	2070	700	0.84	25	20	29.3	55	98.1	4.7	115.0	101.0	1.1	4	NAILOR 30RW	–
VAV–1–7	WOMENS 106 & MENS 107	LOBBY 102	12	1150	1150	0.65	25	20	40.5	55	89.0	7.6	115.0	104.0	5.2	4	NAILOR 30RW	–
VAV–1–8	LOBBY 102	OPEN OFFICE 111	12	1540	600	1.07	25	20	23.1	55	95.4	4.0	115.0	102.0	1.5	4	NAILOR 30RW	–
VAV–1–9	LOBBY 102	OPEN OFFICE 111	16	2000	700	0.79	25	20	29.3	55	98.1	4.7	115.0	101.0	1.1	4	NAILOR 30RW	–
VAV–1–10	BREAKOUT ROOM 109	BREAKOUT ROOM 109	10	830	500	0.58	25	20	18.5	55	93.9	3.3	115.0	102.0	0.9	4	NAILOR 30RW	–
VAV–1–11	DIRECTOR FOB 111A	DIRECTOR FOB 111A	08	430	100	0.3	25	20	3.7	55	96.3	0.7	115.0	102.0	0.1	3	NAILOR 30RW	–
VAV–1–12	FOB CLIENT MEETING 111B	FOB CLIENT MEETING 111B	05	250	100	0.15	25	20	3.7	55	96.3	0.7	115.0	102.0	0.1	3	NAILOR 30RW	–
VAV–1–13	111C, D, F, G	OFFICE SUITE 111	10	885	300	0.32	25	20	10.1	55	86.2	2.0	115.0	105.0	1.0	2	NAILOR 30RW	–
VAV–1–14	CONFERENCE ROOM 111E	OFFICE SUITE 111	08	390	200	0.16	25	20	7.2	55	95.7	1.4	115.0	102.0	0.3	3	NAILOR 30RW	–
VAV–1–15	111H, OFFICE SUITE 111	OFFICE SUITE 111	10	615	200	0.17	25	20	7.5	55	89.7	1.4	115.0	104.0	0.5	2	NAILOR 30RW	–
VAV–1–16	A/V CONTROL RM 104	MENS 107	08	500	100	0.06	25	20	2.7	55	80.2	1.0	115.0	110	0.6	1	NAILOR 30RW	–
VAV–2–1	BREAKOUT LOUNGE 202	WOMEN'S ROOM 106	14	2000	700	0.77	25	20	28.4	55	92.4	4.7	115.0	103.0	3.8	3	NAILOR 30RW	–
VAV–2–2	GALLERY 221	GALLERY 221	16	690	300	0.13	25	20	29.3	55	108.0	4.7	115.0	108.0	1.1	4	NAILOR 30RW	–
VAV–2–3	BREAKOUT LOUNGE 202	GALLERY 221	14	2340	1000	1.0	25	20	28.4	55	87.2	4.7	115.0	100.0	3.8	3	NAILOR 30RW	–
VAV–2–4	BREAKOUT LOUNGE 202	BREAKOUT ROOM 212	12	1400	700	0.68	25	20	25.8	55	89.0	4.7	115.0	104.0	3.2	3	NAILOR 30RW	–
VAV–2–5	BREAKOUT ROOM 212	BREAKOUT ROOM 213	10	650	350	0.38	25	20	14.3	55	97.3	2.4	115.0	102.0	0.5	4	NAILOR 30RW	–
VAV–2–6	BREAKOUT ROOM 213	BREAKOUT ROOM 213	12	1400	650	0.19	25	20	24.4	55	89.7	4.3	115.0	104.0	2.7	3	NAILOR 30RW	–
VAV–2–7	BREAKOUT ROOM 214	BREAKOUT ROOM 214	12	1260	500	0.57	25	20	20.1	55	92.1	3.3	115.0	103.0	1.6	3	NAILOR 30RW	–
VAV–2–8	BREAKOUT ROOM 215	BREAKOUT ROOM 215	12	1050	500	0.42	25	20	20.1	55	92.1	3.3	115.0	103.0	1.6	3	NAILOR 30RW	–
VAV–2–9	BREAKOUT ROOM 216	CORR. 220, CONFERENCE ROOM 217	10	705	350	0.44	25	20	14.3	55	97.3	2.4	115.0	102.0	0.5	4	NAILOR 30RW	–
VAV–2–10	BREAKOUT ROOM 216	BREAKOUT ROOM 216	14	1530	450	0.49	25	20	16.3	55	96.5	3.0	115.0	101.0	1.6	3	NAILOR 30RW	–
VAV–2–11	WOMENS 208 & MENS 209	MENS 209	12	1100	1100	0.65	25	20	40.5	55	89.0	7.6	115.0	104.0	5.2	4	NAILOR 30RW	–

NOTE: ALL VAV BOXES SHALL HAVE MANUFACTURER'S INTEGRATED SOUND ATTENUATORS.

FAN POWERED VAV BOXES

FPTU
XX

TAG	FAN CFM	MIN. PRIMARY AIR	NOMINAL INLET SIZE	NC LEVEL		MAX EXTERNAL SP (IN WG)	ELECTRICAL				HOT WATER REHEAT COIL							BASIS OF DESIGN	REMARKS
				RAD (MAX)	DISCH (MAX)		MOTOR HP	VOLTS	PHASE	HERTZ	CAPACITY (MBH)	EAT (°F) ②	LAT (°F) ②	ROWS	GPM	EWT (°F)	LWT (°F)		
FPTU–2–1	725	450	–	30	25	–	–	–	–	–	–	–	–	–	1.7	–	–	NAILOR 35SW	
FPTU–2–2	725	450	–	30	25	–	–	–	–	–	–	–	–	–	1.7	–	–	NAILOR 35SW	
FPTU–2–3	300	–	–	30	25	–	–	–	–	–	–	–	–	–	1.0	–	–	NAILOR 35SW	
FPTU–B–1	2000	700	–	30	25	–	–	–	–	–	–	–	–	–	4.7	–	–	NAILOR 35SW	

SOUND ATTENUATOR SCHEDULE

SA
X

TAG	AREA SERVED	UNIT LOCATION	CFM	DIMENSIONS		MAX SP (IN. WG)	FACE VELOCITY (FPM)	DYNAMIC INSERTION LOSS DB OCTAVE BAND & MID–FREQUENCY (CPS)								BASIS OF DESIGN	REMARKS
				WxH OR DIA. (IN)	LENGTH (IN)			63	125	250	500	1000	2000	4000	8000		
								1	2	3	4	5	6	7	8		
SA–1–1R	AHU–1 RETURN	2ND FLOOR	7,000	48x18	108	0.32	1167	9	19	29	45	45	28	17	12	VIBRO–ACOUSTICS RD–MHV–F4–108	–
SA–1–2R	AHU–1 RETURN	DROP TO 1ST FLOOR	12,200	72x24	84	0.32	1017	12	15	32	53	47	39	26	16	VIBRO–ACOUSTICS RD–MV–F7–84	–
SA–1–1S	AHU–1 SUPPLY	2ND FLOOR	12,000	56x24	108	0.37	1286	8	10	25	46	55	42	27	21	VIBRO–ACOUSTICS RD–HV–F8–108	–
SA–1–2S	AHU–1 SUPPLY	2ND FLOOR	1,150	18x10	84	0.25	920	8	11	25	45	44	39	26	17	VIBRO–ACOUSTICS RD–MHV–F7–84	–
SA–1–3S	AHU–1 SUPPLY	DROP TO 1ST FLOOR	17,020	48x54	84	0.30	946	11	15	27	44	48	39	21	14	VIBRO–ACOUSTICS RD–MLV–F4–84	–
SA–1–4S	AHU–1 SUPPLY	2ND FLOOR	690	14x8	84	0.31	887	9	14	26	34	37	27	19	15	VIBRO–ACOUSTICS RD–MV–F2–84	–
SA–2–1R	AHU–2 RETURN	2ND FLOOR	13,000	48x48	84	0.29	812	11	16	31	53	55	55	38	23	VIBRO–ACOUSTICS RD–MV–F9–84	–
SA–2–1S	AHU–2 SUPPLY	DROP TO BASEMENT	9,740	28x60	108	0.33	835	12	20	37	44	53	38	25	19	VIBRO–ACOUSTICS RD–MLV–F2–108	–
SA–2–2S	AHU–2 SUPPLY	DROP TO 1ST FLOOR	3,660	20x36	108	0.29	732	10	17	33	53	54	55	51	32	VIBRO–ACOUSTICS RD–MLV–F9–108	–

COIL SCHEDULE

RHC
NO.

TAG	SERVICE	UNIT LOCATION	AIR FLOW (CFM)	SIZE LxH (IN)	ROWS	AIR SIDE					FLUID SIDE					BASIS OF DESIGN	REMARKS
						MAX FACE VELOCITY (FPM)	MAX. APD (IN. WG)	TOTAL CAPACITY (MBH)	EAT (°F)	LAT (°F)	FLUID	FLOW (GPM)	MAX. PD (FT)	EFT (°F)	LFT (°F)		
RHC–10a	MECHANICAL RM 005	MECHANICAL RM 005	1100	24x12	3	550	0.2	70.2	–3	55	WATER	7.1	5	115	105	YORK–CDW	–

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CABINET HEATER AND UNIT HEATER SCHEDULE

CUH / NO. UH / NO.

TAG	AREA SERVED	UNIT LOCATION	CFM	HEATING COIL CAPACITY							ELECTRICAL			ARRANGEMENT	BASIS OF DESIGN	REMARKS
				TOTAL CAPACITY (MBH)	EAT (°F)	LAT (°F)	GPM	WPD (FT)	EWT (°F)	LWT (°F)	HP	VOLTS	PHASE			
CUH–1,2	SEE PLANS	SEE PLANS	970	46.2	60	–	6.0	–	115	105	1/10	120	1	RECESSED WALL MOUNTED	STERLING RW–1120–12	SEE NOTE 1
CUH–3,4	SEE PLANS	SEE PLANS	970	46.2	60	–	6.0	–	115	105	1/10	120	1	RECESSED CEILING MOUNTED	STERLING RC–1200–12	SEE NOTE 1
CUH–5,6	SEE PLANS	SEE PLANS	970	46.2	60	–	6.0	–	115	105	1/10	120	1	WALL TYPE	STERLING W–1060–12	SEE NOTE 1

NOTE 1: TWO ROW, 12 FPI COIL. HORSEPOWER INDICATES 1/10 HP PER EACH OF TWO MOTORS. CABINET HAS SINGLE POINT ELECTRICAL CONNECTION. PERFORMANCE BASED ON LOW SPEED OPERATION OF FAN. UNIT SHALL HAVE FACTORY MOUNTED AND WIRED ELECTRICAL DISCONNECT SWITCH AND THERMOSTAT.

FAN SCHEDULE

TEF / X EF / X SF / X

TAG	AREA SERVED	UNIT LOCATION	CFM	ESP (IN. WG)	FAN RPM	WHEEL TYPE	CLASS	WHEEL SIZE (IN)	BHP	OUTPUT VELOCITY (FPM)	ELECTRICAL			BASIS OF DESIGN	REMARKS
											HP	VOLTS	PHASE		
SF–1	MECH ROOM 005	MECH ROOM 005	1,050	0.75	1383	BI	I	12	0.70	590	1/2	480	3	GREENHECK BSQ–120–3	WITH VFD & ON EMERGENCY POWER
EF–1	MECH ROOM 005	ROOF	1,100	0.50	1126	BI	I	14	0.70	262	1/2	480	3	GREENHECK CUBE–141–3	WITH VFD & ON EMERGENCY POWER
EF–2	ELEV MACH RM 002	BASEMENT STORAGE 001	500	0.25	1070	BI	I	–	–	–	217 WATT	120	1	GREENHECK CSP–A510	–
EF–3	ELECTRIC RM 004	ELECTRIC RM 004	500	0.25	1070	BI	I	–	–	–	217 WATT	120	1	GREENHECK CSP–A510	CONTROLLED BY T–STAT
EF–4	ELECTRIC RM 112	ELECTRIC RM 112	500	0.25	1070	BI	I	–	–	–	217 WATT	120	1	GREENHECK CSP–A510	CONTROLLED BY T–STAT
EF–5	ELECTRIC RM 212	ELECTRIC RM 212	500	0.25	1070	BI	I	–	–	–	217 WATT	120	1	GREENHECK CSP–A510	CONTROLLED BY T–STAT
TEF–1	TOILET EXHAUST	ROOF	3,350	0.75	665	BI	I	24	0.76	302	1	460	3	GREENHECK CUBE–240	–
SEF–1	SMOKE EXHAUST	ATRIUM ROOF	46,000	1.00	806	VANE AXIAL	I	54	17.1	2892	20	460	3	GREENHECK TBI–FS–5L54–200	–

DIFFUSERS, REGISTERS, AND GRILLES SCHEDULE

FG–Z / CFM / X EG–Z / CFM / AxB RG–Z / CFM / AxB SG–Z / CFM / AxB CD–Z / CFM / AxB ND–Z / CFM / AØ

TAG	SERVICE	NECK SIZE	BLOW PATTERN	BASIS OF DESIGN	REMARKS
RG/EG–1	0° DEFLECTION RETURN / EXHAUST GRILLE	SEE PLANS	–	TITUS 350ZFL	–
RG/EG–2	EGGCRATE RETURN / EXHAUST GRILLE	SEE PLANS	–	TITUS 50F	–
CD–1	SQUARE CEILING DIFFUSER	SEE PLANS	SEE PLANS	TITUS TDCA	–
SG–1	SIDEWALL SUPPLY AIR GRILLE	SEE PLANS	–	TITUS 300RL	–
ND–1	NOZZLE DIFFUSER	SEE PLANS	–	SEIHO PK	–
LD–1	LINEAR DIFFUSER	SEE PLANS	–	TITUS FL–10–JT	–
FG–1	SUPPLY AIR FLOOR GRILLE	SEE PLANS	–	TROX FB 200	BLACK FINISH
FG–2	SUPPLY AIR FLOOR GRILLE	SEE PLANS	–	TITUS 300FL	INSTALLED FLUSH TO FLOOR

FINTUBE RADIATION SCHEDULE

FTR–# / LENGTH / GPM

TAG	AREA SERVED	UNIT LOCATION	CAPACITY (BTUH/LF)	GPM	EWT (°F)	LWT (°F)	HEATING ELEMENT				ENCLOSURE		MOUNTING HEIGHT	BASIS OF DESIGN	REMARKS
							PIPE SIZE	FIN SIZE	FINS/FT	ROWS	DEPTH (IN.)	HEIGHT (IN.)			
FTR–1	REFER TO PLANS	REFER TO PLANS	364	2.0	115	105	1	4.25 X3.625	50	1	6.0625	10.75	6.625	STERLING VB–PM–C435	–
FTR–2	LOBBY 102	LOBBY 102	231	REFER TO PLANS	115	105	3/4	NA	NA	NA	1.625	8.625	2.0	RUNTAL RF3	
FTR–3	SECOND FLOOR OF ATRIUM	CEILING OF SECOND FLOOR OF ATRIUM	202	REFER TO PLANS	115	105	3/4	NA	NA	NA	3.375	2.75	5.0	RUNTAL R2F–1	–

PUMP SCHEDULE

P / NO.

TAG	SERVICE	UNIT LOCATION	GPM	HEAD (FT)	BHP	RPM	MIN. PUMP EFF.	ELECTRICAL			BASIS OF DESIGN	REMARKS
								HP	VOLTS	PHASE		
P–HW–1 & 2	PRIMARY HOT WATER	MECH ROOM 005	270	40	–	1750	–	7.5	460	3	ITT BELL & GOSSETT 80–4X4X9–1/2 B	SEE NOTE 1
P–HW–3 & 4	SECONDARY HOT WATER	MECH ROOM 005	450	50	–	1750	–	10	460	3	ITT BELL & GOSSETT 80–6X6X9–1/2 B	SEE NOTE 1
P–HW–5, 6 & 7	FREEZE PROTECTION PUMPS FOR AHU's HEATING COILS	SECOND FLOOR	100	10	–	1150	–	0.75	460	3	ITT BELL & GOSSETT 80–3X3X7B	SEE NOTE 3
P–CH–1 & 2	PRIMARY CHILLED WATER	MECH ROOM 005	270	40	–	1750	–	7.5	460	3	ITT BELL & GOSSETT 80–4X4X9–1/2 B	SEE NOTE 1
P–CH–3 & 4	SECONDARY CHILLED WATER	MECH ROOM 005	450	50	–	1750	–	10	460	3	ITT BELL & GOSSETT 80–6X6X9–1/2 B	SEE NOTE 1
P–CH–5 & 6	FREEZE PROTECTION PUMPS FOR AHU's COOLING COILS	SECOND FLOOR	100	10	–	1150	–	0.75	460	3	ITT BELL & GOSSETT 80–3X3X7B	SEE NOTE 3
P–GW–1, 2, 3, 4 & 5	GEOTHERMAL WATER	GEOTHERMAL WELLS	90	140	–	3500	–	7.5	460	3	ITT GOULDS PUMP 80 GS	SEE NOTE 2

NOTE 1: ONE OF THE PUMP SERVES AS A STANDBY. PUMP CONTROLLED BY VFD.
NOTE 3: SUBMERSIBLE PUMP CONTROLLED BY VFD
NOTE 3: PUMP ON EMERGENCY POWER.

AIR SEPARATOR SCHEDULE

AS / NO.

TAG	AREA SERVED	UNIT LOCATION	GPM	MAX PD (FT.)	PIPE CONNECTION SIZE (IN)	BASIS OF DESIGN	REMARKS
AS–1	GEOTHERMAL WATER SYSTEM	MECHANICAL RM 005	450	0.65	6" FLANGED	ITT BELL & GOSSETT RL–6	–
AS–2	HOT WATER SYSTEM	MECHANICAL RM 005	450	0.65	6" FLANGED	ITT BELL & GOSSETT RL–6	–
AS–3	CHILLED WATER SYSTEM	MECHANICAL RM 005	450	0.65	6" FLANGED	ITT BELL & GOSSETT RL–6	–

EXPANSION TANK SCHEDULE

ET / NO.

TAG	AREA SERVED	UNIT LOCATION	TANK MOUNTING	MIN. FILL PRESSURE (PSIG)	TANK VOLUME (GAL)	ACCEPTANCE VOLUME (GAL)	BASIS OF DESIGN	REMARKS
ET–1	GEOTHERMAL WATER SYSTEM	MECHANICAL RM 005	FLOOR	–	132	61	TACO CAX 500	–
ET–2	HOT WATER SYSTEM	MECHANICAL RM 005	FLOOR	–	132	61	TACO CAX 500	–
ET–3	CHILLED WATER SYSTEM	MECHANICAL RM 005	FLOOR	–	132	61	TACO CAX 500	–

WATER SOURCE HEAT PUMP SCHEDULE

GTHP / NO.

TAG	AREA SERVED	UNIT LOCATION	BUILDING LOOP PERFORMANCE															GEOTHERMAL WATER			ELECTRICAL			BASIS OF DESIGN	REMARKS
							COOLING CAPACITY						HEATING CAPACITY												
			CFM	ESP (IN. WG)	GPM	PD (FT)	HEAT OF REJECTION (MBH)	TOTAL CAPACITY (MBH)	SENSIBLE HEAT (MBH)	EWT (°F)	LWT (°F)	KW	HEAT OF ABSORPTION (MBH)	TOTAL CAPACITY (MBH)	EWT (°F)	LWT (°F)	KW	GPM	PD (FT)	EWT (°F)	VOLTS	PHASE	MAX FUSE SIZE		
GTHP–1, 2, 3, 4 & 5	REFER TO PLANS	REFER TO PLANS	N/A	N/A	90	18.9	380	330	–	55	45	14.55	233	330	105	115	28.5	90	20.1	50	460	3	70	CLIMATE MASTER GSW360	–
GTHP–6, 7 & 8	REFER TO PLANS	REFER TO PLANS	700	0.45	N/A	N/A	30.6	24.7	17.3	–	–	1.17	18.8	26.0	–	–	1.83	6	3.6	50	460	3	15	CLIMATE MASTER GSH024	–

STORAGE TANK SCHEDULE

ST / NO.

TAG	SERVICE	TANK							HEAT EXCHANGER										BASIS OF DESIGN	REMARKS
		DIMENSIONS			CONNECTIONS															
		VOLUME (GAL)	HEIGHT (IN)	DIAMETER (IN)	PRIMARY INLET	PRIMARY OUTLET	SECONDARY INLET	SECONDARY INLET	TUBE EWT	TUBE LWT	FLOW (GPM)	CAPACITY (MBH)	WPD (FT)	MINIMUM SURFACE AREA (SF)	FOULING FACTOR	TUBE BUNDLE DIAMETER	# OF PASSES	LENGTH (FT)		
ST–1	HOT WATER	400	72	48	6" FLANGED	6" FLANGED	6" FLANGED	6" FLANGED	40	110	3	105	–	–	–	–	–	–	PVI	–
ST–2	CHILLED WATER	400	72	48	6" FLANGED	6" FLANGED	6" FLANGED	6" FLANGED											PVI	

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