THE LINE SHOWN ABOVE IS EXACTLY ONE INCH LONG AT THIS SHEET'S ORIGINAL PAGE SIZE

ABBREVIATIONS

ABV	ABOVE
AD	ACCESS DOOR
AFF	ABOVE FINISHED FLOOR
ARF	ABOVE RAISED FLOOR
AFG	ABOVE FINISHED GRADE
AMS	AIRFLOW MEASURING SYSTEM
AP	ACCESS PANEL
APR	AIR PRESSURE
APD	AIR PRESSURE DROP
ARCH	ARCHITECT/ARCHITECTURAL
BSL	BIOSAFETY LEVEL
BEL	BELOW
BF	BELOW FLOOR
BM	BEAM
BOD	BOTTOM OF DUCT
BCS	BUILDING CONTROL SYSTEM
CFM	CUBIC FEET PER MINUTE
CLG	CEILING
COL	COLUMN
CONN	CONNECT/CONNECTION
CONT	CONTINUATION/CONTINUOUS
CTE	CONNECT TO EXISTING
DB	DRY BULB
DN	DOWN
DWG	DRAWING
EA	EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE
ELEC	ELECTRICAL/ELECTRIC
EWT	ENTERING WATER TEMPERATURE
EX	EXISTING
EXP	EXPOSED
ETO	ETHYLENE OXIDE
FC	FLEXIBLE CONNECTION
FL	FLOOR
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
GPM	GALLONS PER MINUTE
GR	GRADE
HPD	HIGH PRESSURE DRIP ASSEMBLY
HT	HOT TAP
LAT	LEAVING AIR TEMPERATURE
LS	LINE STOP
LWT	LEAVING WATER TEMPERATURE
MPD	MEDIUM PRESSURE DRIP ASSEMBLY
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OA	OUTSIDE AIR
OBD	OPPOSED-BLADE DAMPER
OC	ON CENTER
PS	PIPE STAND SUPPORT
PRV	PRESSURE REDUCING VALVE
RA	RETURN AIR
REL	RELOCATE
REM	REMOVE
SA	SOUND ATTENUATOR
SDA	STEAM DRIP ASSEMBLY
SPEC	SPECIFICATION
TEMP	TEMPERATURE
TS	TIGHT TO STRUCTURE
TYP	TYPICAL
UG	UNDERGROUND
VFD	VARIABLE FREQUENCY DRIVE
WB	WET BULB
WG	WATER GAUGE
WPD	WATER PRESSURE DROP

DUCTWORK AND AIR DISTRIBUTION

20X20	RECTANGULAR DUCT (FIRST DIMENSION IS SIDE SHOWN IN INCHES)
20/20	FLAT OVAL DUCT (FIRST DIMENSION IS SIDE SHOWN IN INCHES)
	DUCT LINING (1" THICK UNLESS 2" NOTED)
	SUPPLY AIR DUCT SECTION
	RETURN OR OUTSIDE AIR DUCT SECTION
	EXHAUST AIR DUCT SECTION
	TRANSITION
	PRESS-ON COLLAR FITTING WITH ROUND FLEXIBLE DUCT AND DAMPER
	PRESS-ON COLLAR FITTING WITH ROUND RIGID DUCT AND DAMPER
	90° BRANCH TAKEOFF
	RADIUS BRANCH TAKEOFF
SP	STATIC PRESSURE SENSOR SENSING LOCATION
	RECTANGULAR OR FLAT OVAL DUCTWORK WITH CONICAL TAP AND FLAT OVAL OR ROUND BRANCH DUCT
	TRANSITION FROM RECTANGULAR TO ROUND DUCTWORK
FS	BACKDRAFT DAMPER (BD), LOW LEAKAGE MANUAL DAMPER (LMD), OR CONTROL DAMPER (CD), FIRE DAMPER (FD), COMBINATION FIRE/SMOKE DAMPER, (FS)
	MANUAL DAMPER
FS	FIRE DAMPER (FD), 3 HOUR FIRE DAMPER (FD3), SMOKE DAMPER (SD), OR COMBINATION FIRE/SMOKE DAMPER (FS), HORIZONTAL POSITION. H DENOTES 286°F FUSIBLE LINKS.
	TURNING VANES
12X12 S-100	SIDEWALL SUPPLY GRILLE OR REGISTER WITH SIZE, TYPE, AND CFM
12X12 R-100	SIDEWALL RETURN OR EXHAUST GRILLE OR REGISTER WITH SIZE, TYPE, AND CFM
18X18 R-600	CEILING RETURN OR EXHAUST GRILLE OR REGISTER WITH SIZE, TYPE, AND CFM
12"Ø S-600	RIGID DUCT AND CEILING SUPPLY DIFFUSER WITH ROUND NECK SIZE, TYPE, AND CFM
12"Ø S-600	FLEXIBLE DUCT AND CEILING SUPPLY DIFFUSER WITH ROUND NECK SIZE, TYPE, AND CFM
7"Ø S-LA 180	FLEXIBLE DUCT AND LINEAR DIFFUSER WITH LENGTH, TYPE, AND CFM. (A-SIZE; B-TYPE; C- ACTIVE LENGTH)
AD	ACCESS DOOR, OPENING OUTWARD
AD	ACCESS DOOR, OPENING INWARD
	24" x 24" CEILING RETURN GRILLE (R-RP UNLESS NOTED OTHERWISE)
	TERMINAL UNIT WITH HOT WATER REHEAT

PIPING AND VALVES

- PIPE CAP
- CLEANOUT (CO) IN DRAIN LINE
- DIRECTION OF FLOW
- ELBOW - 45°
- ELBOW - 90°
- ELBOW - TURNED DOWN
- ELBOW - TURNED UP
- FLEXIBLE CONNECTOR - PIPING
- STRAINER
- REDUCER - CONCENTRIC
- REDUCER - ECCENTRIC
- TEE
- TEE OUTLET DOWN
- TEE OUTLET UP
- UNION OR FLANGE
- STEAM TRAP (SEE SPECIFICATIONS FOR TYPE AND USE)
- STEAM DRIP ASSEMBLY
- BALL OR BUTTERFLY VALVE (SEE SPECIFICATIONS FOR USE)
- CHECK VALVE
- 2-WAY CONTROL VALVE
- 3-WAY CONTROL VALVE
- GATE VALVE
- WATER PRESSURE REDUCING VALVE
- RELIEF VALVE
- BALANCING VALVE
- M — FLOW CONTROL VALVE (M-MANUAL TYPE; A-AUTOMATIC TYPE)
- T — FLOW METER (A-ANNULAR TYPE; T-TURBINE TYPE; V-VENTURI TYPE)
- M V — AIR VENT (M-MANUAL TYPE; A-AUTOMATIC TYPE; T-THERMOSTATIC TYPE)
- THERMOMETER
- PRESSURE GAUGE
- TEMPERATURE AND PRESSURE TEST PORT; PETE'S PLUG
- THERMOMETER TEST WELL

HYDRONIC PIPING

CHS	CHILLED WATER SUPPLY
CHR	CHILLED WATER RETURN
HWS	HOT WATER SUPPLY
HWR	HOT WATER RETURN
D	CONDENSATE DRAIN
R	REFRIGERANT

CONTROLS AND SENSORS

T	THERMOSTAT
O	OXYGEN SENSOR
T	TEMPERATURE SENSOR
R	REFRIGERANT LEAK SENSOR
N	NIGHT SETBACK THERMOSTAT
H	HUMIDISTAT
H	HUMIDITY SENSOR
C	CARBON MONOXIDE SENSOR
CO_2	CARBON DIOXIDE SENSOR
N	NITROGEN DIOXIDE SENSOR
G	GASOLINE VAPOR SENSOR
FL	FLOAT SWITCH
E	EMERGENCY FAN SHUTDOWN STATION
EO	EMERGENCY OIL FLOW SHUTDOWN STATION
EB	EMERGENCY BOILER SHUTDOWN STATION
DP	DIFFERENTIAL PRESSURE SENSOR SENSING LOCATION
M	MANUAL PUSH BUTTON
NETWORK	BACNET NETWORK CONNECTION
FA	SIGNAL FROM FIRE ALARM SYSTEM
	CONSTANT SPEED DRIVE
VFD	VARIABLE FREQUENCY DRIVE
FACP	FIRE ALARM CONTROL PANEL
	TWO-WAY CONTROL VALVE
	TWO-WAY CONTROL VALVE
	LOUVER
	HUMIDIFIER
C2	CARBON DIOXIDE SENSOR
DP	DIFFERENTIAL PRESSURE SENSOR SENSING LOCATION
ES	END SWITCH
FA	FIRE ALARM RELAY (BY DIVISION 28)
HL	HUMIDITY HIGH LIMIT SENSOR
LL	HUMIDITY LOW LIMIT SENSOR
FACP SD	DUCT SMOKE DETECTOR BY FA
F	FLOW METER
A	ALARM
T	AVERAGING TYPE THERMOSTAT
DP	DIFFERENTIAL PRESSURE SENSOR
CT	CURRENT TRANSDUCER
VS	VIBRATION SWITCH
AM	AMPERAGE METER
S	STARTER
DM	DEMAND LIGHT
DP	DIFFERENTIAL PRESSURE
CS	CONDENSATE SENSOR
LCD	LAB CONTROL DISPLAY
PI	POSITION INDICATOR
HPL	HIGH PRESSURE LIMIT
O	OXYGEN SENSOR
E	EMERGENCU FAM SHUTDOWN STATION
EB	EMERGENCY BOILER SHUTDOWN STATION
SD	SMOKE DETECTOR
M	MANUAL PUSH BUTTON
HS	HIGH STATIC SHUTDOWN

APPLICABLE CODE INFORMATION

CODES AND STANDARDS:

- BUILDING CODE: 2018 NORTH CAROLINA BUILDING CODE
- MECHANICAL CODE: 2018 NORTH CAROLINA MECHANICAL CODE
- PLUMBING CODE: 2018 NORTH CAROLINA PLUMBING CODE
- ELECTRICAL CODE: 2020 NATIONAL ELECTRIC CODE
- FIRE CODE: 2018 NORTH CAROLINA FIRE CODE
- ENERGY CODE: 2018 NORTH CAROLINA ENERGY CONSERVATION CODE
- ACCESSIBILITY: 2017 ANSI A117.1

OCCUPANCY USE GROUP

- A-3, B, S-2

CONSTRUCTION CLASSIFICATIONS:

- 1B

SPRINKLER SYSTEM:

- NFPA 13, 2013ED

NEW HANOVER COUNTY · NORTH CAROLINA · ESTABLISHED 1729

CFD Cape Fear Development

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DocuSigned by: 0892D62E305D47A...
Signed on 05/22/2023 using a Digital Signature.

Project Grace

Grace Street
Wilmington, NC 28401

LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC LEGEND, ABBREVIATIONS AND GENERAL NOTES

ORIG SUBMISSION: 2023.05.22

SHEET: M-001

PROJECT GENERAL NOTES

HVAC GENERAL

1. DRAWINGS ARE DIAGRAMMATIC IN NATURE AND, UNLESS EXPLICITLY DIMENSIONED, INDICATE APPROXIMATE LOCATIONS OF APPARATUS, EQUIPMENT, DUCTWORK AND PIPING. CHANGES IN THE LOCATION, AND OFFSETS, OF SAME WHICH ARE NOT SHOWN ON THE DRAWINGS BUT ARE NECESSARY IN ORDER TO ACCOMMODATE BUILDING CONDITIONS AND COORDINATION WITH THE WORK OF OTHER TRADES, SHALL BE MADE DURING THE PREPARATION OF COORDINATION DRAWINGS AND PRIOR TO INITIAL INSTALLATION, WITHOUT ADDITIONAL COST TO THE OWNER.
2. DO NOT LOCATE VALVES, DAMPERS, ACTUATORS, CONTROL COMPONENTS, ANY EQUIPMENT WITH MOVING PARTS OR ANY EQUIPMENT REQUIRING ACCESS OR REGULAR MAINTENANCE ABOVE INACCESSIBLE CEILINGS. OBTAIN PRIOR APPROVAL IF UNAVOIDABLE & PROVIDE AN ACCESS PANEL THAT WILL ALLOW SAFE AND PRACTICAL ACCESS.
3. PIPING, EQUIPMENT, OR DUCTWORK SHALL NOT BE INSTALLED IN ELECTRICAL EQUIPMENT ROOMS, ELEVATOR EQUIPMENT ROOMS, OR ELEVATOR SHAFTS UNLESS SPECIFICALLY INDICATED ON THE DRAWINGS. IN ADDITION, PIPING, DUCTWORK, OR MECHANICAL EQUIPMENT SHALL NOT BE INSTALLED IN THE SPACE EQUAL TO THE WIDTH AND DEPTH OF SWITCHGEAR, SWITCHBOARDS, PANELBOARDS, AND MOTOR CONTROL CENTERS FROM FLOOR TO STRUCTURE ABOVE NOR WITHIN THE WORKING SPACE IN FRONT, REAR AND/OR SIDE (WHERE REAR AND/OR SIDE ACCESS IS REQUIRED TO WORK ON EQUIPMENT) OF ELECTRICAL EQUIPMENT (SWITCHGEAR, SWITCHBOARDS, PANELBOARDS, MOTOR CONTROL CENTERS, VARIABLE FREQUENCY DRIVES, TRANSFORMERS, AND STARTERS). DIMENSIONS OF THE WORKING SPACE SHALL BE A MINIMUM DEPTH OF 42" HORIZONTALLY, THE WIDTH OF THE EQUIPMENT OR 30", WHICHEVER IS GREATER, AND THE HEIGHT OF THE EQUIPMENT OR 78", WHICHEVER IS GREATER. MINIMUM DEPTH SHALL BE INCREASED TO 60" FOR EQUIPMENT RATED OVER 600 V.
4. MOUNT SPACE HUMIDITY SENSORS, HUMIDISTATS, SPACE CO2 SENSORS, SPACE TEMPERATURE SENSORS, AND THERMOSTATS AT 48" ABOVE THE FLOOR.
   A. ALIGN HORIZONTALLY WITH ADJACENT LIGHT SWITCHES.
   B. FINAL LOCATIONS SHALL BE ACCESSIBLE AND SHALL BE COORDINATED WITH THE FURNITURE LAYOUT AND ARCHITECTURAL LAYOUT.
   C. MORE THAN 2 SENSORS IN A SINGLE LOCATION SHALL BE INSTALLED WITH A COMMON FACEPLATE TO MINIMIZE WALL SPACE.
5. PROVIDE INSULATED BASES FOR THERMOSTATS AND TEMPERATURE SENSORS INSTALLED ON EXTERIOR WALLS OR WALLS TO UNCONDITIONED SPACES.
6. PROVIDE PREFABRICATED INSULATED EQUIPMENT SUPPORT CURBS FOR EQUIPMENT LOCATED ON THE ROOF. FLASH WITH SHEET METAL AND TRIM WITH ROOFING AND SEALANT TO MATCH ROOFING. FOR ALL PIPING PENETRATIONS PROVIDE FLASHING COLLARS AND TRIM WITH ROOFING AND SEALANT TO MATCH ROOFING.
7. HVAC/ELECTRICAL DESIGN COORDINATION:
   A. THE POWER RATINGS OF MOTORS AND OTHER HVAC EQUIPMENT AND THE ELECTRICAL CHARACTERISTICS OF ELECTRICAL SYSTEMS SERVING THEM, AS SPECIFIED HEREIN AND INDICATED ON THE DRAWINGS, HAVE BEEN ESTABLISHED AS MINIMUMS WHICH WILL ALLOW THAT EQUIPMENT TO SATISFACTORILY FUNCTION WHILE PRODUCING THE REQUIRED CAPACITIES. THESE POWER RATINGS INCLUDE A SAFETY FACTOR DEEMED APPROPRIATE TO ACCOMMODATE COMMON DIFFERENCES BETWEEN DESIGN PARAMETERS AND FIELD CONSTRUCTION PRACTICES. UNDER NO CIRCUMSTANCES SHALL EQUIPMENT WITH POWER RATINGS LESS THAN THOSE INDICATED ON THE DRAWINGS OR SPECIFIED HEREIN BE PROVIDED.
   B. REASONABLE EFFORTS HAVE BEEN MADE TO COORDINATE THE ELECTRICAL REQUIREMENTS OF THE HVAC EQUIPMENT WITH THE ELECTRICAL SYSTEMS SERVING THAT EQUIPMENT. DIFFERENCES AMONG MANUFACTURERS OF HVAC EQUIPMENT MAKE IT IMPOSSIBLE TO PRODUCE A SINGLE ELECTRICAL DESIGN WHICH WILL SATISFY THE VARYING ELECTRICAL REQUIREMENTS OF THOSE MANUFACTURERS. CONSEQUENTLY, THE CONTRACTOR SHALL COORDINATE THE ELECTRICAL REQUIREMENTS OF THE HVAC EQUIPMENT ACTUALLY FURNISHED ON THIS PROJECT AND PROVIDE THE ELECTRICAL SYSTEMS REQUIRED BY THAT EQUIPMENT. THIS COORDINATION EFFORT SHALL BE COMPLETED PRIOR TO THE INSTALLATION OF EITHER THE HVAC EQUIPMENT OR THE ELECTRICAL SYSTEMS SERVING THAT EQUIPMENT. ELECTRICAL SYSTEM REVISIONS REQUIRED TO COORDINATE WITH THE HVAC EQUIPMENT ACTUALLY FURNISHED SHALL BE PROVIDED AT NO ADDITIONAL COST TO THE OWNER.
8. MOTOR QUANTITIES, SIZES AND EQUIPMENT WATTAGE RATINGS SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS ARE THE MINIMUM REQUIREMENTS, UNLESS NOTED OTHERWISE. MOTOR QUANTITIES, SIZES AND EQUIPMENT WATTAGE RATINGS LESS THAN THOSE SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS ARE NOT ACCEPTABLE. LARGER MOTOR SIZES AND EQUIPMENT WATTAGE RATINGS MAY ONLY BE PROVIDED IF NECESSARY, TO MEET THE PRESCRIPTIVE REQUIREMENTS SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS. WHERE MULTIPLE MOTORS OR MOTOR SIZES OR EQUIPMENT WATTAGE RATINGS LARGER THAN SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS ARE FURNISHED, PROVIDE AND COORDINATE THE CORRESPONDING INCREASED NUMBER OR CAPACITY OF FEEDERS AND OTHER ELECTRICAL EQUIPMENT SERVING THEM, AT NO ADDITIONAL COST TO THE OWNER.
9. ALL ELECTRICAL WORK IN CEILING CAVITIES USED AS RETURN AIR PLENUMS SHALL USE PLENUM RATED CABLE OR WIRING IN CONDUIT.
10. PIPING, CONDUITS, CABLES, ETC. SHALL BE RUN NEATLY AND GENERALLY PARALLEL TO BUILDING STRUCTURE.
11. ALL FLOOR OR SLAB-ON-GRADE MOUNTED EQUIPMENT SHALL BE MOUNTED ON A MINIMUM OF 4" HIGH CONCRETE HOUSEKEEPING PAD(S) OR AS RECOMENDED BY THE EQUIPMENT MANUFACTURER. FOR EQUIPMENT WITH CONDENSATE DRAINAGE, PROVIDE SUFFICIENT PAD HEIGHT FOR INSTALLATION OF CONDENSATE TRAP.
12. PROTECT ALL MATERIALS AND EQUIPMENT FROM DAMAGE.
13. INSTALLATION OF ALL EQUIPMENT SHALL PERMIT ACCESSIBILITY FOR SERVICE AND/OR REPLACEMENT.
14. THE INSTALLATION OF MOTOR STARTERS THAT ARE NOT FACTORY-INSTALLED, THERMAL OVERLOAD SWITCHES, AND POWER WIRING TO MOTORS, STARTERS, THERMAL OVERLOAD SWITCHES, ELECTRIC HEATING COILS, ELECTRIC HUMIDIFIERS, AND CONTACTORS, IS SPECIFIED IN ANOTHER DIVISION. THIS SECTION INCLUDES THE FURNISHING AND INSTALLATION OF CONTROLS AND WIRING FOR AUTOMATIC CONTROLS, ELECTRIC DAMPER AND VALVE ACTUATORS AND MOTORS, TERMINAL UNIT CONTROLLERS, INTERLOCKS, STARTING CIRCUITS, AND 120 V AND LOW VOLTAGE POWER WIRING TO POWER CONSUMING CONTROL DEVICES.
15. SEAL ALL EXTERIOR WALL PENETRATIONS WATERPROOF.
16. COORDINATE ALL WALL, CEILING, FLOOR, ROOF, AND BEAM PENETRATIONS WITH ARCHITECT AND STRUCTURAL ENGINEER.
17. PROVIDE ALL MISCELLANEOUS STRUCTURAL SUPPORTS REQUIRED FOR DUCTWORK, PIPING, AND EQUIPMENT INSTALLATIONS.
18. COLOR AND FINISHES FOR ALL EXPOSED EQUIPMENT (REGISTERS, UNIT HEATERS, ETC.) SHALL BE SELECTED BY ARCHITECT, UNLESS OTHERWISE NOTED.

MOTORS

1. PROVIDE MOTORS FOR EQUIPMENT COVERED IN DIVISION 23 UNLESS OTHERWISE SPECIFIED HEREIN. SELECT MOTORS FOR OPERATION NOT EXCEEDING A 1.0 SERVICE FACTOR AND WITHIN THE NAMEPLATE AMPERAGE AND NOMINAL POWER RATING.
2. MOTORS INDICATED ON THE DRAWINGS AS BEING CONTROLLED BY VARIABLE FREQUENCY DRIVES SHALL BE PROVIDED WITH FACTORY-INSTALLED SHAFT GROUNDING RINGS, WHICH SHALL CONSIST OF A CIRCUMFERENTIAL RING OF CONDUCTIVE MICROFIBERS THAT DISCHARGE SHAFT VOLTAGES TO GROUND.
   A. MANUFACTURER: AEGIS SGR.

VIBRATION ISOLATION

1. SELECT AND LOCATE VIBRATION ISOLATION EQUIPMENT FOR UNIFORM LOADING AND DEFLECTION, ACCORDING TO WEIGHT DISTRIBUTION OF EQUIPMENT.
2. VIBRATION ISOLATORS SHALL BE INSTALLED AND CONNECTED AS SPECIFIED OR INDICATED ON THE DRAWINGS IN ACCORDANCE WITH THE MANUFACTURER'S WRITTEN INSTRUCTIONS AND CERTIFIED SUBMITTAL DATA.
3. THERE SHALL BE NO RIGID CONTACT OF PIPING, DUCTWORK, VIBRATION ISOLATED EQUIPMENT, CONDUIT CONNECTED TO VIBRATION ISOLATED EQUIPMENT, OR OTHER ELEMENTS RIGIDLY CONNECTED TO VIBRATION ISOLATED EQUIPMENT WITH WALLS, FLOOR SLABS, ROOF-CEILING ASSEMBLIES, STRUCTURAL ELEMENTS, FRAMING ELEMENTS, OR ANY OTHER NON-ISOLATED ITEM EXCEPT FOR FIRE DAMPER INSTALLATION CONDITIONS AS APPROVED BY THE ENGINEER AND AS SHOWN IN PROJECT DETAILS AND DOCUMENTS.
4. NO RIGID CONNECTION SHALL BE MADE THAT DEGRADES THE NOISE AND VIBRATION CONTROL SYSTEMS PROVIDED IN THE SPECIFICATIONS OR DRAWING.
5. PRIOR TO STARTUP, CLEAN OUT FOREIGN MATTER BETWEEN BASES, ISOLATORS, EQUIPMENT, AND MOUNTING SURFACES. VERIFY THAT THERE ARE NO RIGID CONNECTIONS BETWEEN EQUIPMENT AND BUILDING STRUCTURE.
6. ABSENCE OF STEEL RAIL OR STEEL BASE ISOLATION BASES SCHEDULED ON DRAWINGS SHALL NOT PRECLUDE THEIR USE. COORDINATE WITH THE MANUFACTURER IF INSTALLATION CONDITIONS WARRANT THEIR USE ONCE SPECIFIC EQUIPMENT SELECTION IS FINALIZED.

VIBRATION ISOLATION CONTINUED:

7. CONFLICTS WITH OTHER TRADES THAT WILL RESULT IN DIRECT CONTACT WITH ISOLATED EQUIPMENT, PIPING, OR DUCTWORK, SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO INSTALLATION.
8. DISCREPANCIES BETWEEN THE SPECIFICATIONS AND THE FIELD CONDITIONS, OR CHANGES REQUIRED DUE TO SPECIFIC EQUIPMENT SELECTION SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO INSTALLATION.
9. ISOLATED EQUIPMENT MOUNTING SYSTEMS SHALL PERMIT EQUIPMENT MOTION IN ALL DIRECTIONS.
10. ISOLATOR HANGERS SHALL BE INSTALLED WITH HOUSINGS A MINIMUM OF 2" BELOW BUT AS CLOSE TO THE STRUCTURE AS POSSIBLE.
11. PROVIDE HEIGHT SAVING BRACKETS WHERE RECOMMENDED BY THE MANUFACTURER FOR EQUIPMENT STABILITY, OR OPERATING HEIGHT REQUIREMENTS.
12. ALL BOLTED CONNECTIONS THROUGH TYPE NP ISOLATION PADS OR OTHER ELASTOMERIC VIBRATION ISOLATION LAYERS SHALL BE PROVIDED TYPE IWG ISOLATION GROMMET AND WASHER TO PREVENT SHORT CIRCUITING OF ISOLATION AT BOLTED CONNECTIONS.
13. NON-ROTATING EQUIPMENT THAT DOES NOT HAVE SPECIFIED VIBRATION ISOLATION, SUCH AS HEAT EXCHANGERS, EXPANSIONS TANKS, ETC., THAT ARE ATTACHED TO VIBRATION ISOLATED PIPING THAT IS REQUIRED TO BE ISOLATED SHALL BE MOUNTED ON THE ISOLATION TYPE AND WITH EQUAL STATIC DEFLECTION TO THAT OF THE CONNECTED PIPING FOR CONDITIONS WHERE THE NON-ROTATING EQUIPMENT IS LESS THAN 1500 LBS. FOR CONDITIONS WHERE THE EQUIPMENT IS GREATER THAN 1500 LBS., THE NON-ROTATING EQUIPMENT SHALL BE MOUNTED ON NEOPRENE PADS AND PROVIDED WITH FLEXIBLE CONNECTIONS BETWEEN THE PIPING AND THE EQUIPMENT.
14. EXTERNAL ISOLATORS ARE REQUIRED FOR ALL VIBRATION ISOLATED EQUIPMENT UNLESS ALL OF THE FOLLOWING REQUIREMENTS ARE SATISFIED:
    A. INTERNAL SPRING ISOLATION OF FAN(S) AND MOTOR(S) SHALL ACHIEVE THE STATIC DEFLECTION REQUIREMENTS OF VIBRATION ISOLATION SCHEDULED.
    B. EXTERNAL ELASTOMERIC ISOLATION FROM A SPECIFICATION 230548 LISTED ISOLATOR TYPE THAT ACHIEVES A MINIMUM 0.25" STATIC DEFLECTION SHALL BE PROVIDED FOR THE ENTIRE UNIT IN ADDITION TO INTERNALLY SPRING ISOLATED FAN(S) AND MOTOR(S).
    C. ALL OTHER INTERNAL ROTATING OR RECIPROCATING COMPONENTS, SUCH AS COMPRESSORS AND CONDENSERS, SHALL BE PROVIDED ON NEOPRENE ISOLATION MOUNTS
    D. EXTERNAL SPRING ISOLATION SYSTEMS ARE NOT SPECIFICALLY SCHEDULED, NOTED, OR DETAILED TO BE REQUIRED.
15. ALL INTERNAL SPRING ISOLATORS SHALL BE LOCKED DOWN AND INOPERABLE FOR EQUIPMENT PROVIDED ON EXTERNAL SPRING ISOLATION.
16. ALL PIPING LOCATED IN MECHANICAL ROOMS AND BUILDING ROOFTOPS SHALL BE VIBRATION ISOLATED. ADDITIONALLY, ALL PIPING WITHIN THE FOLLOWING DISTANCES FROM CONNECTION TO ROTATING OR RECIPROCATING EQUIPMENT OR PRESSURE REDUCING VALVES SHALL BE VIBRATION ISOLATED AS FOLLOWS:
    A. ALL PIPING WITH 4" OR LESS DIAMETER FOR 50'.
    B. ALL PIPING LARGER THAN 4" AND UP TO 8" IN DIAMETER FOR 60'.
    C. ALL PIPING LARGER THAN 8" IN DIAMETER FOR 70'.
    D. PIPING BEYOND THESE DISTANCES TO EQUIPMENT INSTALLED INSIDE OF, IN A SPACE HORIZONTALLY ADJACENT TO, OR IN A SPACE VERTICALLY ADJACENT TO SPACES IDENTIFIED TO BE NOISE AND/OR VIBRATION SENSITIVE SHALL BE VIBRATION ISOLATED PER THE REQUIREMENTS AS SHOWN ON THE DRAWING PLANS, NOTES, AND/OR DETAILS.
17. THE FIRST FOUR VIBRATION ISOLATED PIPING SUPPORTS FROM CONNECTION TO EQUIPMENT SHALL BE PRE-COMPRESSED SPRING TYPE PSH FOR SUSPENDED PIPING OR LIMIT STOP TYPE LS FOR PIPE STAND SUPPORTED PIPING WITH STATIC DEFLECTION EQUAL TO THAT OF THE CONNECTED ROTATING EQUIPMENT ISOLATOR OR A MAXIMUM OF 2" EXCEPT FOR THE FOLLOWING CONDITIONS:
    A. WHEN CONNECTED EQUIPMENT IS NOT SPRING ISOLATED, NEOPRENE TYPE NH HANGERS, TYPE DN MOUNTS, OR TYPE NP PADS ACHIEVING MINIMUM 0.25" STATIC DEFLECTION ARE ALLOWED.
    B. WHERE PIPING IS SUPPORTED OVERHEAD FROM STRUCTURE AND CONNECTED EQUIPMENT IS FLOOR MOUNTED ON GRADE, TYPE PSH PRE-COMPRESSED SPRING ISOLATORS SHALL BE USED FOR THE FIRST FOUR SUPPORTS FROM THE CONNECTION TO ROTATING EQUIPMENT. MINIMUM STATIC DEFLECTIONS FOR SUCH CONDITIONS SHALL BE:
       1) 0.75" FOR PIPES UP TO AND INCLUDING 3" DIAMETERS.
       2) 1.5" FOR PIPES LARGER THAN 3" DIAMETERS AND UP TO AND INCLUDING 6" DIAMETERS.
       3) 2.5" FOR PIPES WITH LARGER THAN 6" DIAMETERS.
18. PIPING BEYOND THE FIRST FOUR SUPPORTS FROM CONNECTION TO ROTATING EQUIPMENT SHALL BE PROVIDED PER THE FOLLOWING CONDITIONS:
    A. PIPING 2" DIAMETER OR LARGER THAT IS CONNECTED TO SPRING ISOLATED EQUIPMENT SHALL BE PROVIDED WITH TYPE SH, FS, OR LS SPRING ISOLATION WITH MINIMUM STATIC DEFLECTION OF 0.75".
    B. PIPING 2" OR LARGER THAT IS CONNECTED TO EQUIPMENT THAT IS NOT SPRING ISOLATED SHALL BE PROVIDED WITH TYPE NH, DN, OR NP NEOPRENE ISOLATORS ACHIEVING MINIMUM 0.25" STATIC DEFLECTION.
    C. PIPING LESS THAN 2" SHALL BE ISOLATED USING TYPE NH, DN, OR NP NEOPRENE ISOLATORS, TYPE PIM ISOLATION HANGERS, OR TYPE PIF ISOLATION HANGER TREATMENT.
19. DIFFERENT SECTIONS OF PIPING REQUIRING THE SAME TYPE OF ISOLATOR MAY BE SUPPORTED ON A COMMON TRAPEZE SUPPORT THAT IS ISOLATED WITH THE COMMON ISOLATOR TYPE. COMMON SUPPORT ISOLATION SHALL BE SIDED TO MEET THE LARGEST STATIC DEFLECTION REQUIREMENTS OF ANY SINGLE PIPING ELEMENT THEY SUPPORT.
20. NON-VIBRATION ISOLATED PIPING, OR OTHER NON-ISOLATED ELEMENTS SUCH AS CONDUIT, SHALL NOT BE MOUNTED ON VIBRATION ISOLATED TRAPEZE.
21. ALL DUCTWORK AND PLENUM BOXES LOCATED IN MECHANICAL ROOMS AND BUILDING ROOFTOPS SHALL BE ISOLATED WITH TYPE SH, NP, OR ND NEOPRENE ISOLATORS SIZED FOR 0.75" 0.25" STATIC DEFLECTION UNLESS OTHER REQUIREMENTS FOR VIBRATION ISOLATION ARE PROVIDED. ADDITIONALLY, ALL DUCTWORK AND ALL PLENUM BOXES SERVING AIR MOVEMENT EQUIPMENT SHALL BE VIBRATION ISOLATED FROM THE BUILDING STRUCTURE FOR ALL FLOOR MOUNTED OR CEILING SUSPENDED CONDITIONS ABOVE, BELOW, OR HORIZONTALLY ADJACENT TO TYPICAL OCCUPIED OR NOISE AND/OR VIBRATION SENSITIVE SPACES PER THE REQUIREMENTS AS SHOWN ON THE DRAWING PLANS, NOTES, AND/OR DETAILS.
22. FLEXIBLE CONNECTIONS ARE REQUIRED FOR ALL VIBRATION ISOLATED EQUIPMENT PIPING, DUCTWORK, AND ELECTRICAL CONNECTIONS. RIGID CONTACT ACROSS FLEXIBLE CONNECTIONS SHALL NOT BE ALLOWED. FLEXIBLE PIPE CONNECTIONS SHALL BE INSTALLED ON THE EQUIPMENT SIDE OF THE SHUT OF VALVE.
23. ELASTOMERIC FLEXIBLE PIPE CONNECTIONS ARE REQUIRED AT ALL PUMPS, CHILLERS, COOLING TOWERS, AHU, RTU, ERU, DOAS AND OTHER ROTATING OR RECIPROCATING EQUIPMENT LOCATED IN COMMONLY ACCESSIBLE AREAS SUCH AS ROOFTOPS AND MECHANICAL ROOMS. ALL PIPING WITH A DIAMETER OF 2" OR GREATER SHALL BE PROVIDED WITH A TWIN SPHERE FLEXIBLE CONNECTOR. ALL PIPING WITH A DIAMETER OF LESS THAN 2" SHALL BE PROVIDED WITH A SINGLE SPHERE FLEXIBLE CONNECTOR.
24. FLEXIBLE METAL HOSE PIPING CONNECTIONS ARE ONLY ALLOWED IF ONE OF THE FOLLOWING CONDITIONS ARE SATISFIED:
    A. WHERE EQUIPMENT IS LOCATED IN INACCESSIBLE AREAS, SUCH AS ABOVE CEILINGS, OR IN LOCATIONS WHERE FLOOR DRAINS ARE NOT PRESENT FLEXIBLE METAL HOSE CONNECTIONS MUST BE PROVIDED.
    B. WHEN PIPE PRESSURE OR TEMPERATURE EXCEED MANUFACTURER TOLERANCES FOR RUBBER FLEXIBLE CONNECTIONS AND HAVE BEEN APPROVED IN WRITING BY THE ENGINEER.
25. FOR ALL CONDITIONS WHERE FLEXIBLE METAL HOSE PIPING CONNECTIONS ARE USED FOR VIBRATION ISOLATION, UTILIZE A DOUBLE SET OF BRAIDED FLEXIBLE CONNECTORS WITH ONE ORIENTED VERTICALLY AND ONE ORIENTED HORIZONTALLY OR PROVIDE AS A SINGLE FLEXIBLE METAL HOSE INSTALLED IN A LOOSE 360-DEGREE LOOP TO PROVIDED THREE-DIMENSIONAL VIBRATION ISOLATION.
26. ALL ELECTRICAL CONNECTIONS TO VIBRATION ISOLATED EQUIPMENT SHALL BE MADE WITH FLEXIBLE CONDUIT IN A LOOSE 360-DEGREE LOOP.
27. ALL INTAKE AND DISCHARGE DUCTWORK SHALL BE CONNECTED TO VIBRATION PRODUCING MECHANICAL EQUIPMENT WITH FLEXIBLE DUCT CONNECTIONS WITH A MINIMUM OF 2" OF SEPARATION. FLEXIBLE CONNECTIONS SHALL NOT BE USED TO CORRECT FOR MISALIGNMENT AND SHALL NOT BE ALLOWED TO CREATE A BULGE WHEN OPERATED UNDER PRESSURE. FLEXIBLE DUCT CONNECTORS ARE NOT REQUIRED ON FAN POWERED TERMINAL UNITS WITH INTERNAL FAN AND DRIVE ISOLATION, GREASE DUCT CONNECTIONS, AND CONNECTIONS SERVING PERCHLORIC ACID HOODS.
28. WHEN MECHANICAL EQUIPMENT IS OPERATING AT 2" OF WATER OR MORE STATIC PRESSURE OR WHEN EQUIPMENT THRUST, FORCES EXCEED 10% OF THE EQUIPMENT WEIGHT HORIZONTAL THRUST RESTRAINTS ARE REQUIRED. SIZE AND ADJUST TO LIMIT LATERAL MOVEMENT TO 0.25" OR LESS UNDER NORMAL OPERATIONAL STATIC PRESSURES.
29. ALL DUCTED CONNECTIONS TO FIRE DAMPERS SHALL BE PROVIDED WITH A FLEXIBLE DUCT CONNECTOR.
30. INSTALL FLEXIBLE METAL HOSE WITH AT LEAST ONE 360-DEGREE LOOP WHEN THE STRAIGHT HOSE LENGTH BETWEEN CONNECTION WOULD BE LESS THAN 5 TIMES THE HOSE DIAMETER FOR AIR COMPRESSORS AND VACUUM PUMPS.
31. ALL DUCT, PIPE, CONDUIT, OR OTHER MECHANICAL EQUIPMENT PENETRATIONS THROUGH MECHANICAL SPACE PARTITIONS, EXTERIOR WALLS, ROOFTOPS, ACOUSTICALLY RATED PARTITIONS, FIRE RATED PARTITIONS, FULL HEIGHT PARTITIONS, AND PARTITIONS AT OCCUPIED SPACES SHALL BE SEALED BY MAINTAINING A MINIMUM 1/4" ANNULAR SPACE AROUND THE PENETRATION ELEMENTS. ANNULAR CAVITY TO BE PACKED WITH MINERAL WOOL OR FIBERGLASS 100 FULL ON ALL SIDES AND SEALED WITH ACOUSTICAL SEALANT OR NON-HARDENING FIRESTOP AS REQUIRED. ALL CAULKING AT MECHANICAL EQUIPMENT PENETRATIONS SHALL BE INSTALLED IN ACCORDANCE WITH ASTM C919-2012 (2017). ALL DUCTS, ALL PIPES, AND CONDUITS CONNECTED TO VIBRATING EQUIPMENT SHALL BE SUPPORTED ON BOTH SIDES OF THE PENETRATION WITHIN 12". NO WEIGHT MAY REST ON THE PARTITION, AND NO RIGID CONTACT BETWEEN THE PENETRATING ELEMENT AND ANY ELEMENT OF THE PARTITION OR INTERNAL TO THE PARTITION SHALL BE MADE. THE PARTITION SHALL NOT BE USED TO GUIDE THE PENETRATION ELEMENT.

HVAC PERFORMANCE VERIFICATION

1. SUBMITTALS
   A. SUBMIT ADDITIONAL DOCUMENTATION AS REQUIRED TO SUPPORT THE PERFORMANCE VERIFICATION PROCESS. THIS ADDITIONAL SUBMITTAL DOCUMENTATION SHALL INCLUDE, AT A MINIMUM, THE PROPOSED START-UP AND INITIAL CHECK-OUT PROCEDURES, AND PREFUNCTIONAL CHECKLISTS.
2. START-UP PLAN AND PREFUNCTIONAL TESTING
   A. PREFUNCTIONAL TESTING SHALL BE REQUIRED FOR EACH PIECE OF EQUIPMENT TO ENSURE THAT THE EQUIPMENT AND SYSTEMS ARE PROPERLY INSTALLED AND READY FOR OPERATION, SO THAT FUNCTIONAL TESTING MAY PROCEED WITHOUT DELAYS. FOLLOW THE APPROVED START-UP, INITIAL CHECK-OUT, AND PREFUNCTIONAL TESTING PROCEDURES. SAMPLING STRATEGIES SHALL NOT BE USED FOR PREFUNCTIONAL TESTING. THE PREFUNCTIONAL TESTING FOR EQUIPMENT AND SUBSYSTEMS OF A GIVEN SYSTEM SHALL BE SUCCESSFULLY COMPLETED AND DOCUMENTED PRIOR TO FUNCTIONAL TESTING OF THE SYSTEM.
   B. PROCEDURES FOR PERFORMANCE VERIFICATION SHALL INCLUDE:
      1) START-UP AND INITIAL CHECK-OUT PLAN: DEVELOP THE DETAILED START-UP AND PREFUNCTIONAL TESTING PLANS FOR EQUIPMENT AND SYSTEMS. THAT ARE TO BE PERFORMANCE VERIFIED, AS SPECIFIED HEREIN. REVIEW THE PROPOSED PROCEDURES AND PREFUNCTIONAL TESTING DOCUMENTATION TO ENSURE THAT THERE IS WRITTEN DOCUMENTATION THAT EACH OF THE MANUFACTURER-RECOMMENDED PROCEDURES HAVE BEEN COMPLETED.
      2) THE START-UP AND INITIAL CHECK-OUT PLAN SHALL CONSIST, AS A MINIMUM, OF THE FOLLOWING:
         A) THE MANUFACTURER'S STANDARD WRITTEN START-UP AND CHECK-OUT PROCEDURES COPIED FROM THE INSTALLATION MANUALS AND MANUFACTURER'S NORMALLY USED FIELD CHECK-OUT SHEETS. THE PLAN SHALL INCLUDE CHECKLISTS AND PROCEDURES WITH SPECIFIC BOXES OR LINES FOR RECORDING AND DOCUMENTING THE CHECKING AND INSPECTIONS OF EACH PROCEDURE AND A SUMMARY STATEMENT WITH A SIGNATURE BLOCK AT THE END OF THE PLAN.
         B) FIRST-RUN CHECKLIST FOR EQUIPMENT PER SPECIFICATIONS FOR EACH PIECE OF EQUIPMENT.
         C) CONTRACTOR-DEVELOPED PREFUNCTIONAL CHECKLISTS.
      3) IDENTIFY WHICH TRADE IS RESPONSIBLE FOR EXECUTING AND DOCUMENTING EACH OF THE LINE ITEM TASKS AND NOTE THAT TRADE ON THE FORM. EACH FORM MAY HAVE MORE THAN ONE TRADE RESPONSIBLE FOR ITS EXECUTION.
   C. FOUR WEEKS PRIOR TO START-UP, SCHEDULE EQUIPMENT AND SYSTEMS START-UP AND CHECK-OUT. AND NOTIFY THE ARCHITECT IN WRITING. THE EXECUTION OF THE PREFUNCTIONAL CHECKLISTS, START-UP AND CHECK-OUT SHALL BE DIRECTED AND PERFORMED BY THE CONTRACTOR, IN ACCORDANCE WITH MANUFACTURER'S PUBLISHED PROCEDURES. THE ARCHITECT SHALL BE PRESENT FOR THE START-UP, CHECK-OUT, AND PREFUNCTIONAL TESTING OF THE FIRST UNIT OF EACH TYPE OF EQUIPMENT, AND ANY OTHER TESTS HE DESIGNATES.
   D. SENSOR CALIBRATION: CALIBRATION OF SENSORS ASSOCIATED WITH A GIVEN PIECE OF EQUIPMENT OR SYSTEM SHALL BE INCLUDED AS PART OF THE PREFUNCTIONAL TESTING. AND LISTED ON THE APPROPRIATE TEST CHECKLISTS AND REPORTS FOR THE SYSTEM. THIS REQUIREMENT MAY BE MET DURING THE PREFUNCTIONAL TESTING OF THE BUILDING CONTROL SYSTEM, BUT SHALL ALSO BE DOCUMENTED WITH THE FUNCTIONAL TESTING PROCEDURES.
   E. COMPLETED START-UP, CHECK-OUT, AND PREFUNCTIONAL TEST FORMS SHALL BE COMPLETED AND MADE AVAILABLE FOR REVIEW UPON REQUEST. TO THE ARCHITECT FOR REVIEW. LIST OUTSTANDING ITEMS OF THE INITIAL START-UP AND PREFUNCTIONAL PROCEDURES THAT WERE NOT COMPLETED SUCCESSFULLY, AT THE BOTTOM OF THE PROCEDURES FORM OR ON AN ATTACHED SHEET. THE PROCEDURES FORM AND ANY OUTSTANDING DEFICIENCIES SHALL BE PROVIDED TO THE ARCHITECT WITHIN 2 DAYS OF TEST COMPLETION. THE ARCHITECT SHALL REVIEW THE CONTRACTOR'S START-UP AND PREFUNCTIONAL TESTING REPORTS AND SHALL SUBMIT EITHER A NONCOMPLIANCE REPORT OR AN APPROVAL FORM TO THE CONTRACTOR. THE CONTRACTOR SHALL CORRECT ITEMS THAT ARE DEFICIENT OR INCOMPLETE IN THE CHECKLISTS AND TESTS IN A TIMELY MANNER, AND SHALL NOTIFY THE ARCHITECT AS SOON AS OUTSTANDING ITEMS HAVE BEEN CORRECTED AND RESUBMIT AN UPDATED START-UP REPORT AND A STATEMENT OF CORRECTION ON THE ORIGINAL NONCOMPLIANCE REPORT. WHEN REQUIREMENTS ARE COMPLETED, THE ARCHITECT SHALL RECOMMEND APPROVAL OF THE START-UP AND PREFUNCTIONAL TESTING OF EACH SYSTEM AND SCHEDULE THE FUNCTIONAL TESTING OF THE EQUIPMENT OR SYSTEM.
   F. COMPLETE START-UP AND PREFUNCTIONAL TESTING FOR A SYSTEM BEFORE FUNCTIONAL TEST OF THAT SYSTEM MAY PROCEED.
   G. DO NOT OPERATE HVAC SYSTEMS IN A MODE THAT WOULD INDUCE UNCONDITIONED, HUMID OUTSIDE AIR INTO THE BUILDING.
3. RETESTING OF EQUIPMENT AND/OR SYSTEMS
   A. PROVIDE LABOR AND MATERIALS REQUIRED FOR RETESTING OF ANY FUNCTIONAL TEST FOUND TO BE DEFICIENT.
   B. PRIOR TO RETESTING, SUBMIT REQUIRED DATA INDICATING THAT THE DEFICIENT ITEMS HAVE BEEN COMPLETED AND/OR CORRECTED TO THE ARCHITECT FOR APPROVAL AND RESCHEDULING OF THE FUNCTIONAL TEST. IF DURING THE RETESTING IT BECOMES APPARENT THAT THE DEFICIENT ITEMS HAVE NOT BEEN COMPLETED AND/OR CORRECTED AS INDICATED IN THE DATA PROVIDED BY THE CONTRACTOR, THE RETESTING SHALL BE STOPPED. COSTS FOR THE DESIGN TEAM TO FURTHER SUPERVISE THE RETESTING OF A FUNCTIONAL TEST SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
4. DEFERRED TESTING
   A. SCHEDULE AND COORDINATE, WITH THE APPROVAL OF THE ARCHITECT, ANY REQUIRED SEASONAL TESTING, TESTS DELAYED UNTIL BUILDING CONSTRUCTION IS COMPLETED, REQUIRED BUILDING OCCUPANCY OR LOADING, WEATHER, OR OTHER CONDITIONS ARE SUITABLE FOR THE DEMONSTRATION OF EQUIPMENT OR SYSTEM'S PERFORMANCE. AS SPECIFIED HEREIN. DEFERRED TESTING SHALL BE EXECUTED, DOCUMENTED, AND DEFICIENCIES CORRECTED AS SPECIFIED HEREIN FOR FUNCTIONAL TESTING. ADJUSTMENTS OR CORRECTIONS TO THE OPERATIONS AND MAINTENANCE MANUALS AND AS-BUILT DOCUMENTS REQUIRED BY THE RESULTS OF THE TESTING SHALL BE MADE BEFORE THE SEASONAL TESTING PROCESS IS CONSIDERED COMPLETE.
5. SEASONAL ADJUSTMENTS
   A. THE HVAC PERFORMANCE VERIFICATION SUPERVISOR SHALL SCHEDULE, COORDINATE AND COMPLETE THE SEASONAL ADJUSTMENT PROCESS. DURING THIS EFFORT, THE HVAC PERFORMANCE VERIFICATION SUPERVISOR SHALL:
      1) CHECK AND VERIFY THE CALIBRATION OF TEMPERATURE CONTROL DEVICES AND THERMOSTATS. TEST AND VERIFY CONTROL SEQUENCES FOR PROPER OPERATION FOR THE SEASON.
      2) CHECK THE OPERATION, PERFORMANCE, AND BALANCE OF AIR AND HYDRONIC SYSTEMS TO PROVIDE UNIFORM DISTRIBUTION AND COMFORT CONDITIONS.
   B. WHERE DEFICIENT OPERATION OR DEFECTIVE EQUIPMENT IS DISCOVERED, PROVIDE CORRECTIVE MEASURES.
6. TESTING DOCUMENTATION, NONCONFORMANCE, AND APPROVALS
   A. LIST OUTSTANDING ITEMS OF THE INITIAL START-UP AND PREFUNCTIONAL PROCEDURES THAT WERE NOT COMPLETED SUCCESSFULLY, AT THE BOTTOM OF THE FUNCTIONAL TEST PROCEDURE FORMS OR ON AN ATTACHED SHEET. THE FUNCTIONAL TEST PROCEDURE FORMS AND ANY OUTSTANDING DEFICIENCIES SHALL BE PROVIDED TO THE ARCHITECT WITHIN 2 DAYS OF TEST COMPLETION. THE ARCHITECT SHALL REVIEW THE CONTRACTOR'S START-UP AND PREFUNCTIONAL TESTING DOCUMENTATION AND SHALL SUBMIT EITHER A NONCOMPLIANCE REPORT OR AN APPROVAL FORM TO THE CONTRACTOR. WORK WITH THE ARCHITECT TO CORRECT AND RETEST DEFICIENCIES OR UNCOMPLETED ITEMS. CORRECT ITEMS THAT ARE DEFICIENT OR INCOMPLETE IN A TIMELY MANNER, AND NOTIFY THE ARCHITECT AS SOON AS OUTSTANDING ITEMS HAVE BEEN CORRECTED AND RESUBMIT AN UPDATED START-UP REPORT AND A STATEMENT OF CORRECTION ON THE ORIGINAL NONCOMPLIANCE REPORT. WHEN REQUIREMENTS ARE COMPLETED, SCHEDULE THE FUNCTIONAL TESTING OF THE EQUIPMENT OR SYSTEM.
   B. AS FUNCTIONAL PERFORMANCE TESTING PROGRESSES AND DEFICIENCIES ARE IDENTIFIED, WORK WITH THE ARCHITECT TO RESOLVE THE ISSUES.
7. OPERATION AND MAINTENANCE MANUALS
   A. THE HVAC PERFORMANCE VERIFICATION SUPERVISOR CONTRACTOR SHALL COMPILE AND PREPARE DOCUMENTATION FOR EQUIPMENT AND SYSTEMS COVERED IN DIVISION 23 AND DELIVER THIS DOCUMENTATION FOR INCLUSION IN THE OPERATION AND MAINTENANCE MANUALS PRIOR TO THE TRAINING OF THE OWNER'S PERSONNEL.
8. INSTRUCTION OF OPERATING PERSONNEL
   A. THE CONTRACTOR SHALL SCHEDULE, COORDINATE AND ASSEMBLE, AND DELIVER THE DOCUMENTATION OF TRAINING REQUIRED BY DIVISION 23.
9. FUNCTIONAL TESTS
   A. FUNCTIONAL TEST REQUIREMENTS FOR THE DEMONSTRATION OF PROPER SYSTEM AND EQUIPMENT OPERATION SHALL BE DEFINED BY THE HVAC PERFORMANCE VERIFICATION SUPERVISOR. EXECUTION OF THESE TEST AND DEMONSTRATION OF THE REQUIRED PERFORMANCE SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
   B. FUNCTIONAL TESTING IS INTENDED TO BEGIN UPON COMPLETION OF A SYSTEM. FUNCTIONAL TESTING MAY PROCEED PRIOR TO THE COMPLETION OF SYSTEMS OR SUBSYSTEMS AT THE DISCRETION OF THE CONTRACTOR. BEGINNING SYSTEM TESTING BEFORE FULL COMPLETION OF CONSTRUCTION SHALL NOT RELIEVE THE CONTRACTOR FROM FULLY COMPLETING THE SYSTEM, INCLUDING PREFUNCTIONAL CHECKLISTS.
   C. FUNCTIONAL TESTING SHALL BE COMPLETED AND TEST DOCUMENTATION APPROVED BY THE ARCHITECT, ENGINEER, AND OWNER BEFORE THE PROJECT WILL BE CONSIDERED SUBSTANTIALLY COMPLETE.

TESTING, ADJUSTING AND BALANCING

1. TESTING, ADJUSTING AND BALANCING
   A. PROVIDE MATERIALS, EQUIPMENT, LABOR, AND POWER TO TEST, ADJUST, AND PROPORTIONALLY BALANCE NEW HEATING, VENTILATING, REFRIGERATION, AND AIR CONDITIONING SYSTEMS AND COMPONENTS AS INDICATED ON THE DRAWINGS AND AS SPECIFIED. VERIFY FUNCTIONING OF OPERATING DEVICES AND EQUIPMENT. IN ADDITION, THE FOLLOWING SPECIFIC TESTING, ADJUSTING AND BALANCING SHALL BE PERFORMED.

1) DUCTWORK LEAKAGE TESTING:
   A) FOR DUCTWORK WITH STATIC PRESSURE CLASSIFICATION OF 4" WG, 6" WG, OR 10" WG, A LEAKAGE TEST SHALL BE MADE AFTER INSTALLATION OF THE FIRST REPRESENTATIVE SAMPLE OF DUCTWORK OF EACH CLASSIFICATION. THE TEST SAMPLE SHALL INCORPORATE AT LEAST: 5 TRANSVERSE JOINTS, TYPICAL SEAMS, ONE ELBOW, 2 TYPICAL BRANCH CONNECTIONS, AND FOR RISER DUCTS OR OTHER SYSTEMS THAT INCLUDE MULTIPLE FIRE DAMPERS, ONE FIRE DAMPER AND ONE ACCESS DOOR. AFTER SATISFACTORY RESULTS FOR THE TEST SAMPLE, ADDITIONAL DUCTWORK SHALL BE TESTED TOTALING NO LESS THAN 25% OF THE TOTAL DUCT AREA FOR EACH PRESSURE CLASS. REMAINING DUCT SECTIONS SHALL BE TESTED UNTIL THE TOTAL DUCT AREA FOR EACH PRESSURE CLASS HAS BEEN TESTED.
   B) FOR DUCTWORK WITH STATIC PRESSURE CLASSIFICATION OF 3" WG, A LEAKAGE TEST SHALL BE MADE AFTER INSTALLATION OF THE FIRST REPRESENTATIVE SAMPLE OF DUCTWORK. THE TEST SAMPLE SHALL INCORPORATE AT LEAST: 5 TRANSVERSE JOINTS, TYPICAL SEAMS, ONE ELBOW, 2 TYPICAL BRANCH CONNECTIONS, AND FOR RISER DUCTS OR OTHER SYSTEMS THAT INCLUDE MULTIPLE FIRE DAMPERS, ONE FIRE DAMPER AND ONE ACCESS DOOR. AFTER SATISFACTORY RESULTS FOR THE TEST SAMPLE, ADDITIONAL DUCTWORK SHALL BE TESTED TOTALING NO LESS THAN 25% OF THE TOTAL DUCT AREA. AFTER SATISFACTORY RESULTS FOR THE TEST SAMPLE, REMAINING DUCT SECTIONS SHALL BE TESTED UNTIL THE TOTAL DUCT AREA HAS BEEN TESTED.
   C) FOR DUCTWORK WITH STATIC PRESSURE CLASSIFICATION OF 0.5" WG, 1" WG, OR 2" WG, A LEAKAGE TEST SHALL BE MADE AFTER INSTALLATION OF THE FIRST REPRESENTATIVE SAMPLE OF DUCTWORK OF EACH CLASSIFICATION. THE TEST SAMPLE SHALL INCORPORATE AT LEAST: 5 TRANSVERSE JOINTS, TYPICAL SEAMS, ONE ELBOW, 2 TYPICAL BRANCH CONNECTIONS, AND FOR RISER DUCTS OR OTHER SYSTEMS THAT INCLUDE MULTIPLE FIRE DAMPERS, ONE FIRE DAMPER AND ONE ACCESS DOOR. AFTER SATISFACTORY RESULTS FOR THE TEST SAMPLE, ADDITIONAL DUCTWORK SHALL BE TESTED TOTALING NO LESS THAN 25% OF THE TOTAL DUCT AREA FOR EACH PRESSURE CLASS.
   D) PRIOR TO TESTING, SUBMIT DRAWINGS INDICATING SECTIONS OF DUCTWORK TO BE TESTED, INCLUDING AREA CALCULATIONS.
   E) LEAKAGE TESTING SHALL BE PERFORMED IN ACCORDANCE WITH SMACNA HVAC AIR DUCT LEAKAGE TEST MANUAL-2012.
   F) TEST PRESSURE SHALL EQUAL THE STATIC PRESSURE CLASSIFICATION FOR THE DUCT.
   G) LEAKAGE IN EACH TYPE OF DUCTWORK SHALL NOT EXCEED:

1) RECTANGULAR DUCTWORK:

STATIC PRESSURE CLASSIFICATION, WG	LEAKAGE CLASS
0.5", 1", 2"	16
3"	8
4", 6", 10"	4

2) ROUND AND FLAT OVAL DUCTWORK:

STATIC PRESSURE CLASSIFICATION, WG	LEAKAGE CLASS
0.5", 1", 2"	8
3"	4
4", 6", 10"	2

   H) SUBMIT A REPORT CERTIFYING DUCTWORK TESTING AND RESULTS.
   I) IN ADDITION TO THE TESTS SPECIFIED HEREIN, TEST DUCTWORK LOCATED OUTDOORS IN ACCORDANCE WITH THE CRITERIA SPECIFIED HEREIN FOR THE PRESSURE CLASSIFICATION OF THE DUCTWORK.
   J) IN ADDITION TO THE TESTS SPECIFIED HEREIN, TEST SUPPLY, OUTSIDE AIR, AND EXHAUST / RELIEF DUCTWORK ASSOCIATED WITH AIR HANDLING UNITS AND EXHAUST / RELIEF DUCTWORK ASSOCIATED WITH FANS, WHICH ARE PART OF THE SMOKE CONTROL SYSTEM. TEST DUCT LEAKAGE AT 1.5 TIMES THE MAXIMUM FAN DISCHARGE PRESSURE FOR POSITIVE PRESSURE DUCTWORK AND MAXIMUM FAN SUCTION PRESSURE FOR NEGATIVE PRESSURE DUCTWORK. PERFORM TESTS BEFORE DUCTWORK IS INSULATED. SUBMIT REPORT WITH LEAKAGE RESULTS REPORTED IN AIRFLOW LEAKAGE PER SYSTEM WITHIN 5 DAYS OF TEST. LEAKAGE SHALL NOT EXCEED 5% OF DESIGN FLOW.

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△	DATE	DESCRIPTION

SHEET NAME: HVAC GENERAL NOTES

ORIG SUBMISSION: 2023.05.22

SHEET: M-002

PERMIT SET

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PROJECT GENERAL NOTES

TESTING, ADJUSTING, AND BALANCING CONTINUED:

2) AIR SYSTEMS BALANCING, GENERAL:

A) VARIABLE FREQUENCY DRIVES SHALL BE SET UP AND TESTED TO VERIFY:

1) DESIGN CONDITIONS:

A) VERIFY FAN CAN PRODUCE DESIGN FLOW AT DESIGN TOTAL STATIC PRESSURE WITHOUT OVERLOADING THE FAN MOTOR WHILE OPERATING AT, OR LESS THAN 100% INPUT SIGNAL.

2) INSTALLED CONDITIONS:

A) VERIFY FAN CAN PRODUCE DESIGN FLOW AT INSTALLED TOTAL STATIC PRESSURE WITHOUT OVERLOADING THE FAN MOTOR WHILE OPERATING AT, OR LESS THAN 100% INPUT SIGNAL. SIMULATE FILTER LOADING AS NEEDED TO ESTABLISH DESIGN FILTER PRESSURE DROP ALLOWANCE.

B) VERIFY AFTER SYSTEM BALANCE THAT FAN CAN OPERATE AT 100% INPUT SIGNAL WITHOUT OVERLOADING FAN MOTOR OR CREATING EXCESSIVE INLET OR DISCHARGE PRESSURES. RESCALE INPUT SIGNAL AS NEEDED TO PREVENT MOTOR OVERLOAD OR EXCESSIVE PRESSURES.

B) BALANCE AIR HANDLING UNIT FANS THAT ARE CONTROLLED IN PARALLEL SUCH THAT THE FAN INLET STATIC PRESSURES AND FAN DISCHARGE STATIC PRESSURES ARE THE SAME FOR EACH AIR HANDLING UNIT. THE MANUAL DAMPERS AND OUTSIDE AIR DAMPERS ASSOCIATED WITH EACH UNIT SHALL BE ADJUSTED TO EQUALIZE THOSE PRESSURES.

C) BALANCE AIR HANDLING UNITS SUCH THAT DUCT STATIC PRESSURES ARE MAINTAINED AS LOW AS POSSIBLE WHILE MAINTAINING MINIMUM INLET STATIC PRESSURE AND AIRFLOW REQUIREMENTS AT EACH TERMINAL UNIT.

D) TOTAL SUPPLY, RETURN AND OUTSIDE AIR AIRFLOW FOR EACH AIR HANDLING UNIT SHALL BE MEASURED USING PITOT TUBE DUCT TRAVERSES. WHERE THE OUTSIDE AIR INLET CONFIGURATION IS INSUFFICIENT FOR A PITOT TUBE DUCT TRAVERSE, THE OUTSIDE AIR SHALL BE CALCULATED AS THE DIFFERENCE BETWEEN THE SUPPLY AND RETURN.

E) DETERMINE THE MINIMUM AND MAXIMUM SUPPLY DUCT STATIC PRESSURE SETPOINTS, AS DESCRIBED IN THE AIR HANDLING UNIT CONTROLS SEQUENCES ON THE DRAWINGS.

F) FOR AIR HANDLING UNITS WITH MULTIPLE SUPPLY DUCT STATIC PRESSURE SENSORS, DETERMINE UNIQUE SUPPLY DUCT STATIC PRESSURE SETPOINTS FOR EACH SENSOR LOCATION.

G) FOR SYSTEMS WITH DIVERSITY, WITH THE FAN UNDER CONTROL AND LOADS COMMANDED TO MINIMUM FLOW SETPOINT TO SIMULATE DIVERSITY, VERIFY DESIGN FLOW THROUGH EACH TERMINAL UNIT. DIVERSITY SHALL BE CALCULATED AS THE RATIO OF THE TOTAL SYSTEM CAPACITY TO THE TOTAL CONNECTED LOAD.

H) ADJUST PATTERN ADJUSTMENT DEVICES IN DIFFUSERS FOR HORIZONTAL DISCHARGE, UNLESS OTHERWISE INDICATED ON THE DRAWINGS.

I) CALIBRATION OF BCS FLOW ELEMENTS SHALL BE VERIFIED THROUGH THE USE OF DUCT TRAVERSES OR FLOW HOODS, AS APPROPRIATE FOR THE DEVICE BEING CALIBRATED. BCS FLOW ELEMENTS SHALL NOT BE USED FOR BALANCE ADJUSTMENTS PRIOR TO THE VERIFICATION OF THEIR CALIBRATION. USE A 3-POINT CALIBRATION METHOD TO CALIBRATE TERMINAL UNITS. PERFORM 3-POINT CALIBRATION FOR AIRFLOW MEASUREMENT SYSTEMS THAT WILL EXPERIENCE VARIABLE FLOW, USING THE LOWER AND UPPER AIRFLOW LIMITS AS TWO OF THE CALIBRATION POINTS.

J) TEST, ADJUST AND BALANCE OUTSIDE AIR BALANCING, MINIMUM OUTSIDE AIR AND RETURN DAMPERS TO PRODUCE THE QUANTITY OF MINIMUM OUTSIDE AIR INDICATED ON THE DRAWINGS WHEN EACH AIR HANDLING UNIT IS OPERATING AT ITS MAXIMUM SUPPLY AIR QUANTITY. RETURN AIR DAMPERS SHALL BE ADJUSTED TO A LESS THAN FULLY OPEN POSITION ONLY IF REQUIRED TO ACHIEVE THE MINIMUM OUTSIDE AIR QUANTITY INDICATED ON THE DRAWINGS. RETURN AND MINIMUM OUTSIDE AIR DAMPER LINKAGES SHALL BE ADJUSTED TO POSITION THEIR RESPECTIVE DAMPERS AT FULL STROKE. PERMANENTLY MARK DAMPER LINKAGE ADJUSTMENTS. MEASURE, RECORD AND ADJUST THE OUTSIDE AIR BALANCING DAMPER DIFFERENTIAL PRESSURE MIXING PLENUM STATIC PRESSURE SETPOINTS, INCLUDING ASSOCIATED LOWER AND UPPER LIMITS, AS NECESSARY TO ACHIEVE THE REQUIRED OUTSIDE AIR QUANTITY DESCRIBED IN THE AIR HANDLING UNIT CONTROLS SEQUENCES ON THE DRAWINGS.

K) FOR MULTIPLE AIR HANDLING UNITS BEING CONTROLLED IN PARALLEL (AS INDICATED IN THE CONTROLS SEQUENCES), TEST, ADJUST AND BALANCE THE UNITS FOR EACH POTENTIAL OPERATING CONDITION (I.E., ONE UNIT OPERATING, 2 UNITS OPERATING, ETC.), AND PROVIDE UNIQUE OUTSIDE AIR CONTROL SETPOINTS FOR EACH CONDITION.

L) BALANCE AND ADJUST SYSTEM BALANCING TOLERANCES (WITHIN SPECIFIED LIMITS) TO ENSURE PRESSURIZATION OF THE ENTIRE BUILDING, AND TO MINIMIZE STACK EFFECT DURING THE WINTER.

M) BALANCE AND ADJUST INDIVIDUAL ROOM AIR DISTRIBUTION DEVICES BALANCING TOLERANCES (WITHIN SPECIFIED LIMTS) TO ACHIEVE PRESSURE RELATIONSHIPS INDICATED ON THE DRAWINGS.

N) BALANCE AND ADJUST INDIVIDUAL ROOM AIR DISTRIBUTION DEVICES TO ACHIEVE PRESSURE RELATIONSHIPS AS FOLLOWS:

1) INITIAL CFM OFFSETS ARE SHOWN ON THE DRAWINGS.

2) ADJUST CFM OFFSETS TO ACHIEVE A MINIMUM DIFFERENTIAL PRESSURE BETWEEN 0.03" WG TO 0.05" WG.

3) THE FINAL REPORT SHALL INCLUDE THE FINAL MEASURED DIFFERENTIAL FOR EACH SPACE WITH THE CORRESPONDING OFFSET.

3) HYDRONIC SYSTEMS - VARIABLE FLOW, VARIABLE SPEED PUMPS:

A) VARIABLE FREQUENCY DRIVES FOR PUMPS SHALL BE SET UP AND TESTED TO:

1) DESIGN CONDITIONS:

A) VERIFY PUMP CAN PRODUCE DESIGN FLOW AT DESIGN TOTAL HEAD WITHOUT OVERLOADING THE MOTOR WHILE OPERATING AT, OR LESS THAN 100% INPUT SIGNAL.

2) INSTALLED CONDITIONS:

A) VERIFY PUMP CAN PRODUCE DESIGN FLOW AT INSTALLED TOTAL HEAD WITHOUT OVERLOADING THE MOTOR WHILE OPERATING AT, OR LESS THAN 100% INPUT SIGNAL.

B) VERIFY AFTER SYSTEM BALANCE THAT PUMP CAN OPERATE AT 100% INPUT SIGNAL WITHOUT OVERLOADING MOTOR OR CREATING EXCESSIVE PRESSURES. RESCALE INPUT SIGNAL AS NEEDED TO PREVENT MOTOR OVERLOAD OR EXCESSIVE PRESSURES.

B) OPERATE THE SYSTEM PUMPS UNDER CONTROL AND BALANCE TERMINAL DEVICES FOR DESIGN FLOW WITH CONTROL VALVES WIDE OPEN. RECORD THE PUMP OPERATING DATA AND PIPING LOSS DATA. DO NOT THROTTLE THE PUMP DISCHARGE. CALCULATE THE PUMP DIFFERENTIAL PRESSURE SETPOINT NEEDED TO OBTAIN FULL FLOW AT THE WORST-CASE LOAD AND SET THE PUMP CONTROLLER TO THAT VALUE.

C) BALANCE PUMPS THAT ARE CONTROLLED IN PARALLEL SUCH THAT THE PUMP SUCTION AND DISCHARGE PRESSURES ARE THE SAME FOR EACH PUMP. THE BALANCING VALVE ASSOCIATED WITH EACH PUMP SHALL BE ADJUSTED TO EQUALIZE THOSE PRESSURES.

D) BALANCE HYDRONIC SYSTEMS SUCH THAT DISTRIBUTION SYSTEM DIFFERENTIAL PRESSURES ARE MAINTAINED AS LOW AS POSSIBLE WHILE MAINTAINING THE MINIMUM DIFFERENTIAL PRESSURE AND VOLUME REQUIREMENTS AT CONNECTED LOADS.

E) FOR SYSTEMS WITH DIVERSITY, WITH THE PUMP UNDER CONTROL AND LOADS NEAREST TO THE PUMP CLOSED OFF TO SIMULATE DIVERSITY, VERIFY DESIGN FLOW THROUGH EACH TERMINAL DEVICE. DIVERSITY SHALL BE CALCULATED AS THE RATIO OF THE TOTAL SYSTEM CAPACITY TO THE TOTAL CONNECTED LOAD.

4) HYDRONIC SYSTEMS - VARIABLE FLOW, CONSTANT SPEED PUMPS:

A) OPERATE THE SYSTEM PUMPS AND BALANCE TERMINAL DEVICES FOR DESIGN FLOW WITH CONTROL VALVES WIDE OPEN. RECORD THE PUMP OPERATING DATA AND PIPING LOSS DATA. DO NOT THROTTLE THE PUMP DISCHARGE.

5) HYDROSTATIC PRESSURE TESTING:

A) TEST PIPING SYSTEMS IN ACCORDANCE WITH THE SPECIFICATIONS.

B) TEST SHALL BE HELD FOR 4 HOURS, MINIMUM, WITH COMPENSATION MADE FOR TEMPERATURE CHANGE.

C) NO PRESSURE CHANGE ALLOWED.

6) REFRIGERANT PIPING SYSTEM TESTING:

A) TEST REFRIGERANT PIPING, EQUIPMENT, VALVES AND FITTINGS AT A PRESSURE OF 250 PSIG WITH DRY NITROGEN OR DRY CARBON DIOXIDE, TOGETHER WITH A SMALL AMOUNT OF REFRIGERANT. TEST JOINTS WITH A SOAP SOLUTION, WIPE CLEAN AND TEST AGAIN WITH HALIDE TORCH OR ELECTRONIC REFRIGERANT LEAK DETECTOR. AFTER LEAKS HAVE BEEN REPAIRED, EVACUATE ENTIRE SYSTEM TO 500 MICRONS OF VACUUM FOR A MINIMUM OF 4 HOURS. VALVE OFF THE VACUUM PUMP AND OBSERVE RISE IN PRESSURE FOR 15 MINUTES. IF FINAL PRESSURE IS ABOVE 750 MICRONS, CONTINUE THE EVACUATION AND LEAK REPAIR PROCESS UNTIL SATISFACTORY RESULTS ARE OBTAINED. AFTER EVACUATION, CHARGE THE SYSTEM AS RECOMMENDED BY THE MANUFACTURER.

B) SUBMIT A CERTIFICATE STATING THAT THE DEHYDRATION TEST WAS PERFORMED.

2. SEASONAL ADJUSTMENTS

A. ASSIST THE HVAC PERFORMANCE VERIFICATION SUPERVISOR WITH THE SEASONAL ADJUSTMENT PROCESS. DURING THIS EFFORT, THE HVAC PERFORMANCE VERIFICATION SUPERVISOR WILL:

1) CHECK THE OPERATION, PERFORMANCE, AND BALANCE OF AIR AND HYDRONIC SYSTEMS TO PROVIDE UNIFORM DISTRIBUTION AND COMFORT CONDITIONS.

2) WHERE DEFICIENT OPERATION OR DEFECTIVE EQUIPMENT IS DISCOVERED, CONTRACTOR SHALL PROVIDE CORRECTIVE MEASURES AS REQUIRED BY THE WARRANTY PROVISIONS OF THESE SPECIFICATIONS AND SHALL ASSIST THE PERFORMANCE VERIFICATION SUPERVISOR IN THE CORRECTION OF THESE DEFICIENCIES.

PIPING, VALVES AND ACCESSORIES

1. PIPING SHALL NOT BLOCK THE SWING OR USE OF ACCESS DOORS, PANELS, SERVICING OF FILTERS OR OTHER EQUIPMENT. LOCATE UNIONS AND SHUT OFF VALVES TO ALLOW REMOVAL OF COIL OR ANY MODULE WITHOUT REQUIRING SHUT DOWN OF ANY OTHER PART OF THE SYSTEM.
2. COILS SHALL BE PIPED FOR COUNTER-FLOW CONFIGURATION.
3. ON MULTIPLE COILS WITH SINGLE CONTROL VALVE PROVIDE METERING TYPE BALANCING VALVE IN RETURN FROM EACH COIL SECTION.
4. THE SIZE OF PIPE RUNOUTS TO EQUIPMENT SHALL BE AS SHOWN ON THE EQUIPMENT SCHEDULES, UNLESS NOTED OTHERWISE ON DRAWINGS. PIPE RUNOUT SIZES MAY OR MAY NOT BE THE SAME AS THE EQUIPMENT PIPE CONNECTION SIZES. PROVIDE REDUCERS OR EXPANSION FITTINGS WHERE EQUIPMENT PIPE CONNECTION SIZES DIFFER FROM PIPE RUNOUT SIZES.
5. PROVIDE REDUCERS BEFORE AND AFTER CONTROL VALVES TO SUIT SIZE OF VALVE PROVIDED. ALL OTHER VALVES, STRAINERS, ETC. SHALL BE FULL LINE SIZE.
6. PROVIDE A TEST PLUG AT EACH TEMPERATURE AND PRESSURE SENSOR.
7. COOLING COIL CONDENSATE PIPING IS GRAVITY FLOW, UNLESS OTHERWISE NOTED. PROVIDE A CLEANOUT AT EVERY CHANGE IN DIRECTION GREATER THAN 45 DEGREES FOR BOTH PUMPED AND GRAVITY FLOW CONDENSATE PIPING.
8. PIPE HANGERS SHALL SUPPORT PIPING INDEPENDENTLY OF EQUIPMENT.
9. MATERIAL OF NEW PIPING SHALL MATCH EXISTING AT TIE-INS.
10. BUTTERFLY VALVES MAY BE USED IN LIEU OF THE GATE AND BALANCING VALVES INDICATED ON THE DRAWINGS FOR 125 PSIG AND 200°F CHILLED, HOT, AND CONDENSER WATER SERVICE.
11. BALL VALVES MAY BE USED IN LIEU OF THE GATE AND BALANCING VALVES INDICATED ON THE DRAWINGS FOR CHILLED, HOT, AND CONDENSER WATER SERVICE.
12. BUTTERFLY VALVES ADJACENT TO EQUIPMENT SHALL BE FUNCTIONAL WHEN EQUIPMENT IS REMOVED.
13. KITCHEN EQUIPMENT, LAUNDRY EQUIPMENT, STERILIZERS, FUME HOODS, AND CASEWORK ARE IS SPECIFIED UNDER ANOTHER DIVISION. PROVIDE FINAL STEAM AND CONDENSATE CONNECTIONS FOR OPERATION.
14. STEAM PRESSURES ARE:
    A. LOW PRESSURE: 0 PSIG TO 15 PSIG.
    B. HIGH PRESSURE: ABOVE 15 PSIG.
15. STRAINERS IN WATER PIPING SHALL BE INSTALLED WITH BLOWDOWN OUTLETS AT THE LOW POINT.
16. STRAINERS IN HORIZONTAL STEAM PIPING SHALL BE INSTALLED ON THE SIDE.
17. MANUAL FLOW CONTROL VALVES MAY BE USED IN LIEU OF BALANCING VALVES INDICATED ON THE DRAWINGS BUT THE FLOW CONTROL VALVE METER CONNECTIONS MAY NOT BE A SUBSTITUTE FOR PRESSURE GAUGES OR NEEDLE VALVES INDICATED ON THE DRAWINGS.
18. INLINE AIR SEPARATORS:
    A. SUPPORT WITH HANGERS INDEPENDENTLY FROM THE ADJACENT PIPING.
19. INSTALL CONTROL VALVES, THERMOMETERS, AND VALVED PRESSURE TAPS PROVIDED UNDER SECTION 230923, DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC.

HVAC INSULATION

1. GENERAL

A. SURFACES TO BE INSULATED SHALL BE CLEAN, DRY, AND FREE OF FOREIGN MATERIAL, RUST, SCALE AND DIRT WHEN INSULATION IS APPLIED. PERFORM PRESSURE AND LEAKAGE TESTS AND SUBMIT RESULTS REQUIRED BY OTHER SECTIONS BEFORE APPLYING INSULATION.

B. WHERE EXISTING INSULATION IS DAMAGED DUE TO THE NEW WORK, REPAIR DAMAGE TO MATCH EXISTING WORK OR REPLACE DAMAGED PORTION WITH INSULATION SPECIFIED FOR NEW WORK.

2. MATERIAL SELECTIONS

A. WHERE MULTIPLE INSULATION MATERIALS ARE SPECIFIED HEREIN FOR THE SAME SERVICE, ONE OF THE SPECIFIED MATERIALS SHALL BE APPLIED AND USED CONSISTENTLY THROUGHOUT THE PROJECT, SUBJECT TO THE REQUIREMENTS OF THESE SPECIFICATIONS.

3. INSULATION FOR HOT PIPE

A. INSULATE THE FOLLOWING PIPE WITH PREFORMED FIBERGLASS PIPE INSULATION OF THE THICKNESS INDICATED, AND WHITE ALL SERVICE JACKET WITH SELF-SEALING LAP:

		INSULATION THICKNESS, INCHES				
	FLUID DESIGN OPERATING TEMPERATURE RANGE, °F	LESS THAN 1"	1"-1.25"	PIPE SIZES 1.5"-3"	4"-6"	8" AND OVER
HEATING						
HOT WATER LOW TEMPERATURE	THROUGH 200 201 TO 250	1.5 2.5	1.5 2.5	2 2.5	2 3	2 3
STEAM, LOW PRESSURE	--	2.5	2.5	3	3	3
CONDENSATE	--	2.5	2.5	2.5	3	3
AIR CONDITIONING						
REFRIGERANT HOT-GAS	--	1	1	1.5	1.5	1.5

1) END JOINT BUTT STRIPS SHALL BE MINIMUM 3" WIDE AND OF MATERIAL IDENTICAL TO JACKET.

2) INSULATE STRAINERS AND VALVES IN PIPING LARGER THAN 1" AND FITTINGS AND FLANGES WITH PREFORMED OR MITERED FIBERGLASS FITTINGS. WIRE FITTINGS IN PLACE AND COVER WITH A SMOOTHING COAT OF INSULATING CEMENT. FINISH WITH GLASS FABRIC EMBEDDED BETWEEN 2 COATS OF WHITE BREATHER MASTIC. GLASS FABRIC SHALL OVERLAP ADJOINING INSULATION AT LEAST 2".

4. INSULATION FOR HOT EQUIPMENT

A. INSULATE THE FOLLOWING WITH 3" CALCIUM SILICATE BLOCKS OR 2", 3 PCF MINIMUM DENSITY FIBERGLASS BOARD:

1) INLINE AIR SEPARATORS.

2) SECURE INSULATION WITH GALVANIZED BANDS OR ON WELD PINS. MITER OR SCORE BLOCKS TO ENSURE TIGHT JOINTS. SEAL JOINTS WITH INSULATING CEMENT. APPLY A THICK TOP COAT OF INSULATING CEMENT OVER ENTIRE INSULATED SURFACE.

3) FINISH WITH 0.016" ALUMINUM JACKET.

B. INSULATE BOILER BREECHING, AND STACKS INSIDE THE BUILDING, INCLUDING CONNECTIONS ON BOILERS, WITH 4" CALCIUM SILICATE BLOCKS OR 3", 3PCF MINIMUM DENSITY FIBERGLASS BOARD.

1) SECURE INSULATION WITH GALVANIZED BANDS OR ON WELD PINS. MITER OR SCORE BLOCKS TO ENSURE TIGHT JOINTS. SEAL JOINTS WITH INSULATING CEMENT. APPLY WIRE MESH SECURELY TO SURFACE AND FINISH WITH A THICK TOP COAT OF INSULATING CEMENT TROWELLED TO A SMOOTH HARD FINISH.

C. INSULATE THE FOLLOWING WITH REMOVABLE INSULATION BLANKETS AND PADS, 2" THICK:

1) EQUIPMENT ACCESS PLATES.

2) STEAM CONTROL VALVES.

5. INSULATION FOR COLD PIPE

A. INSULATE THE FOLLOWING PIPE WITH PREFORMED PHENOLIC OR POLYISOCYANURATE PIPE INSULATION OF THE THICKNESS INDICATED WITH A VAPOR RETARDER AND ALL SERVICE JACKET WITH SELF-SEALING LAP:

INSULATION THICKNESS, INCHES			
	PIPE SIZES		
	THROUGH 1.25".	1.5" - 12"	4" AND OVER
CHILLED WATER SUPPLY AND RETURN	0.5 - 1	1 1.5	1.5
CONDENSATE DRAIN	0.5	0.5	0.5
EXTERIOR CHILLED WATER SUPPLY AND RETURN	1	1.5	1.5
EXTERIOR MAKE-UP WATER	1	1.5	1.5

1) SEAL LONGITUDINAL AND END JOINTS WITH SEALANT AND MASTIC AS RECOMMENDED BY THE MANUFACTURER TO ACHIEVE THE PERMEANCE RATING SPECIFIED HEREIN. INSTALL INSULATION WITH JACKET DRAWN TIGHT WITH SIDE-LAPS AND END JOINT BUTT STRIPS SECURED. END JOINT BUTT STRIPS SHALL BE SAME MATERIAL AS JACKET, NOT LESS THAN 3" WIDE.

2) INSULATE FITTINGS, FLANGES, STRAINERS, UNIONS, AND VALVES WITH PREFORMED OR MITERED PHENOLIC OR POLYISOCYANURATE FITTING SECTIONS. SECURE FITTINGS IN PLACE, SEAL JOINTS AND CONTOUR MITERED SECTIONS WITH INSULATING CEMENT, AND FINISH WITH A LAYER OF GLASS FABRIC EMBEDDED BETWEEN 2 COATS OF VAPOR BARRIER MASTIC. GLASS FABRIC SHALL OVERLAP ADJOINING INSULATION AT LEAST 2".

3) WHERE TEMPERATURE MAINTENANCE CABLE IS SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS, PIPING SHALL BE INSULATED AFTER APPLICATION OF TEMPERATURE MAINTENANCE CABLE.

4) PROVIDE VAPOR STOPS CONSISTING OF GLASS FABRIC AND VAPOR BARRIER MASTIC OVER THE ENTIRE END OF BUTT JOINTS AT CONTROL VALVES, STRAINERS, AND EQUIPMENT REQUIRING ACCESS.

6. INSULATION FOR COLD EQUIPMENT

A. INSULATE CHILLER EVAPORATOR END PLATES AND WATER BOXES, AND SUCTION PIPE COUPLINGS ON CHILLERS; FLANGED ENDS OF STRAINERS WITH 1" THICK FLEXIBLE ELASTOMERIC SHEET. INSULATION SHALL BE SECURED WITH ADHESIVE, EXCEPT PIECES COVERING STRAINER FLANGES AND OTHER COMPONENTS REQUIRING ACCESS SHALL BE DESIGNED FOR REMOVAL AND REINSTALLATION WITHOUT DAMAGE TO INSULATION.

B. INSULATE CHILLED WATER PUMPS WITH 1" THICK FLEXIBLE ELASTOMERIC SHEETS. INSULATION SHALL BE ADHERED TO INSIDE OF 18 GAUGE ALUMINUM CASINGS. CASINGS SHALL BE FABRICATED IN A MINIMUM OF 2 SECTIONS, WITH FLANGED AND BOLTED JOINTS OR OPERABLE LATCHES AND HINGES. HARDWARE SHALL BE GALVANIZED OR CADMIUM-PLATED STEEL. CASINGS SHALL BE DESIGNED FOR REMOVAL TO ALLOW ACCESS FOR MAINTENANCE WITHOUT DAMAGING INSULATION. SEAL PENETRATIONS OF CASINGS.

C. INSULATE CHILLED WATER EXPANSION TANKS, CHILLED WATER BUFFER TANKS, AND INLINE AIR SEPARATORS AS SPECIFIED HEREIN FOR CHILLED WATER PIPE.

D. INSULATE CHILLED WATER AND REFRIGERANT PIPING APPURTENANCES, THERMOWELLS, THERMOMETER TEST WELLS, GAUGE COCKS, VALVE STEMS, AND HANGERS AND SUPPORTS SUBJECT TO SWEATING WITH FLEXIBLE ELASTOMERIC TAPE.

7. INSULATION FOR DUCT SYSTEMS

A. INSULATE THE FOLLOWING CONCEALED DUCT SYSTEMS WITH FLEXIBLE, FIBERGLASS INSULATION, NOMINAL 2.2" THICKNESS, MINIMUM R-VALUE AT THE INSTALLED CONDITION OF 6.0 $H \cdot FT^2 \cdot °F/BTU$, WITH FOIL-SCRIM-KRAFT FACING: SUPPLY, RETURN, EXHAUST, OUTSIDE AIR.

8. INSTALLATION

A. PROVIDE REMOVABLE AND REPLACEABLE COVERS ON PUMPS, EQUIPMENT, AND REMOVABLE ENDS OF STRAINERS REQUIRING INSULATION THAT MUST BE OPENED PERIODICALLY FOR INSPECTION, CLEANING, OR REPAIR.

B. DO NOT USE SCRAP PIECES OF INSULATION WHERE A FULL LENGTH SECTION WILL FIT.

C. BANDING WIRES SHALL HAVE THE TWISTED TERMINALS TURNED DOWN TOWARD THE INSULATION WITHOUT DAMAGING THE VAPOR BARRIER.

D. WIRE INNER LAYER 9" ON CENTER; APPLY OUTER LAYER AND FINISH AS SPECIFIED HEREIN.

E. FINISH OPEN ENDS OF PIPE INSULATION AS SPECIFIED HEREIN FOR FITTINGS.

F. PROVIDE RIGID INSERTS AT EACH INSULATION PROTECTOR LOCATION FOR PIPING 1.5" AND LARGER.

G. FILL HOLLOW STEEL PIPE COVERING PROTECTION SADDLES WITH FIBERGLASS INSULATION.

H. LINED DUCTWORK:

1) WHERE DUCTWORK AND PLENUMS ARE LINED, NO EXTERNAL THERMAL INSULATION IS REQUIRED.

2) WHERE LINING IS INTERRUPTED AT DAMPERS AND HEATING COILS, INSULATE DUCTWORK.

3) WHERE UNLINED DUCT AND LINED DUCT CONNECT, THE INSULATION SHALL OVERLAP LINED SECTION AT LEAST 4".

I. INSULATION AND VAPOR BARRIER SHALL BE CONTINUOUS AROUND AND UNDER STANDOFF BRACKETS USED FOR MOUNTING BALANCING AND CONTROL DEVICES ON DUCTWORK.

J. WHERE EQUIPMENT IS FURNISHED WITH OTHER COMPONENTS AND ADJOINING PIPING FACTORY-ASSEMBLED ON A SKID OR OTHER COMMON PLATFORM, SUCH EQUIPMENT AND PIPING SHALL BE INSULATED AS SPECIFIED HEREIN.

9. WEATHERPROOFING

A. PROTECT INSULATION ON DUCTWORK AND EQUIPMENT EXPOSED TO WEATHER OUTSIDE THE BUILDING WITH SELF-ADHERING FLEXIBLE EXTERIOR COVERING. JUNCTIONS OF HORIZONTAL AND VERTICAL SURFACES SHALL HAVE A MINIMUM OF 3" VERTICAL OVERLAP. HORIZONTAL SEAMS SHALL HAVE A MINIMUM OF 6" OVERLAP IN ROOF SHINGLE FASHION. INSTALL AS RECOMMENDED BY THE MANUFACTURER.

B. PROTECT INSULATION, EXCEPT FLEXIBLE ELASTOMERIC, ON PIPING EXPOSED TO WEATHER OUTSIDE THE BUILDING WITH 0.016" THICK CORRUGATED ALUMINUM JACKETING WITH FACTORY-APPLIED MOISTURE RETARDER PROTECTIVE FILM ON THE INNER SURFACE. PROVIDE 2" OVERLAP AT JOINTS WITH SEALANT AS RECOMMENDED BY THE MANUFACTURER. LOCATE LONGITUDINAL JOINTS TO SHED WATER. SECURE JACKETING WITH ALUMINUM BANDS EVERY 12" AND AT END JOINTS.

C. PROTECT EXTERIOR FLEXIBLE ELASTOMERIC INSULATION WITH UV RESISTANT WHITE ACRYLIC LATEX COATING.

EQUIPMENT

1. ELECTRONIC STEAM HUMIDIFIERS

A. PROVIDE A SPARE STEAM GENERATOR FOR EACH HUMIDIFIER AND TURN OVER TO THE OWNER. OBTAIN SIGNED RECEIPT.

B. WATER TEMPERING DEVICES EXTERNAL TO THE HUMIDIFIER, IF REQUIRED, SHALL BE LOCATED AS CLOSE AS POSSIBLE TO THE HUMIDIFIER.

2. CHILLERS

A. PROVIDE A COMPLETE PARTS AND LABOR WARRANTY, INCLUDING REFRIGERANTS AND LUBRICANTS, FOR 1 YEAR AFTER DATE OF SUBSTANTIAL COMPLETION.

B. MANUFACTURERS MAY USE A SMALL AMOUNT OF CHILLED OR CONDENSER WATER FOR OIL COOLER OR MOTOR CONTROLLER COOLING.

C. CHILLER MANUFACTURER SHALL COORDINATE AND APPROVE CONTROLS PROVIDED IN SECTION 230923, DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC, AND SHALL INDICATE SUCH APPROVAL IN WRITING ON THE CONTROL SHOP DRAWING SUBMITTAL.

D. WRITTEN INSTRUCTIONS AND CONTROL DIAGRAMS SHOWING WIRING AND PROGRAMMING FOR BUILDING CONTROL SYSTEM INTERFACES SHALL BE FURNISHED BY THE MANUFACTURER TO BE INCORPORATED IN THE CONTROL DIAGRAMS SPECIFIED IN SECTION 230923, DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC.

E. PROVIDE BALL VALVE ON DRAIN. DRAIN VALVES SHALL HAVE HOSE END CONNECTIONS.

F. PERFORM CHILLER COMMISSIONING AND PROVIDE ASSISTANCE AND SUPPORT DURING CONTROLS SYSTEM COMMISSIONING. SUBMIT A STATEMENT THAT THE CHILLERS ARE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS, AND THAT SAFETIES AND CONTROLS ARE OPERATING PROPERLY.

3. AIR HANDLING UNITS

A. FOR AIR HANDLING UNITS WITH COIL SECTIONS THAT ARE NEAR THE FLOOR, COORDINATE THE UNIT MOUNTING HEIGHT WITH THE CONDENSATE DRAIN TRAP DETAIL. IF THE BOTTOM OF THE INSULATED DRAIN TRAP CONFLICTS WITH THE FLOOR SLAB, PROVIDE HEIGHT ADJUSTMENT SUPPORTS BETWEEN THE AIR HANDLING UNIT AND HOUSEKEEPING PAD. LOCATE SUPPORTS AT MANUFACTURER RECOMMENDED LOAD POINTS.

B. CUSTOM UNITS: UNITS NOT FACTORY-ASSEMBLED SHALL BE PRESSURE TESTED IN THE FIELD AFTER INSTALLATION. UNIT CASING LEAKAGE SHALL NOT EXCEED 0.5 CFM/FT^2 OF CASING AREA AT A PRESSURE OF 5" WG.

4. PUMPS

A. FURNISH AN EXTRA SET OF MECHANICAL SEALS FOR EACH PUMP AND SUBMIT RECEIPT ACKNOWLEDGING SAME.

B. PROVIDE BASE ELBOW SUPPORTS FOR HORIZONTAL CONNECTIONS TO BASE-MOUNTED PUMPS.

C. PUMP AND MOTOR ALIGNMENT FOR EACH FLEXIBLE-COUPLED PUMP SHALL BE VERIFIED TO BE ±0.002" BY THE MANUFACTURER AFTER PUMP AND PIPING HAVE BEEN INSTALLED AND BASE HAS BEEN GROUTED. SUBMIT A WRITTEN STATEMENT VERIFYING COMPLETION AND TOLERANCE OF ALIGNMENT.

D. PUMP IMPELLERS SHALL BE NONOVERLOADING TYPE SO MOTOR NAMEPLATE RATING WILL NOT BE EXCEEDED AT ANY POINT ON THE PUMP CURVE UP TO 125% OF THE FLOW INDICATED ON THE DRAWINGS.

E. PUMPS SHALL BE DESIGNED FOR A WORKING PRESSURE OF 175 PSIG AND A MAXIMUM FLUID TEMPERATURE OF 150°F FOR CHILLED WATER SERVICE AND 240°F FOR HOT WATER SERVICE.

F. IMPELLER DIAMETER SHALL NOT EXCEED 95% OF THE MAXIMUM IMPELLER DIAMETER AVAILABLE FOR THE PUMP SELECTION.

G. FOR CHILLED WATER APPLICATIONS: GALVANIZED DRAIN PAN, 16 GAUGE MINIMUM WITH A 0.5" DRAIN COUPLING.

H. VERTICAL TURBINE PUMP MOTORS SHALL BE REMOVABLE FROM THE PUMP HEAD ASSEMBLY. SOLEPLATE SHALL BE DESIGNED TO SUPPORT ENTIRE WEIGHT OF PUMP ASSEMBLY AND TO ALLOW COMPLETE REMOVAL OF ASSEMBLY.

I. VERTICAL TURBINE PUMPS OPERATED WITH VARIABLE FREQUENCY DRIVES SHALL BE SUPPLIED WITH A STEEL FABRICATED HEAD, DESIGNED TO AVOID CRITICAL FREQUENCIES ASSOCIATED WITH THAT HEAD AND SHAFT COMBINATION FOR SPEEDS RANGING FROM 100% TO 20% SPEED.

5. WATER TREATMENT SYSTEMS

A. SYSTEMS SHALL INCLUDE EQUIPMENT, PIPING, FITTINGS, INSTALLATION, WIRING AND ADJUSTMENTS FOR AUTOMATIC OR MANUAL OPERATION AS SPECIFIED HEREIN.

B. ASSIST THE BUILDING CONTROL SYSTEM SUPPLIER WITH ESTABLISHING REMOTE MONITORING OF PARAMETERS AS SPECIFIED HEREIN, INCLUDING REASONABLE ALARM VALUES. ADJUST THE MEASUREMENT RANGE OF ANALOG OUTPUTS FOR CONDUCTIVITY AND OTHERS BASED ON EXPECTED OPERATING CONDITIONS.

C. PROVIDE SERVICE UNTIL, AND FOR 1 YEAR AFTER, THE DATE OF SUBSTANTIAL COMPLETION, INCLUDING CHEMICALS, WATER ANALYSES AND RECOMMENDATIONS, START-UP INSTRUCTIONS TO THE OWNER, RECORD FORMS AND LOG SHEETS, AND TECHNICAL AND LABORATORY ASSISTANCE. CHEMICALS SHALL MEET FEDERAL, STATE, AND LOCAL REGULATIONS.

6. BOILERS

A. PRESSURE TEST THE BOILERS AFTER ASSEMBLY BUT PRIOR TO INSTALLATION OF JACKET TO 200 PSIG.

B. PROVIDE THE SERVICES OF FACTORY-TRAINED TECHNICIANS FOR 7 DAYS TO PLACE THE BOILER PLANT, INCLUDING BOILERS SEQUENCE PROGRAMMER IN SERVICE, AND TO ASSIST IN FLUSHING, TREATMENT, AND TESTING, ADJUSTING AND BALANCING. AN OPERATIONAL PERFORMANCE TEST SHALL BE MADE AT THE TIME THE SYSTEM IS PLACED IN OPERATION, INCLUDING OPERATION OF CONTROLS, SAFETIES, ALARMS, AND INDICATORS. THE OPERATIONAL PERFORMANCE TEST MAY BE WITNESSED BY THE OWNER.

C. TEST BOILER FLUE GASES FOR CO_2, O_2, AND CO, AND TEST STACK TEMPERATURE, DRAFT, BURNER, GAS PRESSURE, BLOWER MOTOR VOLTAGE AND AMPERAGE, AND MAKE ADJUSTMENTS TO BURNERS AND CONTROLS TO ACHIEVE MAXIMUM OPERATING EFFICIENCY AND CLEAN COMBUSTION.

D. TEST RELIEF VALVES AND RECORD CRACKING AND RESEATING PRESSURES.

E. SUBMIT SIGNED STATEMENT BY BOILER MANUFACTURER CERTIFYING RESULTS OF TESTS AND THAT BOILER PERFORMANCE AND OPERATION IS IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS AND SPECIFICATIONS.

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△	DATE	DESCRIPTION

SHEET NAME: HVAC GENERAL NOTES

ORIG SUBMISSION: 2023.05.22

SHEET: M-003

PERMIT SET

EQUIPMENT CONTINUED

7. AUTOMATIC BLOWDOWN SYSTEMS
   - A. THE TIMER SHALL ACTIVATE THE BLOWDOWN VALVE AND IF CONDUCTIVITY OF THE BLOWDOWN IS LESS THAN SETPOINT, THE BLOWDOWN VALVE WILL CLOSE AFTER AN ADJUSTABLE DELAY. IF CONDUCTIVITY IS ABOVE THE SETPOINT, THE VALVE SHALL REMAIN OPEN.

AIR DISTRIBUTION

1. SHEET METAL WORK — GENERAL
   - A. CHANGES IN SHAPE, DIMENSION, OR DIRECTION SHALL BE MADE WITH A MAXIMUM TRANSITION, OFFSET, OR COMBINATION THEREOF OF 1 TO 7.
   - B. EXCEPT WHERE INDICATED OTHERWISE ON THE DRAWINGS, USE METAL HAT SECTIONS OR STANDOFF BRACKETS IN LINED DUCTWORK TO INSTALL DAMPERS, TURNING VANES OR COILS. HAT SECTIONS OR STANDOFF BRACKETS SHALL BE THE SAME HEIGHT AS THE LINING THICKNESS.
   - C. OPENINGS IN PLENUM CASINGS FOR ACCESS DOORS SHALL BE 9" ABOVE THE FLOOR. HINGE DOORS TO CLOSE WITH PLENUM PRESSURE.
   - D. SEPARATE GALVANIZED SHEET METAL FROM ALUMINUM OR COPPER WITH LEAD OR FELT GASKETS.
   - E. PROVIDE SUPPLEMENTAL STIFFENING AND SUPPORTS TO DUCTS AND APPARATUS CASINGS TO PREVENT DRUMMING, SAGGING AND TO PROVIDE A STRUCTURALLY SOUND ASSEMBLY.
   - F. ENTIRE AIR SYSTEM INSTALLATION SHALL BE RIGID, AND FREE FROM RATTLES AND AIR NOISES. INTERIOR OF DUCTS SHALL BE SMOOTH.
   - G. PROVIDE ANGLE BRACKETS INSIDE DUCTWORK ON BOTH SIDES TO SUPPORT SLIP-IN ELECTRIC HEATING COILS IN VERTICAL DUCTS OVER 24" WIDE.
   - H. ON MULTIZONE AIR HANDLING UNITS, MATCH SIZE AND ARRANGEMENT OF ZONE DUCTS TO ZONE DAMPER SECTIONS TO ACHIEVE UNIFORM OUTLET VELOCITY FOR EACH ZONE.
   - I. PROVIDE TRANSITIONS BETWEEN DIFFERENT SIZE SECTIONS OF AIR HANDLING UNITS.
   - J. INSTALL UNINSULATED DUCTWORK EXPOSED IN FINISHED AREAS AGAINST THE CEILING.
   - K. PROVIDE OFFSETS, ELBOWS, AND TRANSITIONS TO COORDINATE WITH OTHER WORK.
   - L. PROVIDE TRANSITIONS TO CONNECT DUCTWORK TO EQUIPMENT AND COILS.
   - M. ELBOWS:
     - 1) ELBOWS IN ROUND AND FLAT OVAL DUCTWORK ARE SPECIFIED HEREINBEFORE.
     - 2) RADIUS ELBOWS IN RECTANGULAR AND SQUARE DUCTWORK SHALL HAVE AN INSIDE RADIUS EQUAL TO THE WIDTH OF THE DUCT, EXCEPT WHERE SPACE CONDITIONS PROHIBIT, IN WHICH CASE A REDUCED INSIDE RADIUS WITH FULL HEEL RADIUS IS PERMITTED. WHERE THE SPACE CONDITIONS REQUIRE THE INSIDE RADIUS TO BE LESS THAN 75% OF THE DUCT WIDTH, PROVIDE MULTIPLE SPLITTER VANES INSIDE THE ELBOW.
     - 3) SQUARE (MITERED) ELBOWS IN RECTANGULAR AND SQUARE DUCTWORK SHALL CONTAIN SINGLE-THICKNESS TURNING VANES AND SHALL BE LIMITED TO 90° TURN APPLICATIONS.
       - A) SHALL BE PARALLEL TO AIRFLOW.
       - B) VANES EXCEEDING THE MAXIMUM UNSUPPORTED LENGTH DEFINED BY SMACNA SHALL BE DIVIDED INTO MULTIPLE SECTIONS WITH INTERMEDIATE VANE RAILS OR SHALL BE BRACED WITH TIE RODS SPANNING PERPENDICULARLY ACROSS THE LEADING EDGES OF THE VANES. THE TIE RODS SHALL BE WELDED TO THE LEADING EDGE OF EACH VANE.
     - 4) TURNS LESS THAN 90° IN RECTANGULAR AND SQUARE DUCTWORK SHALL BE MADE WITH RADIUS TYPE ELBOWS. MITERED ELBOWS ARE NOT PERMITTED.
   - N. SEAL WALL AND FLOOR PENETRATIONS.
   - O. INTERNAL SURFACES OF CLOTHES DRYER EXHAUST SHALL BE FREE OF OBSTRUCTIONS. SHEET METAL SCREWS SHALL NOT BE USED FOR FASTENING. ELBOWS IN SQUARE AND RECTANGULAR DUCTWORK SHALL BE RADIUS TYPE WITHOUT SPLITTER VANES.
   - P. INSTRUMENT TEST PORTS: PROVIDE WHERE REQUIRED FOR MEASUREMENTS.
2. AIR DISTRIBUTION SYSTEMS
   - A. NEW DUCTWORK AND AIR DISTRIBUTION EQUIPMENT IN SYSTEMS SHALL BE THOROUGHLY CLEANED INTERNALLY OF DUST, DIRT AND DEBRIS BEFORE INSTALLATION OF FILTERS AND OPERATION OF SYSTEMS. SUBMIT SIGNED STATEMENT CERTIFYING COMPLETION OF CLEANING BEFORE INSTALLATION OF FILTERS.
3. PLENUM LINING
   - A. LINE RETURN TRANSFER DUCTWORK WITH FIBROUS PLENUM LINING.
   - B. INSTALL LINING WITH COATED SIDE FACING AIR STREAM. ADHERE LINING TO INSIDE OF PLENUMS WITH 100% COVERAGE OF ADHESIVE. COAT EXPOSED EDGES AND JOINTS WITH EDGE SEALER. ATTACH LINING TO SHEET METAL PLENUMS WITH WELD OR MECHANICAL GRIP PINS 16" ON CENTER. MECHANICAL FASTENERS SHALL NOT COMPRESS THE LINING MORE THAN 0.125". COAT FIELD CUTS AND MINOR SURFACE DAMAGE WITH EDGE SEALER AFTER LINING IS INSTALLED.
4. ROUND AND FLAT OVAL DUCTWORK
   - A. EXPOSED DUCTWORK SHALL BE PARALLEL TO BUILDING SURFACES AND STRUCTURAL MEMBERS, AND SHALL HAVE SEAMS ALIGNED AT JOINTS.
   - B. CONSTRUCT A MOCK-UP OF EXPOSED DUCTWORK SHOWING TYPICAL JOINTS, METHODS OF SUPPORT, LINEAR DIFFUSERS, AND FITTINGS FOR APPROVAL BY THE ARCHITECT AND ENGINEER BEFORE FABRICATION OF EXPOSED DUCTWORK.

JOINTS SHALL BE SEALED WITH DUCT SEALER. DUCT SEALER SHALL NOT BE VISIBLE ON THE EXTERIOR OF THE DUCTWORK.

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Firm Lic. # F-0312

NORTH CAROLINA PROFESSIONAL SEAL 043322 ENGINEER PAUL JACKSON KITCHENS

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using a Digital Signature.

Project Grace
Grace Street
Wilmington, NC 28401
LS3P PROJECT: 7701-177600

△	DATE	DESCRIPTION

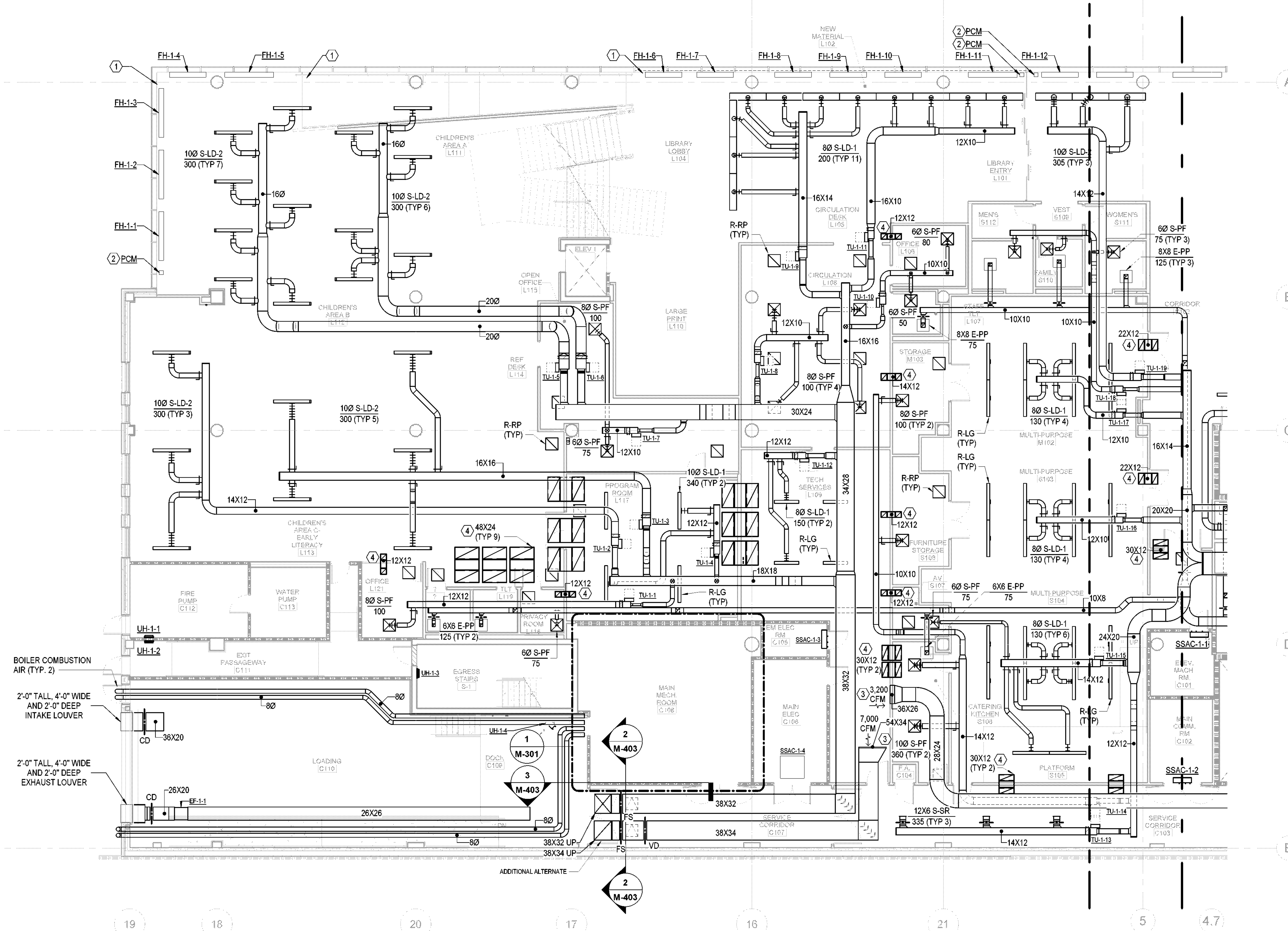
SHEET NAME:
HVAC GENERAL NOTES

ORIG SUBMISSION: 2023.05.22

SHEET: **M-004**

PERMIT SET

5/22/2023 10:14:48 AM



KEY NOTES:

1. CONTINUOUS LINEAR FLOOR GRILLE ABOVE RECESSED ELECTRIC BASEBOARD HEATER. PROVIDE CONTINUOUS SECTION, PROVIDE MITERED CORNER, AND VERIFY ALL DIMENSIONS IN FIELD.
2. POWER AND CONTROL MODULE SERVING FLOOR HEATERS. LOCATE WITHIN FLOOR TRENCH ADJACENT TO FLOOR HEATERS. DAISY CHAIN CONTROL WIRING BETWEEN FLOOR HEATERS. REFER TO MANUFACTURERS INSTRUCTIONS FOR INSTALLATION AND WIRING.
3. OPEN ENDED DUCT WITH WIRE MESH SCREEN. BALANCE TO CFM INDICATED.
4. TRANSFER DUCT. REFER TO DETAIL 9/M-601.

ADDITIONAL ALTERNATE

1. SCOPE ASSOCIATED WITH PARKING DECK ACCESS DOOR.
   A. DUCTWORK SHALL SHIFT TO BE HOUSED WITHIN ALTERNATE SHAFT LOCATION. ADJACENT SYSTEMS SHALL SHIFT TO ACCOMODATE THE ALTERNATE SHAFT LOCATION. REFER TO ARCHITECTURAL DRAWINGS FOR MORE INFORMATION.

1 HVAC DUCTWORK LEVEL 1 - AREA A
1/8" = 1'-0"

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SHEET NAME:
HVAC DUCTWORK
LEVEL 1 - AREA A

ORIG SUBMISSION: 2023.05.22

SHEET: M-101A

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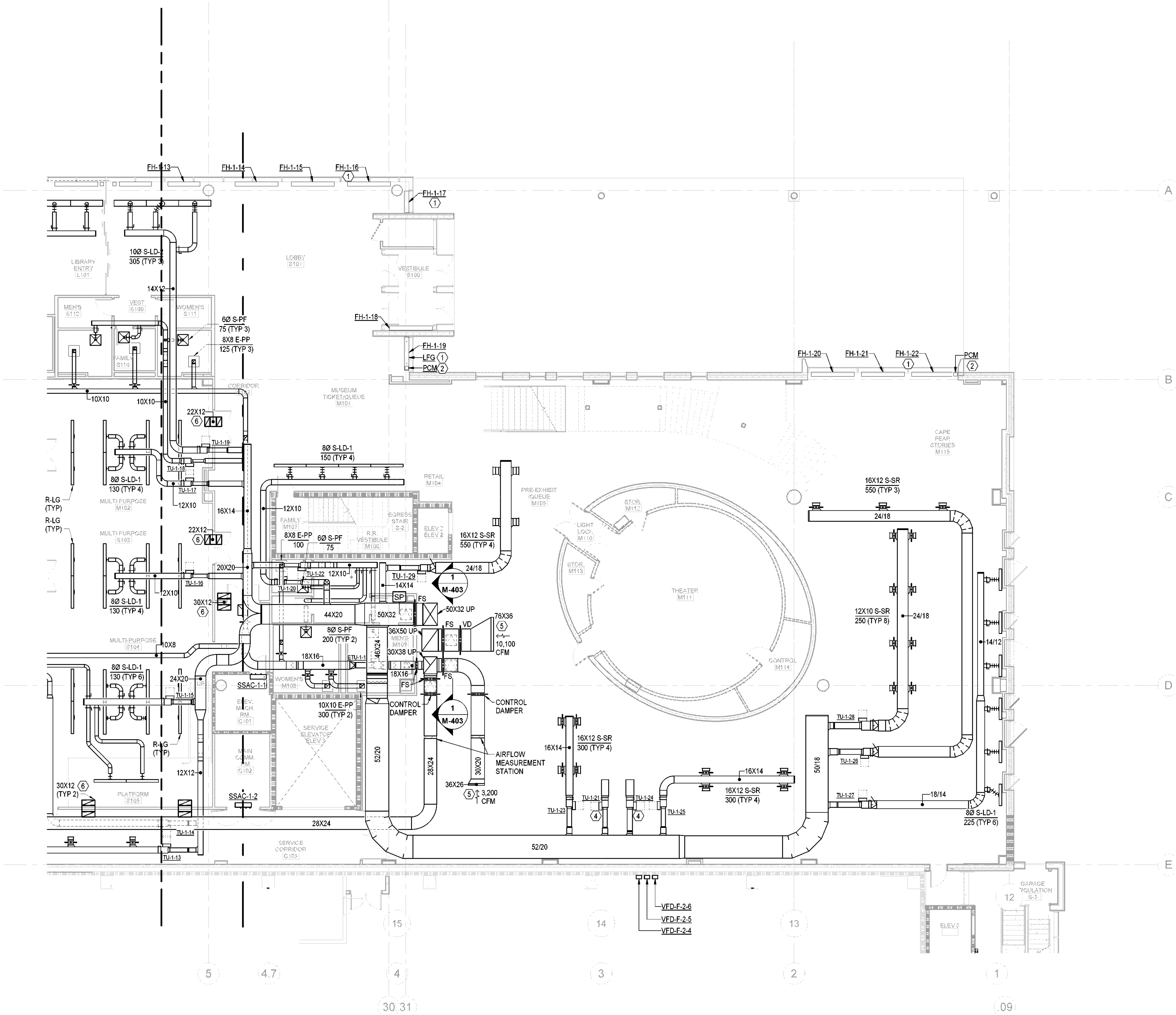
5/22/2023 10:14:54 AM



1 HVAC DUCTWORK LEVEL 1 - AREA B
1/8" = 1'-0"

GENERAL NOTES:

1. EXPOSED DUCTWORK LOCATED ABOVE GALLERY SPACES SHALL BE INSULATED DOUBLE WALL ROUND AND FLAT OVAL TYPE. DIMENSIONS ON PLANS REFER TO INTERNAL CLEAR DIMENSIONS. OUTER DUCTWORK SHALL BE SIZED TO ACCOMMODATE INNER DIMENSIONS AND INSULATION THICKNESS.
2. EXPOSED DUCTWORK AND ALL ASSOCIATED APPURTENANCES, INCLUDING EQUIPMENT AND GRILLES / DIFFUSERS SHALL BE PAINTED BLACK TO MATCH THE CEILING. REFER TO ARCHITECTURAL PLANS AND SPECIFICATIONS FOR MORE INFORMATION.

KEY NOTES:

1. CONTINUOUS LINEAR FLOOR GRILLE ABOVE RECESSED ELECTRIC BASEBOARD HEATER. PROVIDE CONTINUOUS SECTION, PROVIDE MITERED CORNER, AND VERIFY ALL DIMENSIONS IN FIELD.
2. POWER AND CONTROL MODULE SERVING FLOOR HEATERS. LOCATE WITHIN FLOOR TRENCH ADJACENT TO FLOOR HEATERS. DAISY CHAIN CONTROL WIRING BETWEEN FLOOR HEATERS. REFER TO MANUFACTURERS INSTRUCTIONS FOR INSTALLATION AND WIRING.
3. LINEAR RETURN WITH PLENUM SERVING DISPLAY.
4. TERMINAL UNIT SERVING FUTURE THEATER.
5. OPEN ENDED DUCT WITH WIRE MESH SCREEN. BALANCE TO CFM INDICATED.
6. TRANSFER DUCT. REFER TO DETAIL 9/M-601.

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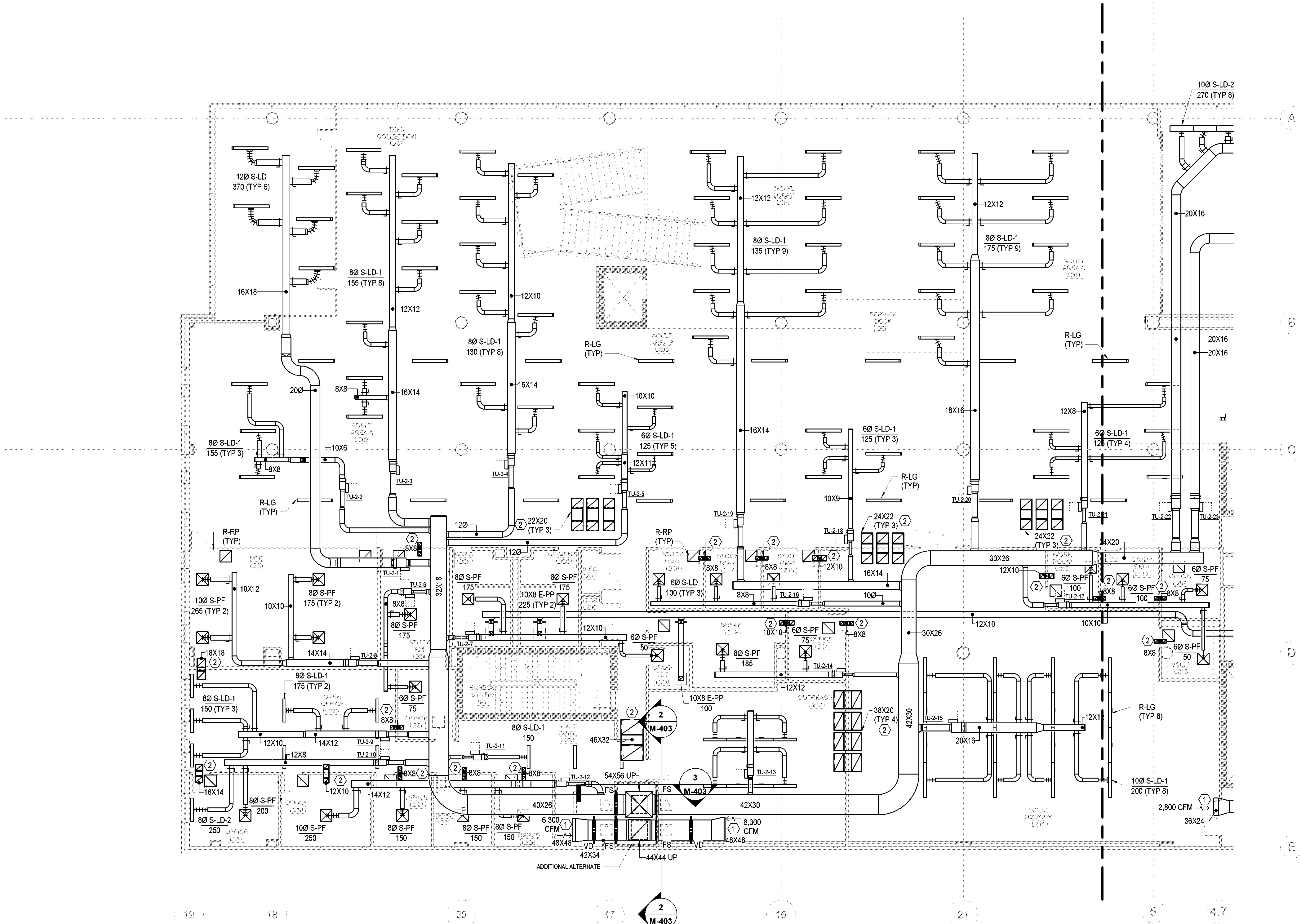
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC DUCTWORK LEVEL 1 - AREA B

ORIG SUBMISSION: 2023.05.22

SHEET:
M-101B

PERMIT SET



KEY NOTES:

1. OPEN ENDED DUCT WITH WIRE MESH SCREEN. BALANCE TO CFM INDICATED.
2. TRANSFER DUCT. REFER TO DETAIL 9/M-601.

ADDITIONAL ALTERNATE

1. SCOPE ASSOCIATED WITH PARKING DECK ACCESS DOOR.
   A. DUCTWORK SHALL SHIFT TO BE HOUSED WITHIN ALTERNATE SHAFT LOCATION. ADJACENT SYSTEMS SHALL SHIFT TO ACCOMMODATE THE ALTERNATE SHAFT LOCATION. REFER TO ARCHITECTURAL DRAWINGS FOR MORE INFORMATION.

1 HVAC DUCTWORK LEVEL 2 - AREA A
1/8" = 1'-0"

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SHEET NAME:
HVAC DUCTWORK LEVEL 2 - AREA A

ORIG SUBMISSION: 2023.05.22

SHEET: M-102A

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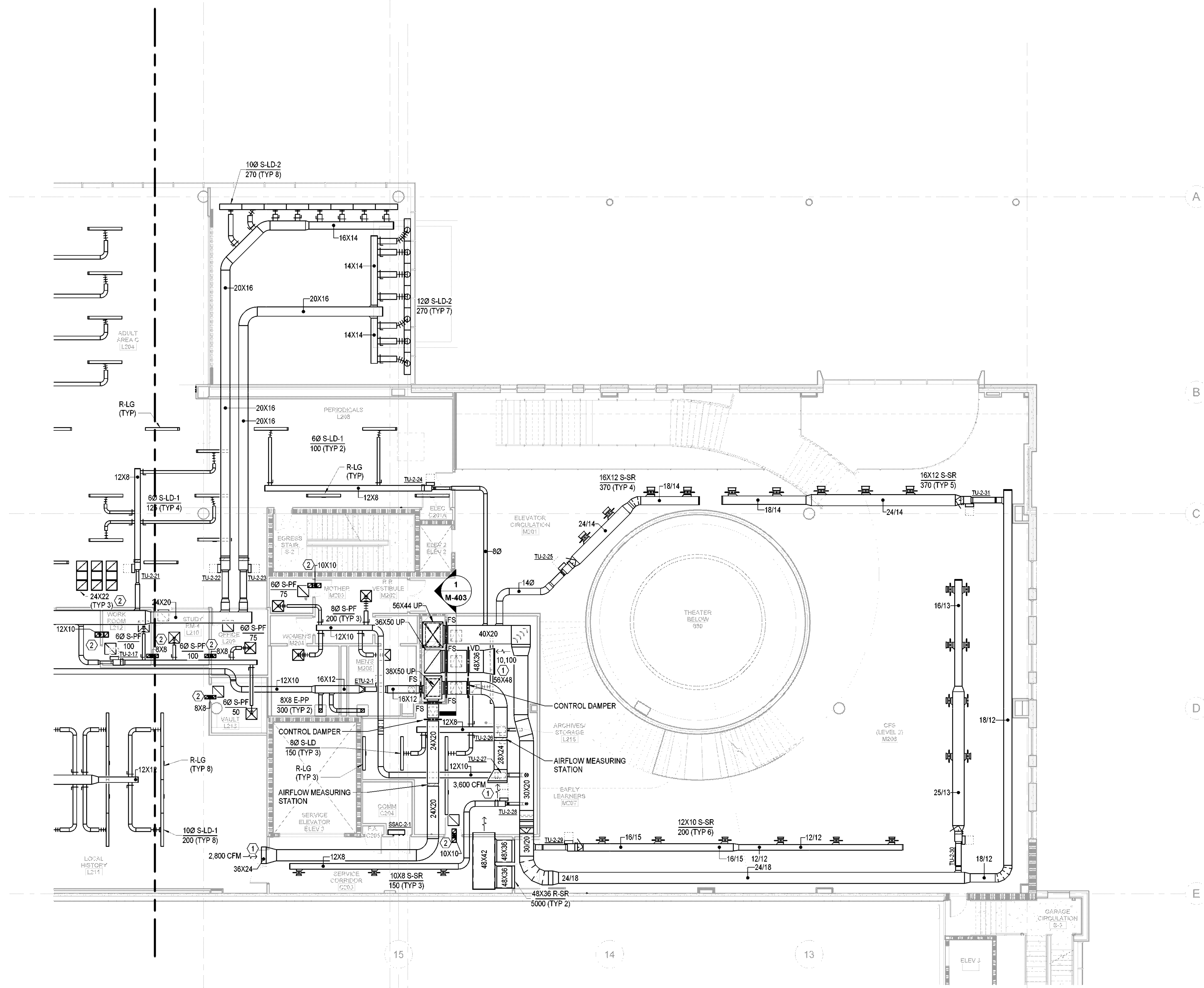
5/22/2023 10:15:04 AM

GENERAL NOTES:

1. EXPOSED DUCTWORK LOCATED ABOVE GALLERY SPACES SHALL BE INSULATED DOUBLE WALL ROUND AND FLAT OVAL TYPE. DIMENSIONS ON PLANS REFER TO INTERNAL CLEAR DIMENSIONS. OUTER DUCTWORK SHALL BE SIZED TO ACCOMMODATE INNER DIMENSIONS AND INSULATION THICKNESS.
2. EXPOSED DUCTWORK AND ALL ASSOCIATED APPURTENANCES, INCLUDING EQUIPMENT AND GRILLES / DIFFUSERS SHALL BE PAINTED BLACK TO MATCH THE CEILING. REFER TO ARCHITECTURAL PLANS AND SPECIFICATIONS FOR MORE INFORMATION.

KEY NOTES:

1. OPEN ENDED DUCT WITH WIRE MESH SCREEN. BALANCE TO CFM INDICATED.
2. TRANSFER DUCT. REFER TO DETAIL 9/M-601.



1 HVAC DUCTWORK LEVEL 2 - AREA B
1/8" = 1'-0"

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SHEET NAME:
HVAC DUCTWORK LEVEL 2 - AREA B

ORIG SUBMISSION: 2023.05.22

SHEET: M-102B

PERMIT SET

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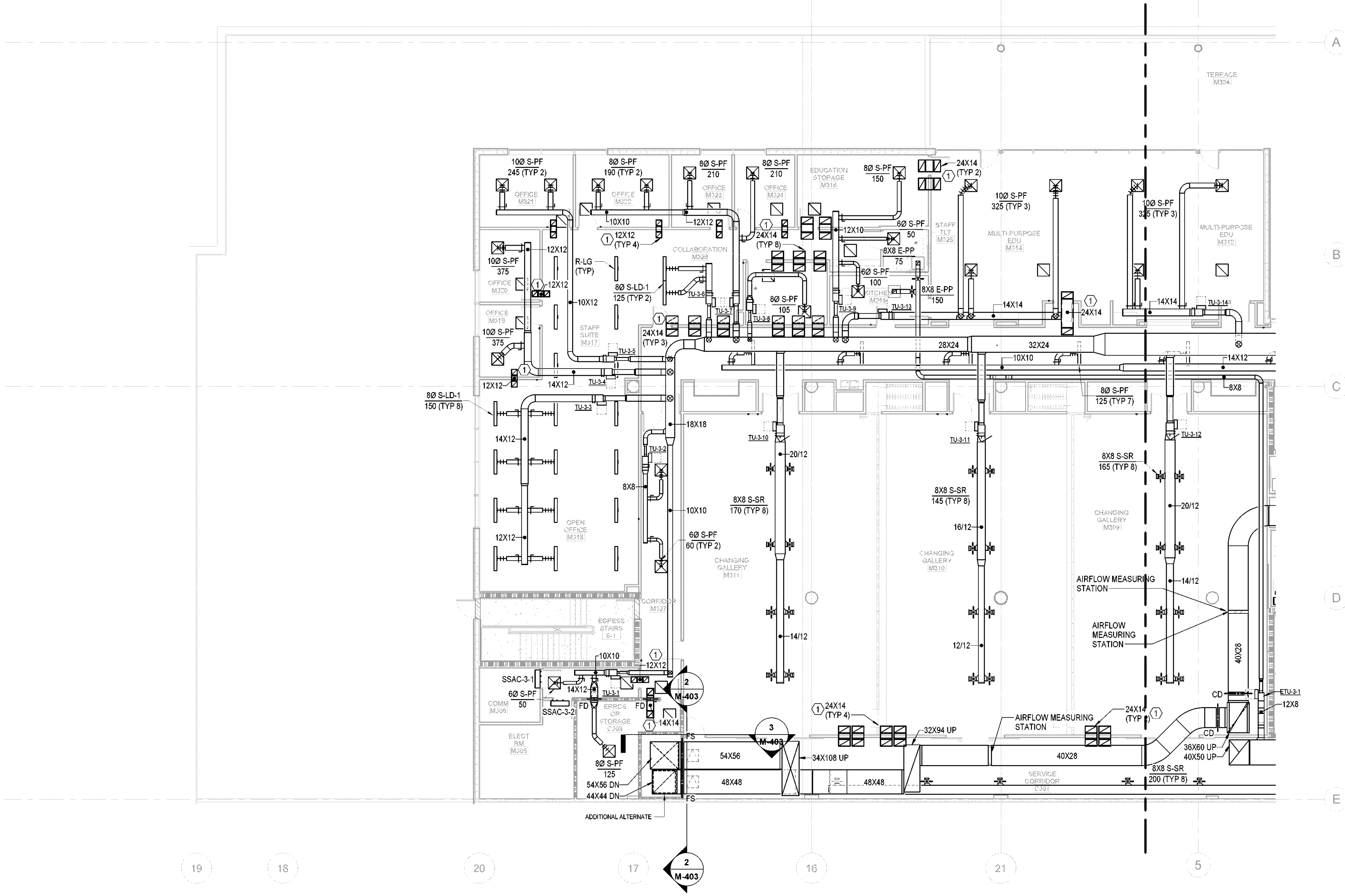

1 HVAC DUCTWORK LEVEL 3 - AREA A

1/8" = 1'-0"

GENERAL NOTES:

1. EXPOSED DUCTWORK LOCATED ABOVE GALLERY SPACES SHALL BE INSULATED DOUBLE WALL ROUND AND FLAT OVAL TYPE. DIMENSIONS ON PLANS REFER TO INTERNAL CLEAR DIMENSIONS. OUTER DUCTWORK SHALL BE SIZED TO ACCOMMODATE INNER DIMENSIONS AND INSULATION THICKNESS.
2. EXPOSED DUCTWORK AND ALL ASSOCIATED APPURTENANCES, INCLUDING EQUIPMENT AND GRILLES / DIFFUSERS SHALL BE PAINTED BLACK TO MATCH THE CEILING. REFER TO ARCHITECTURAL PLANS AND SPECIFICATIONS FOR MORE INFORMATION.

KEY NOTES:

1. TRANSFER DUCT. REFER TO DETAIL 9/M-601.

ADDITIONAL ALTERNATE

1. SCOPE ASSOCIATED WITH PARKING DECK ACCESS DOOR.
   A. DUCTWORK SHALL SHIFT TO BE HOUSED WITHIN ALTERNATE SHAFT LOCATION. ADJACENT SYSTEMS SHALL SHIFT TO ACCOMMODATE THE ALTERNATE SHAFT LOCATION. REFER TO ARCHITECTURAL DRAWINGS FOR MORE INFORMATION.

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SHEET NAME:
HVAC DUCTWORK LEVEL 3 - AREA A

ORIG SUBMISSION: 2023.05.22

SHEET: M-103A

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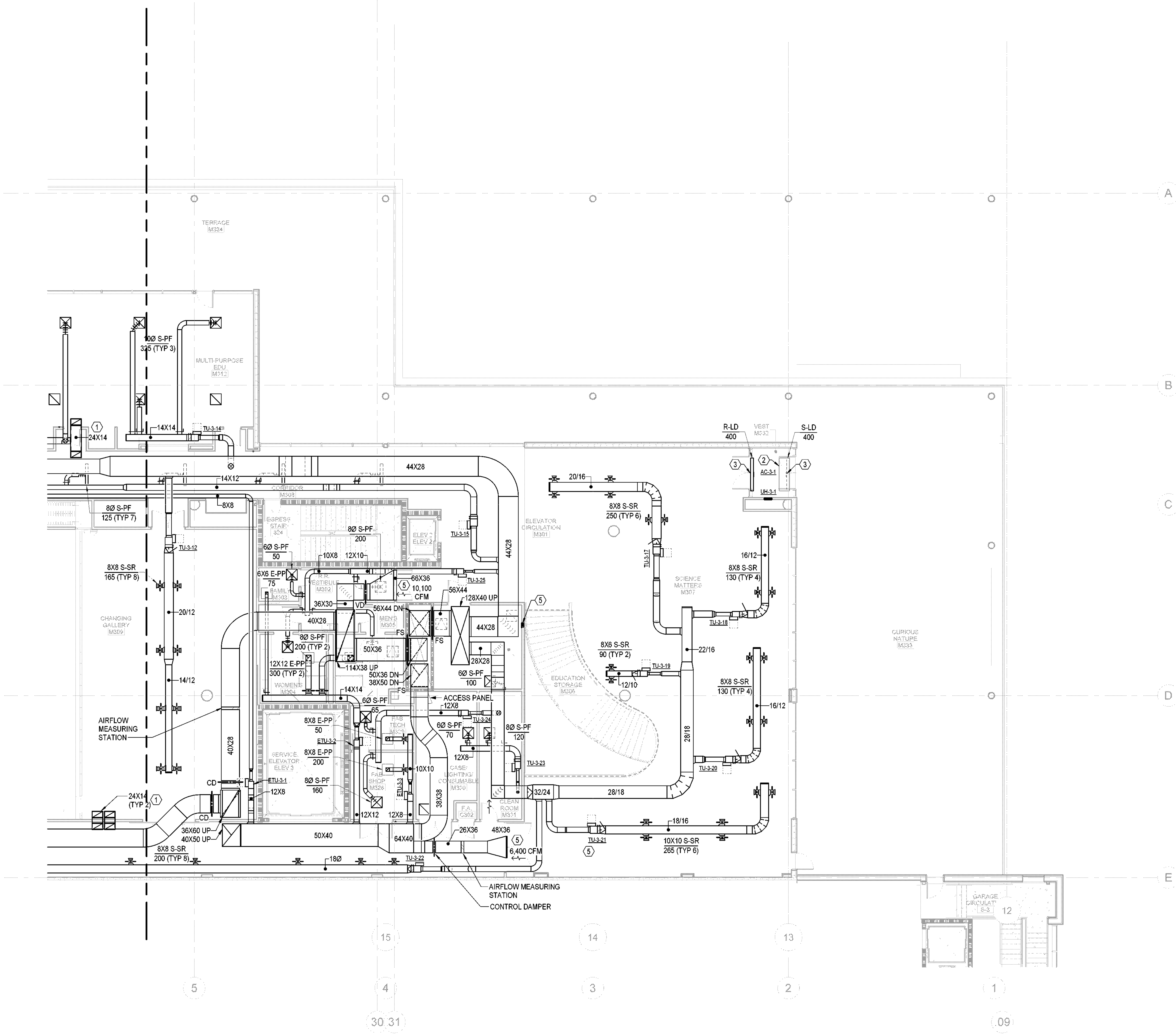

HVAC DUCTWORK LEVEL 3 - AREA B

1/8" = 1'-0"

GENERAL NOTES:

1. EXPOSED DUCTWORK LOCATED ABOVE GALLERY SPACES SHALL BE INSULATED DOUBLE WALL ROUND AND FLAT OVAL TYPE. DIMENSIONS ON PLANS REFER TO INTERNAL CLEAR DIMENSIONS. OUTER DUCTWORK SHALL BE SIZED TO ACCOMMODATE INNER DIMENSIONS AND INSULATION THICKNESS.
2. EXPOSED DUCTWORK AND ALL ASSOCIATED APPURTENANCES, INCLUDING EQUIPMENT AND GRILLES / DIFFUSERS SHALL BE PAINTED BLACK TO MATCH THE CEILING. REFER TO ARCHITECTURAL PLANS AND SPECIFICATIONS FOR MORE INFORMATION.

KEY NOTES:

1. TRANSFER DUCT. REFER TO DETAIL 9/M-601.
2. AIR CURTAIN MOUNTED ABOVE CEILING. PROVIDE DUCTWORK FROM AIR CURTAIN DISCHARGE TO LINEAR DIFFUSER. PROVIDE DOOR CONTACT FOR OPERATION.
3. LINEAR DIFFUSER SUPPLY AND RETURN SERVING VESTIBULE. LINEAR DIFFUSERS SHALL NOT BE PROVIDED WITH PLENUM.
4. OPEN ENDED DUCT WITH WIRE MESH SCREEN. BALANCE TO CFM INDICATED.
5. DRYER VENT BOX WITH 4" DRYER VENT TO ROOF.

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SHEET NAME:
HVAC DUCTWORK LEVEL 3 - AREA B

ORIG SUBMISSION: 2023.05.22

SHEET: **M-103B**

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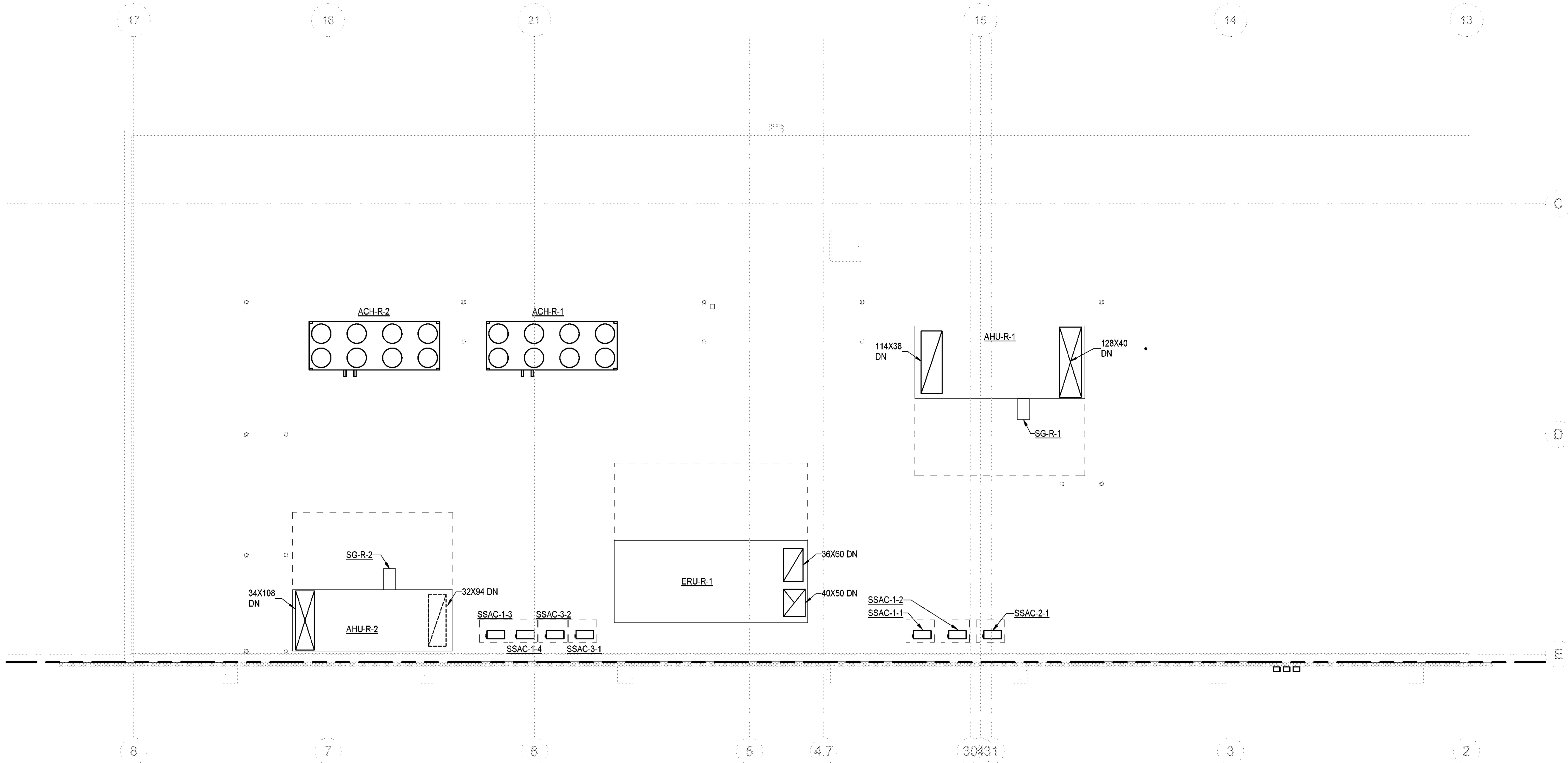

1 HVAC DUCTWORK OVERALL ROOF

1/8" = 1'-0"

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LS3P PROJECT: 7701-177600

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SHEET NAME:
HVAC DUCTWORK OVERALL ROOF

ORIG SUBMISSION: 2023.05.22

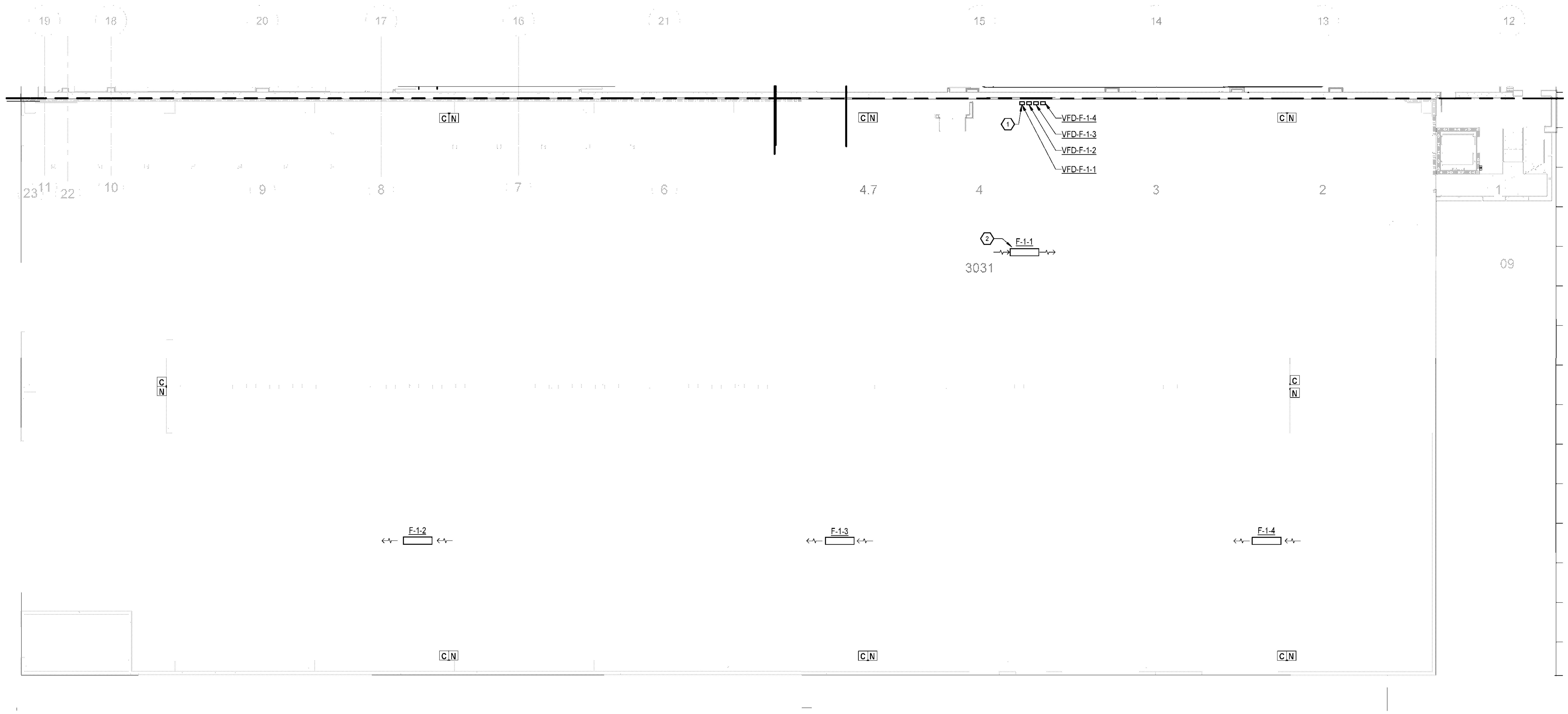
SHEET: **M-104**

PERMIT SET

5/22/2023 10:15:20 AM

KEY NOTES:

1. VFD'S SERVING PARKING DECK JET FANS. PROVIDE WITH NEMA-4 ENCLOSURE RATED FOR OUTDOOR APPLICATION. PROVIDE TAMPER PROOF WIRE ENCLOSURE WITH GATE AND LOCK AROUND VFD'S. PROVIDE BOLLARDS IN FRONT OF VFD'S. TYPICAL FOR ALL LEVELS OF PARKING DECK
2. JET FAN LOCATED ON GROUND LEVEL OF PARKING DECK BELOW FIRST FLOOR RAMP



1 **HVAC PARKING DECK LEVEL 1**
3/32" = 1'-0"

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Wilmington, NC 28401

LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION

SHEET NAME:
HVAC PARKING DECK LEVEL 1

ORIG SUBMISSION: 2023.05.22

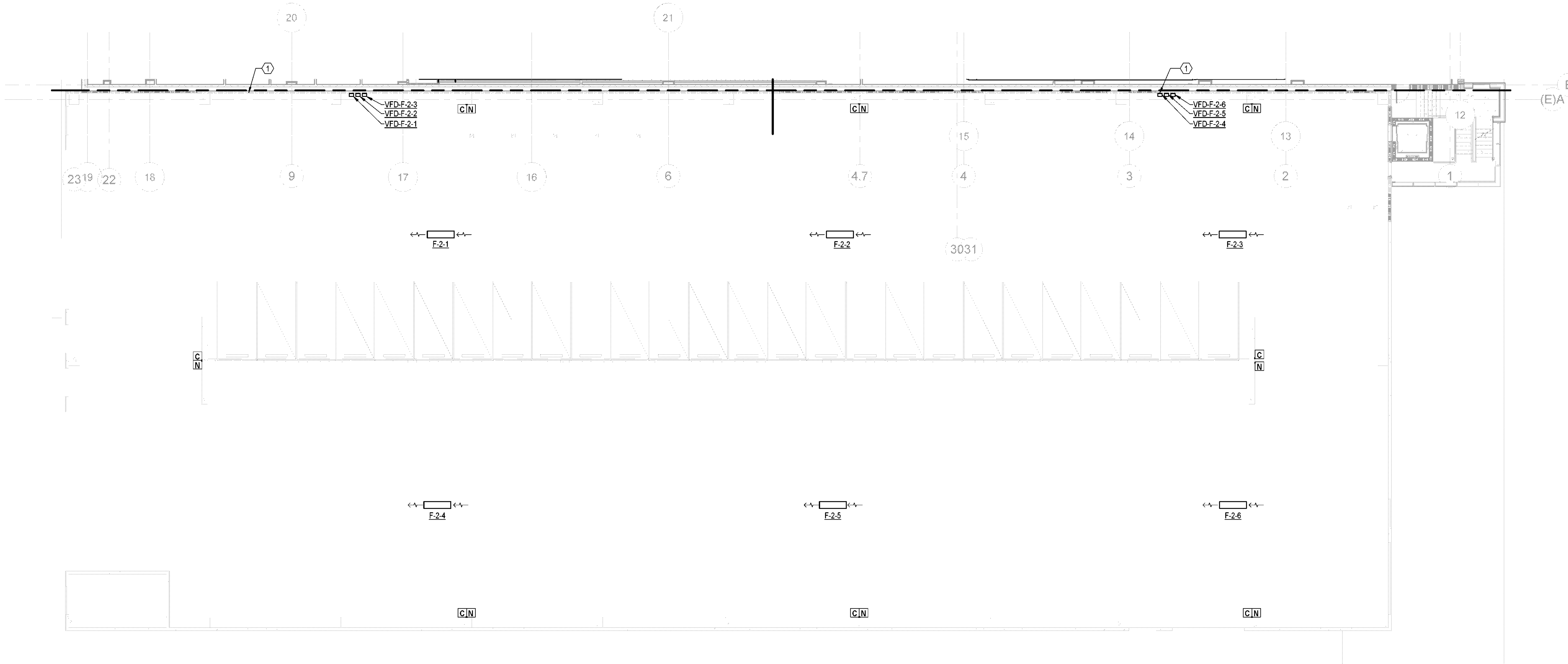
SHEET: **M-105**

PERMIT SET

5/22/2023 10:15:24 AM

KEY NOTES:

1. VFD'S SERVING PARKING DECK JET FANS. PROVIDE WITH NEMA-4 ENCLOSURE RATED FOR OUTDOOR APPLICATION. PROVIDE TAMPER PROOF WIRE ENCLOSURE WITH GATE AND LOCK AROUND VFD'S. PROVIDE BOLLARDS IN FRONT OF VFD'S. TYPICAL FOR ALL LEVELS OF PARKING DECK



1 HVAC PARKING DECK LEVEL 2
3/32" = 1'-0"

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
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SHEET NAME:
HVAC PARKING DECK LEVEL 2

ORIG SUBMISSION: 2023.05.22

SHEET: M-106

PERMIT SET

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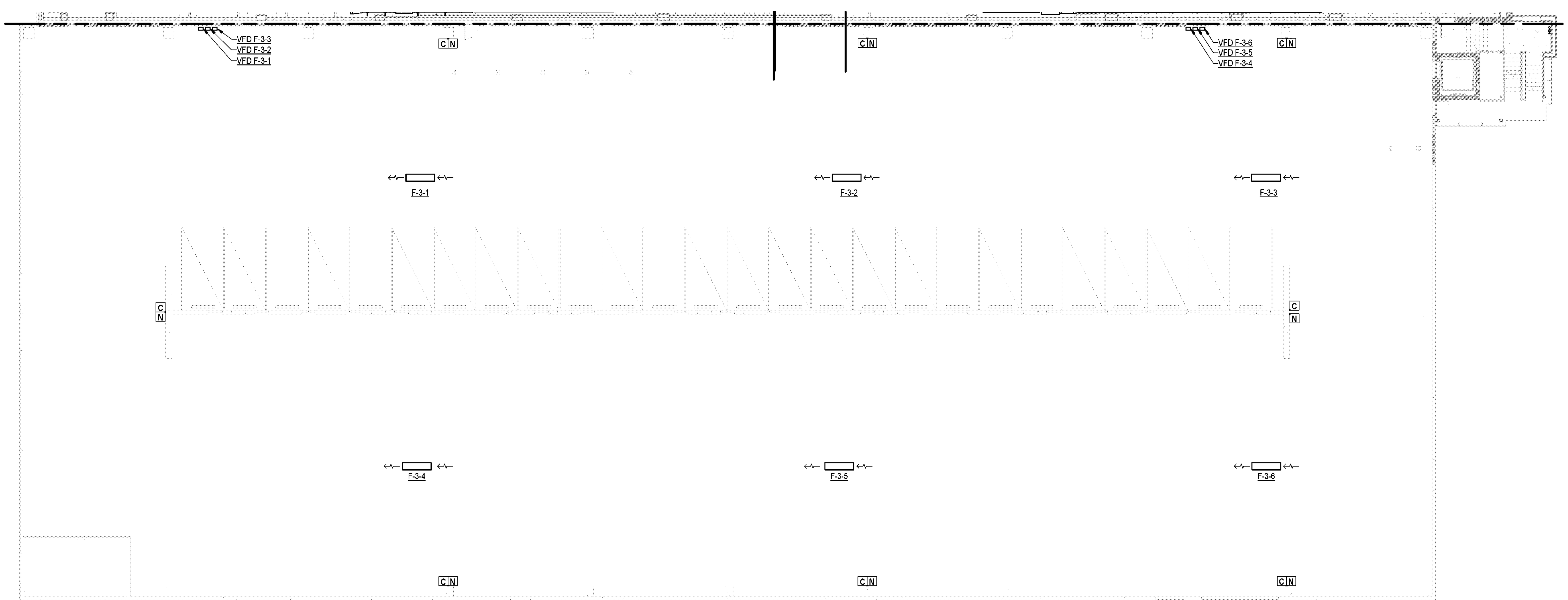

1 HVAC PARKING DECK LEVEL 3
3/32" = 1'-0"

5/22/2023 10:15:30 AM

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LS3P PROJECT: 7701-177600

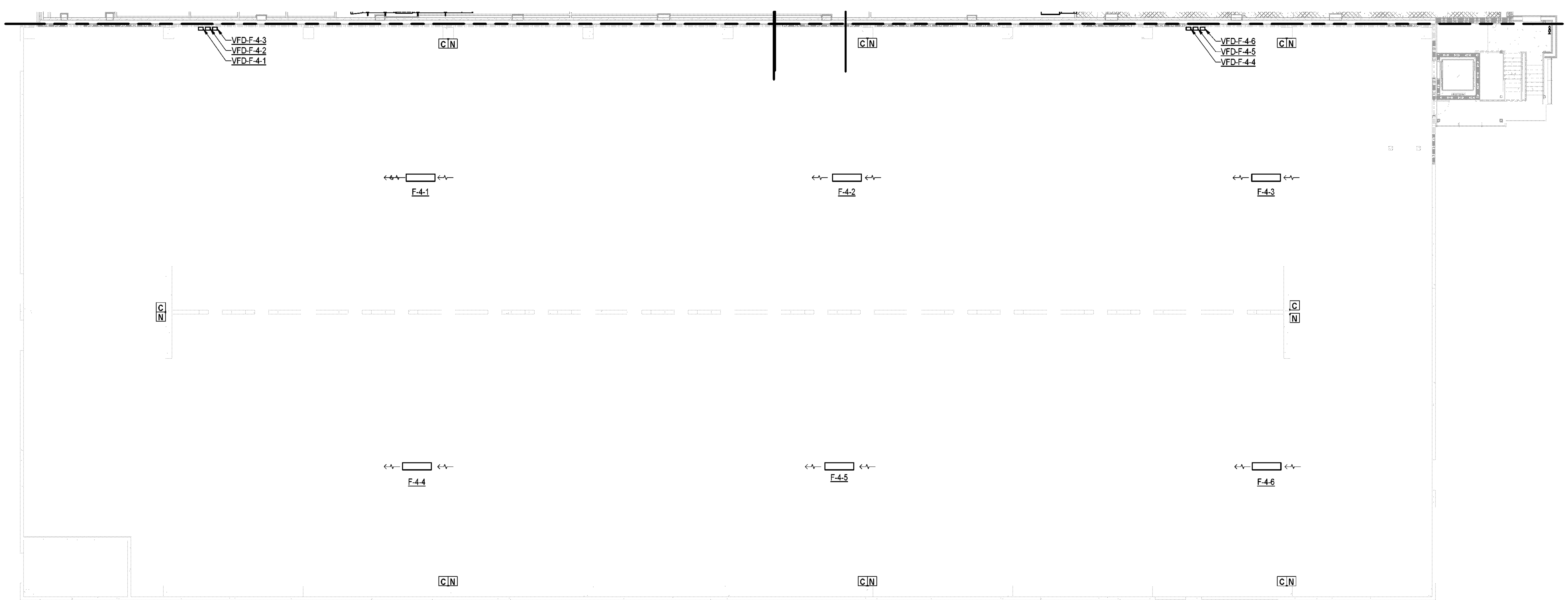
Δ	DATE	DESCRIPTION

SHEET NAME:
HVAC PARKING DECK LEVEL 3

ORIG SUBMISSION: 2023.05.22

SHEET: M-107

PERMIT SET



1 HVAC PARKING DECK LEVEL 4

3/32" = 1'-0"

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION

SHEET NAME: HVAC PARKING DECK LEVEL 4

ORIG SUBMISSION: 2023.05.22

SHEET: M-108

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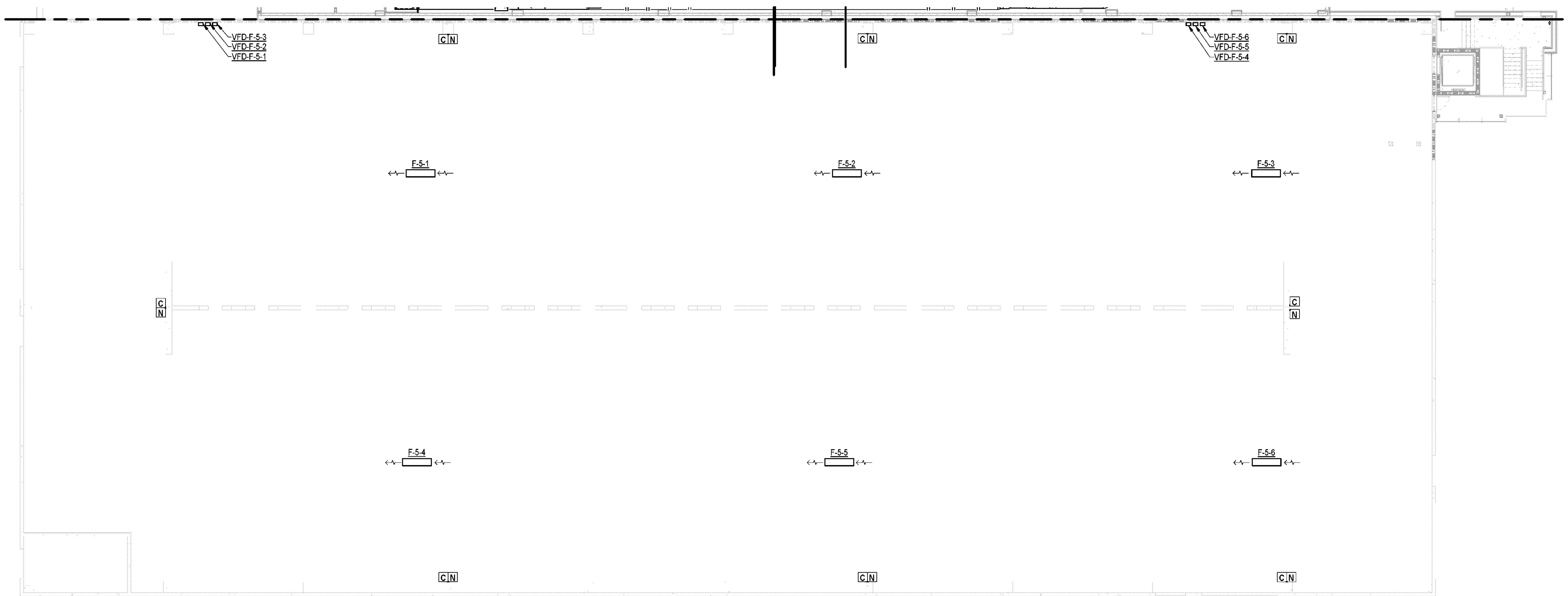

1 **HVAC PARKING DECK LEVEL 5**

3/32" = 1'-0"

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION

SHEET NAME:
HVAC PARKING DECK LEVEL 5

ORIG SUBMISSION: 2023.05.22

SHEET: **M-109**

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5/22/2023 10:15:36 AM

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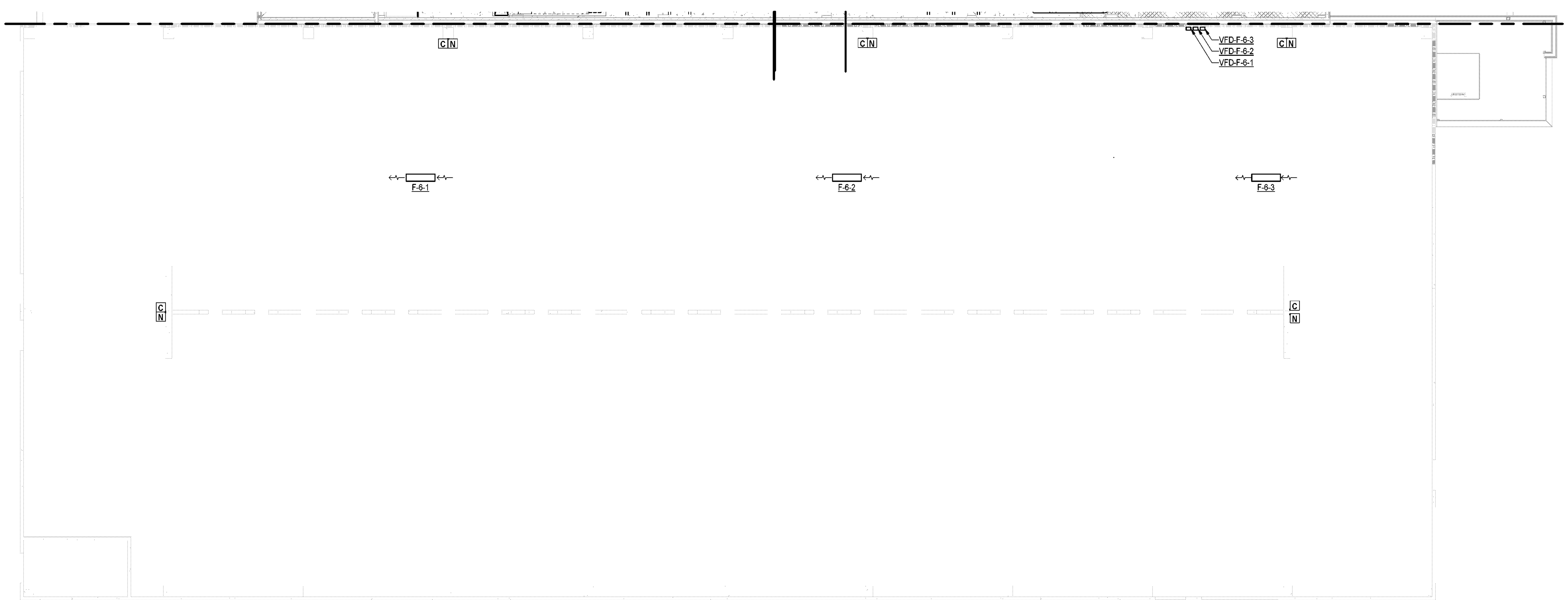

1 HVAC PARKING DECK LEVEL 6

3/32" = 1'-0"

5/22/2023 10:15:39 AM

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NB Contact: Brandon R. Nevin
N&B PROJECT: 21N185
Newcomb & Boyd, LLP
Firm Lic. # F-0312

NORTH CAROLINA PROFESSIONAL SEAL 043322 ENGINEER PAUL JACKSON KITCHENS

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Project Grace

Grace Street
Wilmington, NC 28401

LS3P PROJECT: 7701-177600

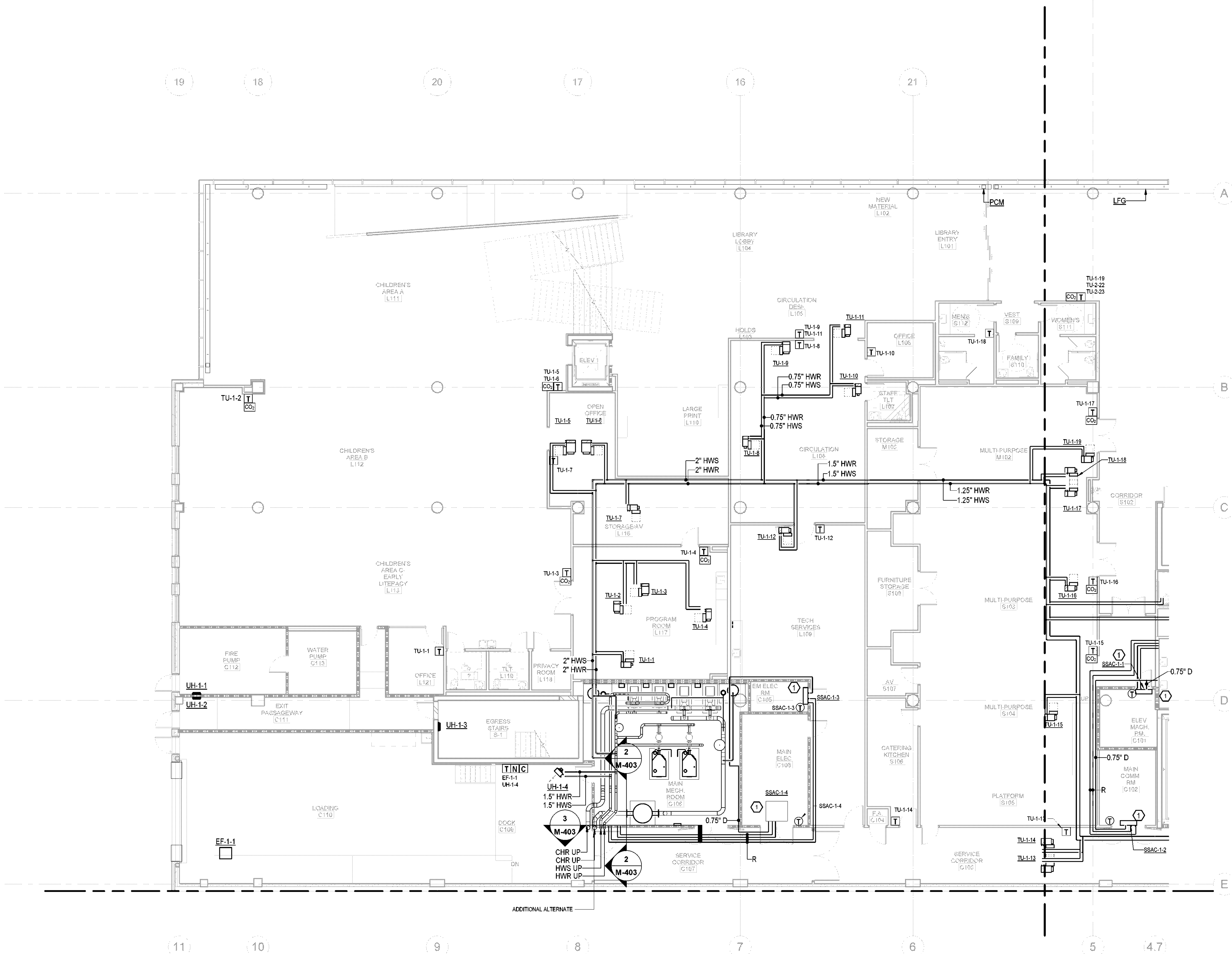
Δ	DATE	DESCRIPTION

SHEET NAME:
HVAC PARKING DECK LEVEL 6

ORIG SUBMISSION: 2023.05.22

SHEET: M-110

PERMIT SET



KEY NOTES:

1. ROUTE CONDENSATE TO FLOOR DRAIN IN MAIN MECH. ROOM (C108).

ADDITIONAL ALTERNATE

1. SCOPE ASSOCIATED WITH PARKING DECK ACCESS DOOR.
   A. PIPING SHALL SHIFT TO BE HOUSED WITHIN ALTERNATE SHAFT LOCATION. ADJACENT SYSTEMS SHALL SHIFT TO ACCOMMODATE THE ALTERNATE SHAFT LOCATION. REFER TO ARCHITECTURAL DRAWINGS FOR MORE INFORMATION.

1 HVAC PIPING LEVEL 1 - AREA A
1/8" = 1'-0"

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Cape Fear Development

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Project Grace
Grace Street
Wilmington, NC 28401
LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC PIPING
LEVEL 1 - AREA A

ORIG SUBMISSION: 2023.05.22

SHEET: M-201A

PERMIT SET

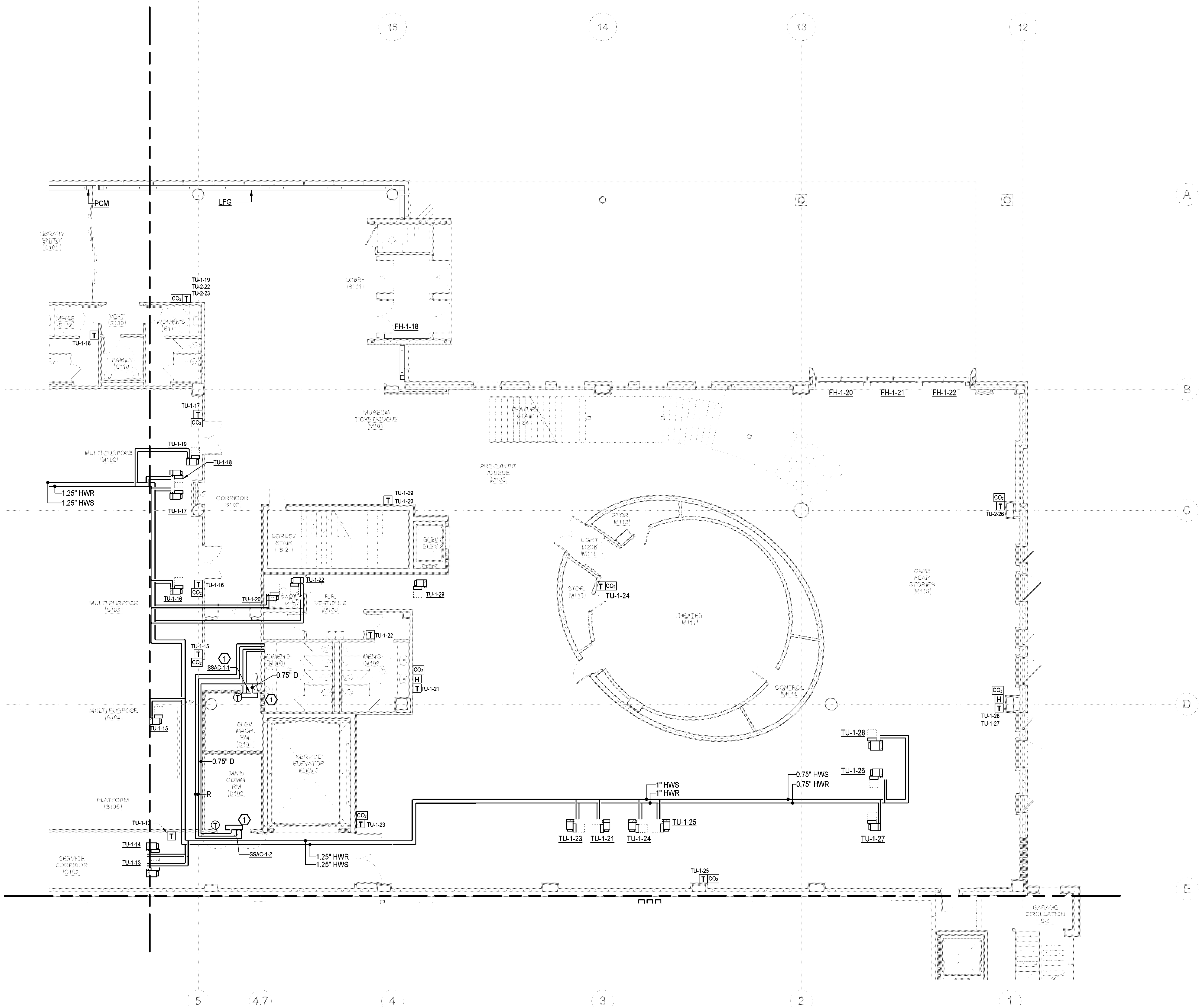
5/22/2023 10:15:48 AM

GENERAL NOTES:

1. EXPOSED PIPING AND ALL ASSOCIATED APPURTENANCES, INCLUDING EQUIPMENT SHALL BE PAINTED BLACK TO MATCH THE CEILING. REFER TO ARCHITECTURAL PLANS AND SPECIFICATIONS FOR MORE INFORMATION.

KEY NOTES:

1. CONDENSATE DRAIN PIPING TO TIE INTO SINK TAILPIECE.



1 **HVAC PIPING LEVEL 1 - AREA B**
1/8" = 1'-0"

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
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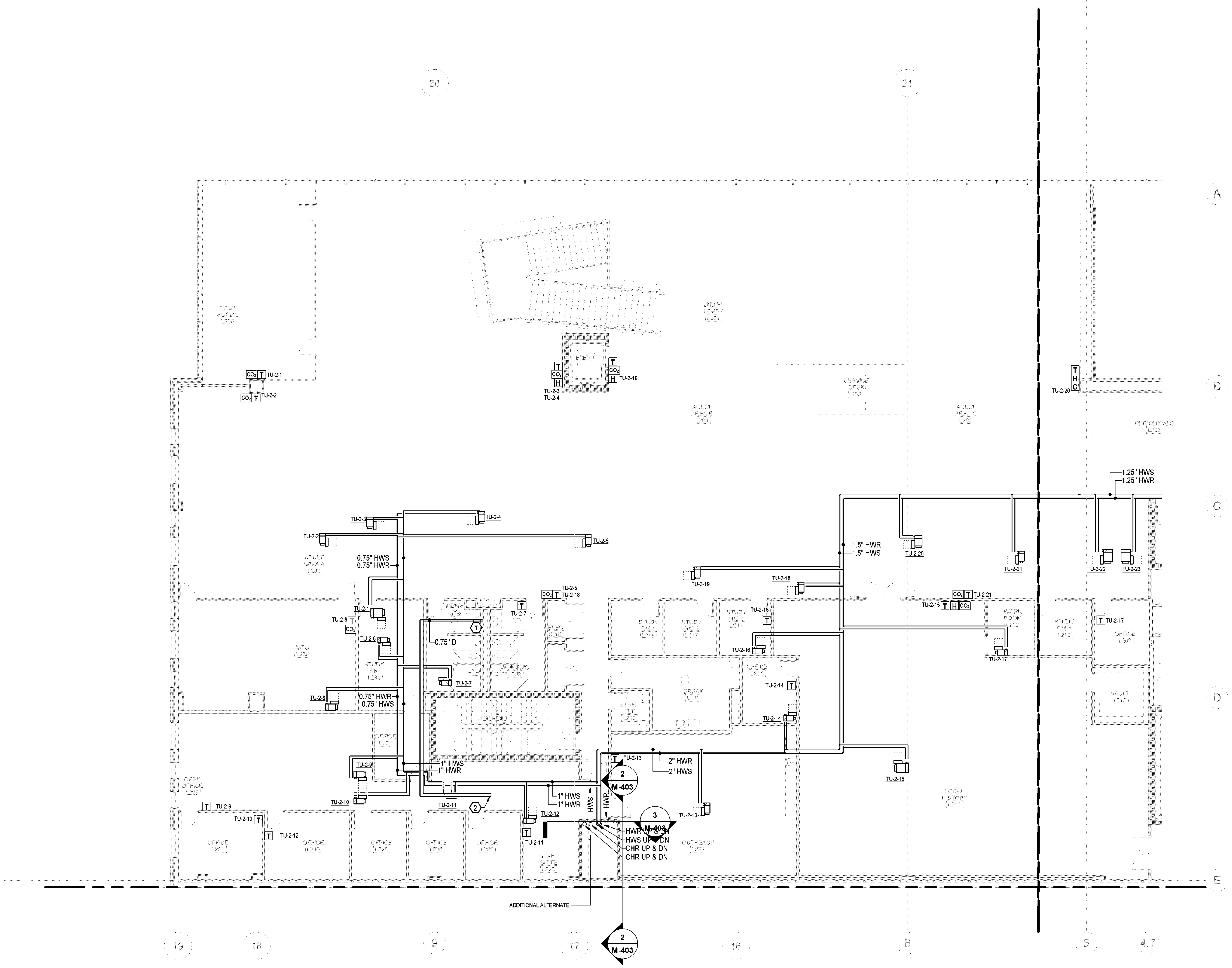
SHEET NAME: HVAC PIPING LEVEL 1 - AREA B

ORIG SUBMISSION: 2023.05.22

SHEET: M-201B

PERMIT SET

5/22/2023 10:15:52 AM



KEY NOTES:

1. CONDENSATE DRAINS TO TIE IN TO TAILPIECE OF SINK.
2. CONDENSATE DRAIN PIPING FROM ABOVE.

ADDITIONAL ALTERNATE

1. SCOPE ASSOCIATED WITH PARKING DECK ACCESS DOOR.
   A. PIPING SHALL SHIFT TO BE HOUSED WITHIN ALTERNATE SHAFT LOCATION. ADJACENT SYSTEMS SHALL SHIFT TO ACCOMMODATE THE ALTERNATE SHAFT LOCATION. REFER TO ARCHITECTURAL DRAWINGS FOR MORE INFORMATION.

1 HVAC PIPING LEVEL 2 - AREA A

1/8" = 1'-0"

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
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SHEET NAME:
HVAC PIPING
LEVEL 2 - AREA A

ORIG SUBMISSION: 2023.05.22

SHEET: M-202A

PERMIT SET

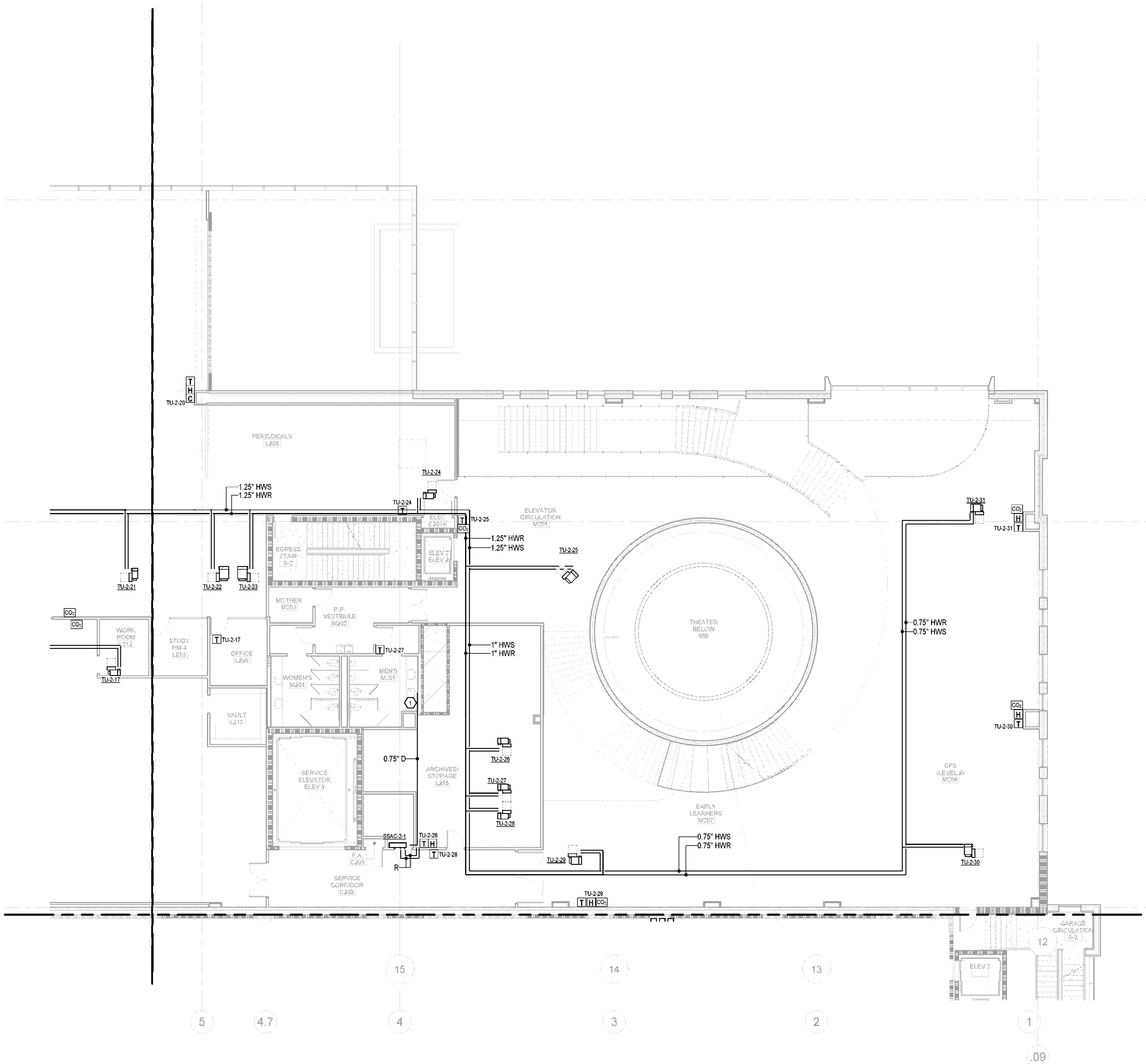
5/22/2023 10:15:58 AM

GENERAL NOTES:

1. EXPOSED PIPING AND ALL ASSOCIATED APPURTENANCES, INCLUDING EQUIPMENT SHALL BE PAINTED BLACK TO MATCH THE CEILING. REFER TO ARCHITECTURAL PLANS AND SPECIFICATIONS FOR MORE INFORMATION.

KEY NOTES:

1. CONDENSATE DRAIN PIPING TO TIE INTO SINK TAILPIECE



1 HVAC PIPING LEVEL 2 - AREA B

1/8" = 1'-0"

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC PIPING LEVEL 2 - AREA B

ORIG SUBMISSION: 2023.05.22

SHEET: M-202B

PERMIT SET

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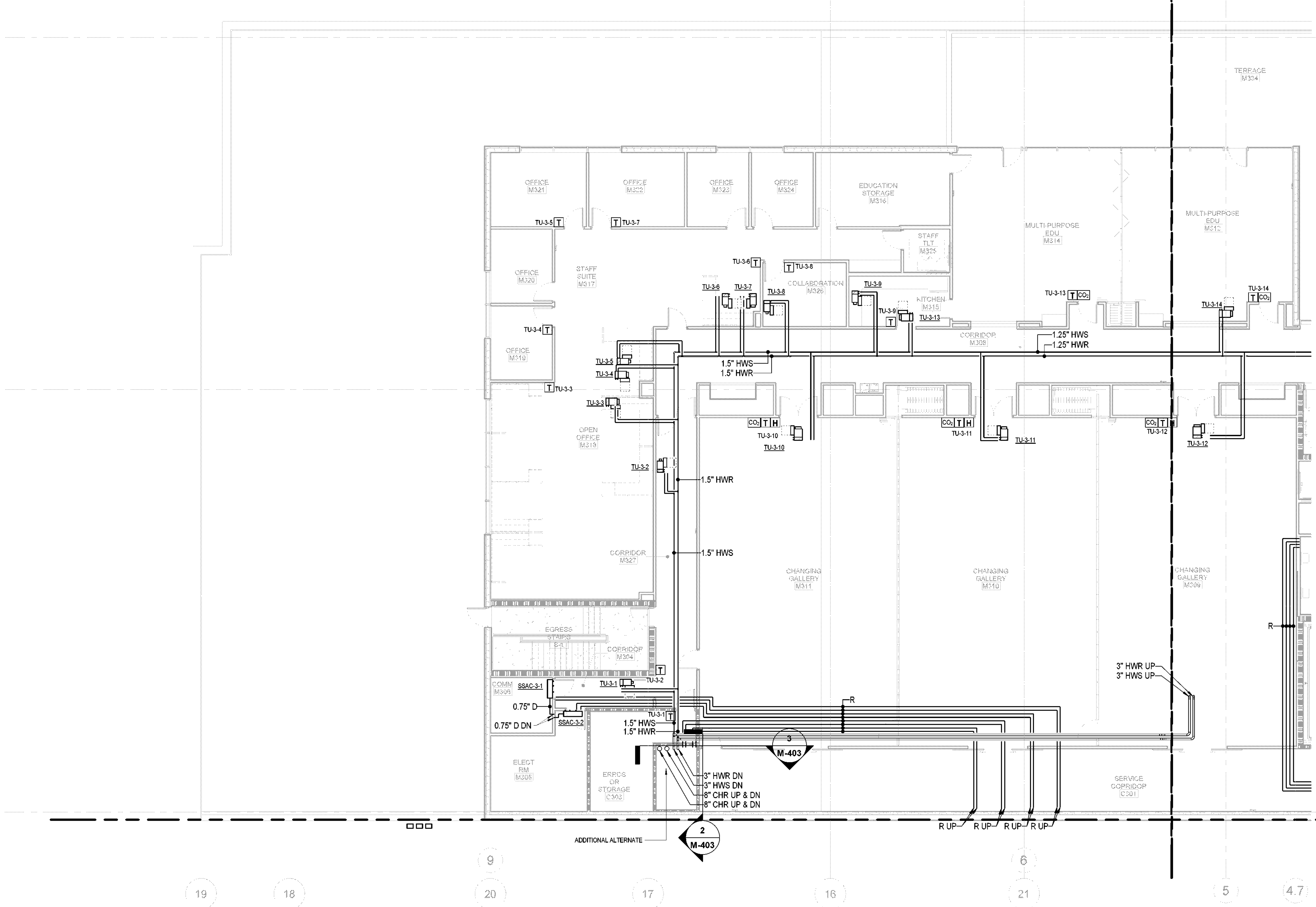

1 **HVAC PIPING LEVEL 3 - AREA A**
1/8" = 1'-0"

GENERAL NOTES:

1. EXPOSED PIPING AND ALL ASSOCIATED APPURTENANCES, INCLUDING EQUIPMENT SHALL BE PAINTED BLACK TO MATCH THE CEILING. REFER TO ARCHITECTURAL PLANS AND SPECIFICATIONS FOR MORE INFORMATION.

ADDITIONAL ALTERNATE

1. SCOPE ASSOCIATED WITH PARKING DECK ACCESS DOOR.
   A. PIPING SHALL SHIFT TO BE HOUSED WITHIN ALTERNATE SHAFT LOCATION. ADJACENT SYSTEMS SHALL SHIFT TO ACCOMMODATE THE ALTERNATE SHAFT LOCATION. REFER TO ARCHITECTURAL DRAWINGS FOR MORE INFORMATION.

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Wilmington, NC 28401

LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC PIPING
LEVEL 3 - AREA A

ORIG SUBMISSION: 2023.05.22

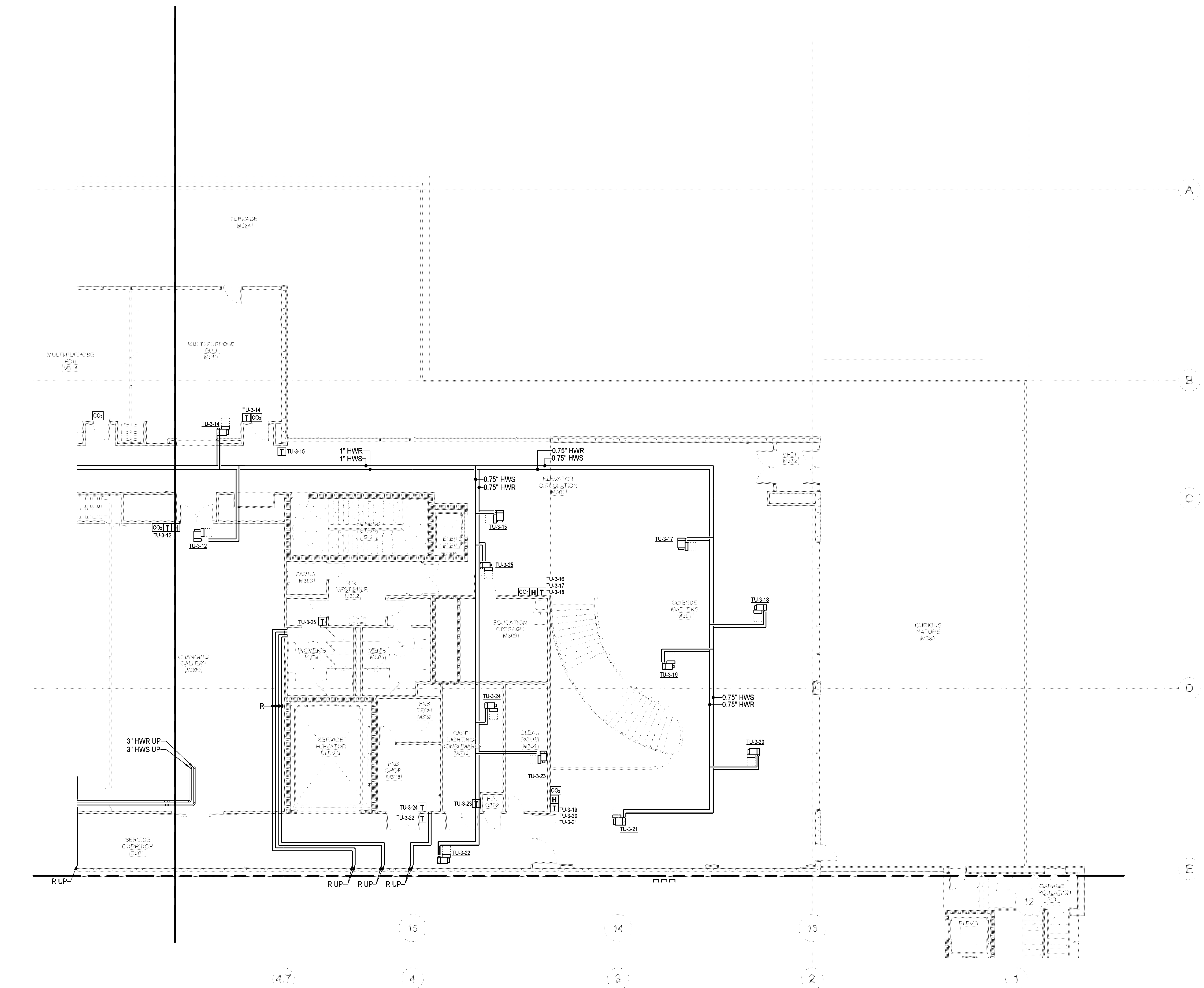
SHEET: **M-203A**

PERMIT SET

5/22/2023 10:16:07 AM

GENERAL NOTES:

1. EXPOSED PIPING AND ALL ASSOCIATED APPURTENANCES, INCLUDING EQUIPMENT SHALL BE PAINTED BLACK TO MATCH THE CEILING. REFER TO ARCHITECTURAL PLANS AND SPECIFICATIONS FOR MORE INFORMATION.



1 HVAC PIPING LEVEL 3 - AREA B

1/8" = 1'-0"

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC PIPING
LEVEL 3 - AREA B

ORIG SUBMISSION: 2023.05.22

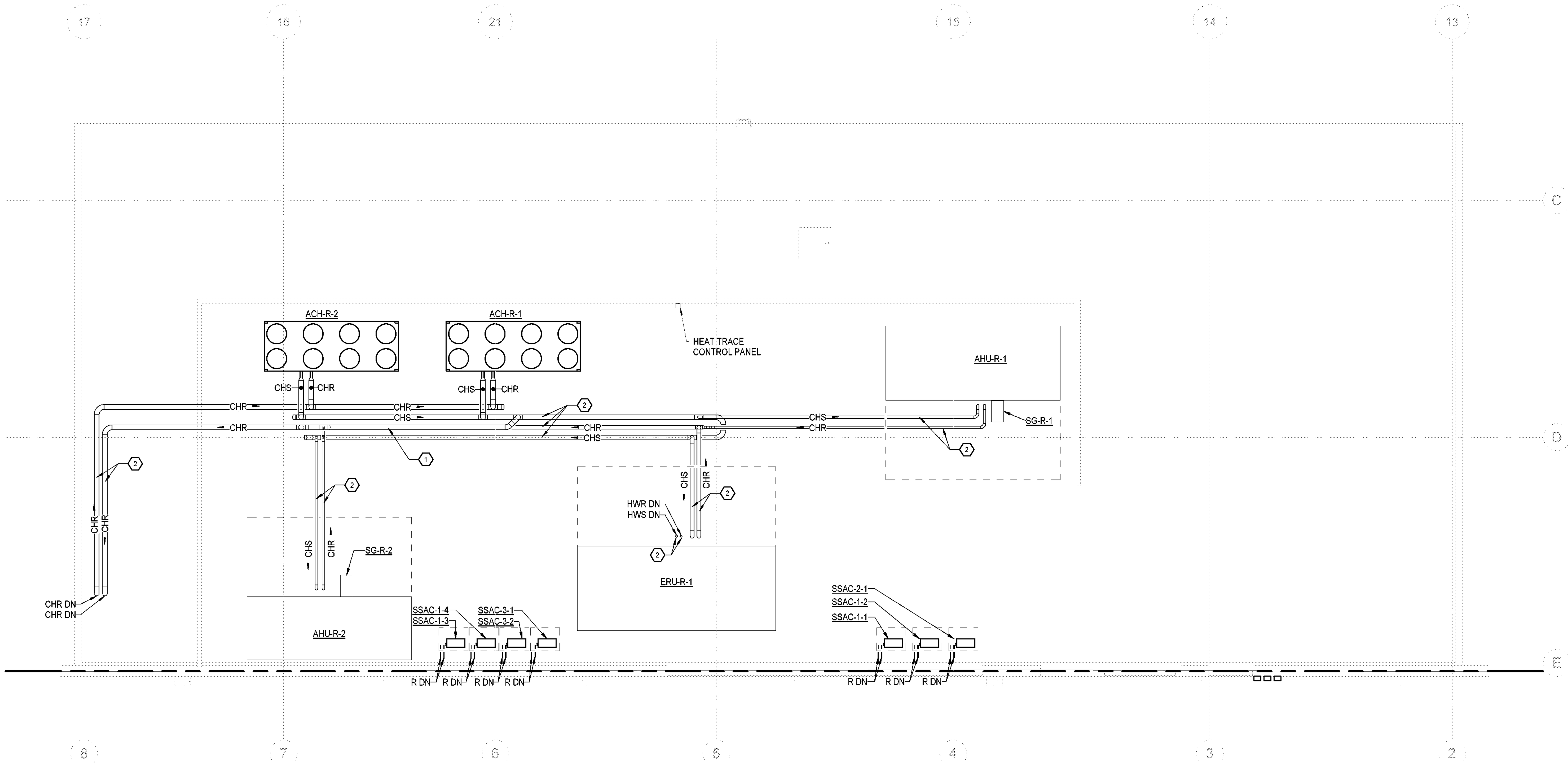
SHEET: **M-203B**

PERMIT SET

5/22/2023 10:16:11 AM

KEY NOTES:

1. CHILLED WATER BYPASS PIPING. BYPASS PIPING ROUTED ABOVE CHILLED WATER RETURN PIPING. REFER TO 1/M-401 AND 1/M-703 FOR MORE INFORMATION.
2. PROVIDE HEAT TRACE FOR EXTERIOR HYDRONIC PIPING.



1 **HVAC PIPING OVERALL ROOF**
1/8" = 1'-0"

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Grace Street
Wilmington, NC 28401
LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC PIPING OVERALL ROOF

ORIG SUBMISSION: 2023.05.22

SHEET: **M-204**

PERMIT SET

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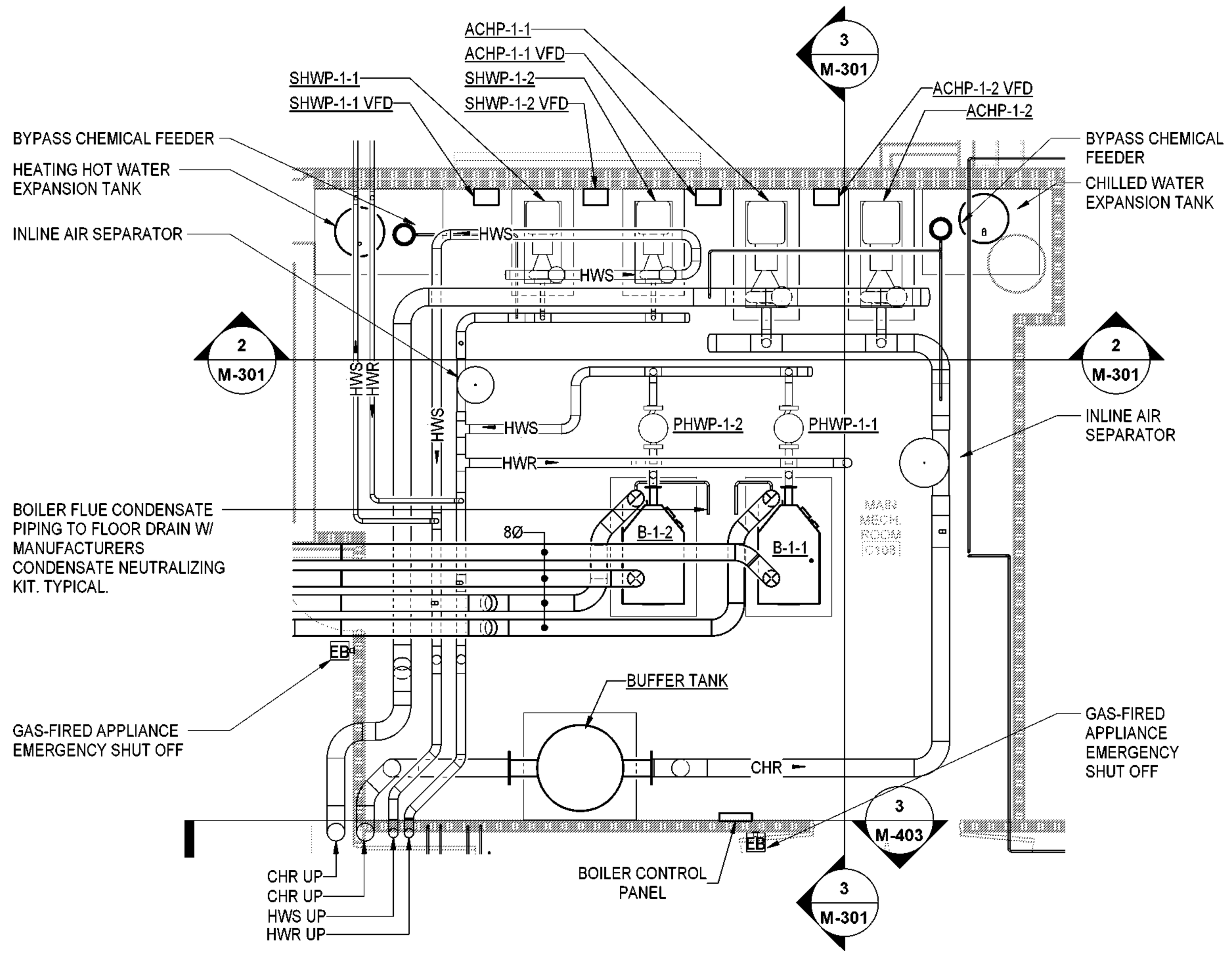
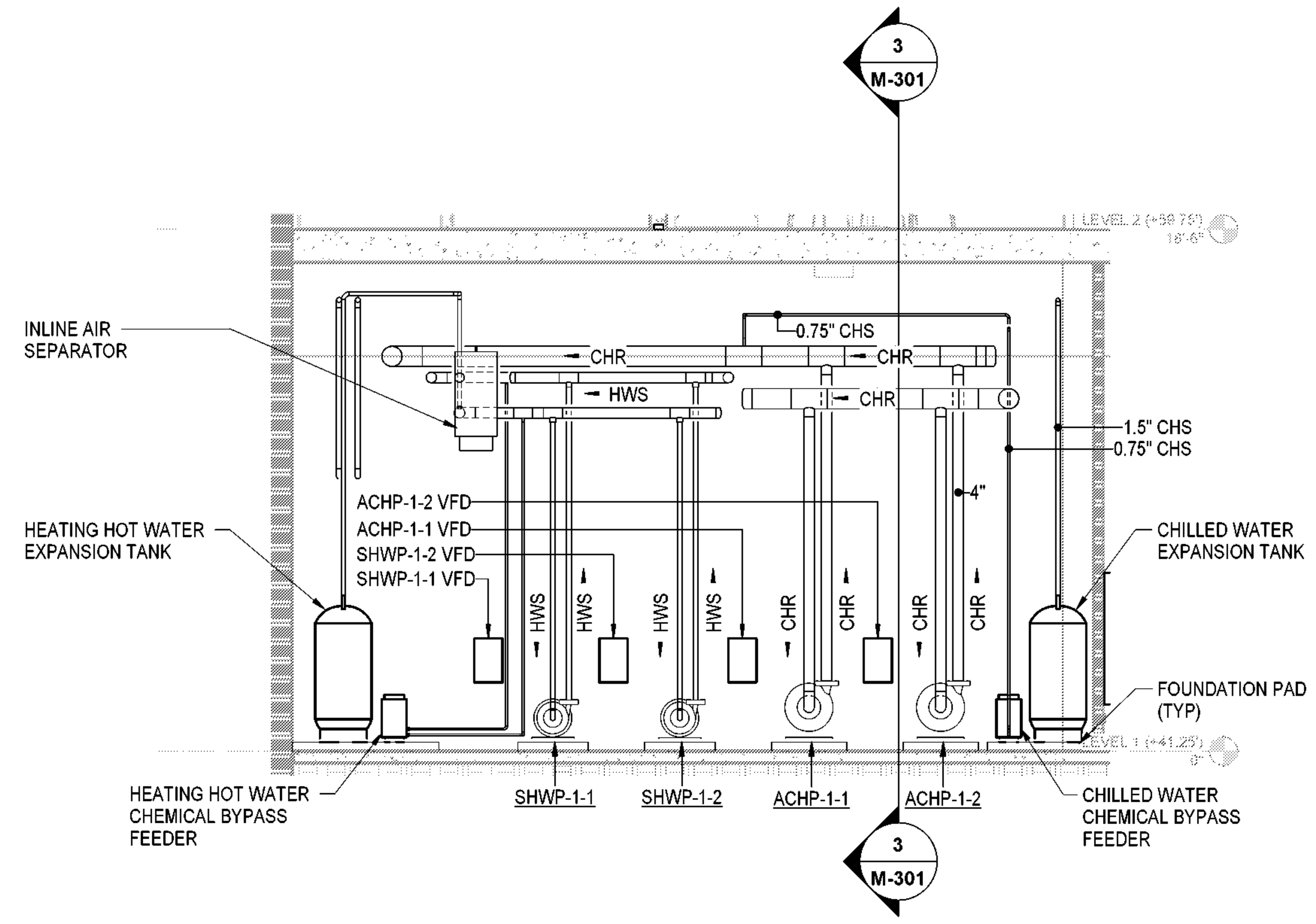
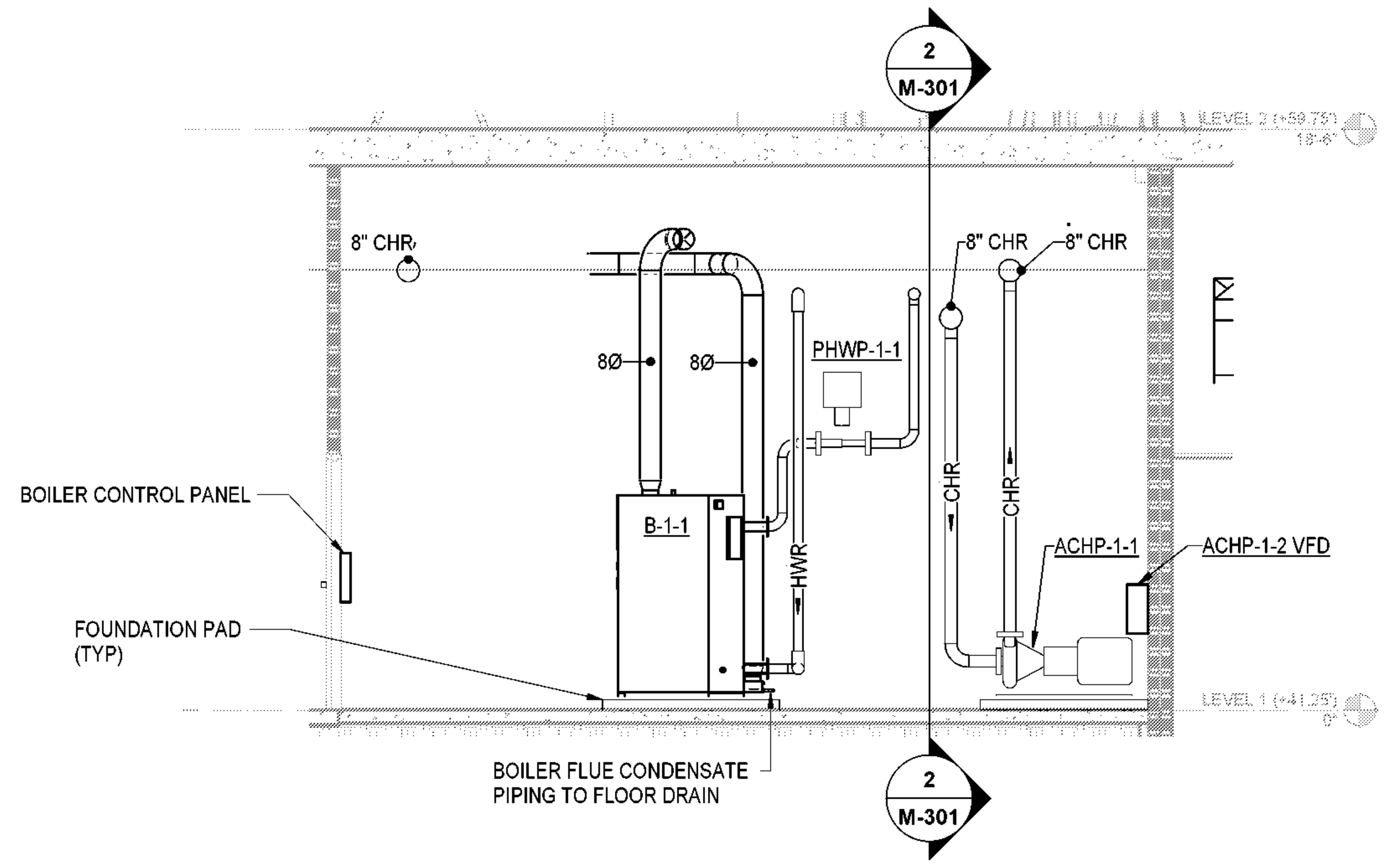


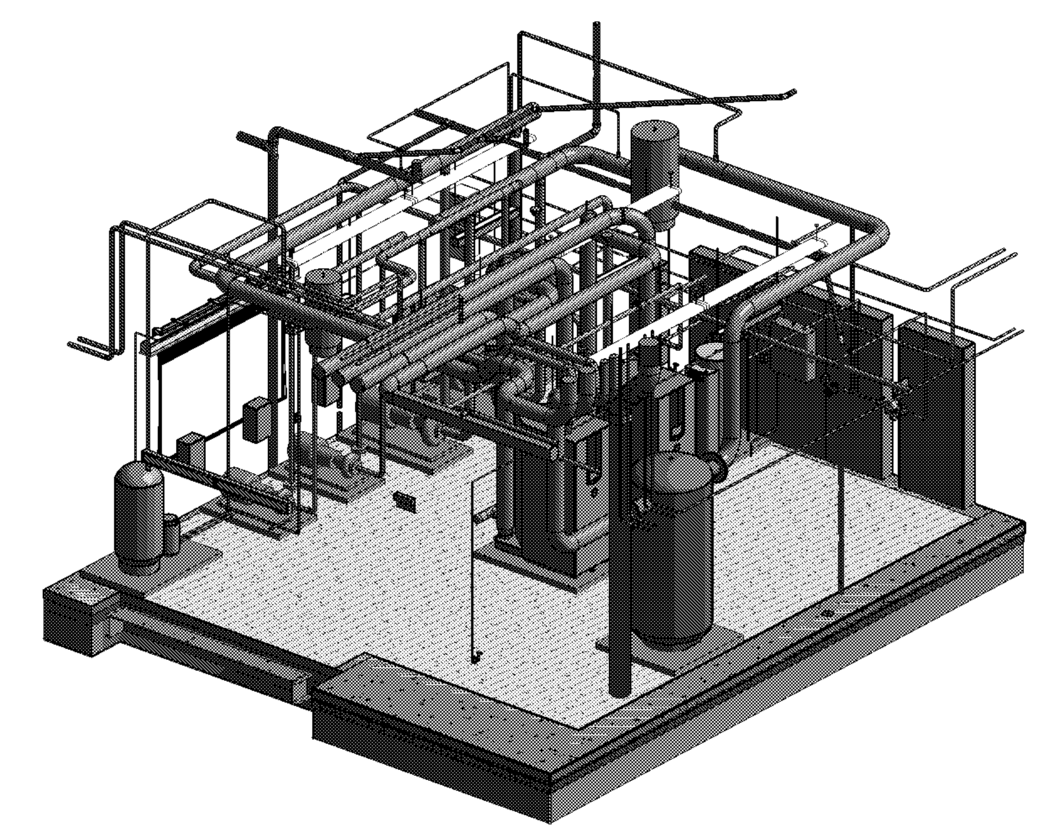
1 **HVAC PART PLAN - MAIN MECHANICAL ROOM**
1/4" = 1'-0"



2 **HVAC PART PLAN - MAIN MECHANICAL ROOM NORTH SECTION**
1/4" = 1'-0"



3 **HVAC PART PLAN - MAIN MECHANICAL ROOM WEST SECTION**
1/4" = 1'-0"



4 **HVAC PART PLAN - MAIN MECHANICAL ROOM ISOMETRIC**

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Wilmington, NC 28401
LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC PART PLAN - MAIN MECHANICAL ROOM

ORIG SUBMISSION: 2023.05.22

SHEET: **M-301**

PERMIT SET

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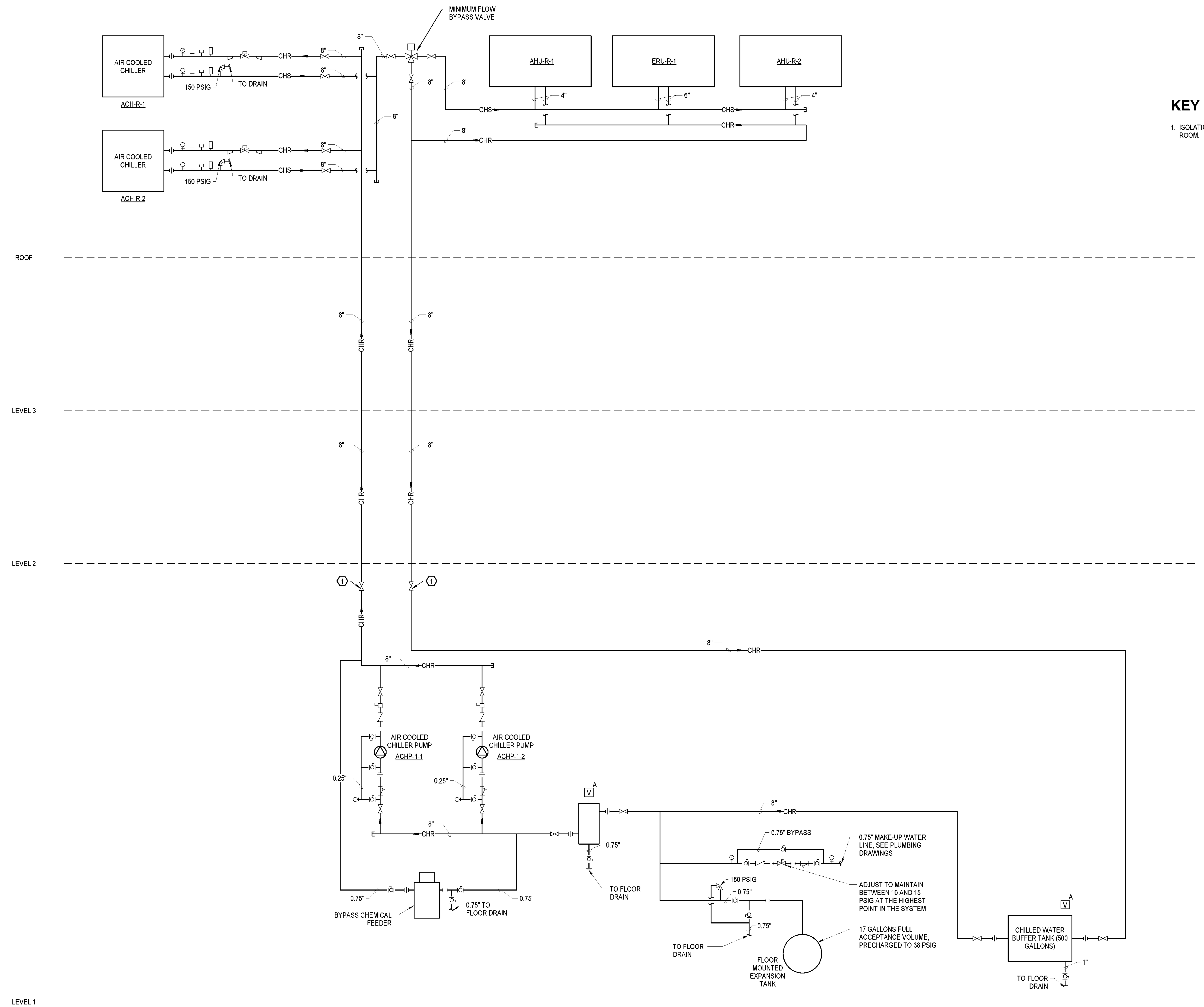

KEY NOTES:

1. ISOLATION VALVES SHALL BE LOCATED IN MECHANICAL ROOM.

1 **HVAC CHILLED WATER FLOW SCHEMATIC**
NO SCALE

5/22/2023 10:16:28 AM

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Wilmington, NC 28401

LS3P PROJECT: 7701-177600

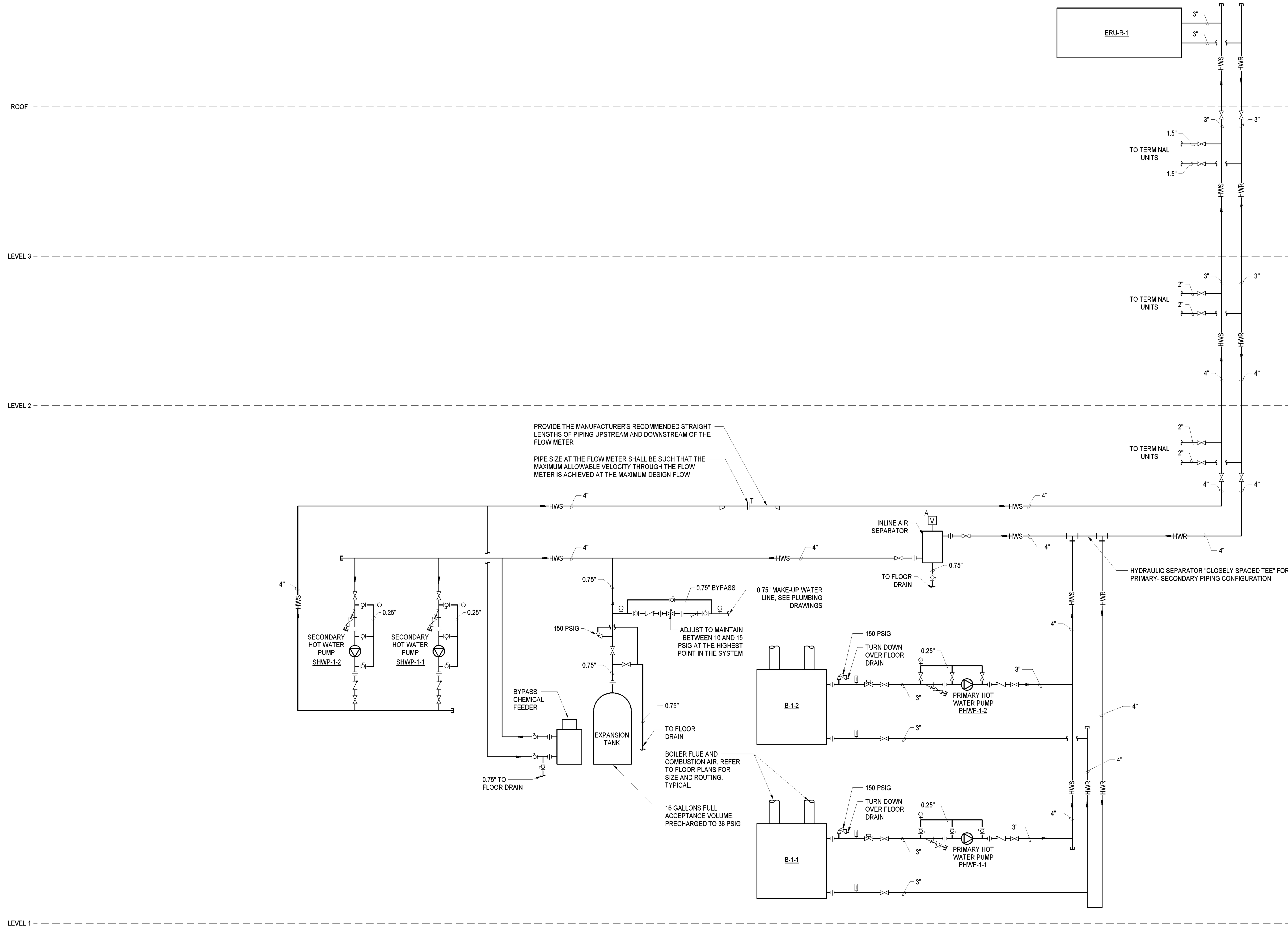
Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC CHILLED WATER FLOW SCHEMATIC

ORIG SUBMISSION: 2023.05.22

SHEET: **M-401**

PERMIT SET



1 HVAC HOT WATER FLOW SCHEMATIC
NO SCALE

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

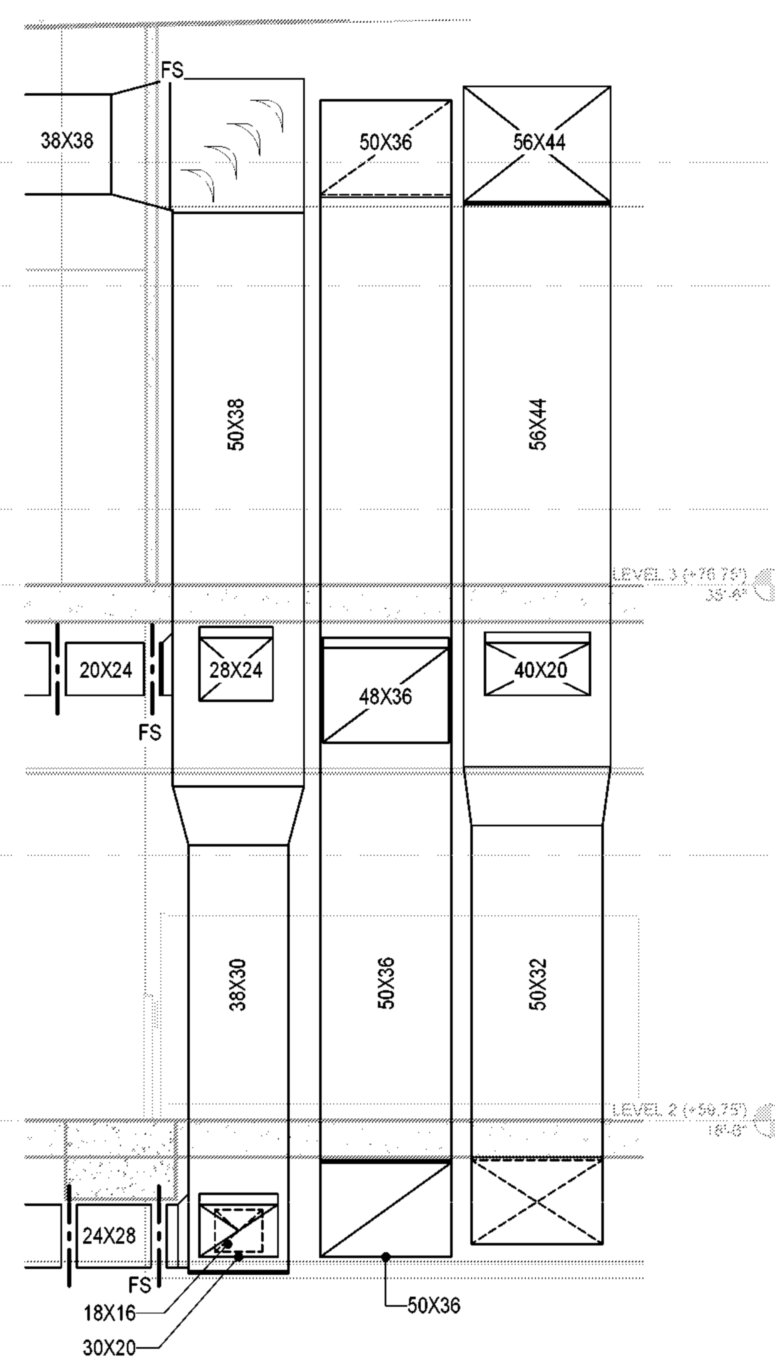
SHEET NAME:
HVAC HOT WATER FLOW SCHEMATIC

ORIG SUBMISSION: 2023.05.22

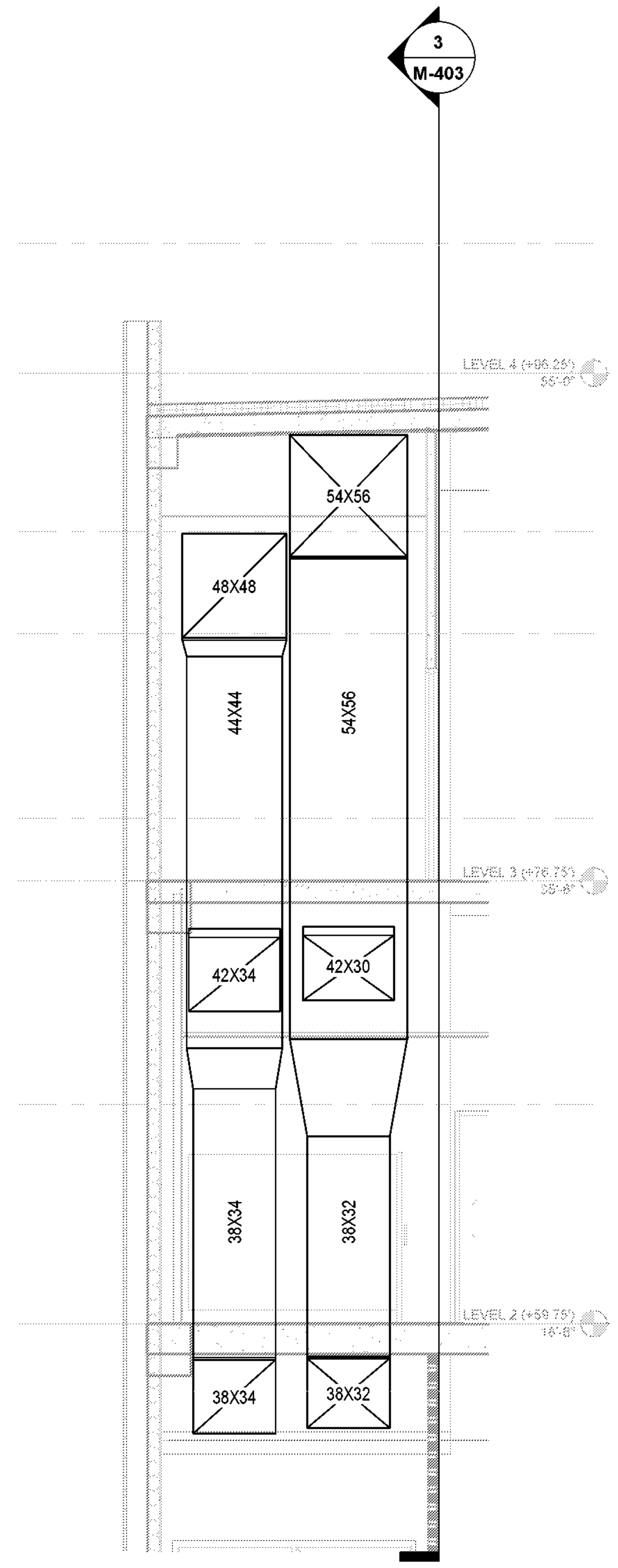
SHEET: M-402

PERMIT SET

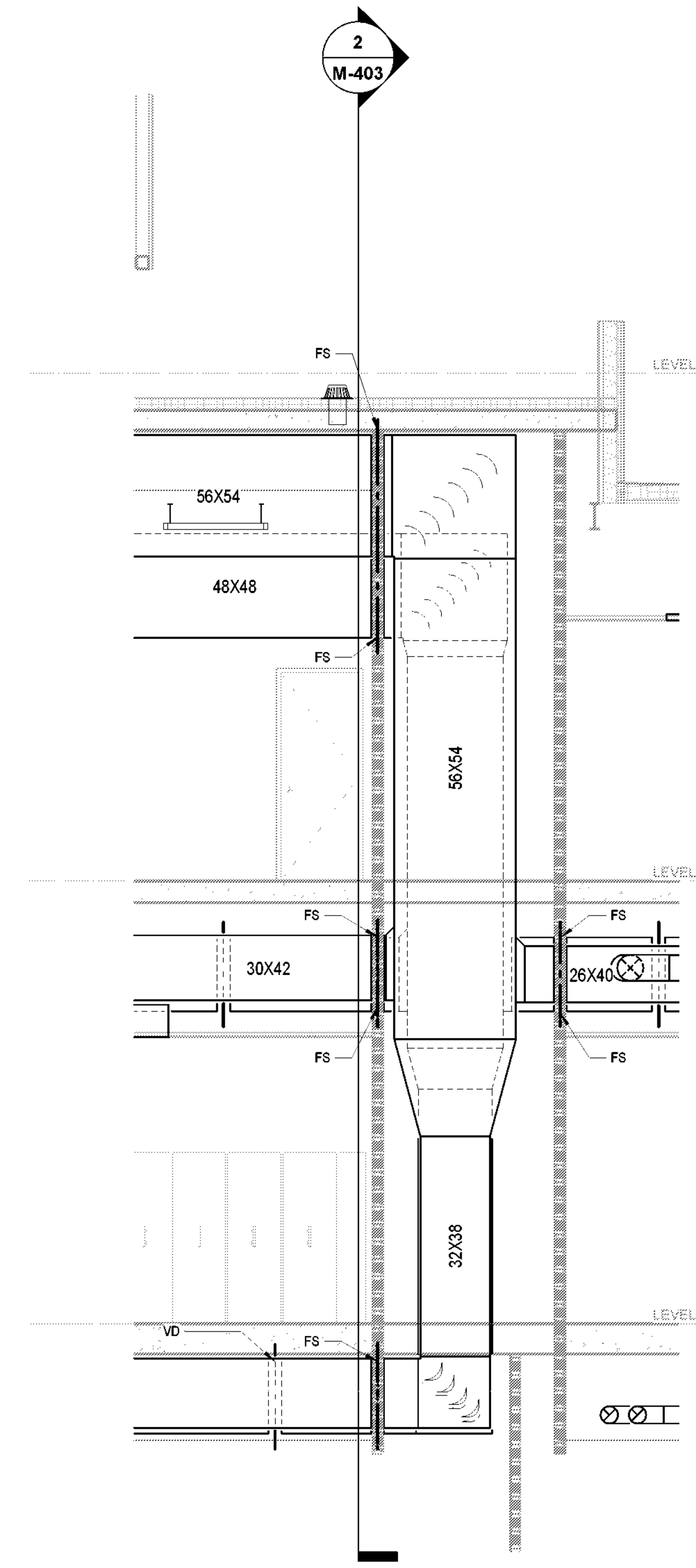
5/22/2023 10:16:30 AM



1 AHU-R-1 HVAC RISER
1/4" = 1'-0"



2 AHU-R-2 HVAC RISER
1/4" = 1'-0"



3 AHU R-3 HVAC RISER
1/4" = 1'-0"

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LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC RISER DIAGRAM

ORIG SUBMISSION: 2023.05.22

SHEET: M-403

PERMIT SET

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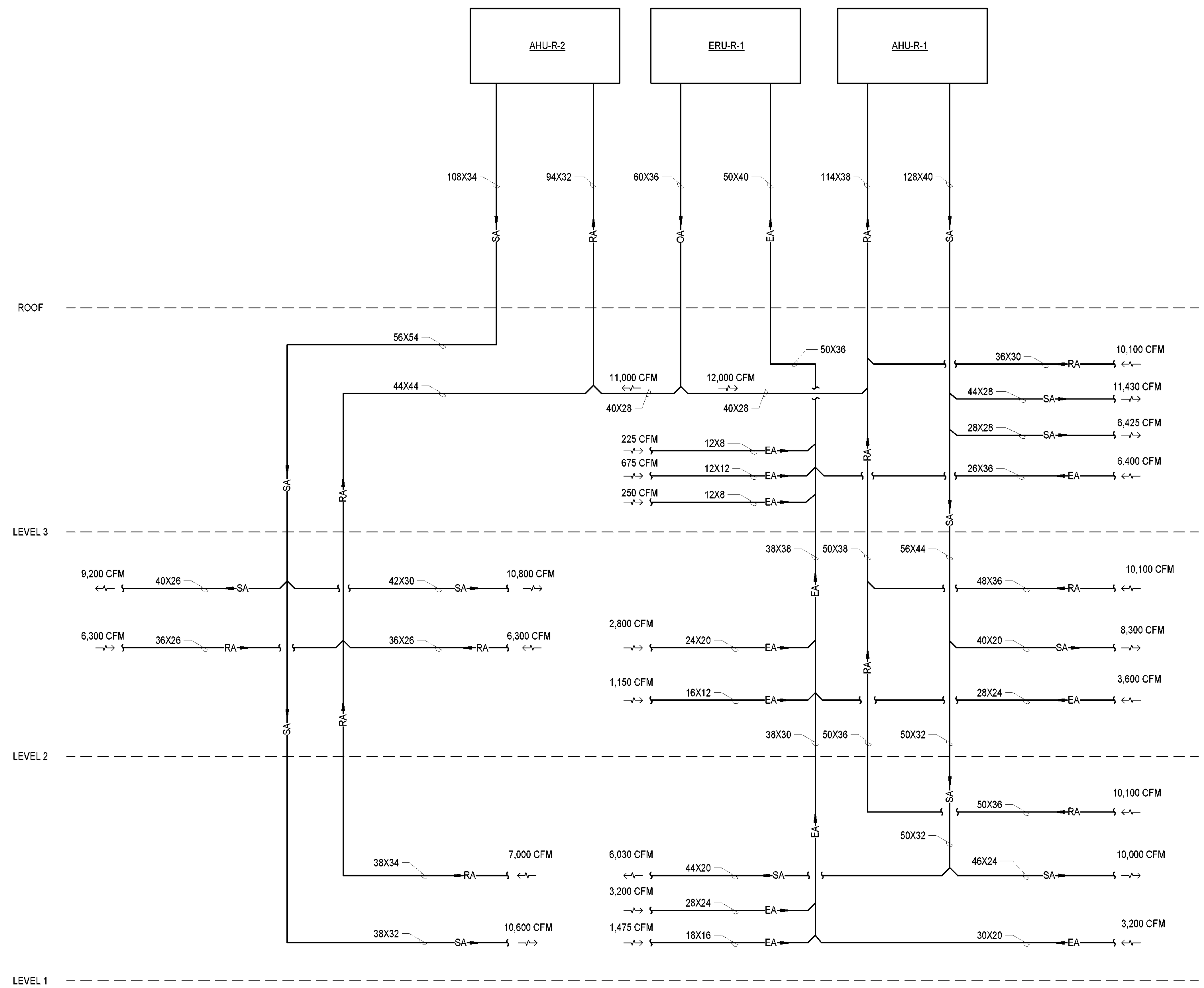

1

HVAC AIR FLOW SCHEMATIC

NO SCALE

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Wilmington, NC 28401

LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION

SHEET NAME:
HVAC AIR FLOW DIAGRAM

ORIG SUBMISSION: 2023.05.22

SHEET: M-404

PERMIT SET

5/22/2023 10:16:35 AM

ENERGY RECOVERY UNIT SCHEDULE

OUTSIDE AIR SUPPLY SIDE

NO.	CONDITIONS OF OPERATION	OUTSIDE AIR CONDITIONS °F, DB	OUTSIDE AIR CONDITIONS °F, WB	SUPPLY FAN (NOTE 14) CFM (NOTE 13)	SUPPLY FAN MAXIMUM RPM	SUPPLY FAN FAN TYPE (NOTE 1)	SUPPLY FAN ESP. IN. WG (NOTE 2)	SUPPLY FAN MOTOR MINIMUM HP (PER FAN)	SUPPLY FAN MOTOR MAXIMUM BRAKE HP (PER FAN)	FILTERS TYPE (NOTE 3)	FILTERS DEPTH, INCHES
ERU-R-1	SUMMER DESIGN	95	77	23,000	3,000	P-AF	2	7.5 (7 FANS)	5.4 (7 FANS)	P (MERV 8 / 15)	2, 12
	WINTER DESIGN	15	10	23,000	3,000	P-AF	2	7.5 (7 FANS)	5.4 (7 FANS)	P (MERV 8 / 15)	2, 12

NO.	CONDITIONS OF OPERATION	ENERGY RECOVERY WHEEL (NOTE 4) CFM	TOTAL ENERGY EFFECTIVENESS	EAT °F DB	EAT °F WB	LAT °F DB	LAT °F WB	COOLING COIL (NOTE 12) CFM (NOTE 5)	CHILLED WATER GPM (NOTE 6)	EAT °F DB	EAT °F WB	LAT °F DB	LAT °F WB	CONTROL VALVE TYPE (NOTE 7)	HOT WATER HEATING COIL (NOTE 12) CFM (NOTE 10)	HOT WATER GPM (NOTE 11)	EAT °F	LAT °F	CONTROL VALVE TYPE (NOTE 7)
ERU-R-1	SUMMER DESIGN	23,000	62.84%	95.0	77.0	82.2	69.5	23,000	284.2	95.0	77.0	52.2	52.0	2	23,000	-	-	-	-
	WINTER DESIGN	23,000	66.00%	15.0	10.0	49.5	39.5	23,000	-	-	-	-	-	-	23,000	67.1	15	55.3	2

ENERGY RECOVERY UNIT SCHEDULE CONTINUED

EXHAUST SIDE

NO.	CONDITIONS OF OPERATION	OUTSIDE AIR CONDITIONS °F, DB	OUTSIDE AIR CONDITIONS °F, WB	EXHAUST FAN (NOTE 14) CFM (NOTE 13)	MAXIMUM RPM	FAN TYPE (NOTE 1)	ESP. IN. WG (NOTE 8)	MOTOR MINIMUM HP (PER FAN)	MOTOR MAXIMUM BRAKE (PER FAN)	FILTERS TYPE (NOTE 3)	FILTERS DEPTH, IN.	ENERGY RECOVERY WHEEL (NOTE 9) CFM	EAT °F DB	EAT °F WB	VIBRATION ISOLATION TYPE	VIBRATION ISOLATION MIN. STATIC DEFLECTION IN.	NOTES
ERU-R-1	SUMMER DESIGN	95	77	23,000	3,000	P - AF	3	7.5 (5 FANS)	5.3 (5 FANS)	P - MERV 8	2	23,000	75.0	64.0	SC	1.5	
	WINTER DESIGN	15	10	23,000	3,000	P - AF	3	7.5 (5 FANS)	5.3 (5 FANS)	P - MERV 8	2	23,000	70.0	53.0	SC	1.5	

1. FAN TYPE:
   FAN:
   C DWDI CENTRIFUGAL
   P PLUG
   M MIXED-FLOW
   WHEEL:
   AF AIRFOIL
   FC FORWARD-CURVED
   BI BACKWARD-INCLINED
2. EXTERNAL STATIC PRESSURE DOES NOT INCLUDE UNIT CASING, ENERGY RECOVERY WHEELS, OR HEATING AND COOLING COILS, BUT DOES INCLUDE FILTERS.
3. FILTER TYPE:
   P PLEATED
4. OUTSIDE AIR SUPPLY SIDE OF ENERGY RECOVERY WHEELS SHALL HAVE MAXIMUM 0.85" WG APD.
5. MAXIMUM 500 FPM COIL FACE VELOCITY AND MAXIMUM 0.85" WG COOLING COIL APD
6. CHILLED WATER BASED ON 44°F EWT AND MAXIMUM 18' WPD.
7. CONTROL VALVE TYPE:
   2 2-WAY
   3 3-WAY
8. EXTERNAL STATIC PRESSURE DOES NOT INCLUDE UNIT CASING OR ENERGY RECOVERY WHEELS, BUT DOES INCLUDE FILTERS.
9. EXHAUST SIDE OF ENERGY RECOVERY WHEELS SHALL HAVE MAXIMUM 0.50" WG APD.
10. MAXIMUM 0.20" WG APD.
11. HOT WATER BASED ON 140°F EWT AND MAXIMUM 6' WPD.
12. PROVIDE COOLING AND HEATING COIL CONNECTIONS THROUGH SIDE OF UNIT.
13. CFM DOES NOT INCLUDE PURGE FOR WHEEL.
14. PROVIDE VARIABLE FREQUENCY DRIVE FOR FAN MOTOR.
15. REFER TO THE ELECTRICAL DRAWINGS FOR THE EQUIPMENT ELECTRICAL CHARACTERISTICS.

AIR HANDLING UNIT SCHEDULE

NO.	AREA SERVED (NOTE 1)	TYPE (NOTE 2)	FAN CFM	FAN MAXIMUM RPM	FAN TYPE (NOTE 3)	FAN ESP. IN. WG (NOTE 4)	FAN MOTOR MINIMUM HP	FAN MOTOR MAXIMUM BRAKE HP	COOLING COIL MINIMUM OA CFM	COOLING COIL CFM (NOTE 5)	MAXIMUM CHILLED WATER GPM (NOTE 6)	EAT °F DB	EAT °F WB	LAT °F DB	LAT °F WB	CONTROL VALVE TYPE (NOTE 7)	HUMIDIFIER TYPE (NOTES 8-10)	HUMIDIFIER CAPACITY LB/H (NOTES 9)	VIBRATION ISOLATION TYPE	VIBRATION ISOLATION MIN. STATIC DEFLECTION, IN.	NOTES
AHU-R-1	MUSEUM	DT-HZ-VV	42,000	1,750	P-AF	3.0	4 @ 20	4 @ 15.23	12,000	42,000	178	69.0	62.0	51.9	51.9	2	A	264	SC	1.5	11-14
AHU-R-2	LIBRARY	DT-HZ-VV	35,000	3,500	P-AF	3.0	4 @ 20	4 @ 13.65	11,000	35,000	89.3	66.2.0	57.6	51.6	50.9	2	A	96	SC	1.5	11-14

NOTES:

1. DESIGN CONDITIONS:

	SUMMER	WINTER
OUTSIDE	93.3°F DB, 78.5°F WB	23.2°F
LIBRARY	75°F DB, 50% RH	70°F
GALLERIES	72°F DB, 55% RH	70°F
OFFICES	75°F DB, 50% RH	70°F
ELECTRICAL ROOMS	80°F DB	50°F
MECHANICAL SPACES	80°F DB	50°F
COMMUNICATION ROOMS	78°F DB	70°F
ELEVATOR MACHINE ROOMS	80°F DB	50°F

2. TYPE:
   DT DRAW-THROUGH
   VV VARIABLE VOLUME
   HZ HORIZONTAL
3. FAN TYPE:
   FAN: P PLENUM
   WHEEL: AF AIRFOIL
4. EXTERNAL STATIC PRESSURE DOES NOT INCLUDE UNIT CASING, PLENUMS, DIFFUSER SECTION, OR UNIT MOUNTED HEATING AND COOLING COILS, BUT DOES INCLUDE FILTERS.
5. MAXIMUM FOR VARIABLE VOLUME UNITS: 550 FPM COIL FACE VELOCITY, .2" WG APD.
6. CHILLED WATER BASED ON 44°F EWT, 58°F LWT AND MAXIMUM 18' WPD.
7. CONTROL VALVE TYPE:
   2 2-WAY
8. TYPE:
   A ELECTRIC
9. HUMIDIFIER SELECTION SHALL PROVIDE COMPLETE ABSORPTION OF STEAM INTO THE AIR-STREAM PRIOR TO CONTACT WITH DOWNSTREAM COMPONENTS.
10. PROVIDE OUTDOOR RATED ENCLOSURE FOR HUMIDIFIER. BASIS OF DESIGN IS DRISTEEM RX SERIES.
11. PROVIDE VARIABLE FREQUENCY DRIVES.
12. REFER TO THE ELECTRICAL DRAWINGS FOR EQUIPMENT ELECTRICAL CHARACTERISTICS.
13. PRE-FILTER: PLEATED, MERV 8
14. FILTER: VARICAL VXL CARTRIDGE, MERV 14

PUMP SCHEDULE

NO.	SERVICE	TYPE (NOTE 1)	GPM	TOTAL DYNAMIC HEAD, FT. WG	MINIMUM EFFICIENCY, %	RPM	MOTOR MINIMUM HP	MOTOR MAXIMUM BRAKE HP	VIBRATION ISOLATION TYPE	MINIMUM STATIC DEFLECTION, IN.	INERTIA BASE	NOTES
ACHP-1-1	CHILLED WATER	E	630	85	80	1800	20	16.6	FS	0.75	Y	2, 3
ACHP-1-2	CHILLED WATER	E	630	85	80	1800	20	16.6	FS	0.75	Y	2, 3
PHWP-1-1	PRIMARY HEATING WATER	I	150	45	76	3600	5	3.0	SH	0.75	N	3
PHWP-1-2	PRIMARY HEATING WATER	I	150	45	76	3600	5	3.0	SH	0.75	N	3
SHWP-1-1	SECONDARY HEATING WATER	E	150	55	75	3600	5	2.7	FS	0.75	Y	2, 3
SHWP-1-2	SECONDARY HEATING WATER	E	150	55	75	3600	5	2.7	FS	0.75	Y	2, 3

NOTES:

1. TYPE:
   I INLINE
   E END-SUCTION
2. PROVIDE VARIABLE FREQUENCY DRIVE.
3. REFER TO THE ELECTRICAL DRAWINGS FOR THE EQUIPMENT ELECTRICAL CHARACTERISTICS.

AIR-COOLED CHILLER SCHEDULE

NO.	CAPACITY, TONS (NOTES 1 & 2)	MAXIMUM POWER INPUT kW AT FULL LOAD	MINIMUM EER	MINIMUM IPLV	EVAPORATOR EWT °F	EVAPORATOR LWT °F	EVAPORATOR GPM	EVAPORATOR MAXIMUM PRESS. DROP, FT. WG	NOTES	VIBRATION ISOLATION TYPE	MINIMUM STATIC DEFLECTION, IN.	VIBRATION BASE
ACH-R-1	150	168.4	10.75	17.2	58	44	258	29.4	3	LS	2.5	N
ACH-R-2	150	168.4	10.75	17.2	58	44	258	29.4	3	LS	2.5	N

NOTES:

1. CAPACITY BASED ON 95°F AMBIENT TEMPERATURE.
2. PROVIDE LOW AMBIENT OPERATION DOWN TO 30°F.
3. REFER TO THE ELECTRICAL DRAWINGS FOR EQUIPMENT ELECTRICAL CHARACTERISTICS.

BOILER SCHEDULE

NO.	TYPE (NOTE 1)	OUTPUT, MBH	OPERATING PRESSURE, PSIG	TURNDOWN RATIO	MINIMUM EFFICIENCY, % (NOTE 3)	HOT WATER EWT °F	HOT WATER LWT °F	GPM	FUEL	NOTES
B-1-1	C-H	960	125	20:1	96	110	140	67	NATURAL GAS	3
B-1-2	C-H	960	125	20:1	96	110	140	67	NATURAL GAS	3

NOTES:

1. TYPE:
   C CONDENSING - H HOT WATER
2. PER THE TEST PROCEDURES AND CONDITIONS REQUIRED IN THE NORTH CAROLINA ENERGY CONSERVATION CODE-2018
3. REFER TO THE ELECTRICAL DRAWINGS FOR THE EQUIPMENT ELECTRICAL CHARACTERISTICS.
4. GAS PRESSURE 4-14" W.G.
5. WATER PRESSURE DROP: 3 PSIG @ 100 GPM

CFD
Cape Fear Development

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Newcomb & Boyd, LLP
Firm Lic. # F-0312

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 043322 PAUL JACKSON KITCHENS
Signed on 05/22/2023 using a Digital Signature.

Project Grace
Grace Street
Wilmington, NC 28401
LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME: HVAC SCHEDULES

ORIG SUBMISSION: 2023.05.22

SHEET: M-501

PERMIT SET

5/22/2023 10:16:41 AM

FAN SCHEDULE

NO.	AREA SERVED	TYPE (NOTES 1 & 2)	CFM	STATIC PRESSURE, IN.WG	MAXIMUM RPM	MOTOR: MINIMUM HP	MOTOR: MAXIMUM BRAKE HP	DRIVE (NOTE 2)	VIBRATION ISOLATION: TYPE	VIBRATION ISOLATION: MINIMUM STATIC DEFLECTION, IN.	VIBRATION ISOLATION: VIBRATION BASE	NOTES
EF-1-1	LOADING DOCK	I	1,400	0.25	950	1	0.2	D	FS	0.75	N	3, 4
F-1-1	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-1-2	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-1-3	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-1-4	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-2-1	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-2-2	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-2-3	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-2-4	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-2-5	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-2-6	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-3-1	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-3-2	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-3-3	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-3-4	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-3-5	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-3-6	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-4-1	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-4-2	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-4-3	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-4-4	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-4-5	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-4-6	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-5-1	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-5-2	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-5-3	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-5-4	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-5-5	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-5-6	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-6-1	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-6-2	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4
F-6-3	PARKING DECK	A	4,700	0.25	1,800	2	1.9	D	SH	0.75	N	3, 4

NOTES:

1. TYPE:
   I INLINE
   A AXIAL
2. DRIVE:
   D DIRECT
3. PROVIDE VARIABLE FREQUENCY DRIVE.
4. REFER TO THE ELECTRICAL DRAWINGS FOR THE EQUIPMENT ELECTRICAL CHARACTERISTICS.

DUCTLESS SPLIT SYSTEM SCHEDULE

NO.	AREA SERVED	TYPE (NOTE 2)	INDOOR UNIT NOMINAL CFM (NOTE 3)	COOLING (NOTE 4): SENSIBLE CAPACITY, MBH	COOLING (NOTE 4): TOTAL CAPACITY, MBH	COOLING (NOTE 4): MINIMUM EER	NOTES
SSAC-1-1	ELEVATOR MACHINE ROOM	AC	600	19.0	22.0	13.4	4, 5
SSAC-1-2	MAIN COMM. ROOM	AC	600	19.0	22.0	13.4	4, 5
SSAC-1-3	EM ELEC RM	AC	600	19.0	22.0	13.4	4, 5
SSAC-1-4	MAIN ELEC ROOM	AC	1,200	34.3	48.0	15.1	4, 5
SSAC-2-1	LEVEL 2 COMM	AC	600	19.0	22.0	13.4	4, 5
SSAC-3-1	LEVEL 3 COMM	AC	600	19.0	22.0	13.4	4, 5
SSAC-3-2	LEVEL 3 ELEC RM	AC	810	25.0	36.0	10.8	4, 5

NOTES:

1. DESIGN CONDITIONS:

	SUMMER
OUTSIDE	93.7°F DB, 76.3°F WB
ELECTRICAL ROOMS	80°F DB
MECHANICAL SPACES	80°F DB
ELEVATOR MACHINE ROOMS	80°F DB

2. TYPE:
   AC COOLING ONLY
3. INDOOR UNIT CFM BASED ON MEDIUM FAN SPEED.
4. INTEGRAL CONDENSATE PUMP.
5. REFER TO THE ELECTRICAL DRAWINGS FOR EQUIPMENT ELECTRICAL CHARACTERISTICS.
6. MAXIMUM REFRIGERANT PIPE LENGTH OF 492FT.

ELECTRIC FLOOR HEATER SCHEDULE

NO.	TYPE (NOTE 1)	MINIMUM ACTIVE LENGTH (FT.)	MINIMUM CAPACITY (kW)	NOTES
FH-1-1	W	8	2	3
FH-1-2	W	8	2	3
FH-1-3	W	8	2	3
FH-1-4	W	6	2	3
FH-1-5	W	8	2	3
FH-1-6	W	6	2	3
FH-1-7	W	6	2	3
FH-1-8	W	6	2	3
FH-1-9	W	6	2	3
FH-1-10	W	6	2	3
FH-1-11	W	8	2	3
FH-1-12	W	6	2	3
FH-1-13	W	6	2	3
FH-1-14	W	8	2	3
FH-1-15	W	8	2	3
FH-1-16	W	8	2	3
FH-1-17	W	4	1	3
FH-1-18	W	8	2	3
FH-1-19	W	4	1	3
FH-1-20	W	8	2	3
FH-1-21	W	8	2	3
FH-1-22	W	8	2	3

NOTES:

1. TYPE:
   W RECESSED FLOOR HEATER
2. PROVIDE WITH INTEGRAL DISCONNECT
3. REFER TO THE ELECTRICAL DRAWINGS FOR THE EQUIPMENT ELECTRICAL CHARACTERISTICS.

AIR CURTAIN SCHEDULE

NO.	AREA SERVED	NORMAL CFM	MINIMUM MOTOR HP	MOUNTING HEIGHT (FT)	UNIT WIDTH (FT)	NOTES
AC-3-1	VESTIBULE M332	2,252	1 @ 1/5	8	6	1, 2

NOTES:

1. REFER TO ELECTRICAL DRAWINGS FOR THE EQUIPMENT ELECTRICAL CHARACTERISTICS.
2. PROVIDE CONTACTOR SWITCH AT EXTERIOR DOOR THAT SHALL ENERGIZE AIR CURTAIN FAN WHEN OPEN.

ELECTRIC UNIT HEATER SCHEDULE

NO.	AREA SERVED	TYPE (NOTE 1)	CAPACITY, kW (NOTE 2)	NOMINAL CFM	NOTES
UH-1-1	FIRE PUMP	W	2	150	3
UH-1-2	EXIT PASSAGEWAY C111	W	2	150	3
UH-1-3	STAIR S1	W	1.5	100	3
UH-3-1	VESTIBULE L237	W	1.5	100	3

NOTES:

1. TYPE:
   W WALL
2. BASED ON 60°F EAT.
3. REFER TO THE ELECTRICAL DRAWINGS FOR EQUIPMENT ELECTRICAL CHARACTERISTICS.

HYDRONIC UNIT HEATER SCHEDULE

NO.	AREA SERVED	TYPE (NOTE 1)	CAPACITY, MBH (NOTE 2)	GPM	NOMINAL CFM	NOTES
UH-1-4	LOADING DOCK	CH	32	4.5	1,100	

NOTES:

1. TYPE:
   CH CEILING HUNG
2. BASED ON 60°F EAT.
3. REFER TO THE ELECTRICAL DRAWINGS FOR EQUIPMENT ELECTRICAL CHARACTERISTICS.

TERMINAL UNIT SCHEDULE - SUPPLY

NO.	TYPE (NOTE 1)	SYSTEM	PRIMARY CFM: COOLING MAXIMUM	PRIMARY CFM: MINIMUM	PRIMARY CFM: HEATING MAXIMUM	HOT WATER COIL: CAPACITY MBH (NOTE 2)	HOT WATER COIL: GPM (NOTE 3)	HOT WATER COIL: PIPE RUNOUT SIZE, IN.	NOTES
TU-1-1	VV-R	AHU-R-2	175	55	55	1.8	0.5	0.75"	
TU-1-2	VV-R-D	AHU-R-2	900	180	450	14.6	1.0	0.75"	
TU-1-3	VV-R	AHU-R-2	1500	450	450	14.6	1.0	0.75"	
TU-1-4	VV-R	AHU-R-2	680	205	205	6.6	0.5	0.75"	
TU-1-5	VV-R-D	AHU-R-2	2100	420	1050	34.0	2.3	0.75"	
TU-1-6	VV-R-D	AHU-R-2	1800	360	900	29.2	2.0	0.75"	
TU-1-7	VV-R	AHU-R-2	175	55	55	1.8	0.5	0.75"	
TU-1-8	VV-R	AHU-R-2	400	120	120	3.9	0.5	0.75"	
TU-1-9	VV-R-D	AHU-R-2	1400	280	700	22.7	1.6	0.75"	
TU-1-10	VV-R	AHU-R-2	130	40	40	1.3	0.5	0.75"	
TU-1-11	VV-R-D	AHU-R-2	800	160	400	13.0	0.9	0.75"	
TU-1-12	VV-R	AHU-R-2	300	90	90	2.9	0.5	0.75"	
TU-1-13	VV-R-D	AHU-R-1	1005	205	505	16.4	1.1	0.75"	
TU-1-14	VV-R	AHU-R-1	920	280	280	9.1	0.6	0.75"	
TU-1-15	VV-R	AHU-R-1	855	260	260	8.4	0.6	0.75"	
TU-1-16	VV-R	AHU-R-1	520	160	160	5.2	0.5	0.75"	
TU-1-17	VV-R	AHU-R-1	520	160	160	5.2	0.5	0.75"	
TU-1-18	VV-R	AHU-R-1	225	70	70	2.3	0.5	0.75"	
TU-1-19	VV-R-D	AHU-R-1	915	185	460	14.9	1.0	0.75"	
TU-1-20	VV-R	AHU-R-1	600	180	180	5.8	0.5	0.75"	
TU-1-21	VV-R	AHU-R-1	1000	300	300	9.7	0.7	0.75"	
TU-1-22	CV-R	AHU-R-1	475	475	475	15.4	1.1	0.75"	
TU-1-23	VV-R	AHU-R-1	1200	360	360	11.7	0.8	0.75"	
TU-1-24	VV-R	AHU-R-1	1000	300	300	9.7	0.7	0.75"	
TU-1-25	VV-R	AHU-R-1	1200	360	360	11.7	0.8	0.75"	
TU-1-26	VV-R-D	AHU-R-1	1650	330	825	26.7	1.8	0.75"	
TU-1-27	VV-R-D	AHU-R-1	1350	270	675	21.9	1.5	0.75"	
TU-1-28	VV-R	AHU-R-1	2000	600	600	19.4	1.3	0.75"	
TU-1-29	VV-R	AHU-R-1	2200	660	660	21.4	1.5	0.75"	
TU-2-1	VV-R-D	AHU-R-2	0	0	0	0.0	0.5	0.75"	
TU-2-2	VV-R-D	AHU-R-2	465	95	235	7.6	0.5	0.75"	
TU-2-3	VV-R-D	AHU-R-2	1240	250	620	20.1	1.4	0.75"	
TU-2-4	VV-R-D	AHU-R-2	1040	210	520	16.8	1.2	0.75"	
TU-2-5	VV-R	AHU-R-2	625	190	190	6.2	0.5	0.75"	
TU-2-6	VV-R	AHU-R-2	250	75	75	2.4	0.5	0.75"	
TU-2-7	VV-R	AHU-R-2	400	120	120	3.9	0.5	0.75"	
TU-2-8	VV-R	AHU-R-2	880	265	265	8.6	0.6	0.75"	
TU-2-9	VV-R-D	AHU-R-2	800	160	400	13.0	0.9	0.75"	
TU-2-10	VV-R-D	AHU-R-2	450	90	225	7.3	0.5	0.75"	
TU-2-11	VV-R	AHU-R-2	150	45	45	1.5	0.5	0.75"	
TU-2-12	VV-R	AHU-R-2	700	210	210	6.8	0.5	0.75"	
TU-2-13	VV-R	AHU-R-2	600	180	180	5.8	0.5	0.75"	
TU-2-14	VV-R	AHU-R-2	260	80	80	2.6	0.5	0.75"	
TU-2-15	VV-R	AHU-R-2	1600	480	480	15.6	1.1	0.75"	
TU-2-16	VV-R	AHU-R-2	300	90	90	2.9	0.5	0.75"	
TU-2-17	VV-R	AHU-R-2	325	100	100	3.2	0.5	0.75"	
TU-2-18	VV-R	AHU-R-2	375	115	115	3.7	0.5	0.75"	
TU-2-19	VV-R-D	AHU-R-2	1215	245	610	19.8	1.4	0.75"	
TU-2-20	VV-R-D	AHU-R-2	1575	315	790	25.6	1.8	0.75"	
TU-2-21	VV-R	AHU-R-2	500	150	150	4.9	0.5	0.75"	
TU-2-22	VV-R-D	AHU-R-2	2160	435	1080	35.0	2.4	0.75"	
TU-2-23	VV-R-D	AHU-R-2	1890	380	945	30.6	2.1	0.75"	
TU-2-24	VV-R	AHU-R-1	200	60	60	1.9	0.5	0.75"	
TU-2-25	VV-R-D	AHU-R-1	1480	300	740	24.0	1.6	0.75"	
TU-2-26	VV-R	AHU-R-1	450	135	135	4.4	0.5	0.75"	
TU-2-27	VV-R	AHU-R-1	675	205	205	6.6	0.5	0.75"	
TU-2-28	VV-R	AHU-R-1	450	135	135	4.4	0.5	0.75"	
TU-2-29	VV-R	AHU-R-1	1200	360	360	11.7	0.8	0.75"	
TU-2-30	VV-R-D	AHU-R-1	2000	400	1000	32.4	2.2	0.75"	
TU-2-31	VV-R-D	AHU-R-1	1850	370	925	30.0	2.1	0.75"	
TU-3-1	VV-R	AHU-R-1	175	55	55	1.8	0.5	0.75"	
TU-3-2	VV-R	AHU-R-1	120	40	40	1.3	0.5	0.75"	
TU-3-3	VV-R-D	AHU-R-1	1200	240	600	19.4	1.3	0.75"	
TU-3-4	VV-R-D	AHU-R-1	750	150	375	12.2	0.8	0.75"	
TU-3-5	VV-R-D	AHU-R-1	490	100	245	7.9	0.5	0.75"	
TU-3-6	VV-R	AHU-R-1	250	75	75	2.4	0.5	0.75"	
TU-3-7	VV-R-D	AHU-R-1	800	160	400	13.0	0.9	0.75"	
TU-3-8	VV-R	AHU-R-1	105	35	35	1.1	0.5	0.75"	
TU-3-9	VV-R-D	AHU-R-1	300	60	150	4.9	0.5	0.75"	
TU-3-10	VV-R	AHU-R-1	1360	410	410	13.3	0.9	0.75"	
TU-3-11	VV-R	AHU-R-1	1160	350	350	11.3	0.8	0.75"	
TU-3-12	VV-R	AHU-R-1	1320	400	400	13.0	0.9	0.75"	
TU-3-13	VV-R-D	AHU-R-1	975	195	490	15.9	1.1	0.75"	
TU-3-14	VV-R-D	AHU-R-1	975	195	490	15.9	1.1	0.75"	
TU-3-15	VV-R	AHU-R-1	875	265	265	8.6	0.6	0.75"	
TU-3-17	VV-R-D	AHU-R-1	1500	300	750	24.3	1.7	0.75"	
TU-3-18	VV-R-D	AHU-R-1	520	105	260	8.4	0.6	0.75"	
TU-3-19	VV-R	AHU-R-1	180	55	55	1.8	0.5	0.75"	
TU-3-20	VV-R-D	AHU-R-1	520	105	260	8.4	0.6	0.75"	
TU-3-21	VV-R-D	AHU-R-1	1590	320	795	25.8	1.8	0.75"	
TU-3-22	VV-R-D	AHU-R-1	1600	320	800	25.9	1.8	0.75"	
TU-3-23	VV-R	AHU-R-1	290	90	90	2.9	0.5	0.75"	
TU-3-24	VV-R	AHU-R-1	225	70	70	2.3	0.5	0.75"	
TU-3-25	VV-R	AHU-R-1	590	180	180	5.8	0.5	0.75"	

NOTES:

1. TYPE:
   VV VARIABLE VOLUME - R REHEAT
   CV CONSTANT VOLUME - D DUAL MAX
2. CAPACITY BASED ON 55°F EAT FOR VV-R UNITS.
3. HOT WATER BASED ON 140ºF EWT, 110°F LWT, AND MAXIMUM 3' WPD.
4. SEE SPECIFICATIONS FOR AHRI TESTING/CERTIFICATION REQUIREMENTS AND SUPPLEMENTAL SOUND ATTENUATION REQUIREMENTS. FOR TERMINAL UNITS WHERE THE SOUND POWER LEVEL FIELDS OF THE SCHEDULE ABOVE ARE LEFT BLANK, THE MAXIMUM ALLOWABLE SOUND POWER LEVELS IN dB @ 10 pW, SHALL BE OF THE FOLLOWING LEVELS:

	OCTAVE BAND 2	OCTAVE BAND 3	OCTAVE BAND 4
CASING RADIATED, LESS THAN 400 CFM	58	58	54
CASING RADIATED, 400 CFM TO 700 CFM	62	62	58
CASING RADIATED, 700 CFM OR MORE	64	64	59
DISCHARGE, LESS THAN 400 CFM	62	59	61
DISCHARGE, 400 CFM TO 700 CFM	70	67	64
DISCHARGE, 700 CFM OR MORE	70	68	68

   LEVELS BASED ON MAXIMUM PRIMARY CFM AND MINIMUM DIFFERENTIAL STATIC PRESSURE OF 1" WG FOR VV AND CV UNITS.
5. DIFFERENTIAL STATIC PRESSURE DROP ACROSS COMPLETE ASSEMBLY, INCLUDING HEATING COIL, FOR ALL UNITS SHALL NOT EXCEED 0.3" WG APD.
6. REFER TO THE ELECTRICAL DRAWINGS FOR THE EQUIPMENT ELECTRICAL CHARACTERISTICS.
7. THE DRAWINGS INDICATE THE DESIGN INTENT TO PROVIDE ACCESS TO HEATING COILS, CONTROL PANELS, AND ACCESS DOORS. IF TERMINAL UNITS PROVIDED ARE CONFIGURED DIFFERENTLY, THE ACCESS REQUIREMENTS SHALL BE ADJUSTED IN THE FIELD.
8. INCLUDE NH ISOLATORS (0.25 IN. MINIMUM STATIC DEFLECTION) FOR ALL TERMINAL UNITS LOCATED WITHIN GALLERY SPACES.

TERMINAL UNIT SCHEDULE - EXHAUST

NO.	TYPE (NOTE 1)	PRIMARY CFM: MAXIMUM	PRIMARY CFM: MINIMUM
ETU-1-1	CV	1475	1475
ETU-2-1	CV	1150	1150
ETU-3-1	CV	250	250
ETU-3-2	CV	675	675
ETU-3-3	CV	250	250

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Firm Lic. # F-0312

NORTH CAROLINA PROFESSIONAL SEAL 043322 ENGINEER PAUL JACKSON KITCHENS

Signed on 05/22/2023 using a Digital Signature.

Project Grace

Grace Street
Wilmington, NC 28401

LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
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SHEET NAME: HVAC SCHEDULES

ORIG SUBMISSION: 2023.05.22

SHEET: M-502

PERMIT SET

SEISMIC AND WIND LOAD DESIGN REQUIREMENTS FOR MECHANICAL SYSTEMS

A. EQUIPMENT, APPLIANCES AND SUPPORTS (INCLUDING ROOF CURBS AND ROOF RAILS) EXPOSED TO WIND SHALL BE DESIGNED AND INSTALLED TO RESIST THE WIND PRESSURES DETERMINED IN ACCORDANCE WITH THE INTERNATIONAL BUILDING CODE. WHERE SEISMIC RESTRAINT IS REQUIRED, THE MORE DEMANDING FORCE OF WIND AND SEISMIC MUST BE USED. SEE SEISMIC INFORMATION CONTAINED IN THE STRUCTURAL DRAWINGS FOR SITE SPECIFIC INFORMATION ON SEISMIC DESIGN CATEGORY AND ADDITIONAL SUPPORTING INFORMATION.

B. SEE COMPONENT/SYSTEM SCHEDULE BELOW FOR SPECIFIC COMPONENT IMPORTANCE FACTOR DESIGNATIONS AND SEISMIC DESIGN CRITERIA.

C. USE SEISMIC DESIGN CATEGORY TABLE BELOW TO DETERMINE SEISMIC RESTRAINT REQUIREMENTS FOR EACH COMPONENT/SYSTEM.

D. FOR ALL COMPONENTS/SYSTEMS REQUIRING SEISMIC AND/OR WIND RESTRAINT, THE COMPONENT SUPPORTS AND ATTACHMENTS SHALL BE DESIGNED (CALCULATIONS AND INSTALLATION DETAILS) AND STAMPED BY A REGISTERED PROFESSIONAL ENGINEER (SEISMIC AND/OR STRUCTURAL ENGINEER) WITH AT LEAST FIVE YEARS OF SEISMIC DESIGN EXPERIENCE, LICENSED IN THE STATE OF THE JOB LOCATION. ALL RESTRAINING DEVICES SHALL HAVE A PREAPPROVAL NUMBER FROM CALIFORNIA OSHPD OR SOME OTHER RECOGNIZED GOVERNMENT AGENCY SHOWING MAXIMUM RESTRAINT RATINGS.

E. WHERE SEISMIC RESTRAINT IS REQUIRED, FOUNDATION PADS NEEDED FOR INSTALLATION OF EQUIPMENT UNDER THIS CONTRACT MUST BE DESIGNED AND STAMPED BY THE SEISMIC ENGINEER. DO NOT POUR ANY FOUNDATION PADS PRIOR TO THE RECEIPT OF AN APPROVED SEISMIC SUBMITTAL FROM THE ENGINEER OF RECORD. ALL FOUNDATION PADS DESIGNED AS EXPANSIONS TO EXISTING PADS OR INSTALLED ON TOP OF EXISTING CONCRETE FLOOR SYSTEMS SHALL BE DOWELED INTO THE EXISTING SYSTEMS.

F. SEISMIC RESTRAINTS FOR DUCTWORK AND PIPING MUST BE SHOWN ON LAYOUT DRAWINGS SHOWING SPECIFIC RESTRAINT LOCATIONS ALONG WITH ACCOMPANYING DETAILS AND CALCULATIONS PER THE SEISMIC ENGINEER.

G. AFTER INSTALLATION, MANUFACTURER'S TRAINED REPRESENTATIVE SHALL VERIFY THAT SEISMIC AND WIND RESTRAINTS ARE INSTALLED AND OPERATING PROPERLY AND SHALL SUBMIT A CERTIFICATE SO STATING.

H. REFER TO ASCE 7-10 FOR SEISMIC INSTALLATION GUIDELINES.

J. CABLE RESTRAINTS SHALL BE INSTALLED SLIGHTLY SLACK SUCH THAT THEY DO NOT SHORT CIRCUIT VIBRATION ISOLATORS DURING NORMAL OPERATION. SOLID, BRACKET SWAY BRACES SHOULD BE AVOIDED UNLESS PROPERLY COORDINATED WITH VIBRATION ISOLATORS TO AVOID SHORT CIRCUITING.

COMPONENT/SYSTEM IMPORTANCE FACTOR (Ip) SCHEDULE AND SEISMIC DESIGN INFORMATION

Ip = 1.0	[ALL SYSTEMS] [AND COMPONENTS UNLESS NOTED OTHERWISE]
Ip = 1.5	SYSTEMS AND COMPONENTS AS DESICRIBED IN THE ASCE 7 EDITION REQUIRED BY THE AHJ

SEISMIC DESIGN INFORMATION:

1. SITE CLASSIFICATION = D
2. RISK CATEGORY = III
3. SEISMIC DESIGN CATEGORY = B
4. SHORT PERIOD DESIGN SPECTRAL ACCELERATION (SD1) = 0.11
5. LONG PERIOD DESIGN SPECTRAL ACCELERATION (SDS) = 0.167

AIR DISTRIBUTION SCHEDULE

PRODUCT SPECIFICATIONS:

1. ACTION SUBMITTALS - PRODUCT DATA: FOR EACH TYPE OF PRODUCT.
   a. DATA SHEET: INDICATE MATERIALS OF CONSTRUCTION, FINISH, AND MOUNTING DETAILS; AND PERFORMANCE DATA INCLUDING THROW AND DROP, STATIC-PRESSURE DROP, AND NOISE RATINGS.
2. SELECTION OF GRILLES, REGISTERS AND DIFFUSERS SHALL BE BASED ON AIR INTRODUCED AT A 20°F TEMPERATURE DIFFERENTIAL.
3. GRILLES AND REGISTERS WITH BORDERS SHALL HAVE FELT OR RUBBER GASKETS CEMENTED TO THE BACK FACE AND HOLDING SCREWS NOT OVER 18" ON CENTER AROUND THE PERIMETER.
4. WALL-MOUNTED GRILLES AND REGISTERS LOCATED LESS THAN 7' ABOVE FINISHED FLOOR SHALL BE HEAVY DUTY, IMPACT-RESISTANT TYPE.
5. DIFFUSERS IN LAY-IN CEILINGS SHALL LAY IN A NOMINAL 24" X 24" GRID OPENING AND SHALL BE FURNISHED WITHOUT EXPOSED FLANGES.
6. INTERNAL PARTS OF DIFFUSERS SHALL BE DESIGNED SO THEY CAN BE ADJUSTED, REMOVED, AND ASSEMBLED WITHOUT SPECIAL TOOLS.
7. DIFFUSERS SHALL HAVE ROUND NECKS OR SHALL BE PROVIDED WITH SQUARE-TO-ROUND COLLARS WHERE CONNECTED TO ROUND OR FLEXIBLE DUCT.
8. FINISHES, UNLESS OTHERWISE SPECIFIED HEREIN:
   a. ALUMINUM DIFFUSERS, GRILLES, AND REGISTERS: WHITE BAKED ENAMEL.
   b. DIFFUSER FACES AND FRAMES: BAKED ENAMEL, COLOR SELECTED BY ARCHITECT.
   c. DIFFUSERS INTERIOR: SAME AS FACE AND FRAME.
   e. T-BAR SLOT DIFFUSERS: BAKED ENAMEL, COLOR SELECTED BY ARCHITECT. INTERIOR - FLAT BLACK.
9. GRILLES, REGISTERS AND DIFFUSERS SHALL BE PROVIDED WITH FRAMES, BORDERS, AND MOUNTING ATTACHMENTS FOR INSTALLATION IN THE ACTUAL WALL, SOFFIT, AND CEILING CONSTRUCTION IN WHICH INSTALLED.
10. WALL RETURN AND RELIEF GRILLES INSTALLED ABOVE EYE LEVEL SHALL BE INSTALLED WITH BLADES ANGLED SO THE INSIDE OF THE DUCT OR THE ADJACENT SPACE WILL NOT BE VISIBLE THROUGH THE GRILLES.
11. EXAMINATION
   a. EXAMINE AREAS WHERE DIFFUSERS ARE INSTALLED FOR COMPLIANCE WITH REQUIREMENTS FOR INSTALLATION TOLERANCES AND OTHER CONDITIONS AFFECTING PERFORMANCE OF EQUIPMENT.
   b. PROCEED WITH INSTALLATION ONLY AFTER UNSATISFACTORY CONDITIONS HAVE BEEN CORRECTED.
12. INSTALLATION
   a. INSTALL DIFFUSERS LEVEL AND PLUMB.
   b. OUTLETS AND INLETS: DRAWINGS INDICATE GENERAL ARRANGEMENT OF DUCTS, FITTINGS, AND ACCESSORIES. AIR OUTLET AND INLET LOCATIONS HAVE BEEN INDICATED TO ACHIEVE DESIGN REQUIREMENTS FOR AIR VOLUME, NOISE CRITERIA, AIRFLOW PATTERN, THROW, AND PRESSURE DROP. MAKE FINAL LOCATIONS WHERE INDICATED, AS MUCH AS PRACTICAL. FOR UNITS INSTALLED IN LAY-IN CEILING PANELS, LOCATE UNITS IN THE CENTER OF PANEL. WHERE ARCHITECTURAL FEATURES OR OTHER ITEMS CONFLICT WITH INSTALLATION, NOTIFY ARCHITECT AND ENGINEER. FOR A DETERMINATION OF FINAL LOCATION.
   c. INSTALL DIFFUSERS WITH AIRTIGHT CONNECTIONS TO DUCTS AND TO ALLOW SERVICE AND MAINTENANCE OF DAMPERS, AIR EXTRACTORS, AND FIRE DAMPERS.
   d. INSTALL REGISTERS AND GRILLES WITH AIRTIGHT CONNECTIONS TO DUCTS AND TO ALLOW SERVICE AND MAINTENANCE OF DAMPERS, AIR EXTRACTORS, AND FIRE DAMPERS.
13. AFTER INSTALLATION, ADJUST DIFFUSERS TO AIR PATTERNS INDICATED, OR AS DIRECTED, BEFORE STARTING AIR BALANCING.

TYPE	CHARACTERISTICS					MANUFACTURER	DESCRIPTION
S-PF	SIZE 24"X24" 12"X12"	--- --- ---	--- --- ---	--- --- ---	--- --- ---	NOTE 1	SQUARE PLATE FACE DIFFUSER TYPE WITH SINGLE SQUARE AIR DIFFUSION PANEL. DIFFUSERS SHALL HAVE AN 18" X 18" ALUMINUM FACE PANEL MOUNTED ON AN AERODYNAMICALLY SHAPED, ONE-PIECE, SEAMLESS 24" X 24" BACKPAN. EXPOSED SURFACES OF FACE PANELS SHALL BE SMOOTH, FLAT, AND FREE OF VISIBLE FASTENERS.
S-LF	---	---	---	---	---	NOTE 1	SQUARE LOUVERED FACE DIFFUSER TYPE, 24" X 24" FACE, WITH MITERED CORNERS, AND HORIZONTAL/VERTICAL PATTERN ADJUSTMENT DEVICE. ALUMINUM CONSTRUCTION.
S-SG	---	---	---	---	---	NOTE 1	SIDEWALL SUPPLY GRILLE, DOUBLE-DEFLECTION TYPE WITH VERTICAL FRONT BLADES AND HORIZONTAL REAR BLADES. ALUMINUM CONSTRUCTION.
S-LB S-LB-1 S-LB-2	BAR THICKNESS ON CENTER 0.250" 0.250"	BAR SPACING 0.50" 0.50"	DEFLECTION 15° 15°	MEMBER SPACING ON CENTER 9" 9"	WIDTH 10" 10"	NOTE 1	LINEAR BAR DIFFUSER, EXTRUDED ALUMINUM, CONTINUOUS MULTIPLE-BAR FOR FLOOR INSTALLATION. WHERE INDICATED ON THE DRAWINGS. BARS SHALL BE 0.25" THICK, 15° DEFLECTION, 0.25" ON CENTER; SUPPORT MEMBERS SHALL NOT EXCEED 18" ON CENTER.AND WIDTH SHALL BE 10". DIFFUSERS SHALL BE CONTINUOUS WHERE INDICATED ON THE DRAWINGS. PROVIDE BLANK-OFF SECTIONS, MITERED CORNERS, AND VERTICAL PATTERN CONTROL DAMPERS. FINISH AS DIRECTED BY ARCHITECT. A. FLOOR DIFFUSERS SHALL HAVE PERMANENT FINISH DESIGNED FOR HEAVY DUTY TRAFFIC. PROVIDE HEAVY DUTY FRAME FOR FLUSH FLOOR MOUNTING WITH VERTICAL EDGE TO ABUT CARPET.
S-LD S-LD-1	NUMBER OF SLOTS 2	SLOT WIDTH 0.5"	---	---	---	NOTE 1	LINEAR DIFFUSER, EXTRUDED ALUMINUM TYPE, WITH 1" WIDE SLOTS WITH INTEGRAL VOLUME CONTROL AND PATTERN ADJUSTMENT AND CONCEALED MOUNTING FRAME. FINISH IN BAKED ENAMEL WITH WHITE FACE, AND INTERIOR COMPONENTS VISIBLE AFTER INSTALLATION FINISHED FLAT BLACK.
R-LG	---	---	---	---	---	NOTE 1	LINEAR RETURN GRILLE, EXTRUDUDED ALUMINUM 1" SLOT TYPE WITH CONCEALED MOUNTING FRAME, FINISH IN BAKED ENALMEL WITH WHITE FACE AND INTERIOR COMPONENTS VISIBLE AFTER INTALLATION, FINISHED WITH COLOR SELECTED BY ARCHITECT.
R-RP	---	---	---	---	---	NOTE 1	PERFORATED PLATE GRILLE. ALUMINUM CONSTRUCTION.
R-SG	---	---	---	---	---	NOTE 1	SIDEWALL GRILLE, SINGLE-DEFLECTION, 35° FIXED POSITION, 0.5" ON CENTER, HORIZONTAL BLADES. ALUMINUM CONSTRUCTION.
E-PP	---	---	---	---	---	NOTE 1	PERFORATED PLATE GRILLE. ALUMINUM CONSTRUCTION.

NOTES:

1. MANUFACTURER: NAILOR, E.H. PRICE, OR TITUS.

CFD Cape Fear Development

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NORTH CAROLINA PROFESSIONAL SEAL 043322 ENGINEER PAUL JACKSON KITCHENS
Signed on 05/22/2023 using a Digital Signature.

Project Grace
Grace Street
Wilmington, NC 28401
LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC SCHEDULES

ORIG SUBMISSION: 2023.05.22

SHEET:
M-503

PERMIT SET

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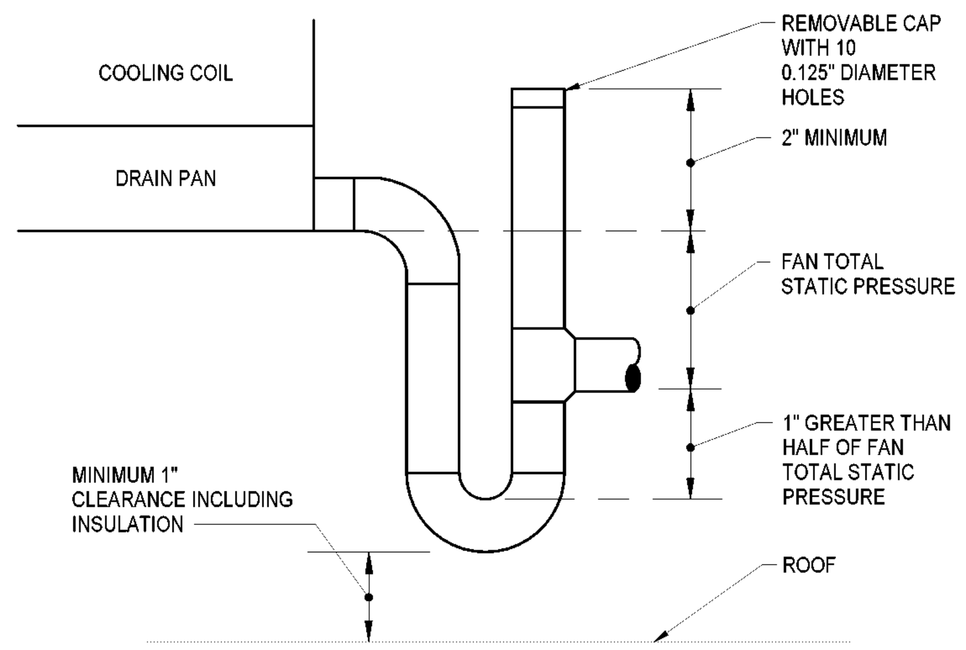
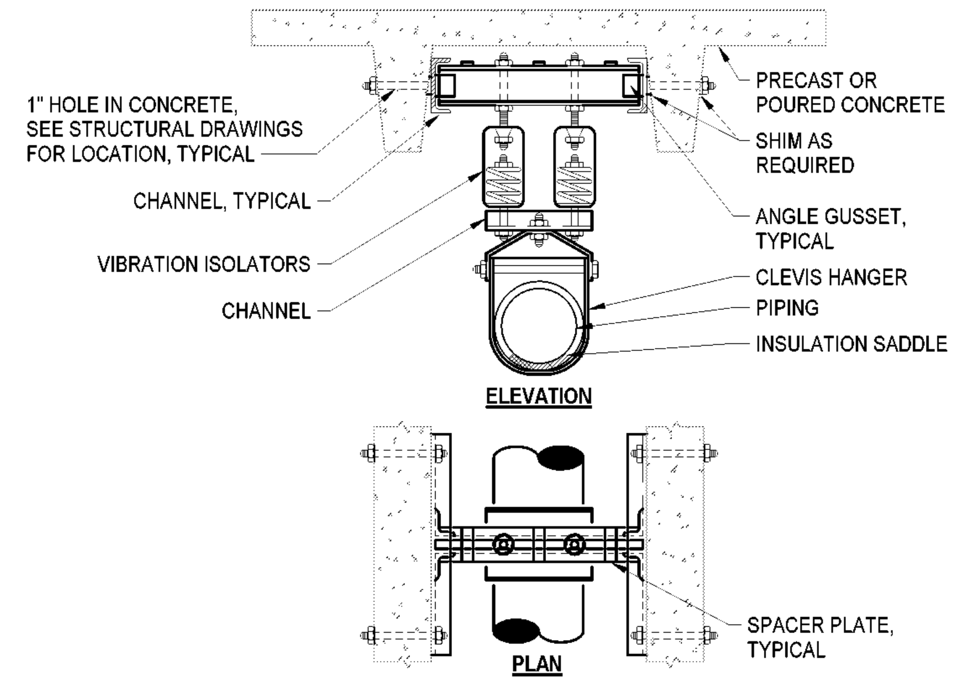


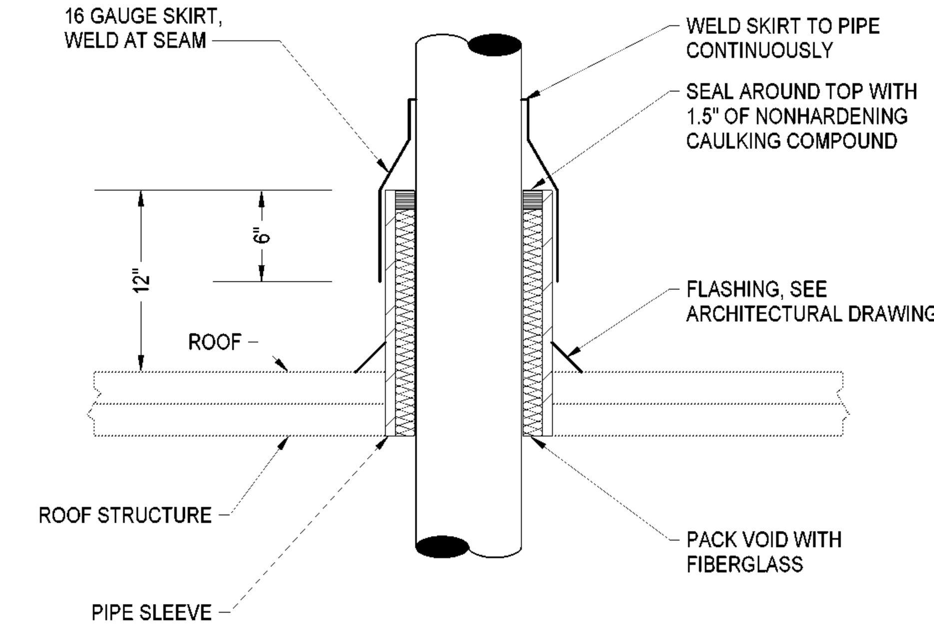
NOTES:
1. PIPING SHALL BE FULL SIZE OF DRAIN CONNECTION.
2. EXTEND DRAIN PIPING AS INDICATED ON THE DRAWINGS OR TO THE NEAREST ROOF RECEPTOR ADJACENT TO EQUIPMENT.
3. WHERE SUPPORTED, ISOLATE DRAIN PIPING FROM CLAMPS WITH TYPE PI ISOLATORS.

1 CONDENSATE DRAIN FOR DRAW THROUGH COOLING COILS
NO SCALE

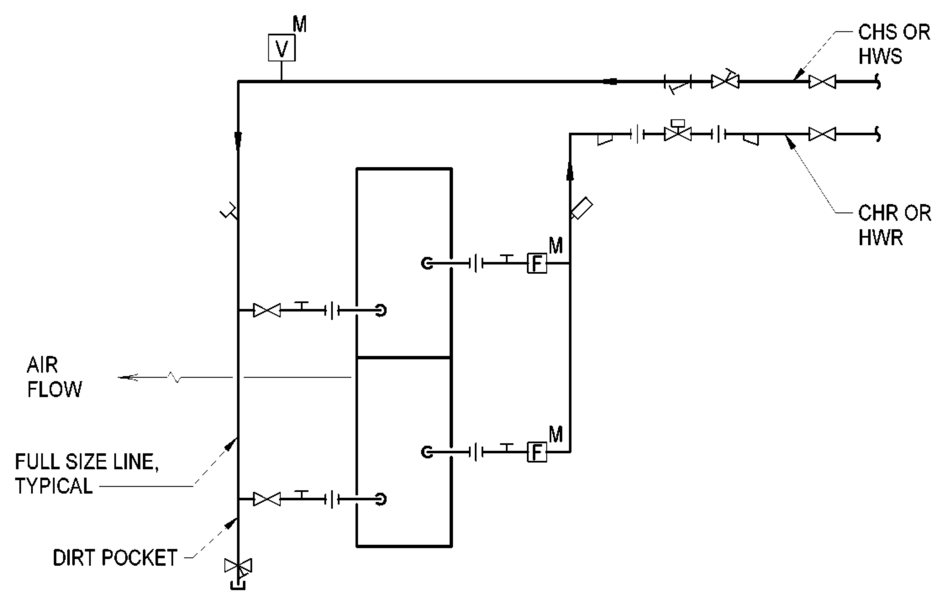


NOTES:
1. SIZE STRUCTURAL MEMBERS FOR THE LOAD TO BE SUPPORTED, WITH A MINIMUM 2:1 SAFETY FACTOR.
2. PAINT ENTIRE ASSEMBLY AS SPECIFIED.
3. ANGLE AND PLATE CONNECTIONS SHALL BE MADE WITH CONTINUOUS WELDS.
4. SEE SPECIFICATIONS FOR VIBRATION ISOLATION REQUIREMENTS.

2 PIPING SUPPORTS
NO SCALE

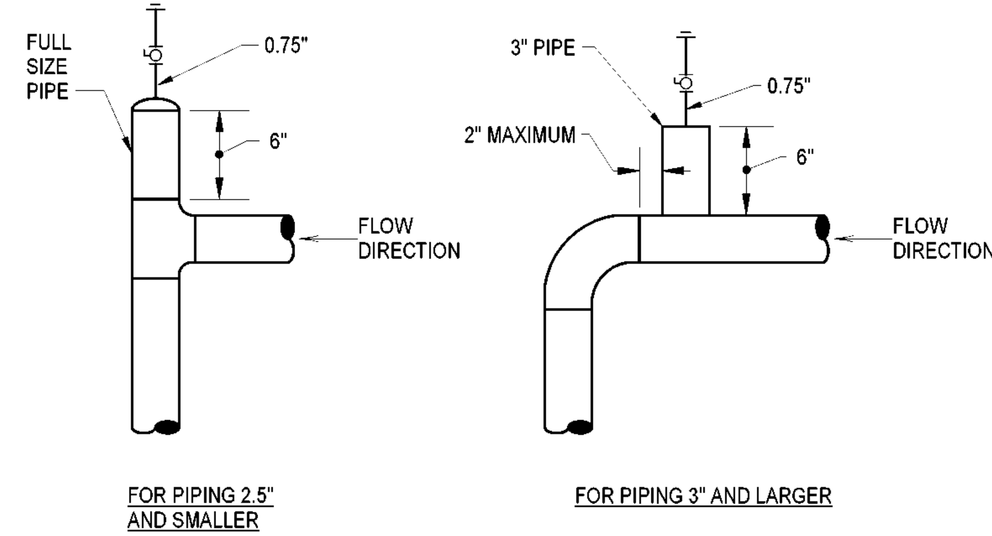


3 PIPING ROOF PENETRATIONS
NO SCALE

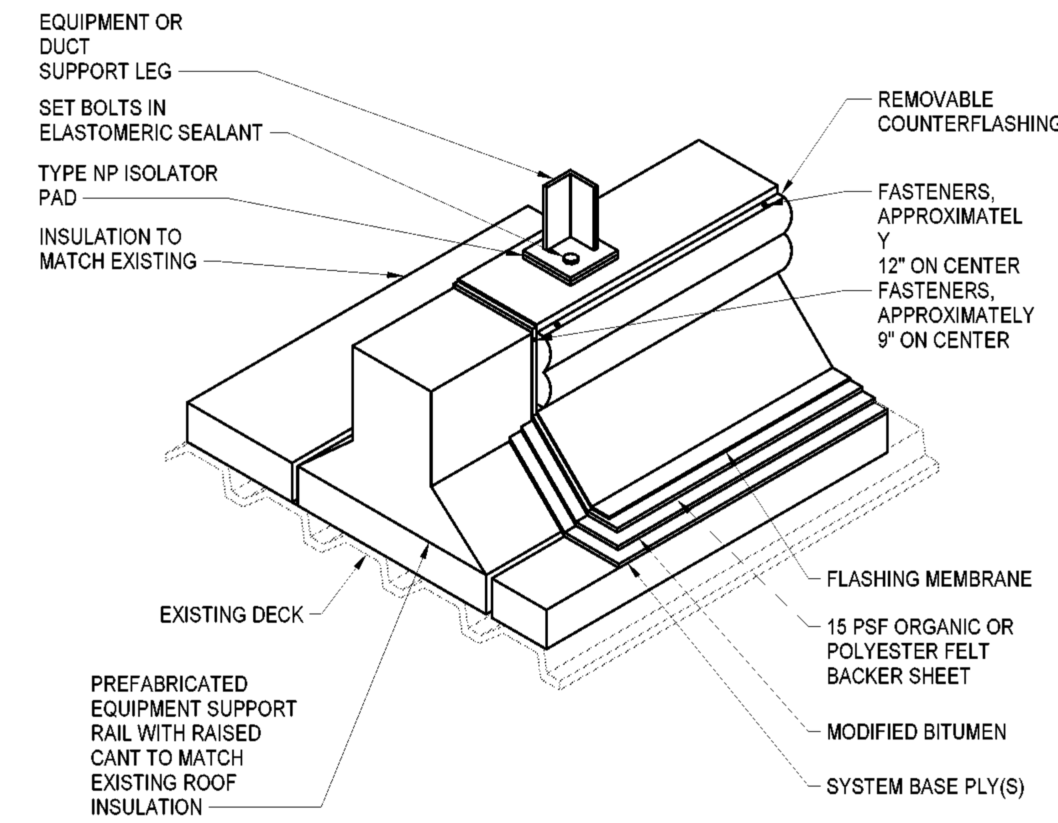


NOTES:
1. COIL CONNECTIONS SHALL BE ARRANGED TO ACCOMMODATE COIL PULL AND TO ISOLATE COIL PIPING FROM SYSTEM.
2. PROVIDE MEANS OF DRAINING AND VENTING EACH COIL.
3. DELETE INDIVIDUAL COIL ISOLATION VALVES IN SINGLE COIL APPLICATIONS.

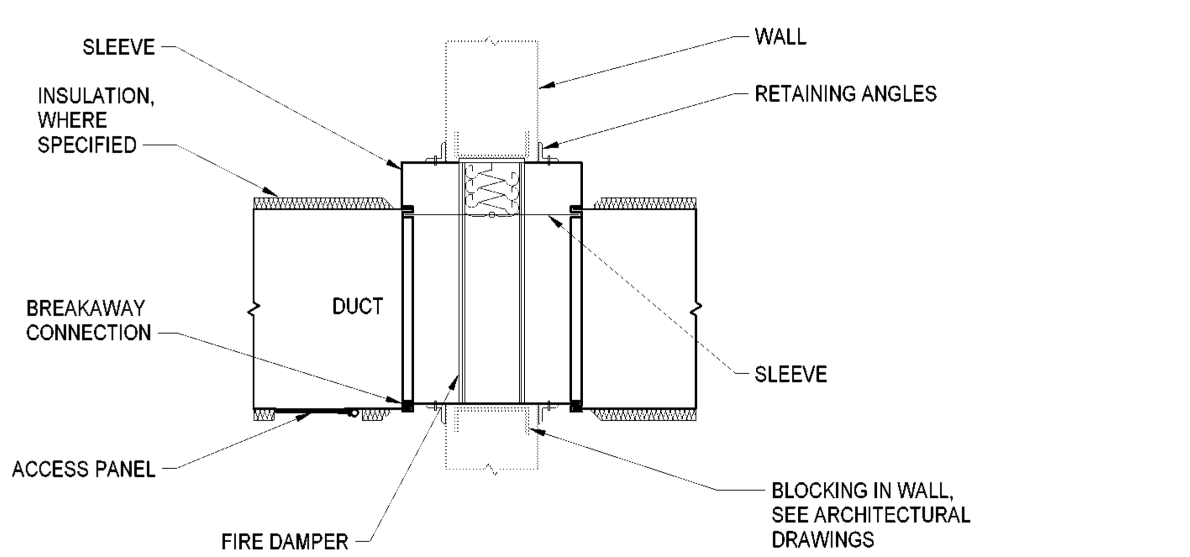
4 WATER COILS WITH 2-WAY VALVES IN AHUs
NO SCALE



5 MANUAL AIR VENTS
NO SCALE

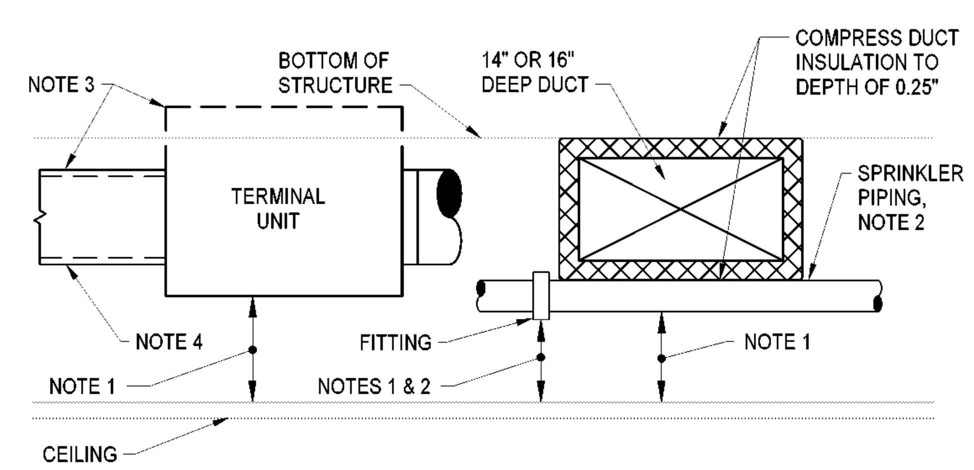


6 EQUIPMENT SUPPORT RAILS
NO SCALE



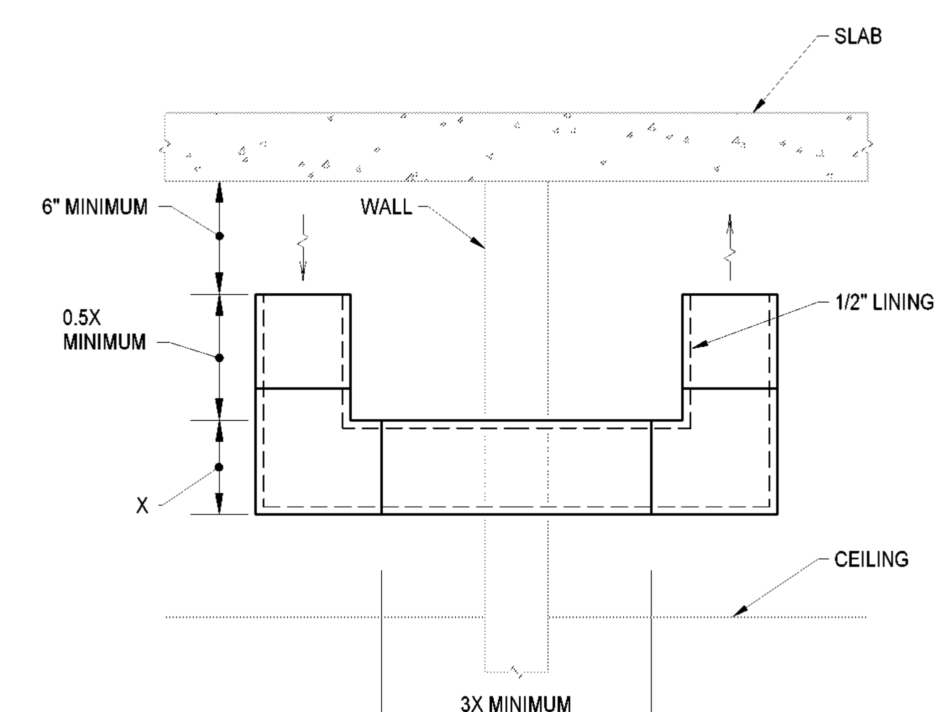
NOTES:
1. INSTALL DAMPERS IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS.
2. TAPE INSULATION TO DUCT AT BREAKAWAY CONNECTIONS. BREAKAWAY CONNECTIONS AND RETAINING ANGLES SHALL BE VISIBLE.
3. TYPE B FIRE DAMPER SHOWN. DO NOT FURNISH TYPE A AND TYPE C DAMPERS.
4. INSTALLATION SIMILAR FOR COMBINATION FIRE/SMOKE DAMPERS.
5. SEAL BREAKAWAY CONNECTIONS.
6. LOCATE ACCESS PANEL ON SIDE OF WALL WITH NO CEILING, OR OVER CORRIDOR CEILING, WHERE APPLICABLE.

7 DUCT WALL PENETRATIONS WITH FIRE DAMPER
NO SCALE



NOTES:
1. MAINTAIN MINIMUM 7" HIGH CLEARANCE FROM BOTTOM OF CEILING FOR LUMINAIRES.
2. DO NOT LOCATE SPRINKLER PIPE FITTINGS UNDER DUCTWORK, DUCTWORK FLANGES, OR TERMINAL UNITS UNLESS 7" CLEARANCE CAN BE MAINTAINED.
3. OFFSET TERMINAL UNITS AND CONNECTING DUCTWORK UP INTO STRUCTURE OR BETWEEN JOISTS TO MAINTAIN 7" CLEARANCE WHERE UNITS HAVE A DEPTH GREATER THAN 16".
4. OFFSET DUCTWORK AND RUNOUTS TO PASS BETWEEN LUMINAIRES TALLER THAN 6.75".
5. OFFSET PIPING, DUCTWORK AND EQUIPMENT TO ACCOMMODATE CEILING COVES AND FRAMING.

8 DUCTWORK INSTALLATION AND COORDINATION
NO SCALE



NOTES:
1. SEAL WALL PENETRATION AIRTIGHT.
2. DUCTS SHALL BE MINIMUM 22 GAUGE SHEET METAL.
3. SEE FLOOR PLANS FOR DUCT SIZES. DUCT SIZE ON PLAN REFERS TO FREE SPACE.
4. 8X8 UNLESS SHOWN OTHERWISE

9 TRANSFER DUCTS
NO SCALE

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SHEET:
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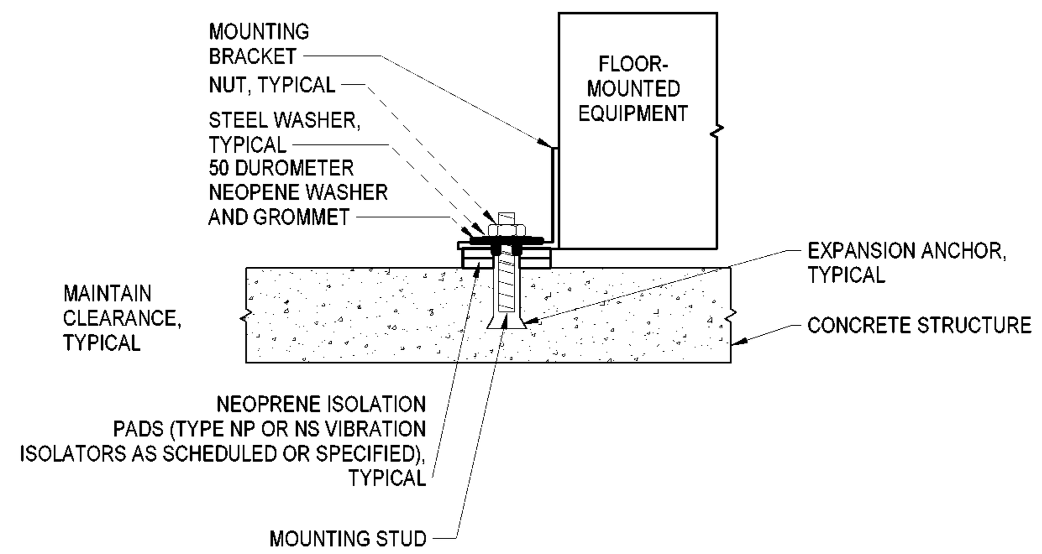
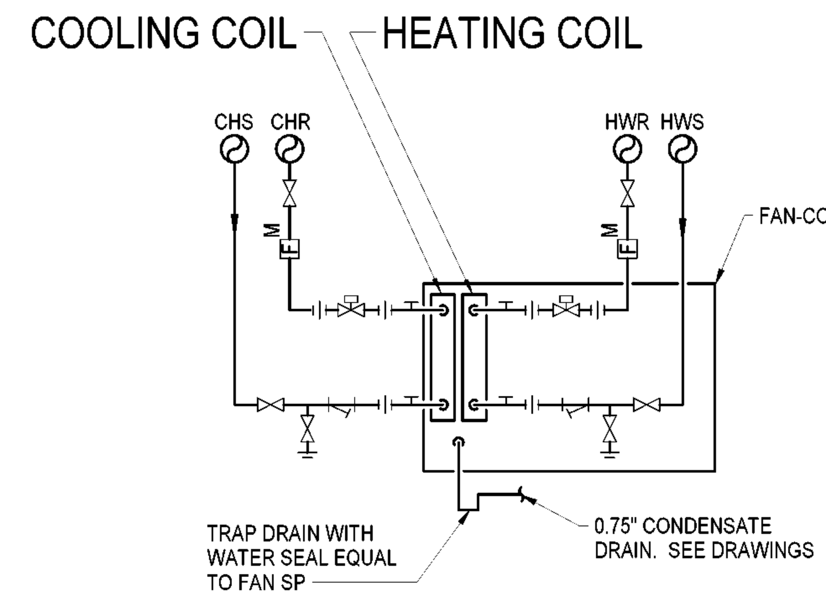


NOTES:
1. MOUNTING STUDS AND ALL-THREAD RODS SHALL BE MINIMUM 0.25" DIAMETER.

1 FLOOR MOUNTED EQUIPMENT WITH VIBRATION ISOLATION

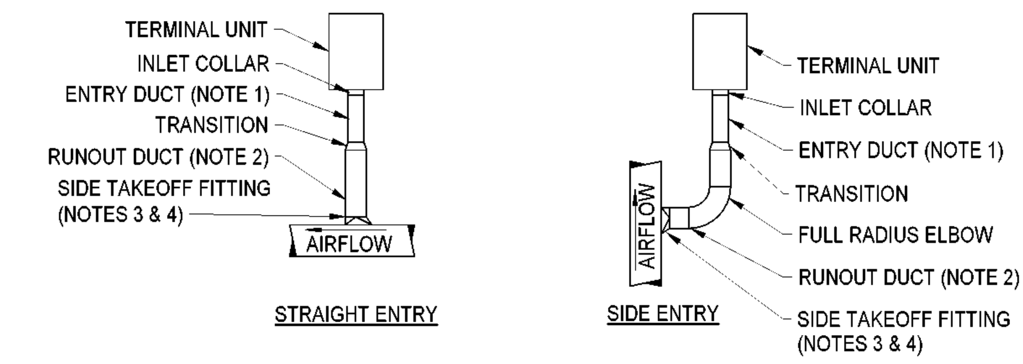
NO SCALE



NOTES:
1. FACTORY-INSTALLED WATER CONTROL PACKAGES ARE ACCEPTABLE. ALL COMPONENTS SHALL MEET THE SPECIFICATION REQUIREMENTS.
2. PROVIDE SWING JOINTS AT HOT WATER SUPPLY AND RETURN CONNECTIONS TO MAINS WHERE COIL RUNOUTS ARE LESS THAN 5'-0" LONG.

2 FAN-COIL UNIT WATER COILS

NO SCALE



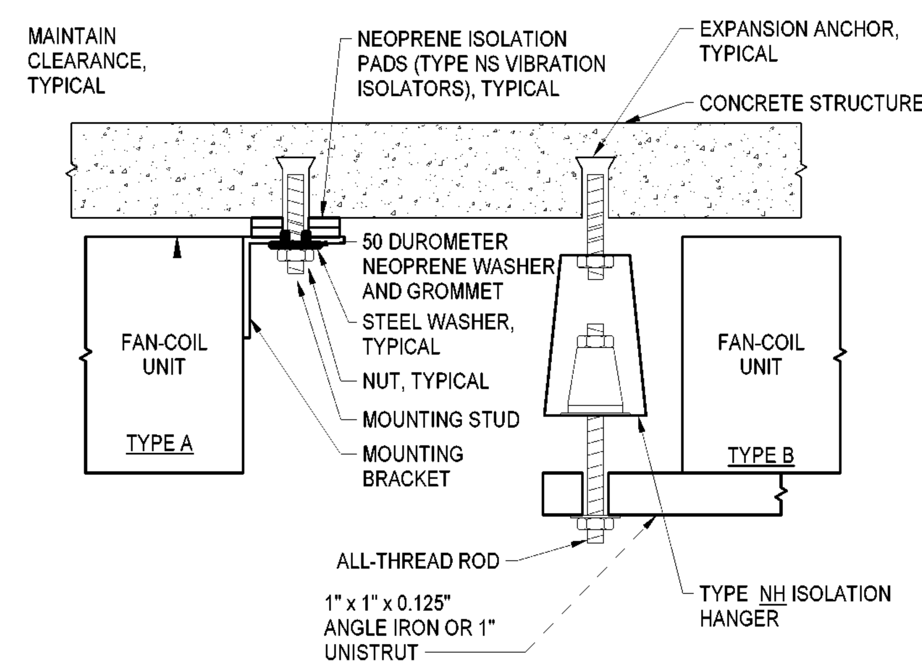
NOTES:
1. ENTRY DUCT SHALL MATCH INLET COLLAR SIZE, BE INDEPENDENTLY SUPPORTED FROM THE TERMINAL UNIT, AND HAVE A TOTAL LENGTH THAT IS 3 TIMES THE DIAMETER OR WIDTH OF THE INLET COLLAR SIZE.
2. THE RUNOUT FROM THE PRIMARY DUCT TO THE ENTRY DUCT, INCLUDING THE FLEXIBLE DUCT, SHALL BE SIZED AS FOLLOWS UNLESS NOTED OTHERWISE ON THE DRAWINGS.

INLET COLLAR AND ENTRY DUCT SIZES	RUNOUT FROM PRIMARY TO ENTRY DUCT
4"ø	8"ø
5"ø	8"ø
6"ø	10"ø
7"ø	12"ø
8"ø	12"ø
9"ø	14"ø
10"ø	14"ø
12"ø	16"ø
14"ø	18"ø
16"ø	20"ø
24"X16"	AS INDICATED ON PLANS

3. FOR ROUND TAKEOFF CONNECTIONS TO ROUND OR FLAT OVAL PRIMARY SUPPLY DUCTS,PROVIDE A CONICAL TAP IN LIEU OF A SIDE TAKEOFF FITTING.
4. FOR AIR HANDLING SYSTEMS WHERE THE PRIMARY SUPPLY DUCT DISTRIBUTION IS PROVIDE A CONICAL TAP IN LIEU OF A SIDE TAKEOFF FITTING. FITTINGS SHALL BE CONCENTRIC TYPE.

3 TERMINAL UNIT INLET

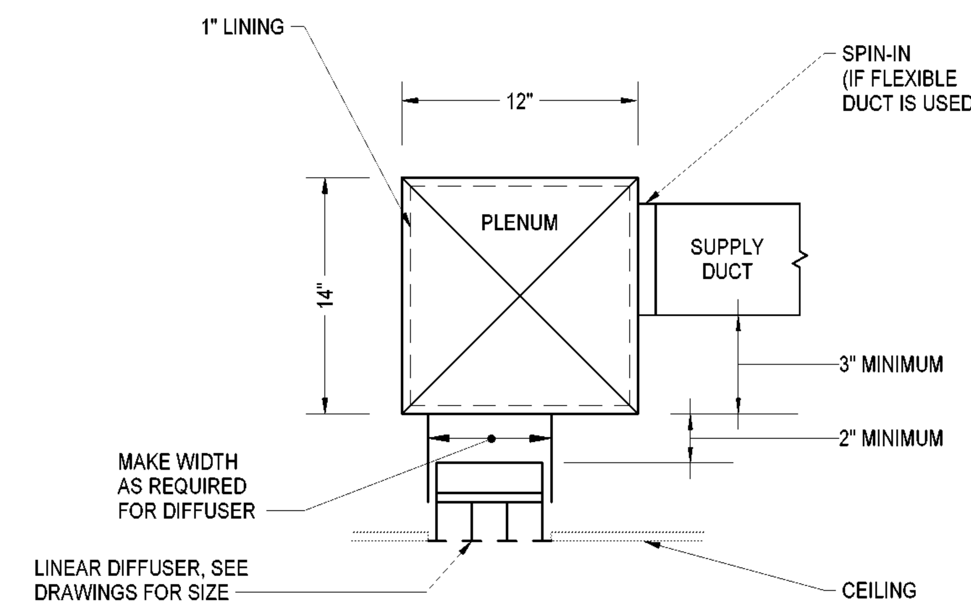
NO SCALE



NOTES:
1. TYPE B MOUNTING ARRANGEMENT SHALL BE USED EXCEPT WHERE SPACE CONSTRAINTS REQUIRE TYPE A MOUNTING.
2. MOUNTING STUDS AND ALL-THREAD RODS SHALL BE MINIMUM 0.25" DIAMETER.

4 FAN COIL UNIT MOUNTINGS WITH VIBRATION ISOLATION

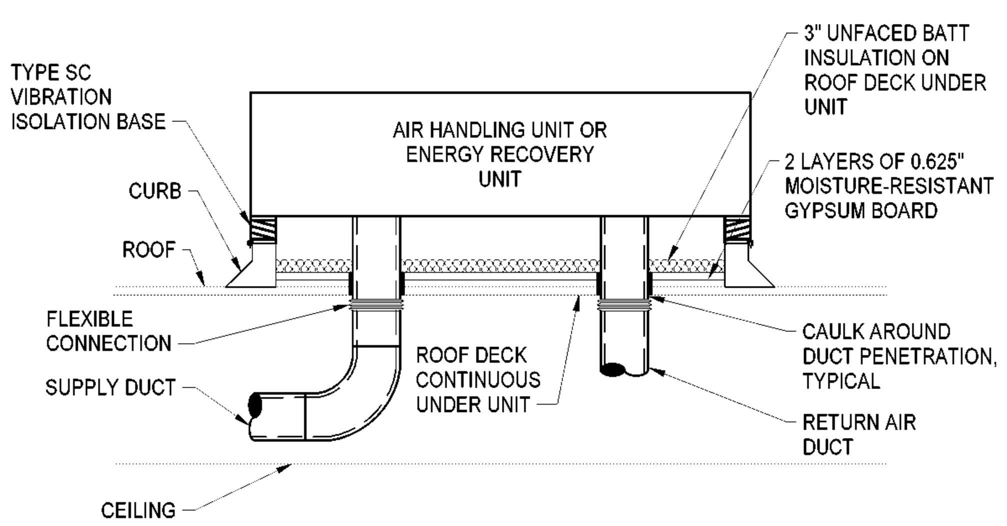
NO SCALE



NOTES:
1. NECK AND PLENUM LENGTH SHALL BE DETERMINED BY ACTIVE DIFFUSER LENGTH.
2. DIFFUSER MOUNTING FRAME SHALL BE DETERMINED BY CEILING CONSTRUCTION AND MOUNTING CONDITIONS. SEE ARCHITECTURAL DRAWINGS.
3. TRANSITION AND/OR ADJUST PLENUM DIMENSIONS TO COORDINATE WITH STRUCTURE OR OTHER UTILITIES.
4. SEE DRAWINGS FOR SPECIAL PLENUM SIZES.

5 LINEAR DIFFUSERS

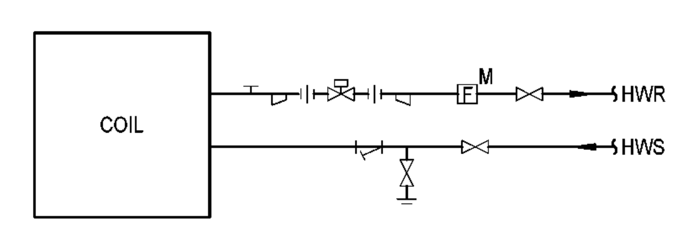
NO SCALE



NOTES:
1. SEE DETAIL FOR CONDENSATE DRAIN PIPING.
2. GYPSUM BOARD JOINTS SHALL BE STAGGERED AND TAPED AND SEALED.

6 OUTDOOR AIR HANDLING UNITS

NO SCALE



NOTES:
1. PROVIDE SWING JOINTS AT SUPPLY AND RETURN CONNECTIONS TO MAINS WHERE COIL RUNOUTS ARE LESS THAN 5'-0" LONG.
2. THIS DETAIL ALSO APPLIES TO DUCT-MOUNTED HOT WATER COILS.
3. LOCATE COMBINATION PRESSURE/TEMPERATURE TEST PORTS AS CLOSE TO COIL CONNECTIONS AS POSSIBLE.

7 TERMINAL UNIT HOT WATER COILS

NO SCALE

CFD
Cape Fear Development

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Firm Lic. # F-0312

NORTH CAROLINA PROFESSIONAL SEAL 043322 ENGINEER PAUL JACKSON KITCHENS
Signed on 05/22/2023 using a Digital Signature.

Project Grace

Grace Street
Wilmington, NC 28401

LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME: HVAC DETAILS

ORIG SUBMISSION: 2023.05.22

SHEET: M-602

PERMIT SET

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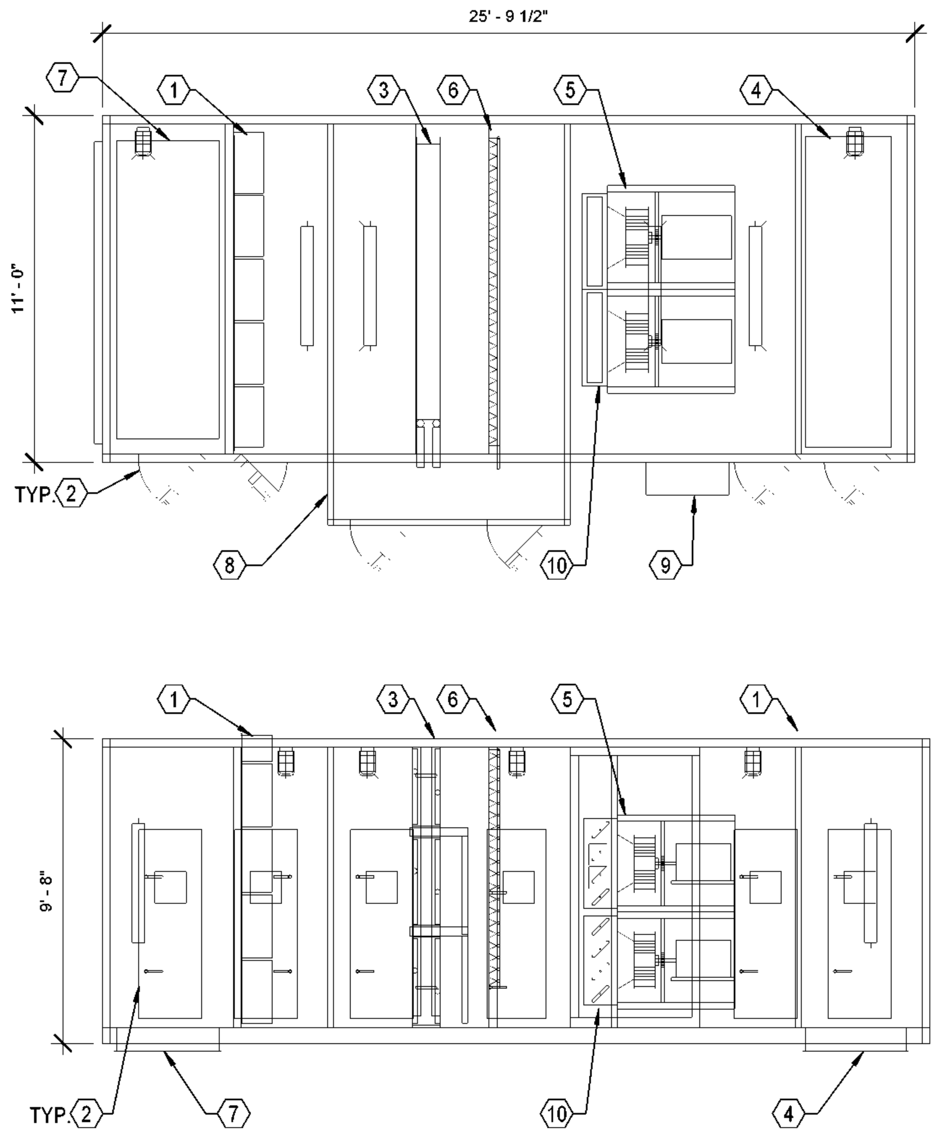
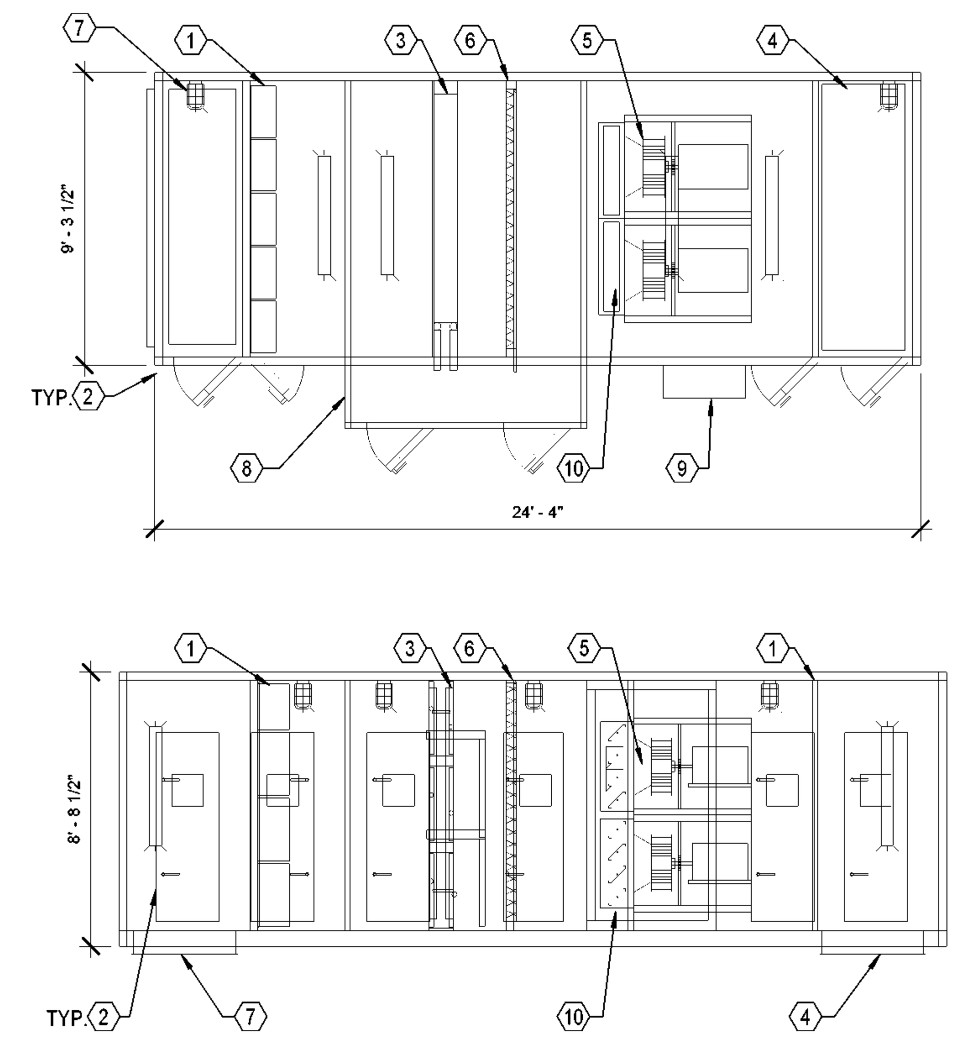


KEYNOTES:

1. FILTER BANK (2" PLEATED MERV 8 + 12" CARTRIDGE MERV 15)
2. ACCESS DOOR
3. CHILLED WATER COIL
4. SUPPLY AIR OPENING
5. SUPPLY FAN ARRAY
6. HUMIDIFIER
7. RETURN AIR OPENING
8. INSULATED COIL CONNECTION VESTIBULE
9. MANUFACTURER PROVIDED VARIABLE FREQUENCY DRIVES. ONE DRIVE PER FAN.
10. ISOLATION DAMPERS. ONE DAMPER FOR FAN.

1 AIR HANDLING UNIT DETAIL (AHU-R-1)

NO SCALE



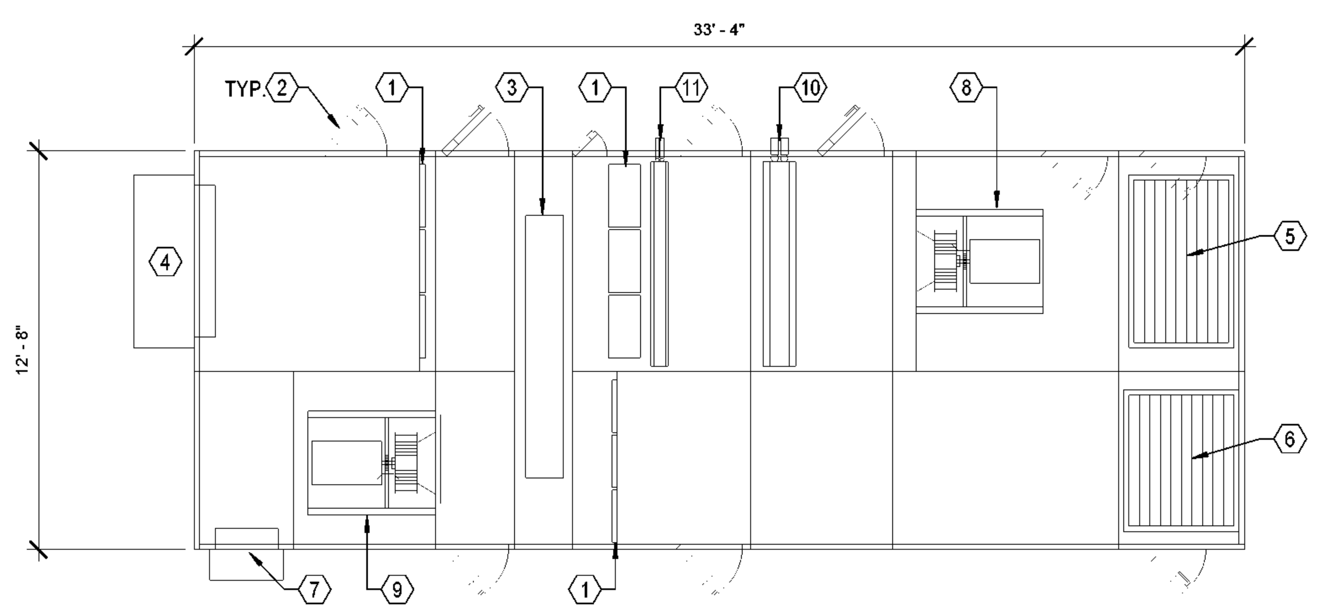
KEYNOTES:

1. FILTER BANK (2" PLEATED MERV 8 + 12" CARTRIDGE MERV 15)
2. ACCESS DOOR
3. CHILLED WATER COIL
4. SUPPLY AIR OPENING
5. SUPPLY FAN ARRAY
6. HUMIDIFIER
7. RETURN AIR OPENING
8. INSULATED COIL CONNECTION VESTIBULE
9. MANUFACTURER PROVIDED VARIABLE FREQUENCY DRIVES. ONE DRIVE PER FAN.
10. ISOLATION DAMPERS. ONE DAMPER FOR FAN.

2 AIR HANDLING UNIT DETAIL (AHU-R-2)

NO SCALE

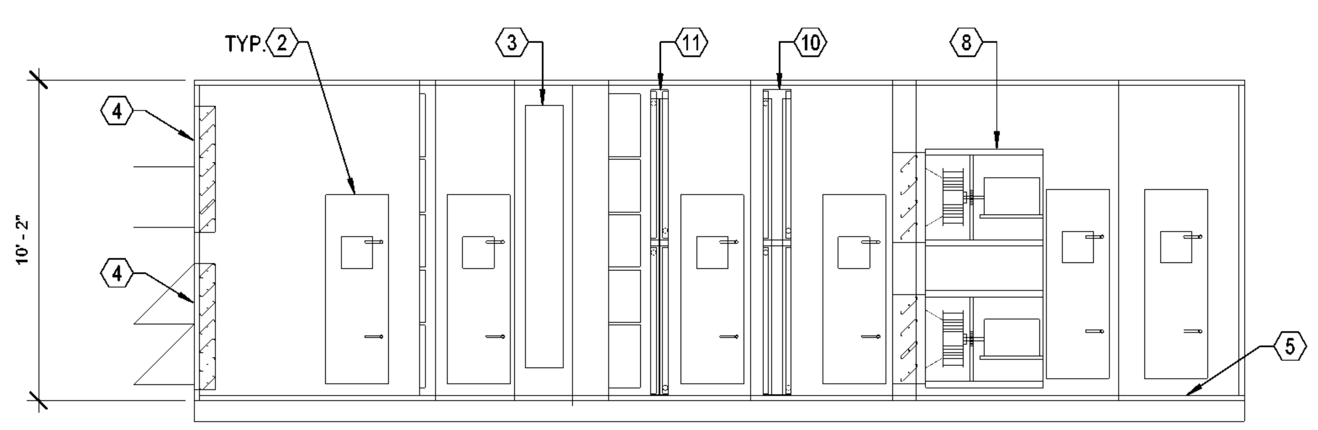
PLAN VIEW



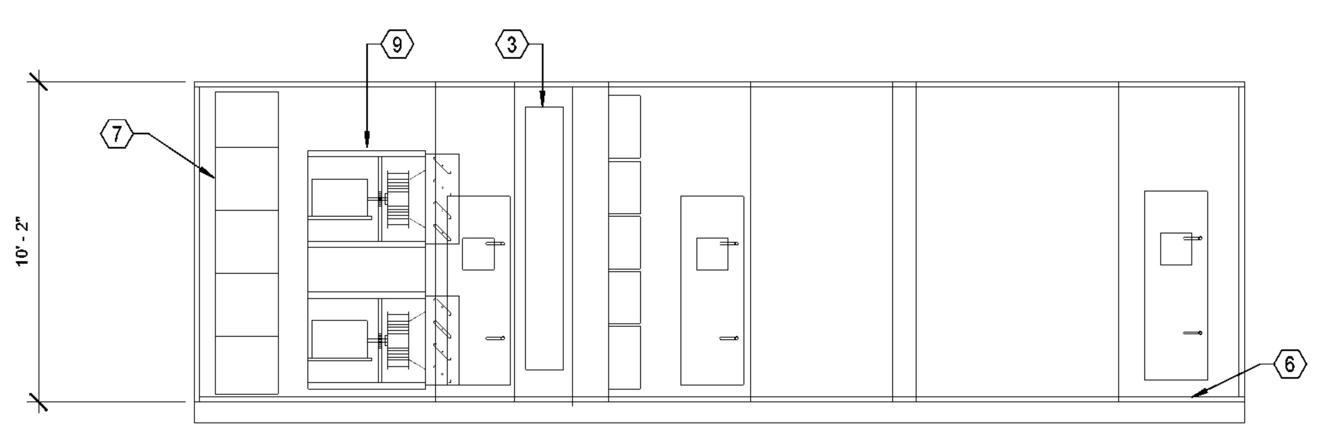
KEYNOTES:

1. FILTER BANK
2. ACCESS DOOR
3. ENERGY WHEEL
4. SUPPLY AIR INLET
5. SUPPLY AIR OUTLET
6. EXHAUST AIR INLET
7. EXHAUST AIR OUTLET
8. SUPPLY FAN ARRAY
9. EXHAUST FAN ARRAY
10. CHILLED WATER COIL
11. HOT WATER COIL

SUPPLY TUNNEL ELEVATION VIEW



EXHAUST TUNNEL ELEVATION VIEW



3 ERU DETAIL

NO SCALE

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CFD Cape Fear Development

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NORTH CAROLINA PROFESSIONAL SEAL 043322 ENGINEER PAUL JACKSON KITCHENS

Signed on 05/22/2023
using a Digital Signature.

Project Grace

Grace Street
Wilmington, NC 28401

LS3P PROJECT: 7701-177600

△	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC DETAILS

ORIG SUBMISSION: 2023.05.22

SHEET: M-603

PERMIT SET

HVAC CONTROLS LEGEND

BCS	SIGNAL TO BCS
BCS	SIGNAL FROM BCS
NETWORK	BACNET NETWORK CONNECTION
FA	SIGNAL FROM FIRE ALARM SYSTEM
	CONSTANT SPEED DRIVE
VFD	VARIABLE FREQUENCY DRIVE
FACP	FIRE ALARM CONTROL PANEL
	AIRFLOW MEASURMENT STATION
	FILTER
C C	COOLING COIL
H C	HEATING COIL
	CONTROL DAMPER
	CENTRIFUGAL FAN
NO	TWO-WAY CONTROL VALVE
	LOUVER
	PUMP
	TERMINAL UNIT
T	ROOM TEMPERATURE SENSOR
T	ROOM THERMOSTAT
C2	CARBON DIOXIDE SENSOR
C	CARBON MONOXIDE SENSOR
N	NITROGEN SENSOR
O	OCCUPANCY SENSOR
CR	CURRENT SENSING RELAY
DP	DIFFERENTIAL PRESSURE SENSOR SENSING LOCATION
ES	END SWITCH
FA	FIRE ALARM RELAY (BY DIVISION 28)
H	ROOM HUMIDITY SENSOR
H	ROOM HUMIDISTAT
HL	HIGH PRESSURE LIMIT SWITCH
LL	LOW PRESSURE LIMIT SWITCH
FACP SD	DUCT SMOKE DETECTOR BY FA
	LOCAL INTERLOCK WIRING
T	DUCT OR PIPE TEMPERATURE SENSOR
H	DUCT HUMIDITY SENSOR
FM	FLOW METER
A	ALARM
T	AVERAGING TEMPERATURE SENSOR
T	AVERAGING TYPE THERMOSTAT
FZ	LOW LIMIT SAFETY THERMOSTAT (FREEZE STAT)
SP	STATIC PRESSURE SENSOR
PS	DIFFERENTIAL PRESSURE SWITCH
DP	DIFFERENTIAL PRESSURE SENSOR
CT	CURRENT TRANSDUCER
S	STARTER
	DIRECTION OF AIRFLOW
	DIRECTION OF WATERFLOW
DP	DIFFERENTIAL PRESSURE
CS	CONDENSATE SENSOR
E	EMERGENCY FAN SHUTDOWN STATION
M	MANUAL PUSH BUTTON
HS	HIGH STATIC SHUTDOWN

ABBREVIATIONS

AP	AIR PRESSURE
APD	AIR PRESSURE DROP
ARCH	ARCHITECT/ARCHITECTURAL
CFM	CUBIC FEET PER MINUTE
CHR	CHILLED WATER RETURN
CHS	CHILLED WATER SUPPLY
DB	DRY BULB
BCS	BUILDING CONTROL SYSTEM
DN	DOWN
DWG	DRAWING
EA	EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE
EWT	ENTERING WATER TEMPERATURE
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
GPM	GALLONS PER MINUTE
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
LAT	LEAVING AIR TEMPERATURE
LWT	LEAVING WATER TEMPERATURE
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OA	OUTSIDE AIR
PRV	PRESSURE REDUCING VALVE
SA	SOUND ATTENUATOR
TEMP	TEMPERATURE
TYP	TYPICAL
VFD	VARIABLE FREQUENCY DRIVE
WB	WET BULB
WG	WATER GAUGE
WPD	WATER PRESSURE DROP

AUTOMATIC TEMPERATURE CONTROLS GENERAL NOTES

GENERAL

1. DESCRIPTION
   A. GENERAL PROVISIONS AND HVAC SYSTEMS ARE SPECIFIED IN OTHER SECTIONS OF DIVISION 23.
   B. THIS SECTION COVERS AUTOMATIC TEMPERATURE CONTROL SYSTEMS AND EQUIPMENT. AUTOMATIC TEMPERATURE CONTROL SYSTEMS INCLUDE THE BUILDING CONTROL SYSTEM (BCS), FACILITY MANAGEMENT CONTROL SYSTEM (FMCS) AND OTHER ANCILLARY SYSTEMS SPECIFIED HEREIN.
   C. THIS SECTION INCLUDES RESPONSIBILITIES AND OBLIGATIONS IN SUPPORT OF THE PERFORMANCE VERIFICATION SPECIFIED IN SECTION 23 00 90, HVAC PERFORMANCE VERIFICATION AND COMMISSIONING SPECIFIED IN SECTION 230800 COMMISSIONING OF HVAC.
   D. THE BCS INCLUDES THE NETWORK OF INTEROPERABLE, STAND-ALONE DIGITAL CONTROLLERS COMMUNICATING VIA NETWORK DEVICES.
2. RELATED WORK
   A. THE INSTALLATION OF MOTOR STARTERS THAT ARE NOT FACTORY-INSTALLED, THERMAL OVERLOAD SWITCHES, AND POWER WIRING TO MOTORS, STARTERS, THERMAL OVERLOAD SWITCHES, ELECTRIC HUMIDIFIERS, AND CONTACTORS, IS SPECIFIED IN ANOTHER DIVISION. THIS SECTION INCLUDES THE FURNISHING AND INSTALLATION OF CONTROLS AND WIRING FOR AUTOMATIC CONTROLS, ELECTRIC DAMPER AND VALVE ACTUATORS AND MOTORS, TERMINAL UNIT CONTROLLERS, INTERLOCKS, STARTING CIRCUITS, AND 120 V AND LOW VOLTAGE POWER WIRING TO POWER CONSUMING CONTROL DEVICES
   B. AREA SMOKE DETECTORS ARE PROVIDED, INSTALLED AND WIRED UNDER DIVISION 28. DUCT SMOKE DETECTORS SHALL BE INSTALLED UNDER DIVISION 23, BUT FURNISHED AND WIRED INTO THE FIRE ALARM SYSTEM UNDER DIVISION 28. THIS SECTION INCLUDES WIRING FIRE ALARM SIGNAL RELAYS, PROVIDED AND INSTALLED UNDER ANOTHER DIVISION, TO THE AUTOMATIC TEMPERATURE CONTROL SYSTEMS.
   C. THE MONITORING AND DATA LOGGING CAPABILITIES OF THE BCS SHALL BE AVAILABLE FOR USE IN THE COMMISSIONING PROCESS.
3. QUALITY ASSURANCE
   A. WITHIN 30 DAYS AFTER NOTICE TO PROCEED, SUBMIT RESUMES FOR THE PROJECT MANAGER, APPLICATION ENGINEER AND FIELD SUPERVISOR ASSIGNED TO THE PROJECT. THE OWNER AND ENGINEER RESERVE THE RIGHT TO EXCLUDE PROPOSED STAFF NOT HAVING THE EXPERIENCE DEEMED SUFFICIENT FOR THE PROJECT. THE PROPOSED STAFF SHALL HAVE THE FOLLOWING MINIMUM EXPERIENCE LEVELS:
      1. PROJECT MANAGER: 5 YEARS EXPERIENCE, AND TWO PROJECTS OF SIMILAR SIZE AND TYPE.
      2. APPLICATION ENGINEER: 7 YEARS EXPERIENCE, AND BE MANUFACTURER-CERTIFIED FOR THE SYSTEM BEING PROVIDED.
      3. FIELD SUPERVISOR: 5 YEARS EXPERIENCE, AND BE MANUFACTURER-CERTIFIED FOR THE SYSTEM BEING PROVIDED.
   B. INSTALLATION SHALL BE BY TECHNICIANS TRAINED BY THE CONTROL MANUFACTURER.
4. SUBMITTALS
   A. SUBMIT A SINGLE COMPREHENSIVE SUBMITTAL PACKAGE INCLUDING THE FOLLOWING ITEMS. AT THE CONTRACTOR'S OPTION, CONTROL VALVES AND CONTROL DAMPERS MAY BE SUBMITTED IN A SEPARATE SUBMITTAL IN ADVANCE OF THE OTHER ITEMS TO MAINTAIN PROJECT SCHEDULE.
      1. BCS DATA: INCLUDING CONTROL MANUFACTURER'S DATA SHEETS ON BCS CONTROLLERS, NACS, WORKSTATIONS, SENSORS, METERS, RELAYS, ACTUATORS, MOTORS, TERMINAL UNIT CONTROLLERS, PROTECTION DEVICES, AND OTHER DEVICES SPECIFIED HEREIN. INCLUDE DATA ON SOFTWARE.
      2. NETWORK DATA: INCLUDING SWITCHES, CONVERTERS, ROUTERS, BROADCAST MANAGEMENT DEVICES AND CABLING, AS NECESSARY.
      3. GRAPHICS: INCLUDE ILLUSTRATIONS OF PROPOSED GRAPHICS DISPLAYS, INCLUDING A FLOWCHART OR SITE MAP INDICATING SYSTEM NAVIGATION LINKS.
      4. DIAGRAMS: SEPARATE FIELD WIRING DIAGRAMS FOR EACH SYSTEM, INCLUDING MOTOR STARTING AND INTERLOCK WIRING, LADDER DIAGRAMS, CONTROL WIRING, INTERIOR ELECTRICAL CIRCUITS OF CONTROL INSTRUMENTS WITH TERMINAL AND CONTROL DEVICE DESIGNATIONS, ACTUATORS AND MOTORS, COLORS OF WIRES, LOCATIONS OF INSTRUMENTS AND REMOTE ELEMENTS, INTERFACES WITH COMMUNICATIONS EQUIPMENT PROVIDED WITH EQUIPMENT SPECIFIED IN OTHER SECTIONS, AND NORMAL POSITION OF RELAYS. EACH DIAGRAM SHALL HAVE TERMINALS LABELED AS THEY WILL BE MARKED ON THE INSTALLED EQUIPMENT.
      5. SYSTEM ARCHITECTURE: PROVIDE A DRAWING OF THE PROPOSED SYSTEM ARCHITECTURE SHOWING CONFIGURATION AND LOCATIONS FOR BCS CONTROLLERS, TERMINAL UNIT CONTROLLERS, SYSTEM SERVERS, CONTROL WIRING FOR EACH DEVICE, AND HARDWARE AND WIRING FOR CONNECTIONS. INDICATE THE SPARE CAPACITY AND BACNET INSTANCE NUMBER OR NETWORK ADDRESS FOR EACH DEVICE. INCLUDE NETWORKING HARDWARE SUCH AS SWITCHES, CONVERTERS, ROUTERS, AND BROADCAST MANAGEMENT DEVICES, AND INDICATE IP ADDRESSES. PROVIDE DIAGRAMS OF THE PROPOSED CONTROL POWER INFRASTRUCTURE, INCLUDING THE DESIGNATION OF THE ELECTRICAL PANELBOARDS THAT WILL BE UTILIZED TO PROVIDE CONTROL POWER, THE QUANTITY, CONFIGURATION, SIZE, AND LOCATION OF CONTROLS SYSTEM TRANSFORMERS, AND THE DISTRIBUTION WIRING TO POWER CONSUMING CONTROL DEVICES. PROVIDE FLOOR PLANS LOCATING EQUIPMENT COORDINATED WITH THE WORK OF OTHER TRADES.
      6. UNINTERRUPTIBLE POWER SUPPLIES: PROVIDE WIRING DIAGRAMS AND SIZING CALCULATIONS FOR UNINTERRUPTIBLE POWER SUPPLIES.
      7. SEQUENCES OF OPERATION: COMPLETE DETAILED SEQUENCES OF OPERATION, INCLUDING A NARRATIVE OF THE SYSTEM OPERATION AND INTERACTIONS AND INTERLOCKS WITH OTHER SYSTEMS, NOTATIONS INDICATING WHETHER INTERLOCK OR INTERACTION IS ACCOMPLISHED THROUGH SOFTWARE OR HARD WIRED CONNECTIONS, DETAILED DELINEATION OF CONTROL BETWEEN PACKAGED CONTROLS AND THE BCS, AND SEQUENCES OF OPERATION FOR PACKAGED CONTROLLED EQUIPMENT THAT INTERFACES WITH THE BCS.
      8. SYSTEM IMPLEMENTATION REQUIREMENTS: NETWORK, WORKSTATION, AND WEB BROWSER REQUIREMENTS FOR BCS FUNCTIONALITY ON THE OWNER'S SYSTEMS. INDICATE OPERATING SYSTEM AND JAVA REQUIREMENTS FOR COMPATIBILITY.
5. PROJECT CONDITIONS
   A. VISIT THE PROJECT BEFORE PREPARING A BID. ATTENTION IS CALLED TO THE FACT THAT THIS PROJECT INVOLVES MODIFICATION AND REWORKING OF AN EXISTING TEMPERATURE CONTROL SYSTEM. EXCEPT AS SPECIFIED HEREIN OR INDICATED OTHERWISE ON THE DRAWINGS, EXISTING CONTROL EQUIPMENT, WHERE APPLICABLE, MAY BE REUSED AFTER REPAIRING TO PLACE IN FIRST-CLASS OPERATING CONDITION. REUSED INSTRUMENTS SHALL BEAR THE SAME WARRANTY AS NEW INSTRUMENTS. WHERE NEW CONTROLLERS ARE PROVIDED, EXISTING PANELS AND DEVICES SHALL BE DISCONNECTED AND REMOVED, AND EXISTING CONDUIT, WIRING, PIPING, TUBING, EQUIPMENT, AND DEVICES THAT ARE NOT REUSED AS PART OF THE RENOVATED CONTROL SYSTEM SHALL BE REMOVED.
   B. ADVISE, IN WRITING, OF ANY MALFUNCTIONS OR INOPERATIVE CONTROL APPARATUS OR INSTRUMENTS THAT BECOME APPARENT DURING THE COURSE OF THE WORK IN PORTIONS OF THE TEMPERATURE CONTROL SYSTEM THAT ARE NOT DIRECTLY AFFECTED BY THIS PROJECT.

PRODUCTS

1. ACCEPTABLE MANUFACTURERS
   A. JCI ONLY.
2. SYSTEM ARCHITECTURE
   A. PROVIDE A COMPLETE PEER-TO-PEER NETWORKED, STAND-ALONE, DISTRIBUTED BCS TO PERFORM THE CONTROLS FUNCTIONS AND MONITOR THE POINTS SPECIFIED HEREIN AND ON THE DRAWINGS. THE BCS SHALL BE ENGINEERED AND EQUIPMENT SELECTED BY THE MANUFACTURER AS REQUIRED TO MEET THE PERFORMANCE SPECIFIED HEREIN. THE BCS SHALL BE COMPRISED OF A NETWORK OF INTEROPERABLE, STAND-ALONE DIGITAL CONTROLLERS COMMUNICATING VIA THE LONMARK OR BACNET COMMUNICATION PROTOCOLS WITH ONE OR MULTIPLE NACS. LOWER LEVEL NETWORKS UTILIZING BACNET OVER MS/TP SHALL ONLY SERVE TERMINAL UNITS. THE FMCS SHALL INTERFACE WITH THE ELECTRIC AND ELECTRONIC SYSTEMS TO PROVIDE CONTROL OUTPUTS AND MONITORING INPUTS TO THE FMCS AS SPECIFIED HEREIN AND AS INDICATED ON THE DRAWINGS. COMPLETE ELECTRIC CONTROL SYSTEMS SHALL BE PROVIDED TO PERFORM SEQUENCES NOT INDICATED TO BE PERFORMED BY THE FMCS. THE BCSS SHALL INTERFACE WITH THE ELECTRIC AND ELECTRONIC SYSTEMS TO PROVIDE CONTROL OUTPUTS AND MONITORING INPUTS TO THE BCSS AS SPECIFIED HEREIN AND AS INDICATED ON THE DRAWINGS. PROVIDE COMMUNICATIONS MEDIA, CONNECTORS, REPEATERS, BRIDGES, SWITCHES, AND ROUTERS NECESSARY TO PROVIDE A FULLY FUNCTIONAL BCS NETWORK. COMPLETE ELECTRIC CONTROL SYSTEMS SHALL BE PROVIDED TO PERFORM SEQUENCES NOT INDICATED TO BE PERFORMED BY THE BCSS. THE LOCATION AND QUANTITY OF BCS CONTROLLERS SHALL BE AS DETERMINED BY THE BCS MANUFACTURER EXCEPT THAT, AS A MINIMUM, A SEPARATE STAND-ALONE CONTROLLER SHALL BE PROVIDED FOR EACH REFRIGERATION PLANT, HEATING PLANT, AIR HANDLING UNIT OVER 3 HP, AND AS INDICATED ON THE DRAWINGS. SENSORS AND CONTROL POINTS FOR EACH SYSTEM SHALL BE CONNECTED TO ITS ASSOCIATED STAND-ALONE CONTROLLER. EACH BCS CONTROLLER SHALL BE DESIGNED TO ALLOW FOR THE FUTURE ADDITION OF AT LEAST 20% OF THE NUMBER OF CONNECTED INPUT/OUTPUT POINTS; IT IS ACCEPTABLE TO ACHIEVE THE 20% SPARE CAPACITY WITH 10% SPARE ON THE BCS CONTROLLER WITH CAPABILITY OF ADDING INPUT/OUTPUT EXPANSION MODULES WITH AN ADDITIONAL 10%. BCS CONTROLLER SPARE CAPACITY SHALL APPLY TO BOTH ANALOG AND DIGITAL CONTROL POINTS. THE BCS AND FMCS, INCLUDING THE SYSTEM SERVERS, THE NETWORK COMPONENTS, AND NETWORK AREA CONTROLLERS (NACS), SHALL BE DESIGNED TO ALLOW FOR THE FUTURE ADDITION OF AT LEAST 100% OF THE NUMBER OF CONTROL OBJECTS CONNECTED TO THE COMPONENTS OR SYSTEMS. AN ALARM CONDITION SHALL BE REPORTED TO THE APPROPRIATE OPERATOR DEVICE NO MORE THAN 10 SECONDS FOLLOWING THE OCCURRENCE OF THAT CONDITION. SENSOR AND CONTROL VALUES DISPLAYED TO THE OPERATOR IN GRAPHICS DISPLAYS SHALL BE DYNAMICALLY UPDATED WITHIN 10 SECONDS OF SIGNIFICANT CHANGE OF VALUE, WITH A TYPICAL RESPONSE TIME OF 1 SECOND OR LESS.
   B. LOWER LEVEL NETWORKS SERVING TERMINAL UNITS, SUCH AS BACNET OVER MS/TP, SHALL BE CONNECTED TO THE ASSOCIATED AIR HANDLING UNIT CONTROLLER. WHEN MULTIPLE LOWER LEVEL NETWORKS ARE REQUIRED FOR A SINGLE AIR HANDLING UNIT, THOSE NETWORKS SHALL BE DIVIDED IN AN ORDERLY METHOD, SUCH AS BY FLOOR OR WING. REMOTE SENSORS SHALL BE WIRED TO THE CONTROLLER ASSOCIATED WITH THAT SENSOR, UNLESS SPECIFIED OTHERWISE.
   C. THE FOLLOWING FUNCTIONS SHALL BE PERFORMED AT THE SERVER OR NAC:
      1. ALARM MONITORING AND ROUTING.
         a. CONTROLLER AND NETWORK FAILURES SHALL BE TREATED AS ALARMS AND ANNUNCIATED.

1. CONTROLLERS
   A. NETWORK AREA CONTROLLERS (NACS):
      1. THE CONTRACTOR SHALL SUPPLY ONE OR MORE NACS. THE QUANTITY AND LOCATION OF NACS IS DEPENDENT ON THE TYPE AND QUANTITY OF CONTROL POINTS AND DEVICES, AND THE FUNCTIONALITY SPECIFIED HEREIN, AND SHALL BE DETERMINED BY THE CONTRACTOR.
      2. NACS SHALL PROVIDE THE INTERFACE BETWEEN THE BUILDING'S COMMUNICATIONS SYSTEM AND THE BCS CONTROL DEVICES, AND PROVIDE GLOBAL SUPERVISORY CONTROL FUNCTIONS OVER THE CONTROL DEVICES CONNECTED TO EACH NAC. IT SHALL BE CAPABLE OF EXECUTING APPLICATION CONTROL PROGRAMS. IT SHALL PERFORM THE FOLLOWING FUNCTIONS:
         a. INTEGRATION OF LONWORKS AND BACNET CONTROLLER DATA.
         b. NETWORK MANAGEMENT FUNCTIONS FOR CONTROL DEVICES.
      3. NACS SHALL HAVE THE FOLLOWING HARDWARE FEATURES AS A MINIMUM:
         a. TWO ETHERNET PORTS - 10/100 MBPS.
         b. ONE LONWORKS INTERFACE PORT - 78KB FTT-10A.
         c. TWO RS-485 PORTS.
         d. BATTERY BACK-UP AND FLASH MEMORY FOR LONG TERM DATA BACKUP, WITH MINIMUM 1 GIGABYTE STORAGE CAPACITY.
      4. LOCAL UPS BATTERY BACKUP SHALL BE INSTALLED WITHIN NAC ENCLOSURE.

      5) NACS SHALL BE CAPABLE OF OPERATING UNDER A TEMPERATURE RANGE BETWEEN 32°F TO 122°F AND A HUMIDITY RANGE BETWEEN 5% TO 95% RH, NON-CONDENSING, AND OF BEING STORED UNDER A TEMPERATURE RANGE BETWEEN 0°F AND 158°F.
      6) NACS SHALL PROVIDE MULTIPLE USER ACCESS TO THE SYSTEM AND SUPPORT FOR ODBC OR SQL. A DATABASE RESIDENT ON THE NACS SHALL BE AN ODBC-COMPLIANT DATABASE OR SHALL PROVIDE AN ODBC DATA ACCESS MECHANISM TO READ AND WRITE DATA STORED WITHIN IT.
      7) ALARM NOTIFICATIONS AND ACTIONS:
         a. NACS SHALL PROVIDE ALARM RECOGNITION, STORAGE, ROUTING, MANAGEMENT, AND ANALYSIS TO SUPPLEMENT DISTRIBUTED CAPABILITIES OF EQUIPMENT OR APPLICATION SPECIFIC CONTROLLERS.
         b. NACS SHALL BE ABLE TO ROUTE ANY ALARM CONDITION TO ANY DEFINED USER LOCATION WHETHER CONNECTED TO A LOCAL NETWORK, OR REMOTE VIA DIAL-UP TELEPHONE CONNECTION OR WIDE-AREA NETWORK.
   A. BCS CONTROLLERS: FIELD PROGRAMMABLE, MICROPROCESSOR-BASED TYPE INCORPORATING DIRECT DIGITAL CONTROL AND ENERGY MANAGEMENT FUNCTIONS. EACH BCS CONTROLLER SHALL PERFORM ITS ASSIGNED CONTROL AND ENERGY MANAGEMENT FUNCTIONS AS A STAND-ALONE UNIT AND SHALL COMPLY WITH FCC PART 15, SUBPART B 2019. PROVIDE A COMMUNICATION INTERFACE FOR COMMUNICATION WITH THE BCS. CONTROLS SHALL BE PERFORMED IN A DIGITAL MANNER USING THE DIGITAL SIGNAL FROM THE MICROPROCESSOR BASED CONTROLLER, CONVERTED THROUGH ELECTRONIC CIRCUITRY FOR MODULATION OF ACTUATORS. EACH BCS CONTROLLER SHALL BE EXPANDABLE BY ADDING ADDITIONAL INPUT/OUTPUT MODULES THAT OPERATE THROUGH THE PROCESSOR OF THE BCS CONTROLLER. THE MASTER PROCESSOR IN THE BCS CONTROLLER SHALL BE ABLE TO MANAGE REMOTE FIELD INTERFACE UNITS THEREBY EXPANDING ITS CONTROL LOOP AND ENERGY MANAGEMENT POINT CAPACITY. EACH BCS CONTROLLER INCLUDING ASSOCIATED INPUT/OUTPUT MODULES SHALL HAVE A MINIMUM OF 10% SPARE INPUT AND OUTPUT POINTS OF EACH TYPE INSTALLED. THE BCS CONTROLLER SHALL BE SUPPLIED WITH A MINIMUM OF 8 HOURS OF BATTERY BACK-UP FOR THE CLOCK OPERATION AND MEMORY RETENTION WITH AN AUTOMATIC BATTERY CHARGER. PROVIDE INTERFACE FOR VALVE AND DAMPER ACTUATORS. BCS CONTROLLER HARDWARE SHALL PROVIDE RELAY OR SOLID STATE ISOLATION ON EACH CONTACT INPUT CIRCUIT AND EACH OUTPUT CIRCUIT TO PREVENT HIGH VOLTAGE SURGES FROM ENTERING THE LOGIC CIRCUITS.
      1. PROVIDE MANUAL HAND-OFF-AUTOMATIC (HOA) OVERRIDE SWITCHES AND MEANS FOR MANUALLY ADJUSTING THE ANALOG OUTPUT OF OUTPUTS CONNECTED TO EACH BCS CONTROLLER. HOA SWITCHES AND MANUAL ADJUSTMENTS SHALL BE EITHER OF A KEY OPERATED DESIGN WITH SWITCHES KEYED ALIKE AND UTILIZING THE SAME KEYING SYSTEM USED FOR OTHER OUTPUTS, OR OTHERWISE PROTECTED FROM UNAUTHORIZED ACCESS BY A KEY LOCKED ENCLOSURE.
      2. BCS CONTROLLERS SHALL BE ARRANGED AND INSTALLED TO ALLOW CONTROLLERS TO SHARE GLOBAL DATA. THIS GLOBAL DATA SHALL INCLUDE, BUT NOT BE LIMITED TO: TIME-OF-DAY, OUTSIDE AIR TEMPERATURE AND HUMIDITY, AND ELECTRICAL METER AND DEMAND INFORMATION. IF BCS CONTROLLERS ARE NOT CONFIGURED IN A COMMUNICATION NETWORK TO SHARE THIS DATA, THEN EACH BCS CONTROLLER SHALL BE PROVIDED WITH SENSOR INPUTS TO IMPLEMENT SEQUENCES INDICATED ON THE DRAWINGS WHEN OPERATING IN A STAND-ALONE MODE.
   B. TERMINAL UNIT CONTROLLERS:
      1. CONTROL OF TERMINAL UNITS SHALL BE ACCOMPLISHED BY MICROPROCESSOR-BASED STAND-ALONE TERMINAL UNIT CONTROLLERS UTILIZING DIRECT DIGITAL CONTROL. AN INDIVIDUAL TERMINAL UNIT CONTROLLER SHALL BE PROVIDED FOR EACH TERMINAL UNIT AND SHALL INTERFACE TO THE BCS. TERMINAL UNIT CONTROLLER COMPONENTS SHALL BE FURNISHED TO THE TERMINAL UNIT MANUFACTURER FOR FACTORY MOUNTING AND CALIBRATION. TERMINAL UNIT CONTROLLER POWER SHALL BE 24 V AC. EACH TERMINAL UNIT CONTROLLER SHALL CONTAIN RESIDENT PROGRAMS WHICH ARE FIELD-SELECTABLE FOR A SPECIFIC APPLICATION. RESIDENT PROGRAMS SHALL BE CONTAINED IN NONVOLATILE MEMORY USING EEPROM, EPROM, OR RAM. SYSTEMS THAT EMPLOY VOLATILE (RAM) MEMORY SHALL PROVIDE 72 HOUR BATTERY BACK-UP FOR EACH TERMINAL UNIT CONTROLLER. TEMPERATURE SETPOINTS FOR HEATING AND COOLING AND NIGHT SETBACK SHALL BE INDEPENDENT OF EACH OTHER AND SHALL PROVIDE A ZERO ENERGY BAND BETWEEN HEATING AND COOLING MODES.
      2. EACH TERMINAL UNIT CONTROLLER SHALL BE ACCESSIBLE FOR PURPOSES OF CONTROL PARAMETER AND SETPOINT ADJUSTMENT AND MONITORING FROM THE BCS. AN OPERATOR'S TERMINAL CONNECTED TO ANY BCS CONTROLLER ON THE NETWORK SHALL HAVE ACCESS TO ALL TERMINAL UNIT CONTROLLERS.
2. MATERIALS
   A. ALL ACTUATORS SHALL BE 24V UNLESS OTHERWISE NOTED.
   B. THERMOSTATS: LINE VOLTAGE TYPE AND SHALL HAVE ADJUSTABLE THROTTLING RANGE WITH AN ACCURACY OF ±1.0ºF. ROOM TYPE SHALL HAVE COVER WITH THERMOMETER, AND ACCESSIBLE CONCEALED MEANS OF ADJUSTMENT. REMOTE ELEMENT TYPE SHALL HAVE ACCESSIBLE ADJUSTMENT KNOB. PROVIDE SEPARABLE WELLS FOR ELEMENTS IN LIQUIDS AND EXTENDED NECKS FOR WELLS IN INSULATED PIPE.
      1. LOW LIMIT SAFETIES: ELEMENTS SHALL RESPOND TO THE LOWEST TEMPERATURE TO WHICH ANY 12" SEGMENT IS EXPOSED; MINIMUM LENGTH 8'.
      2. AVERAGING TYPE: FOR USE IN COIL DISCHARGE AND MIXED AIR LOCATIONS.
      3. THERMOSTATS SHALL NOT CONTAIN MERCURY.
   C. OCCUPIED/UNOCCUPIED SWITCHES: STAINLESS STEEL COVERPLATES WITH RED PILOT LIGHT. COVERPLATES SHALL BE ENGRAVED WITH "OCCUPIED/UNOCCUPIED". PILOT LIGHT SHALL BE ON WHENEVER SWITCH IS IN THE OCCUPIED POSITION.
   D. MANUAL PUSH BUTTONS: FLUSH-MOUNTED, IN NEMA 1 ENCLOSURE WITH PILOT LIGHT.
   E. PANELS: SURFACE TYPE CABINET WITH HINGED FRONT PANEL AND CYLINDER LOCK. PANELS SHALL UTILIZE ONE MASTER KEY.
   F. EMERGENCY FAN SHUTDOWN STATIONS: NORMALLY CLOSED TOGGLE SWITCHES MOUNTED ON A PANEL WITH A LOCKED, TRANSPARENT FRONT COVER. PANEL SHALL SHOW A SYSTEM SCHEMATIC SHOWING EACH AREA, AND HAVE ENGRAVED LABELS FOR EACH SWITCH. SUBMIT DETAILED SHOP DRAWING OF PANEL AND LABELS FOR APPROVAL.
   G. EMERGENCY BOILER SHUTDOWN STATIONS: ALUMINUM, BREAK-GLASS SWITCH, FLUSH-MOUNTED, UL LISTED, WITH COVERPLATE MARKING "TO STOP BOILERS".
   H. THERMOWELLS: MONEL, BRASS, OR COPPER FOR USE IN WATER PIPING AND STAINLESS STEEL FOR OTHER APPLICATIONS. THERMOWELLS SHALL HAVE THREADED PLUG AND CHAIN, RETAINING NUT, AND LAGGING NECK TO CLEAR INSULATION. INSIDE DIAMETER OF INSERTION NECK SHALL ACCOMMODATE THE ELEMENT BEING INSTALLED.
   I. TIME SWITCHES: 7 DAY ELECTRONIC PROGRAMMABLE MICROPROCESSOR TYPE, WITH A TEMPORARY OVERRIDE FEATURE FOR OVER CALLING THE OFF POSITION AND OPERATING THE SYSTEM WITHOUT RESETTING THE PROGRAM, AND A 48 HOUR BATTERY POWERED CARRYOVER FOR LOSS OF POWER.
3. AUXILIARY EQUIPMENT
   J. UNINTERRUPTIBLE POWER SUPPLY (UPS): PROVIDE A SELF-CONTAINED UPS DESIGNED FOR INSTALLATION AND OPERATION AT EACH BCS CONTROLLER SIZED FOR AT LEAST 125% OF THE PEAK DEMAND, AND TO PROVIDE A MINIMUM OF 15 MINUTES OF FULL OPERATION OF THE CONTROLLER AND INPUT/OUTPUT EXPANSION MODULES CONNECTED TO THAT CONTROLLER. EQUIPMENT CONNECTED TO THE UPS SHALL NOT BE AFFECTED IN ANY MANNER BY A POWER OUTAGE OF A DURATION LESS THAN THE RATED CAPACITY OF THE UPS. EACH UPS SHALL BE WIRED SUCH THAT PRIMARY POWER TO THE CONTROLLER WILL BE MAINTAINED UPON FAILURE OF THE UPS, INCLUDING EITHER A RELAY SWITCH UPSTREAM OF THE UPS OR TWO UPSS IN PARALLEL. UPS SHALL BE COMPLETE WITH NECESSARY POWER SUPPLIES, TRANSFORMERS, BATTERIES, AND ACCESSORIES AND SHALL INCLUDE VISUAL INDICATION OF NORMAL POWER OPERATION, UPS OPERATION, ABNORMAL OPERATION AND VISUAL AND AUDIBLE INDICATION OF LOW BATTERY POWER.

EXECUTION

1. GENERAL
   A. WHERE CONTROL DEVICES ARE INSTALLED ON INSULATED PIPING OR DUCTWORK, PROVIDE STANDOFF BRACKETS OR THERMOWELLS SIZED TO CLEAR INSULATION THICKNESS. PROVIDE EXTENDED SENSING ELEMENTS, ACTUATOR LINKAGES, AND OTHER ACCESSORIES AS REQUIRED.
2. COMMISSIONING SUPPORT REQUIREMENTS
   A. PREPARE A WRITTEN PLAN INDICATING IN A STEP-BY-STEP MANNER THE PROCEDURES THAT WILL BE FOLLOWED TO TEST, CHECK-OUT, AND ADJUST THE CONTROL SYSTEM PRIOR TO BEGINNING FUNCTIONAL TESTING. KEEP THE COMMISSIONING AUTHORITY INFORMED OF PROGRESS WITH THE PROJECT AND OF CHANGES TO THE PROPOSED INSTALLATION, PROGRAMMING AND TEST PLAN. AT MINIMUM, THE PLAN SHALL INCLUDE FOR EACH TYPE OF EQUIPMENT CONTROLLED BY THE AUTOMATIC CONTROLS:
      1. STEP-BY-STEP PROCEDURES FOR TESTING EACH TYPE CONTROLLER AFTER INSTALLATION, INCLUDING:
         a. PROCESS OF VERIFYING PROPER HARDWARE AND WIRING INSTALLATION.
         b. PROCESS OF DOWNLOADING PROGRAMS TO LOAD CONTROLLERS AND VERIFYING THAT THEY ARE ADDRESSED CORRECTLY.
      2. PROCESS OF VERIFYING PROPER HARDWARE AND WIRING INSTALLATION.
      3. PROCESS OF PERFORMING OPERATIONAL CHECKS OF EACH CONTROLLED COMPONENT.
      4. PLAN AND PROCESS FOR CALIBRATING VALVE AND DAMPER ACTUATORS AND SENSORS.
      5. A DESCRIPTION OF THE EXPECTED FIELD ADJUSTMENTS FOR TRANSMITTERS, CONTROLLERS AND CONTROL ACTUATORS SHOULD CONTROL RESPONSES FALL OUTSIDE OF EXPECTED VALUES.
      6. A COPY OF THE LOG AND FIELD CHECK-OUT SHEETS THAT WILL DOCUMENT THE PROCESS. THIS LOG SHALL INCLUDE A PLACE FOR INITIAL AND FINAL VALUES READ DURING CALIBRATION OF EACH POINT AND CLEARLY INDICATE WHEN A SENSOR OR CONTROLLER HAS PASSED AND IS OPERATING WITHIN THE CONTRACT PARAMETERS. NOTIFICATION OF ANY EQUIPMENT FAILURES SHALL BE DOCUMENTED.
      7. A DESCRIPTION OF THE INSTRUMENTATION REQUIRED FOR TESTING, INCLUDING A CERTIFICATION OF CALIBRATION FOR EACH TEST INSTRUMENT.
      8. IDENTIFY WHICH TESTS AND SYSTEMS SHOULD BE COMPLETED PRIOR TO USING THE CONTROL SYSTEM FOR TEST, ADJUSTMENT, AND BALANCE WORK.

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Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC CONTROLS LEGEND & GENERAL NOTES

ORIG SUBMISSION: 2023.05.22

SHEET: **M-701**

PERMIT SET

B. PROVIDE THE COMMISSIONING AUTHORITY COMPLETE SYSTEM LOGIC DIAGRAMS, DESCRIBING THE PROPOSED SYSTEM PROGRAMMING, WITH PROGRAMMED ATTRIBUTES SHOWN. THESE DIAGRAMS SHALL BE UPDATED WITH FIELD MODIFICATIONS FROM THE START-UP, CHECK-OUT, AND PREFUNCTIONAL TESTING PRIOR TO THE BEGINNING OF THE FUNCTIONAL TESTING OF THE BCS. PROVIDE A COPY OF EACH PROPOSED GRAPHICAL INTERFACE SCREEN WITH INTERFACE POINTS SHOWN FOR THE ENTIRE SYSTEM.

C. PREFUNCTIONAL TESTS: VERIFY AND DOCUMENT THE PROPER INSTALLATION, ADDRESSING, CALIBRATION, PROGRAMMING, OPERATION, AND FAILURE MODE OF BCS CONTROL POINTS, SEQUENCES, AND EQUIPMENT. PROVIDE A SIGNED AND DATED CERTIFICATION TO THE COMMISSIONING AUTHORITY AND OWNER UPON COMPLETION OF THE CHECK-OUT OF EACH CONTROLLED DEVICE, EQUIPMENT, AND SYSTEM THAT INSTALLATION, SET-UP, ADJUSTMENT, CALIBRATION, AND SYSTEM PROGRAMMING IS COMPLETE AS SPECIFIED HEREIN AND AS INDICATED ON THE DRAWINGS, EXCEPT FUNCTIONAL TESTING. COMPLETED PREFUNCTIONAL DOCUMENTATION OF THE SYSTEM VERIFICATION SHALL BE SUBMITTED TO THE COMMISSIONING AUTHORITY FOR REVIEW AND APPROVAL PRIOR TO THE FUNCTIONAL TESTING OF THE BCS OR ITS BEING USED IN THE TESTING OF OTHER EQUIPMENT OR SYSTEMS, OR OTHER PURPOSES. COPIES OF FINAL FIELD CHECK-OUT SHEETS AND TREND LOGS SHALL BE PROVIDED TO THE COMMISSIONING AUTHORITY FOR INCLUSION IN THE COMMISSIONING REPORT.

D. FUNCTIONAL TESTS: CONDUCT AND DOCUMENT A FUNCTIONAL TEST OF THE COMPLETE INSTALLED BCS, AS DEFINED IN SECTION 23 00 90, PERFORMANCE VERIFICATION. FUNCTIONAL TESTING OF THE BCS MAY BE CONDUCTED IN PHASES OR SECTIONS, AS DEFINED BY THE REQUIREMENTS OF THE FUNCTIONAL TEST, OR AS APPROVED BY THE COMMISSIONING AUTHORITY. THE BCS, OR APPLICABLE PORTIONS OF THE SYSTEM, SHALL HAVE COMPLETED FUNCTIONAL TESTING AND BE APPROVED BY THE COMMISSIONING AUTHORITY BEFORE BEING USED FOR OTHER PURPOSES, SUCH AS TEST AND BALANCE MEASUREMENTS, OR IN SUPPORT OF THE FUNCTIONAL TESTING OF OTHER SYSTEMS.
   1. ASSIST IN THE FUNCTIONAL TESTING OF EQUIPMENT AND SYSTEMS BY IMPLEMENTING TREND LOGS AND EQUIPMENT MONITORING AS SPECIFIED HEREIN AND AS REQUIRED BY SECTION 23 00 90, HVAC PERFORMANCE VERIFICATION.

E. MEET WITH THE TESTING, ADJUSTING, AND BALANCING CONTRACTOR PRIOR TO BEGINNING THE TEST, ADJUSTMENT, AND BALANCE PROCESS AND REVIEW THE TEST, ADJUSTING, AND BALANCING PLAN TO DETERMINE THE CAPABILITIES AND REQUIREMENTS OF THE CONTROL SYSTEM IN COMPLETING THE TESTING, ADJUSTING, AND BALANCING PROCESS. PROVIDE THE TESTING, ADJUSTING, AND BALANCING CONTRACTOR ANY NEEDED UNIQUE INSTRUMENTS FOR SETTING TERMINAL UNITS AND INSTRUCT THE TESTING, ADJUSTING, AND BALANCING CONTRACTOR PERSONNEL IN THEIR USE. ASSIST AND COOPERATE WITH THE TESTING, ADJUSTING, AND BALANCING CONTRACTOR BY PROVIDING A QUALIFIED TECHNICIAN TO OPERATE THE CONTROLS AS REQUIRED TO ASSIST THE TESTING, ADJUSTING, AND BALANCING CONTRACTOR IN PERFORMING HIS WORK, OR ALTERNATIVELY, PROVIDE SUFFICIENT TRAINING FOR THE TESTING, ADJUSTING, AND BALANCING CONTRACTOR TO OPERATE THE SYSTEM WITHOUT ASSISTANCE. VERIFY THE PROPER OPERATION OF AFFECTED CONTROLS AT THE COMPLETION OF THE TEST, ADJUSTMENT, AND BALANCE PROCEDURE.

F. SEASONAL ADJUSTMENT:
   1. ASSIST THE COMMISSIONING AUTHORITY WITH THE SEASONAL ADJUSTMENT PROCESS. DURING THIS EFFORT, THE COMMISSIONING AUTHORITY WILL:
      a. CHECK AND VERIFY THE CALIBRATION OF TEMPERATURE CONTROL DEVICES AND THERMOSTATS. TEST AND VERIFY CONTROL SEQUENCES FOR PROPER OPERATION FOR THE SEASON.
      b. WHERE DEFICIENT OPERATION OR DEFECTIVE EQUIPMENT IS DISCOVERED, PROVIDE CORRECTIVE MEASURES AS REQUIRED BY THE WARRANTY PROVISIONS SPECIFIED HEREIN.

1. BCS
   A. BCS FAILURE MODE:
      1. BCS CONTROLS AND INTERFACES SHALL BE ARRANGED SO THAT EQUIPMENT CONTROLLED BY THE BCS OPERATES AS INDICATED ON THE I/O SUMMARIES ON FAILURE OF THE BCS CONTROLLER FOR ANY REASON, INCLUDING LOGIC POWER SUPPLY FAILURE, CPU LOCK-UP, OR INTERPOSING RELAY FAILURE. SAFETY AND OPERATIONAL INTERLOCKS SHALL REMAIN IN EFFECT.
   B. CONTROL SEQUENCES FOR FIRE ALARM SYSTEM SIGNAL RESPONSES SHALL BE INDEPENDENT OF THE BCS CONTROLLER AND ITS OUTPUTS.
   C. TRANSIENT SURGE SUPPRESSORS: INSTALL ON LOW VOLTAGE SIGNAL OR COMMUNICATIONS CONDUCTORS ENTERING THE BUILDING FROM EXTERIOR LOCATIONS, INCLUDING THOSE CONDUCTORS FROM DEVICES MOUNTED ON THE EXTERIOR OF THE BUILDING. IN ADDITION, PROVIDE AC VOLTAGE POWER TRANSIENT SUPPRESSORS FOR BCS EQUIPMENT POWER SUPPLIES.
   D. BCS SENSORS:
      1. HYDROGEN SENSORS: INSTALL IN AN ACCESSIBLE LOCATION AT THE HIGHEST POINT OF THE ROOM.
      2. LIQUID TEMPERATURE SENSORS: FILL SENSOR WELLS WITH THERMALLY CONDUCTIVE MATERIAL TO ASSURE ACCURATE READINGS.
      3. CURRENT SENSING RELAYS: FAN AND PUMP STATUS SHALL BE SENSED BY A CURRENT SENSING RELAY WIRED ON THE LOAD SIDE OF EACH FAN AND PUMP. FOR CONSTANT SPEED FANS AND PUMPS, THE CURRENT SENSING RELAY TRIP SETPOINT SHALL BE SET AT THE MOTOR'S NORMAL OPERATING SPEED. FOR VARIABLE SPEED FANS AND PUMPS, THE CURRENT SENSING RELAY TRIP SETPOINT SHALL BE SET FOR THE LOWEST OPERATING SPEED, AS DETERMINED BY THE COMMISSIONING PROCESS (TYPICALLY 20%).
      4. PROPER CALIBRATION OF SENSORS SHALL BE DEMONSTRATED AND DOCUMENTED AS PART OF THE COMMISSIONING PROCESS.
      5. SENSOR CALIBRATION: CALIBRATION OF SENSORS SHALL BE INCLUDED AS PART OF THE PREFUNCTIONAL CHECKLISTS ACCORDING TO THE FOLLOWING PROCEDURES:
         a. GENERAL: VERIFY THAT SENSORS WITH SHIELDED CABLE ARE GROUNDED ONLY AT ONE END.
         b. SENSORS WITHOUT EXTERNAL TRANSMITTERS: TAKE A READING WITH A CALIBRATED TEST INSTRUMENT WITHIN 6" OF THE SENSOR INSTALLATION AND VERIFY THE SENSOR READING IS WITHIN THE SPECIFIED TOLERANCE. IF NOT, INSTALL OFFSET, CALIBRATE, OR REPLACE SENSOR TO OBTAIN REQUIRED ACCURACY.
         c. SENSORS WITH EXTERNAL TRANSMITTERS: DISCONNECT SENSOR FROM TRANSMITTER INPUT AND CONNECT A SIGNAL GENERATOR IN PLACE OF SENSOR. USING MANUFACTURER'S DATA, SIMULATE MINIMUM MEASURED VALUE. ADJUST TRANSMITTER POTENTIOMETER ZERO UNTIL MINIMUM SIGNAL IS READ. REPEAT FOR THE MAXIMUM MEASURED VALUE AND ADJUST TRANSMITTER UNTIL MAXIMUM SIGNAL IS READ. RECONNECT SENSOR. MAKE A READING WITH A CALIBRATED TEST INSTRUMENT WITHIN 6" OF THE SENSOR INSTALLATION. VERIFY THAT THE SENSOR READING IS WITHIN THE SPECIFIED TOLERANCE. IF NOT, REPEAT PROCESS UNTIL SPECIFIED ACCURACY IS ACHIEVED, OR REPLACE THE SENSOR AND REPEAT PROCESS.
         d. PAIRED SENSORS: FOR SENSOR PAIRS THAT ARE USED TO DETERMINE A TEMPERATURE OR PRESSURE DIFFERENCE, CALIBRATE BOTH SENSORS TO A COMMON MEASUREMENT AND VERIFY THEY ARE READING WITHIN ±0.25ºF FOR TEMPERATURE AND WITHIN A TOLERANCE EQUAL TO ±2% OF THE SENSOR READING FOR PRESSURE.
   E. BCS START-UP AND CHECK-OUT:
      1. PROVIDE THE SERVICES OF CONTROL TECHNICIANS AT START-UP TO CHECK-OUT THE SYSTEM, VERIFY AND CALIBRATE SENSORS AND OUTPUTS, INPUT DATA SUPPLIED BY THE OWNER, AND PLACE THE SYSTEM IN OPERATION. VERIFY PROPER OPERATION OF EACH ITEM IN THE SEQUENCES OF OPERATION, INCLUDING HARDWARE AND SOFTWARE.
      2. CHECK-OUT EACH SYSTEM FOR CONTROL FUNCTION THROUGH THE ENTIRE SEQUENCE. CHECK ACTUATOR TRAVEL ON DAMPERS AND VALVES FOR ACTION AND EXTENT. VERIFY THAT CONTROL DAMPERS AND VALVES OPEN AND CLOSE COMPLETELY. CHECK CALIBRATION OF INSTRUMENTS. CALCULATE AND VERIFY INSTRUMENT SETPOINTS.
      3. CALIBRATION AND TESTING: CALIBRATE SENSORS AND MONITORING INPUTS AND VERIFY PROPER OPERATION OF OUTPUTS BEFORE THE SYSTEM IS PLACED ON-LINE. CHECK EACH POINT WITHIN THE SYSTEM BY MAKING A COMPARISON BETWEEN THE OPERATOR CONSOLE AND FIELD DEVICE. BCS CONTROL LOOPS, FAILURE MODES, INTERLOCKS, SEQUENCES, ENERGY MANAGEMENT PROGRAMS, AND ALARMS SHALL BE DEBUGGED, TESTED, AND STABLE OPERATION VERIFIED. CONTROL LOOP PARAMETERS AND TUNING CONSTANTS SHALL BE ADJUSTED TO PRODUCE ACCURATE, STABLE CONTROL SYSTEM OPERATION. PROVIDE WRITTEN DOCUMENTATION OF SYSTEM CALIBRATION AND CERTIFICATION THAT THE INSTALLED COMPLETE SYSTEM HAS BEEN CALIBRATED, VERIFIED, AND IS READY TO BEGIN TESTING.
   F. BCS ACCEPTANCE CONDITIONS:
      1. ACCEPTANCE TEST: CONDUCT FINAL ACCEPTANCE TEST, WITH THE OWNER ON SITE, ON THE COMPLETE AND TOTAL INSTALLED AND OPERATIONAL SYSTEM TO DEMONSTRATE THAT IT IS FUNCTIONING IN ACCORDANCE WITH REQUIREMENTS SPECIFIED HEREIN. DEMONSTRATE THE CORRECT OPERATION OF MONITORED AND CONTROLLED POINTS AS WELL AS THE OPERATION AND CAPABILITIES OF SEQUENCES, REPORTS, SPECIALIZED CONTROL ALGORITHMS, DIAGNOSTICS, AND SOFTWARE.
      2. SYSTEM SHALL DEMONSTRATE THE FOLLOWING MINIMUM ACCEPTABLE LEVELS OF PERFORMANCE, WITHIN THE PHYSICAL LIMITATIONS OF THE CONTROLLED EQUIPMENT:
         a. CONTROL LOOPS SHALL MAINTAIN STABLE, NONHUNTING, NONOSCILLATING CONTROL, WITH MINIMUM OVERSHOOT IN RESPONSE TO TRANSIENT AND UPSET CONDITIONS.
         b. SPACE AND AIR TEMPERATURES SHALL BE MAINTAINED WITHIN ±1ºF OF SETPOINT.
         c. HUMIDITY SHALL BE MAINTAINED WITHIN ±5% RH OF SETPOINT.
         d. CHILLED AND HOT WATER SYSTEM TEMPERATURES SHALL BE MAINTAINED WITHIN ±0.5ºF OF SETPOINT.
         e. DUCT STATIC PRESSURES SHALL BE MAINTAINED WITHIN ±0.05" WG OF SETPOINT.
         f. HYDRONIC SYSTEM PRESSURES SHALL BE MAINTAINED WITHIN ±2 PSIG OF SETPOINT.
         g. AIR AND WATER QUANTITIES SHALL BE MAINTAINED WITHIN ±5% OF SETPOINT.
      3. FINAL SYSTEM ACCEPTANCE WILL BE BASED UPON THE COMPLETION OF THE FOLLOWING ITEMS:
         a. COMPLETION OF THE INSTALLATION OF HARDWARE AND SOFTWARE ITEMS. DEMONSTRATE COMPLETE OPERATION OF THE SYSTEM, INCLUDING HARDWARE AND SOFTWARE, WITH NO FAILURES DURING A 10 CONSECUTIVE DAY PERIOD. OBTAIN RECEIPT FROM THE OWNER ACKNOWLEDGING NO FAILURES WITHIN THE TEST PERIOD. SUBMIT A DAILY LOG DOCUMENTING FAILURES.
         b. SATISFACTORY COMPLETION OF FUNCTIONAL PERFORMANCE TESTING.
         c. SATISFACTORY COMPLETION OF THE RECORD DRAWINGS, AND OPERATING AND MAINTENANCE MANUALS.
         d. SATISFACTORY COMPLETION OF TRAINING PROGRAMS.
      4. UPON FINAL ACCEPTANCE, THE WARRANTY PERIOD SHALL BEGIN.
   G. BCS TRAINING:
      1. PROVIDE THE COMMISSIONING AUTHORITY WITH A TRAINING PLAN FOR REVIEW 4 WEEKS BEFORE THE PLANNED TRAINING.
      2. PROVIDE DESIGNATED OWNER PERSONNEL TRAINING ON THE CONTROL SYSTEM. THE INTENT IS TO CLEARLY AND COMPLETELY INSTRUCT THE OWNER ON THE CAPABILITIES OF THE CONTROL SYSTEM.
      3. THE TRAINING SHALL BE TAILORED TO THE NEEDS AND SKILL-LEVEL OF THE TRAINEES.
      4. THE TRAINERS SHALL BE KNOWLEDGEABLE ON THE SYSTEM AND ITS USE IN BUILDINGS. THE OWNER SHALL APPROVE THE INSTRUCTOR PRIOR TO SCHEDULING THE TRAINING.
      5. THE STANDARD OPERATING MANUAL FOR THE SYSTEM AND ANY SPECIAL TRAINING MANUALS SHALL BE PROVIDED FOR EACH TRAINEE, WITH A COPY INCLUDED IN EACH COPY OF THE OPERATION AND MAINTENANCE MANUAL. IN ADDITION, COPIES OF THE SYSTEM TECHNICAL MANUAL SHALL BE DEMONSTRATED DURING TRAINING AND A COPY INCLUDED IN EACH COPY OF THE OPERATION AND MAINTENANCE MANUALS. MANUALS SHALL INCLUDE DETAILED DESCRIPTION OF THE SUBJECT MATTER FOR EACH SESSION. THE MANUALS SHALL COVER CONTROL SEQUENCES AND HAVE A DEFINITIONS SECTION THAT FULLY DESCRIBES RELEVANT WORDS USED IN THE MANUALS AND IN SOFTWARE DISPLAYS.
      6. COPIES OF AUDIO-VISUAL MATERIALS USED IN THE TRAINING PROGRAM SHALL BE DELIVERED TO THE OWNER.
      6. PROVIDE FORMAL TRAINING SESSIONS. EACH SESSION SHALL BE CONDUCTED BY FACTORY-TRAINED PERSONNEL:
         a. TRAINING I: THE FIRST TRAINING SESSION SHALL CONSIST OF 24 HOURS OF ACTUAL TRAINING. THIS TRAINING MAY BE HELD ON-SITE OR IN THE SUPPLIER'S FACILITY. IF HELD OFF-SITE, THE TRAINING MAY OCCUR PRIOR TO FINAL COMPLETION OF THE SYSTEM INSTALLATION. PROVIDE MATERIALS AND TRAINING FOR UP TO 6 PERSONS TO BE DESIGNATED BY THE OWNER. UPON COMPLETION, EACH STUDENT, USING APPROPRIATE DOCUMENTATION, SHOULD BE ABLE TO PERFORM ELEMENTARY OPERATIONS AND DESCRIBE GENERAL HARDWARE ARCHITECTURE AND FUNCTIONALITY OF THE SYSTEM.
         b. TRAINING II: BUILDING SYSTEMS: THE SECOND SESSION SHALL BE HELD ON-SITE FOR A PERIOD OF 24 HOURS OF ACTUAL HANDS-ON TRAINING AFTER THE COMPLETION OF SYSTEM COMMISSIONING. PROVIDE MATERIALS AND TRAINING FOR UP TO 6 PERSONS TO BE DESIGNATED BY THE OWNER. SESSION SHALL INCLUDE INSTRUCTION ON:
            1. SPECIFIC HARDWARE CONFIGURATION OF INSTALLED SYSTEMS IN THIS BUILDING AND SPECIFIC INSTRUCTION FOR OPERATING THE INSTALLED SYSTEM, INCLUDING HVAC SYSTEMS, LIGHTING CONTROLS, AND ANY INTERFACE WITH SECURITY AND COMMUNICATION SYSTEMS.
            2. SECURITY LEVELS, ALARMS, SYSTEM START-UP, SHUT-DOWN, POWER OUTAGE, AND RESTART ROUTINES, CHANGING SETPOINTS, AND ALARMS AND OTHER TYPICAL CHANGED PARAMETERS, OVERRIDES, FREEZE PROTECTION, MANUAL OPERATION OF EQUIPMENT, OPTIONAL CONTROL STRATEGIES THAT CAN BE CONSIDERED, ENERGY SAVINGS STRATEGIES AND SETPOINTS THAT IF CHANGED WILL ADVERSELY AFFECT ENERGY CONSUMPTION, ENERGY ACCOUNTING, AND PROCEDURES FOR OBTAINING VENDOR ASSISTANCE.
            3. TRENDING AND MONITORING FEATURES (VALUES, CHANGE OF STATE, AND TOTALIZATION), INCLUDING SETTING UP, EXECUTING, DOWNLOADING, VIEWING BOTH TABULAR AND GRAPHICALLY AND PRINTING TRENDS. TRAINEES SHALL ACTUALLY SET-UP TRENDS IN THE PRESENCE OF THE TRAINER.
            4. EVERY SCREEN SHALL BE COMPLETELY DISCUSSED, ALLOWING TIME FOR QUESTIONS.
            5. USE OF KEYPAD OR PLUG-IN LAPTOP COMPUTER AT THE ZONE LEVEL.
            6. USE OF REMOTE ACCESS TO THE SYSTEM VIA TELEPHONE LINES OR NETWORKS.
            7. SETTING UP AND CHANGING A TERMINAL UNIT CONTROLLER.
         c. TRAINING III: THE THIRD TRAINING SESSION SHALL BE CONDUCTED ON-SITE 6 MONTHS AFTER OCCUPANCY AND CONSIST OF 24 HOURS OF TRAINING. PROVIDE MATERIALS AND TRAINING FOR UP TO 6 PERSONS TO BE DESIGNATED BY THE OWNER. THE SESSION SHALL BE STRUCTURED TO ADDRESS SPECIFIC TOPICS THAT TRAINEES NEED TO DISCUSS AND TO ANSWER QUESTIONS CONCERNING OPERATION OF THE SYSTEM.
         d. SUPERVISORY TRAINING: PROVIDE A SEPARATE TRAINING COURSE FOR SUPERVISORY PERSONNEL. THIS TRAINING SHALL BRIEFLY COVER THE MATERIAL OF THE OPERATOR TRAINING SESSION BUT SHALL ADDRESS THE MORE ADVANCED FEATURES OF THE SYSTEM WITH EMPHASIS ON THE ENERGY CONSERVATION STRATEGIES AND REPORTING CAPABILITIES OF THE SYSTEM AND HOW TO IMPLEMENT THEM. THE TRAINING SESSION SHALL BE CONDUCTED BY FACTORY-TRAINED PERSONNEL AND SHALL BE A MINIMUM OF TWO 8 HOUR DAYS, FOR A TOTAL OF 16 TRAINING HOURS. PROVIDE MATERIALS AND TRAINING FOR UP TO 6 PERSONS TO BE DESIGNATED BY THE OWNER.
      7. IN ADDITION TO THE SPECIFIED BCS TRAINING, PROVIDE TECHNICALLY COMPETENT TECHNICIANS TO ATTEND TRAINING SESSIONS FOR SYSTEMS AND EQUIPMENT THAT ARE MONITORED OR OTHERWISE INTERFACED WITH THE BCS, TO DISCUSS THE INTERACTION OF THE CONTROL SYSTEM TO THE EQUIPMENT BEING DISCUSSED.

3. THERMOSTATS
   A. MOUNT SPACE HUMIDITY SENSORS, HUMIDISTATS, SPACE CO_2 SENSORS, SPACE TEMPERATURE SENSORS, AND THERMOSTATS AT 48" ABOVE THE FLOOR.
      1. ALIGN HORIZONTALLY WITH ADJACENT LIGHT SWITCHES.
      2. FINAL LOCATIONS SHALL BE ACCESSIBLE AND SHALL BE COORDINATED WITH THE FURNITURE LAYOUT AND ARCHITECTURAL LAYOUT.
      3. MORE THAN 2 SENSORS IN A SINGLE LOCATION SHALL BE INSTALLED WITH A COMMON FACEPLATE TO MINIMIZE WALL SPACE.
   B. REMOTE ELEMENT TYPE: MOUNT ON A VIBRATION FREE SURFACE 5' ABOVE THE FLOOR, UNLESS SPECIFIED HEREIN TO BE MOUNTED ON A CONTROL PANEL. PROVIDE 1 LINEAR FOOT OF ELEMENT TO SENSE THE TEMPERATURE OF EACH FT^2 OF THE COIL FACE. INSTALL IN A SERPENTINE ARRANGEMENT ACROSS THE ENTIRE FACE OF THE COIL.
   C. AVERAGING AND LOW LIMIT SAFETY TYPE ELEMENTS: INSTALL IN A HORIZONTAL SINE CURVE MANNER TO SENSE TEMPERATURES ACROSS THE ENTIRE FACE OF THE COIL, AND SUPPORT INDEPENDENTLY FROM THE COIL BY STAINLESS STEEL BANDS OR MULTIBULB HOLDERS. PROVIDE 1 LINEAR FOOT OF ELEMENT FOR EACH FT^2 OF COIL AREA. PROVIDE 0.5" METALLIC RACEWAY OR 0.375" HARD COPPER RAILS FOR SUPPORT OF ELEMENTS, BOTH TOP AND BOTTOM, FOR PLENUM OR DUCT WIDTH GREATER THAN 36".
   D. UNDER WINDOW FAN-COIL UNIT THERMOSTATS: MOUNT SO THAT ADJUSTING KNOB IS ACCESSIBLE THROUGH ACCESS PANEL.
   E. PROVIDE GUARDS ON THERMOSTATS AND SPACE TEMPERATURE SENSORS IN STORAGE ROOMS AND EQUIPMENT ROOMS.
   F. PROVIDE INSULATED BASES FOR THERMOSTATS AND TEMPERATURE SENSORS INSTALLED ON EXTERIOR WALLS OR WALLS TO UNCONDITIONED SPACES.

4. SENSOR PIPING
   A. TUBING SHALL BE CONCEALED EXCEPT IN MECHANICAL ROOMS.
   B. FASTEN TUBING WITH CLIPS AT REGULAR INTERVALS AND RUN PARALLEL TO BUILDING LINES. ATTACH CONCEALED TUBING ABOVE SUSPENDED CEILINGS TO STRUCTURE OR DUCTWORK SUPPORTS.
   C. COPPER BENDS SHALL BE TOOL MADE. PROVIDE UNIONS AT FINAL CONNECTIONS TO APPARATUS. PROVIDE SEPARATION BETWEEN DISSIMILAR METALS.
   D. NONMETALLIC TUBING RUN IN MECHANICAL ROOMS AND CONCEALED IN INACCESSIBLE LOCATIONS SHALL BE RUN IN METALLIC RACEWAYS. MAKE CONNECTIONS TO HOT EQUIPMENT WITH COPPER TUBING.
   E. TUBING INSTALLED INSIDE CONTROL PANELS AND EQUIPMENT ENCLOSURES, AND ABOVE CEILINGS SHALL BE TIED AND SUPPORTED.
   F. PROVIDE SLEEVES WHERE TUBING PASSES THROUGH CONCRETE OR MASONRY.
   G. TEST TUBING AT 30 PSIG FOR PRESSURE LOSS OF NOT MORE THAN 1 PSIG IN 1 HOUR.
   H. OTHER JOINTS SHALL BE BRAZED USING A BCUP5 BRAZING ALLOY WITH SOLIDUS ABOVE 1,100°F AND LIQUIDUS BELOW 1,500°F. BRAZING FLUX SHALL BE USED ON COPPER-TO-BRASS JOINTS ONLY.
   I. PRIOR TO FINAL CONNECTION TO DEVICES TUBING SHALL BE FLUSHED CLEAN AND DRY AND TESTED AT THREE TIMES THE OPERATING PRESSURE FOR NOT LESS THAN 30 MINUTES WITH NO LOSS OF PRESSURE.
   J. TUBING PASSING THROUGH CONCRETE OR MASONRY SHALL BE SLEEVED AND PROTECTED FROM ABRASION AND ELECTROLYTIC ACTION.
   K. TUBING SERVING OTHER FUNCTIONS SHALL BE ISOLATED FROM TUBING SERVING SMOKE CONTROL SYSTEMS BY AUTOMATIC ISOLATION VALVES OR SHALL BE AN INDEPENDENT SYSTEM.

5. PANELS
   A. PROVIDE A PANEL FOR EACH BCS CONTROLLER OR EACH SYSTEM NOT CONTROLLED BY THE BCS.
   B. MOUNT THE FOLLOWING ITEMS IN THE PANELS UNLESS OTHERWISE SPECIFIED HEREIN:
      1. BCS CONTROLLERS.
      2. RELAYS.
      3. SWITCHES.
      4. 120 V DUPLEX CONVENIENCE OUTLET WIRED FROM THE SAME CIRCUIT AS THE BCS CONTROLLER.
      5. WIRING AND CONTROLS.
      6. TERMINAL BLOCKS.
   C. WIRE CONTROLLERS, RELAYS, SWITCHES, AND CONTROLS IN THE CONTROL PANEL TO A TERMINAL BLOCK. LINE VOLTAGE AND LOW VOLTAGE SHALL BE SEPARATED ON DIFFERENT TERMINAL BLOCKS WITH LABELS INDICATING VOLTAGE. EACH SENSOR OR OTHER ELECTRICAL DEVICE SHALL BE WIRED BACK TO THE TERMINAL BLOCK IN THE CONTROL PANEL. DEVICES IN SERIES SHALL BE INDIVIDUALLY TERMINATED AT THE TERMINAL BLOCK, SUCH THAT EACH SIDE OF EACH DEVICE IS AVAILABLE AT THE CONTROL PANEL FOR TROUBLESHOOTING. IN ADDITION TO NUMBER MARKINGS ON EACH CONDUCTOR, CONDUCTOR COLOR SHALL BE THE SAME THROUGHOUT EACH WIRING RUN. WIRING SHALL BE NEATLY TIED AND ROUTED IN THE CONTROL PANEL. SHIELDED WIRING SHALL BE TERMINATED NEATLY, WITH HEAT SHRINK TUBING PLACED OVER THE BARE END OF THE SHIELD. GROUND CONDUCTORS OVER 4" LONG SHALL BE INSULATED WITH TUBING.
   D. PROVIDE 6" X 6"TROUGH THE WIDTH OF THE CONTROL PANEL, MINIMUM 24" IN LENGTH, ABOVE THE CONTROL PANEL TO PROVIDE AN ENTRANCE FOR CABLING AND TUBING INTO THE PANEL, WITH 50% SPARE NIPPLE CAPACITY.
   E. PROVIDE 120 V POWER WIRING FOR CONTROL POWER IN THE TOP RIGHT CORNER OF EACH PANEL, WITH DISCONNECTS, POWER SUPPLIES, AND TRANSFORMERS ASSOCIATED WITH THE PANEL ALSO LOCATED IN THE TOP RIGHT CORNER.
   F. EACH ITEM IN THE PANEL SHALL BE LABELED AND THE PANEL LABELED AS TO THE SYSTEM OR EQUIPMENT SERVED.
   G. PANELS SHALL BE LOCATED TO AVOID CONFLICTS WITH DUCTWORK, PIPING, EQUIPMENT, THE WORK OF OTHER TRADES, AND BUILDING CONDITIONS. PANEL LOCATIONS INDICATED ON THE DRAWINGS SHALL BE COORDINATED PRIOR TO INSTALLATION AND ADJUSTED TO AVOID CONFLICTS.

6. STATIC PRESSURE SENSORS
   A. INSTALL SENSORS IN THE ASSOCIATED AIR HANDLING UNIT CONTROL PANEL AND USE EXTENDED SENSING LINES. PROVIDE TAPS FOR CALIBRATION PURPOSES.

7. HYDRONIC PRESSURE SENSORS
   A. INSTALL SENSORS ADJACENT TO MEASUREMENT POINTS, WITH SENSING LINES EXTENDED TO ACCESSIBLE LOCATIONS. PROVIDE TEST PORTS EQUIPPED WITH SCHRADER VALVES IN EACH SENSING LINE FOR CALIBRATION PURPOSES.

8. THERMOMETERS
   A. PROVIDE AT EACH REMOTE TEMPERATURE SENSOR AND ELEMENT LOCATION. DO NOT DUPLICATE THERMOMETERS SPECIFIED IN SECTION 23 10 00, PIPING, VALVES AND ACCESSORIES.
   B. MOUNT THERMOMETERS IN PIPING, DUCTS, AND EQUIPMENT IN POSITIONS ADJUSTED TO BE ACCESSIBLE FOR READING. USE ANGLE AND ADJUSTABLE TYPES WHERE STRAIGHT TYPE WOULD NOT BE READABLE.
   C. FILL THERMOMETER WELLS WITH THERMALLY CONDUCTIVE MATERIAL.

9. CONTROL DAMPERS
   A. FOR OUTDOOR AIR DAMPER ASSEMBLIES, STAGE THE OPENING OF EACH SECTION TO PREVENT STRATIFICATION AND POOR MIXING OF OUTSIDE AND RETURN AIR.

10. WIRING
   A. MATERIALS AND INSTALLATION OF WIRING AND ELECTRICAL DEVICES SHALL BE IN ACCORDANCE WITH DIVISION 26.
   B. EXPOSED CONTROL AND SENSOR WIRING SHALL BE INSTALLED IN CONDUITS AND SHALL BE SEPARATE FROM POWER WIRING. PLENUM RATED CABLE MAY BE USED IN CONCEALED SPACES IF RUN PARALLEL TO STRUCTURAL GRID AND SUPPORTED BY CABLE TRAYS OR TIE WRAPS, AND IDENTIFIED IN A MANNER CONSISTENT WITH THE DOCUMENTATION OF THE SYSTEM EVERY 30'. CONDUITS TO DEVICES IN FINISHED SPACES SHALL BE CONCEALED.
   C. PROVIDE TRANSFORMERS OR FILTERS FOR OPERATION OF AUTOMATIC TEMPERATURE CONTROLS FROM BUILDING POWER CIRCUITS. EACH BCS CONTROLLER SHALL BE SERVED BY A DEDICATED TRANSFORMER, AND NO MORE THAN 10 TERMINAL UNIT CONTROLLERS SHALL BE SERVED BY A SINGLE TRANSFORMER.
   D. PROVIDE RELAYS, TRANSFORMERS, FUSES AND INTERLOCK WIRING AS REQUIRED TO ACCOMPLISH THE SEQUENCES INDICATED ON THE DRAWINGS.
   E. WIRING FOR EMERGENCY FAN SHUTDOWN STATIONS SHALL BE SEPARATE FROM CONTROL AND SENSOR WIRING AND DEVICES.
   F. SEE DIVISION 26 FOR SPARE BRANCH CIRCUIT BREAKERS FOR CONTROL POWER IN 120 V/208 V ELECTRICAL PANELBOARDS. PROVIDE POWER WIRING FROM ELECTRICAL BRANCH PANELBOARDS THROUGH CONTROL POWER TRANSFORMERS TO BCS CONTROLLERS, TERMINAL UNIT CONTROLLERS, SMOKE DAMPERS, FLOW MEASURING DEVICES, AND OTHER POWER CONSUMING CONTROL DEVICES.
   G. PROVIDE DATA OUTLETS AND ASSOCIATED LOW VOLTAGE CABLING FOR EACH BCS CONTROLLER AS REQUIRED. SEE DIVISION 27 FOR COMMUNICATIONS CABLING AND OUTLET REQUIREMENTS. COORDINATE THE INSTALLATION OF NEW DATA OUTLETS WITH THE OWNER'S INFORMATION TECHNOLOGY STAFF.
   H. POWER FOR TERMINAL UNIT CONTROLLERS AND SMOKE DAMPERS SHALL BE DISTRIBUTED AT 24 V.
   I. BRANCH CIRCUIT WIRING AND CONDUIT FURNISHED UNDER THIS SECTION FOR CONTROL EQUIPMENT POWER SHALL BE SEPARATE FROM OTHER POWER WIRING. NO MORE THAN 2 BCS CONTROLLER INSTALLATIONS SHALL OPERATE FROM A SINGLE 120 V BRANCH CIRCUIT.
   J. LOW VOLTAGE CONTROL AND SENSOR WIRING SHALL BE CONTINUOUS WITHOUT SPLICING.

SEQUENCE NOTES
1. SEQUENCE OF OPERATIONS ARE AS INDICATED ON THE DRAWINGS.
2. VARIABLE SPEED CONTROLS:
   A. VARIABLE FREQUENCY DRIVES SHALL START AT LOW SPEED. WHEN 2 OR MORE VARIABLE SPEED FANS OPERATE IN PARALLEL, THEIR SPEEDS SHALL BE SYNCHRONIZED AND CONTROLLED FROM A COMMON SIGNAL.
   B. WHEN VARIABLE SPEED PUMPS OPERATE IN PARALLEL WITH CONSTANT SPEED PUMPS, THE BCS CONTROLLER SYSTEM SHALL OPERATE AND MAINTAIN THE VARIABLE SPEED PUMPS AT FULL SPEED WHENEVER A CONSTANT SPEED PUMP IS IN OPERATION.
   C. VARIABLE FREQUENCY DRIVES SHALL NOT OPERATE BELOW THE MINIMUM SPEED SET ON ITS CONTROL PANEL. MINIMUM SPEED SETTING SHALL BE DETERMINED DURING SYSTEM COMMISSIONING AND SHALL NOT BE LOWER THAN THE MOTOR MANUFACTURER'S RECOMMENDATION.
   D. EQUIPMENT SAFETIES SHALL BE WIRED INTO VARIABLE FREQUENCY DRIVE CONTROL CIRCUITS.
3. INDICATION OF EQUIPMENT OPERATING STATUS AND ACTUATION OF CONTROL SEQUENCES SHALL BE ACCOMPLISHED BY CURRENT SENSING RELAYS UNLESS OTHERWISE INDICATED IN THE I/O SUMMARIES.
1. UPON POWER FAILURE AND RESTORATION, SYSTEMS SHALL AUTOMATICALLY RESTART AND RETURN TO THEIR NORMAL MODE OF OPERATION. ADJUSTABLE TIME DELAYS SHALL BE PROVIDED TO SEQUENTIALLY STAGE STARTING OF EQUIPMENT WITH MOTORS GREATER THAN 5 HP OR ELECTRIC HEATING LOADS GREATER THAN 4 kW.
2. HAND-OFF-AUTOMATIC AND CONTROLLER-OFF-BYPASS SWITCHES:
   A. SAFETY DEVICES, INCLUDING FIRE ALARM SYSTEM RELAYS AND EMERGENCY FAN SHUTDOWN STATIONS, SHALL BE WIRED IN SERIES WITH THE MOTOR CONTROLLER HOLDING COIL CIRCUIT AND SHALL BE ACTIVE IN THE HAND AND AUTOMATIC POSITIONS.
   B. INTERLOCKING WITH OTHER FANS, EQUIPMENT, OR SYSTEMS OTHER THAN THOSE REQUIRED FOR THE OPERATION OF THE SPECIFIC EQUIPMENT SHALL BE THROUGH AUTOMATIC POSITIONS ONLY.
   C. REMOTE CONTROL FROM THE BCS SYSTEM SHALL BE THROUGH AUTOMATIC POSITIONS.
   D. HAND POSITION SHALL BE FOR MAINTENANCE OPERATION ONLY.
   E. OPERATION IN HAND POSITION SHALL ENERGIZE ASSOCIATED DAMPERS AND EQUIPMENT NECESSARY TO ALLOW OPERATION.
3. CONTROLS SHALL FAIL AS SPECIFIED HEREIN, OR TO MINIMIZE POSSIBILITY OF DAMAGE ON FAILURE IF NOT SPECIFIED HEREIN.
4. CONTROL SETPOINTS SHALL BE ADJUSTABLE OVER THE RANGE OF THE SENSED MEDIA. MEANS OF ADJUSTMENT AND CURRENT SETPOINT SHALL BE IDENTIFIED. BCS SETPOINTS AND ALARM LIMITS SHALL BE PROGRAMMED AS VARIABLES, EXPRESSED IN THE APPROPRIATE ENGINEERING UNITS, WHICH CAN BE ADJUSTED THROUGH THE DIGITAL DISPLAY UNIT OR FROM A CENTRAL STATION WITHOUT REQUIRING MODIFICATION OR RELOADING OF THE BCS CONTROL PROGRAMS. CONTROL, ALARM, AND LIMIT SETPOINTS FOR EACH BCS CONTROLLER SHALL BE DISPLAYED AND SHALL BE ADJUSTABLE FROM AN APPROPRIATELY PASSWORD-PROTECTED TABULAR GRAPHIC DISPLAY ASSOCIATED WITH THE APPROPRIATE EQUIPMENT. SETPOINTS OR ALARM LIMITS COMMON TO MULTIPLE CONTROL ALGORITHMS SHALL BE CONFIGURED AS A COMMON VARIABLE, REQUIRING A SINGLE ADJUSTMENT. PROVIDE AND ADJUST TIME DELAYS FOR SMOOTH AND SAFE OPERATION OF SYSTEMS.
5. CONTROL OUTPUTS SHALL PROVIDE MAXIMUM RATED ACTUATOR POWER AT EXTREMES OF ACTUATOR TRAVEL. CONTROL OUTPUT RANGE (0%-100%) SHALL CORRESPOND TO ACTUATOR TRAVEL (0%-100%).
6. WHERE SYSTEMS ARE SERVED BY EMERGENCY POWER, CONTROLS FOR OPERATION OF THOSE SYSTEMS SHALL ALSO BE SERVED BY EMERGENCY POWER.
7. WHERE DAMPERS PREVENT AIRFLOW THROUGH AN AIR HANDLING UNIT OR FAN, THOSE DAMPERS SHALL BE PROVEN OPEN PRIOR TO STARTING THE UNIT OR FAN. PROOF SHALL BE BY MECHANICAL SAFETY LIMIT SWITCH ACTIVATED BY THE DAMPER BLADE. THIS SWITCH SHALL BE WIRED IN THE AUTOMATIC AND HAND/TEST POSITIONS.

STATIC PRESSURE SETPOINT RESET WITH CONSTANT DAT SETPOINT:
FOR SYSTEMS WITH MULTIPLE DUCT STATIC DUCT PRESSURE SETPOINTS, THE FOLLOWING SHALL APPLY UNIQUELY TO EACH DUCT STATIC PRESSURE SETPOINT AND ITS ASSOCIATED TERMINAL UNITS.

A. UPON SYSTEM START-UP, THE SUPPLY DUCT STATIC PRESSURE SETPOINT SHALL BE EQUAL TO 75% (ADJUSTABLE) OF THE MAXIMUM DUCT STATIC PRESSURE SETPOINT. THE MAXIMUM AND MINIMUM DUCT STATIC PRESSURE SETPOINTS SHALL BE –AS DETERMINED DURING THE TESTING, ADJUSTING AND BALANCING PROCESS, WITH EACH LOCATION HAVING A UNIQUE SETPOINT. THE MINIMUM SETPOINT SHALL BE EQUAL TO THE DUCT STATIC PRESSURE WHEN ALL VARIABLE AIR VOLUME TERMINAL UNITS SERVED BY THE SENSOR ARE AT MINIMUM AIRFLOW AND AT LEAST ONE TERMINAL UNIT DAMPER IS GREATER THAN 90% OPEN. THE MAXIMUM SETPOINT SHALL CORRESPOND TO THE MAXIMUM DESIGN AIRFLOW.

   1) DEFINE THE FOLLOWING VARIABLES IN THE SEQUENCE BELOW:

      i. SP INCREASE
         1. = SUM OF "SP VOTING MULTIPLIERS" OF TERMINAL UNITS WHOSE DAMPER POSITIONS ARE GREATER THAN 90% (ADJUSTABLE) OPEN
         2. CALCULATED
      ii. SP DECREASE
         1. = SUM OF "SP VOTING MULTIPLIERS" OF TERMINAL UNITS WHOSE DAMPERS POSITIONS ARE LESS THAN 75% (ADJUSTABLE) OPEN
         2. CALCULATED
      iii. SP VOTE UP
         1. VALUE OF "SP INCREASE" REQUIRED TO INCREASE THE DUCT STATIC PRESSURE SETPOINT
         2. ADJUSTABLE
         3. DEFAULT VALUE = 1
      iv. SP VOTE DOWN
         1. = VALUE OF "SP DECREASE" REQUIRED TO DECREASE THE DUCT STATIC PRESSURE SETPOINT
         2. = (SUM OF "SP VOTING MULTIPLIERS" OF ALL TERMINAL UNITS — "SP VOTE UP") + 1
         3. CALCULATED
      v. SP VOTING MULTIPLIER
         1. = VOTING WEIGHT OF EACH TERMINAL UNIT (IF "SP VOTING MULTIPLIER" IS SET TO "SP VOTE UP", THAT TERMINAL UNIT WILL HAVE A SUPER VOTE)
         2. INTEGER BETWEEN 0 AND "SP VOTE UP"
         3. ADJUSTABLE
         4. DEFAULT VALUE = 1

   2) EVERY 10 MINUTES (ADJUSTABLE), THE BCS CONTROLLER SHALL EVALUATE TERMINAL UNIT DAMPER POSITIONS AND DETERMINE THE VALUES OF "SP INCREASE" AND "SP DECREASE".

   3) AT THE ONSET OF EACH EVALUATION CYCLE THE BCS CONTROLLER SHALL EVALUATE RETURN AIR RELATIVE HUMIDITY. IF RETURN AIR RELATIVE HUMIDITY EXCEEDS 54% RH (ADJUSTABLE), DECREASE THE CURRENT SYSTEM DISCHARGE AIR TEMPERATURE SETPOINT BY 2°F, BETWEEN THE LIMITS OF THE INITIAL SETPOINT AND 5°F (ADJUSTABLE) BELOW THE INITIAL SETPOINT. IF, FOR 2 CONSECUTIVE EVALUATION CYCLES, THE RETURN AIR RELATIVE HUMIDITY IS BELOW 49% RH (ADJUSTABLE), RETURN THE SYSTEM DISCHARGE AIR TEMPERATURE SETPOINT TO THE INITIAL SETPOINT.

   4) AFTER ANY EVALUATION CYCLE, IF "SP INCREASE" IS GREATER THAN OR EQUAL TO "SP VOTE UP", THE BCS CONTROLLER SHALL INCREASE THE DUCT STATIC PRESSURE SETPOINT BY 0.1" WC (ADJUSTABLE) UP TO THE MAXIMUM DUCT STATIC PRESSURE SETPOINT.

   5) AFTER ANY EVALUATION CYCLE, IF "SP DECREASE" IS GREATER THAN OR EQUAL TO "SP VOTE DOWN", THE BCS CONTROLLER SHALL REDUCE THE DUCT STATIC PRESSURE SETPOINT BY 0.05" WC (ADJUSTABLE) DOWN TO THE MINIMUM DUCT STATIC PRESSURE SETPOINT.

   6) AFTER ANY EVALUATION CYCLE, IF NEITHER OF THE CONDITIONS ABOVE ARE MET, THE BCS CONTROLLER SHALL NOT ADJUST THE DUCT STATIC PRESSURE SETPOINT.

   7) THE BCS CONTROLLER SHALL ANNUNCIATE AN ALERT CONDITION THROUGH THE BCS WHENEVER ANY TERMINAL UNIT VOTES FOR A STATIC PRESSURE SETPOINT INCREASE AT EVERY EVALUATION CYCLE IN A 24-HOUR TIME PERIOD. THE ALERT MESSAGE SHALL IDENTIFY THE TERMINAL UNIT AND INDICATE THAT TROUBLESHOOTING IS REQUIRED.

B. IF ALL DUCT STATIC PRESSURE SETPOINTS ARE EQUAL TO THE MINIMUM SETPOINTS FOR 30 MINUTES, END THIS ROUTINE AND RUN THE "DAT SETPOINT RESET WITH CONSTANT STATIC PRESSURE SETPOINT" ROUTINE.

DAT SETPOINT RESET WITH CONSTANT DUCT STATIC PRESSURE SETPOINT:

A. WHILE HOLDING ALL SYSTEM DUCT STATIC PRESSURE SETPOINTS CONSTANT, VARY THE DISCHARGE AIR TEMPERATURE SETPOINT BETWEEN THE MINIMUM AND MAXIMUM DISCHARGE AIR TEMPERATURE SETPOINTS.

   1) DEFINE THE FOLLOWING VARIABLES IN THE SEQUENCE BELOW:

      A. DAT INCREASE
         i. = SUM OF "DAT VOTING MULTIPLIERS" OF TERMINAL UNITS WHOSE COOLING LOADS ARE LESS THAN 75% (ADJUSTABLE)
         ii. CALCULATED
      B. DAT DECREASE
         i. = SUM OF "DAT VOTING MULTIPLIERS" OF TERMINAL UNITS WHOSE COOLING LOADS ARE GREATER THAN 90% (ADJUSTABLE)
         ii. CALCULATED
      C. DAT VOTE UP
         i. = VALUE OF "DAT INCREASE" REQUIRED TO INCREASE THE DISCHARGE AIR TEMPERATURE SETPOINT
         ii. = (SUM OF VOTING MULTIPLIERS OF ALL TERMINAL UNITS — "VOTE UP") + 1
         iii. CALCULATED
      D. DAT VOTE DOWN
         i. = VALUE OF "DAT DECREASE" REQUIRED TO DECREASE THE DISCHARGE AIR TEMPERATURE SETPOINT
         ii. ADJUSTABLE
         iii. DEFAULT VALUE = 1
      E. DAT VOTING MULTIPLIER
         i. = VOTING WEIGHT OF EACH TERMINAL UNIT (IF "DAT VOTING MULTIPLIER" IS SET TO "VOTE UP", THAT TERMINAL UNIT WILL HAVE A SUPER VOTE)
         ii. INTEGER BETWEEN 0 AND "SP VOTE UP"
         iii. ADJUSTABLE
         iv. DEFAULT VALUE = 1

   2) EVERY 5 MINUTES (ADJUSTABLE), THE BCS CONTROLLER SHALL EVALUATE TERMINAL UNIT COOLING LOAD PERCENTAGES AND DETERMINE THE VALUE OF "DAT INCREASE" AND "DAT DECREASE".

   3) AFTER ANY EVALUATION CYCLE, IF "DAT INCREASE" IS GREATER THAN OR EQUAL TO "DAT VOTE UP", THE BCS CONTROLLER SHALL INCREASE THE DISCHARGE AIR TEMPERATURE SETPOINT BY 0.3°F WC (ADJUSTABLE) UP TO THE MAXIMUM DISCHARGE AIR TEMPERATURE SETPOINT.

   4) AFTER ANY EVALUATION CYCLE, IF "DAT DECREASE" IS GREATER THAN OR EQUAL TO "DAT VOTE DOWN", THE BCS CONTROLLER SHALL REDUCE THE DISCHARGE AIR TEMPERATURE SETPOINT 0.2°F (ADJUSTABLE) DOWN TO THE MINIMUM DISCHARGE AIR TEMPERATURE SETPOINT.

   5) AFTER ANY EVALUATION CYCLE, IF NEITHER OF THE CONDITIONS ABOVE ARE MET, THE BCS CONTROLLER SHALL NOT ADJUST THE DISCHARGE AIR TEMPERATURE SETPOINT.

   6) THE BCS CONTROLLER SHALL ANNUNCIATE AN ALERT CONDITION THROUGH THE BCS WHENEVER ANY TERMINAL UNIT VOTES FOR A DISCHARGE AIR TEMPERATURE SETPOINT DECREASE AT EVERY EVALUATION IN A 24-HOUR TIME PERIOD. THE ALERT MESSAGE SHALL IDENTIFY THE TERMINAL UNIT, AND INDICATE THAT TROUBLESHOOTING IS REQUIRED.

B. IF THE DISCHARGE AIR TEMPERATURE SETPOINT IS EQUAL TO THE MINIMUM SETPOINT FOR 30 MINUTES, END THIS ROUTINE AND RUN THE "STATIC PRESSURE SETPOINT RESET WITH CONSTANT DAT SETPOINT" ROUTINE.

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Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC CONTROLS GENERAL NOTES CON'T

ORIG SUBMISSION: 2023.05.22

SHEET: **M-702**

PERMIT SET

BCS CONTROLLER INPUT/OUTPUT SUMMARY CHILLED WATER SYSTEM

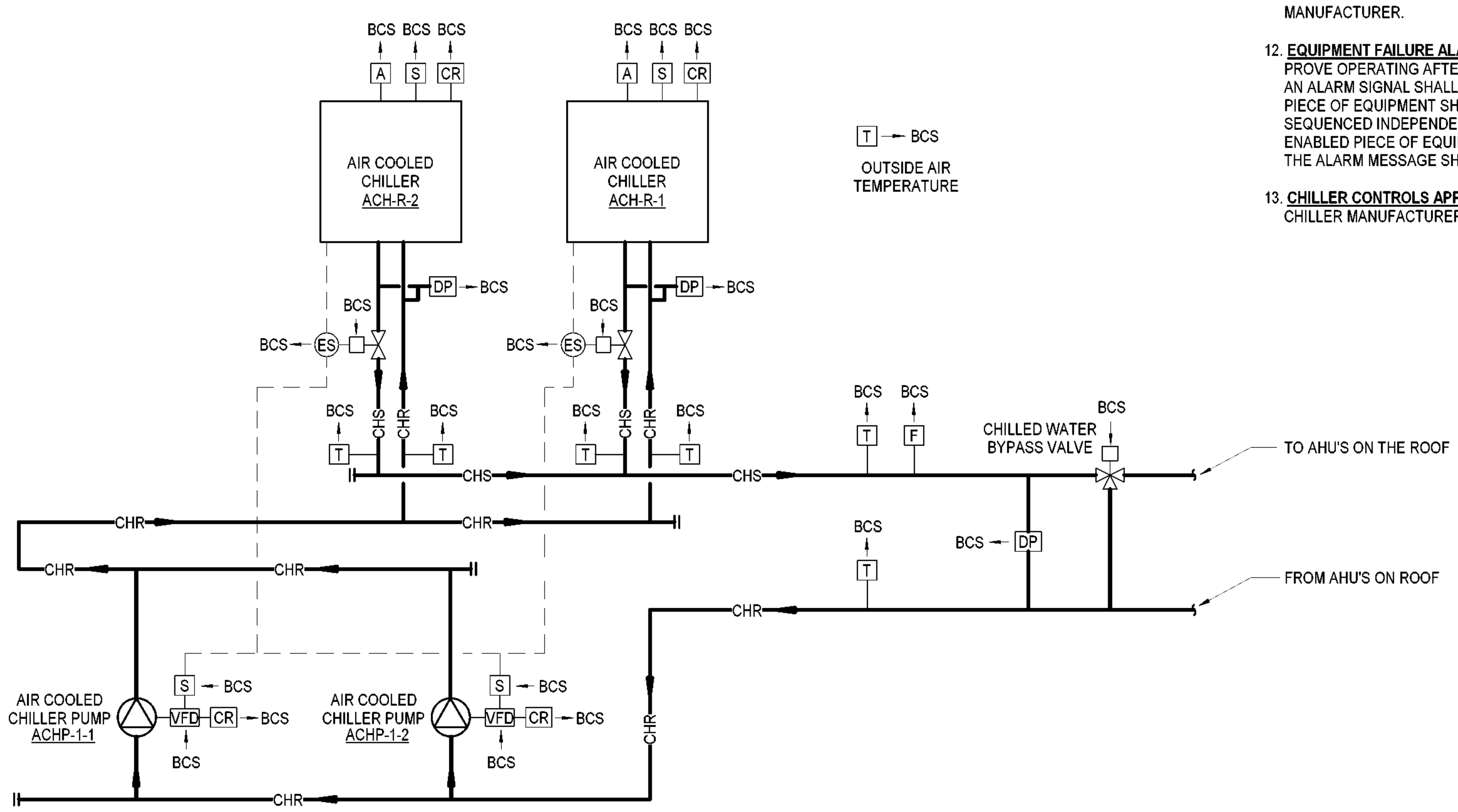
	SYSTEM GRAPHIC DISPLAY	OUTPUTS – DIGITAL: START/STOP	OUTPUTS – DIGITAL: ENABLE/DISABLE	OUTPUTS – DIGITAL: OPEN/CLOSE	OUTPUTS – ANALOG: BCS CONTROL	INPUTS – DIGITAL: CURRENT SENSING RELAY	INPUTS – DIGITAL: DIFFERENTIAL PRESSURE SWITCH	INPUTS – DIGITAL: AUXILIARY CONTACT	INPUTS – DIGITAL: ALARM CONTACT	INPUTS – DIGITAL: PULSE CONTACT	INPUTS – ANALOG: TEMPERATURE	INPUTS – ANALOG: RELATIVE HUMIDITY	INPUTS – ANALOG: FLOW	INPUTS – ANALOG: DIFFERENTIAL PRESSURE	INPUTS – ANALOG: AMPERAGE	SOFTWARE – ALARM: STATUS/INTERLOCK	SOFTWARE – ALARM: HIGH/LOW LIMIT	SOFTWARE – ALARM: RUN TIME TOTALIZATION	SOFTWARE – ALARM: VIBRATION	SOFTWARE – BCS: PROPORTIONAL	SOFTWARE – BCS: PROPORTIONAL + INTEGRAL	SOFTWARE – ENERGY MGMT.: SCHEDULED START/STOP	SOFTWARE – ENERGY MGMT.: OPTIMUM START STOP	SOFTWARE – ENERGY MGMT.: DAY/NIGHT SETBACK	SOFTWARE – ENERGY MGMT.: DEMAND LIMIT CYCLE	SOFTWARE – ENERGY MGMT.: RESET OPTIMIZATION	SOFTWARE – ENERGY MGMT.: ECONOMIZER	FAILURE MODE (SEE NOTES 1 AND 2)	NOTES
CHILLERS ACHR-1, ACH-R-2	●																												4,8
ISOLATION VALVE				●					●												●							O	3
ISOLATION VALVE END SWITCH								●																					3
CHS TEMPERATURE											●																		3
CHR TEMPERATURE											●																		3
CHILLER AMPERAGE															●														3
CHILLER EVAPORATOR DIFFERENTIAL PRESSURE							●																						3
PUMPS ACHP-1-1, ACHP-1-2	●																												6
START/STOP		●																●										O	
STATUS						●										●													
VFD SPEED					●																●							O	5
MISCELLANEOUS																													
SYSTEM CHILLED WATER DIFFERENTIAL PRESSURE														●			●												7
SYSTEM CHILLED WATER BYPASS CONTROL VALVE					●																●							C	
SYSTEM CHILLED WATER SUPPLY TEMPERATURE											●						●												
SYSTEM CHILLED WATER RETURN TEMPERATURE											●						●												
OUTSIDE AIR TEMPERATURE											●																		9
BUILDING WATER FLOW													●																

NOTES:
1. FAILURE MODE: O - ON OR OPEN, C - OFF OR CLOSE, L - LAST COMMAND
2. BCS CONTROLS AND INTERFACES SHALL BE ARRANGED SO THAT EQUIPMENT CONTROLLED BY THE BCS OPERATES AS INDICATED ON FAILURE OF THE BCS CONTROLLER FOR ANY REASON, INCLUDING LOGIC POWER SUPPLY FAILURE, CPU LOCK-UP, OR INTERPOSING RELAY FAILURE. SAFETY AND OPERATIONAL INTERLOCKS SHALL REMAIN IN EFFECT.
3. PROVIDE IDENTICAL CONTROL POINTS AND FUNCTIONS FOR ALL CHILLERS.
4. POINT PROVIDED TO BCS THROUGH CHILLER COMMUNICATION INTERFACE.
5. VFD SHALL FAIL TO 50% SPEED.
6. PROVIDE IDENTICAL CONTROL POINTS AND FUNCTIONS FOR ALL PUMPS.
7. DIFFERENTIAL PRESSURE SENSOR IS LOCATED ON XXX.
8. ALL PACKAGED CONTROL POINTS AVAILABLE FROM PACKAGED CHILLER CONTROLLER SHALL BE INTEGRATED INTO THE BCS.
9. LOCATE OUTSIDE AIR TEMPERATURE SENSOR ON A NORTH FACING WALL OUT OF DIRECT SUNLIGHT.

SEQUENCE OF OPERATION

THE CONTROLS FOR THE CHILLED WATER SYSTEM SHALL FUNCTION AS FOLLOWS:

1. **EQUIPMENT RUNTIME EQUALIZATION:** THE REFRIGERATION PLANT SHALL BE CONFIGURED SO THAT ANY CHILLER CAN OPERATE WITH ANY CHILLED WATER PUMP. THE BCS CONTROLLER SHALL TOTALIZE RUNTIME FOR CHILLERS AND PUMPS AND SHALL START OR ENABLE AND STOP OR DISABLE EQUIPMENT IN A MANNER THAT EQUALIZES EQUIPMENT RUNTIME. THE BCS CONTROLLER SHALL, AT AN OPERATOR DEFINED INTERVAL INITIALLY SET TO MONTHLY, OR UPON OPERATOR REQUEST, EVALUATE THE LEAD EQUIPMENT SELECTIONS AND RESELECT SO AS TO EQUALIZE RUNTIME. WHENEVER EQUIPMENT IS ROTATED, THE NEWLY STARTED EQUIPMENT SHALL START AND BE PROVEN OPERATING FOR 1 MINUTE PRIOR TO THE OPERATING EQUIPMENT BEING STOPPED.
2. **CHILLER ENABLE:** THE BCS CONTROLLER SHALL ENABLE THE LEAD CHILLER UPON A RISE IN OUTSIDE AIR TEMPERATURE ABOVE SETPOINT OR WHEN ANY AIR HANDLING UNIT IS OPERATING WITH CHILLED WATER VALVE OPEN.
3. **LEAVING CHILLED WATER TEMPERATURE SETPOINT:** THE CHILLER SHALL OPERATE UNDER INTERNAL CONTROLS TO MAINTAIN 42°F LEAVING CHILLED WATER TEMPERATURE.
4. **CHILLED WATER PUMP ENABLE:** WHENEVER A CHILLER IS ENABLED, THE BCS CONTROLLER SHALL START A CHILLED WATER PUMP. UPON PROOF OF PUMP OPERATION, THE BCS CONTROLLER SHALL OPEN THE 2-POSITION CHILLER ISOLATION VALVE.
5. **EVAPORATOR ISOLATION VALVE ALARM:** THE BCS CONTROLLER SHALL ANNUNCIATE AN ALARM CONDITION AND STOP A CHILLED WATER PUMP WHENEVER THE EVAPORATOR ISOLATION VALVE ENDSWITCH HAS NOT PROVEN THE VALVE OPEN AND THE NEWLY STARTED PUMP HAS BEEN OPERATING FOR 3 MINUTES (ADJUSTABLE).
6. **ADDITIONAL CHILLER ENABLE:** THE BCS CONTROLLER SHALL ENABLE AN ADDITIONAL CHILLER WHENEVER THE RUNNING AMPERES OF THE ACTIVE CHILLERS EXCEEDS 95% OF THE FULL LOAD AMPERES OR CHILLER LEAVING WATER TEMPERATURE EXCEEDS THE SETPOINT FOR A PERIOD OF 15 MINUTES.
7. **CHILLER DISABLE:** WHENEVER TWO CHILLERS ARE OPERATING AND THE RUNNING AMPERES OF EACH CHILLER IS BELOW 40% OF THE FULL LOAD AMPERES FOR A PERIOD OF 15 MINUTES, THE BCS CONTROLLER SHALL DISABLE ONE CHILLER.
8. **CHILLER EVAPORATOR DIFFERENTIAL PRESSURE CONTROL:** THE BCS CONTROLLER SHALL MODULATE THE CHILLED WATER BYPASS CONTROL VALVE TO MAINTAIN A DIFFERENTIAL PRESSURE ACROSS EACH ACTIVE CHILLER EVAPORATOR AT A SETPOINT EQUIVALENT TO THE MINIMUM CHILLER EVAPORATOR FLOW RATE INDICATED ON THE DRAWINGS. WHENEVER EACH DIFFERENTIAL PRESSURE EXCEEDS SETPOINT, THE CHILLED WATER BYPASS CONTROL VALVE SHALL MODULATE CLOSED. COORDINATE WITH THE CHILLER MANUFACTURER.
9. **LEAVING WATER TEMPERATURE RESET:** THE LEAVING CHILLED WATER TEMPERATURE SETPOINT SHALL BE RESET BY A COMMON SIGNAL TO ACTIVE CHILLERS FROM THE BCS CONTROLLER. RESET THE TEMPERATURE BETWEEN 42°F AND 45°F BASED ON EVAPORATOR ISOLATION VALVE POSITION. RESET TEMPERATURE UPWARD AND DOWNWARD IN 0.5°F INCREMENTS EVERY 30 MINUTES SUCH THAT THE CRITICAL EVAPORATOR ISOLATION VALVE IS NO MORE THAN 90% OPEN.
10. **CHILLER LEAVING WATER TEMPERATURE ALARM:** THE BCS CONTROLLER SHALL ANNUNCIATE AN ALARM CONDITION AT THE BCS CENTRAL STATION WHENEVER A CHILLER IS ENABLED AND CHILLER LEAVING WATER TEMPERATURE EXCEEDS 50°F FOR A PERIOD OF 15 MINUTES.
11. **SOFTWARE AND HARDWARE FOR CHILLER RUNNING AMPERES:** THE BCS MANUFACTURER SHALL BE RESPONSIBLE FOR PROVIDING SOFTWARE AND HARDWARE TO OBTAIN RUNNING AMPERES FROM THE CHILLER CONTROL PANEL.COORDINATE WITH THE CHILLER MANUFACTURER.
12. **EQUIPMENT FAILURE ALARM:** IF AN ENABLED OR STARTED PIECE OF EQUIPMENT DOES NOT PROVE OPERATING AFTER A 15 SECOND TIME PERIOD, OR PROOF IS LOST WHILE OPERATING, AN ALARM SIGNAL SHALL BE INITIATED AT THE BCS CENTRAL STATION AND AN EQUIVALENT PIECE OF EQUIPMENT SHALL BE STARTED OR ENABLED. CHILLERS AND PUMPS SHALL BE SEQUENCED INDEPENDENTLY. UPON PROOF OF OPERATION OF THE NEWLY STARTED OR ENABLED PIECE OF EQUIPMENT, THE ALARMED EQUIPMENT SHALL BE STOPPED OR DISABLED. THE ALARM MESSAGE SHALL REMAIN UNTIL MANUALLY RESET AT THE BCS CENTRAL STATION.
13. **CHILLER CONTROLS APPROVAL:** CHILLER CONTROLS SHALL BE APPROVED IN WRITING BY THE CHILLER MANUFACTURER BY NOTATION ON THE CONTROL SHOP DRAWINGS.



1 **CONTROL SCHEMATIC FOR CHILLED WATER SYSTEM**
NO SCALE

CFD Cape Fear Development

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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 043322 PAUL JACKSON KITCHENS
Signed on 05/22/2023 using a Digital Signature.

Project Grace
Grace Street
Wilmington, NC 28401
LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME: HVAC CONTROLS CHILLED WATER SYSTEM

ORIG SUBMISSION: 2023.05.22

SHEET: **M-703**

PERMIT SET

BCS CONTROLLER INPUT/OUTPUT SUMMARY HEATING WATER SYSTEM

	OUTPUTS						INPUTS										SOFTWARE											
	DIGITAL				ANALOG		DIGITAL					ANALOG					ALARM			BCS		ENERGY MGMT.						
	SYSTEM GRAPHIC DISPLAY	START/STOP	ENABLE/DISABLE	OPEN/CLOSE	SETPOINT ADJUST	BCS CONTROL	CURRENT SENSING RELAY	DIFFERENTIAL PRESSURE SWITCH	AUXILIARY CONTACT	ALARM CONTACT	PULSE CONTACT	TEMPERATURE	RELATIVE HUMIDITY	PRESSURE	FLOW	CARBON DIOXIDE	STATUS/INTERLOCK	HIGH/LOW LIMIT	RUN TIME TOTALIZATION	PROPORTIONAL	PROPORTIONAL + INTEGRAL	SCHEDULED START/STOP	OPTIMUM START/STOP	DEMAND LIMIT CYCLE	ENERGY USE TOTALIZATION	TRENDING AND ARCHIVING	CALCULATED VALUE	FAILURE MODE (SEE NOTE 1)	NOTES
SECONDARY HEATING WATER PUMPS SHWP-1-1, SHWP-1-2	●																												
PUMP START / STOP		●																										O	
PUMP STATUS							●										●								●	●			
PUMP VFD CONTROL						●															●								
SYSTEM DIFFERENTIAL PRESSURE														●				●								●			
HEATING WATER SUPPLY TEMPERATURE												●						●								●			
HEATING WATER RETURN TEMPERATURE												●						●								●			
OUTSIDE AIR TEMPERATURE												●																	2
BOILER ENTERING TEMPERATURE												●						●								●			
BOILER LEAVING WATER TEMPERATURE												●						●								●			
BOILER SEQUENCE CONTROLLER			●																										
HOT WATER SYSTEM FLOW															●														

NOTES:
1. FAILURE MODE
   O - ON OR OPEN
   C - OFF OR CLOSE
   L - LAST COMMAND
2. LOCATE OUTSIDE AIR TEMPERATURE SENSOR ON A NORTH FACING WALL OUT OF DIRECT SUNLIGHT.
3. CONTROLLED BY BOILER SEQUENCE CONTROLLER.

SEQUENCE OF OPERATION:

THE CONTROLS FOR THE BOILER PLANT SHALL FUNCTION AS FOLLOWS:

1. **SYSTEM START-UP**: THE BCS CONTROLLER SHALL ENABLE THE BOILER SEQUENCE CONTROLLER PANEL AND START THE LEAD SECONDARY HOT WATER PUMP WHENEVER OUTSIDE AIR TEMPERATURE IS BELOW 50°F (ADJUSTABLE) FOR 15 MINUTES.

2. **BOILER SEQUENCE CONTROLLER**: THE BOILER SEQUENCE CONTROLLER PANEL SHALL START AND STOP THE BOILER SYSTEM, INCLUDING PRIMARY PUMPS, AND BUILDING HOT WATER SUPPLY TEMPERATURE.

3. **RUNTIME TOTALIZATION:** THE BOILER SEQUENCE CONTROLLER SHALL TOTALIZE RUNTIME FOR BOILERS AND PUMPS AND SHALL START AND STOP EQUIPMENT IN A MANNER THAT EQUALIZES EQUIPMENT RUNTIME. EVALUATION AND ROTATION SHALL OCCUR DURING NONBUSINESS HOURS, OUTSIDE OF 8AM TO 5PM MONDAY THROUGH FRIDAY (ADJUSTABLE). THE BCS CONTROLLER SHALL, AT AN OPERATOR DEFINED INTERVAL INTITIALLY SET TO WEEKLY, OR UPON OPERATOR REQUEST, EVALUATE THE LEAD SECONDARY PUMP SELECTION AND RESELECT SO AS TO EQUALIZE RUNTIME. WHENEVER PUMP SELECTION IS ROTATED, THE NEWLY STARTED PUMP SHALL START AND BE PROVEN OPERATING FOR 1 MINUTE (ADJUSTABLE), PRIOR TO THE OPERATING PUMP BEING STOPPED. EVALUATION AND ROTATION SHALL OCCUR DURING NONBUSINESS HOURS OUTSIDE OF 8AM TO 5PM MONDAY THROUGH FRIDAY (ADJUSTABLE).

4. **HOT WATER SUPPLY TEMPERATURE CONTROL:** EACH ACTIVE BOILER SHALL OPERATE UNDER BOILER SEQUENCE CONTROLLER TO MAINTAIN THE SYSTEM HOT WATER SUPPLY TEMPERATURE SETPOINT OF 140°F (ADJUSTABLE). IF THE HOT WATER SUPPLY TEMPERATURE IS MORE THAN 5°F (ADJUSTABLE) ABOVE OR BELOW SETPOINT FOR 30 MINUTES (ADJUSTABLE), THE BCS SHALL SIGNAL A CRITICAL ALARM.

5. **SYSTEM PRESSURE SETPOINT**: THE BCS CONTROLLER SHALL MODULATE THE SPEED OF ACTIVE SECONDARY HOT WATER PUMP TO MAINTAIN THE SYSTEM DIFFERENTIAL PRESSURE SETPOINT AT THE SENSOR LOCATION INDICATED ON THE DRAWINGS.

6. **SYSTEM PRESSURE AND SUPPLY TEMPERATURE VARIATION:** THE SYSTEM PRESSURE SETPOINT SHALL BE RAMPED FROM THE MINIMUM SYSTEM PRESSURE SETPOINT, 5 PSI (ADJUSTABLE), TO 75% (ADJUSTABLE) OF THE MAXIMUM SYSTEM PRESSURE SETPOINT OVER A PERIOD OF 3 MINUTES (ADJUSTABLE). THE MAXIMUM SYSTEM PRESSURE SETPOINTS SHALL BE DETERMINED DURING THE TESTING, ADJUSTING, AND BALANCING PROCESS. THE MAXIMUM SETPOINTS SHALL CORRESPOND TO MAXIMUM DESIGN FLOW.

   A. EVALUATE LOADED UNITS: EVERY 10 MINUTES (ADJUSTABLE), THE BCS CONTROLLER SHALL EVALUATE CONTROL VALVE POSITIONS AND DETERMINE THE NUMBER OF "LOADED UNITS", DEFINED AS A CONTROL VALVE WHOS VALVE COMMANDED POSITION IS GREATER THAN 90% OPEN (ADJUSTABLE). THE LOADED VALVES SHALL BE IDENTIFIED ON A CONTROL VALVE TABULAR SUMMARY IN THE BCS.

   B. VARY THE SYSTEM PRESSURE WITH A CONSTANT SUPPLY TEMPERATURE: MAINTAIN THE SYSTEM SUPPLY TEMPERATURE SETPOINT AT THE INITIAL SETTING OF 140°F (ADJUSTABLE). WHEN LOADED UNITS ARE EVALUATED, IF MORE THAN EIGHT (ADJUSTABLE) VALVES ARE LOADED UNITS, THE BCS CONTROLLER SHALL INCREASE THE DIFFERENTIAL PRESSURE SETPOINT BY 0.5 PSI (ADJUSTABLE) UP TO THE MAXIMUM SYSTEM PRESSURE SETPOINT. IF FOUR (ADJUSTABLE) OR LESS OF THE VALVES ARE LOADED UNITS, THE BCS CONTROLLER SHALL REDUCE THE ASSOCIATED SYSTEM DIFFERENTIAL PRESSURE SETPOINT BY 0.25 PSI (ADJUSTABLE) DOWN TO THE MINIMUM SYSTEM PRESSURE SETPOINT. IF ALL RISER DIFFERENTIAL PRESSURE SETPOINTS ARE EQUAL TO THE MINIMUM SETPOINTS FOR 30 MINUTES (ADJUSTABLE), MAINTAIN THOSE SETPOINTS AND VARY THE SUPPLY TEMPERATURE.

   C. VARY THE SUPPLY TEMPERATURE WITH A CONSTANT SYSTEM PRESSURE: SEQUENCE C SHALL NOT COMMENCE UNTIL THE FINAL CONDITION FOR SEQUENCE B HAS BEEN MET. VARY THE SYSTEM SUPPLY TEMPERATURE SETPOINT BETWEEN 110°F AND 140°F (ADJUSTABLE) IN 5°F (ADJUSTABLE) INCREMENTS EVERY 30 MINUTES (ADJUSTABLE). IF FOUR (ADJUSTABLE) OR LESS VALVES ARE LOADED, DECREASE SETPOINT. IF MORE THAN EIGHT (ADJUSTABLE) VALVES ARE LOADED, INCREASE SETPOINT. IF, FOR 2 CONSECUTIVE EVALUATION CYCLES, MORE THAN EIGHT (ADJUSTABLE) VALVES ARE LOADED OR AN ERU OR AHU VALVE IS LOADED, RETURN THE SYSTEM SUPPLY TEMPERATURE SETPOINT TO THE INITIAL SETTING OF 140°F (ADJUSTABLE) AND RESUME THE SYSTEM PRESSURE VARIATION SEQUENCE.

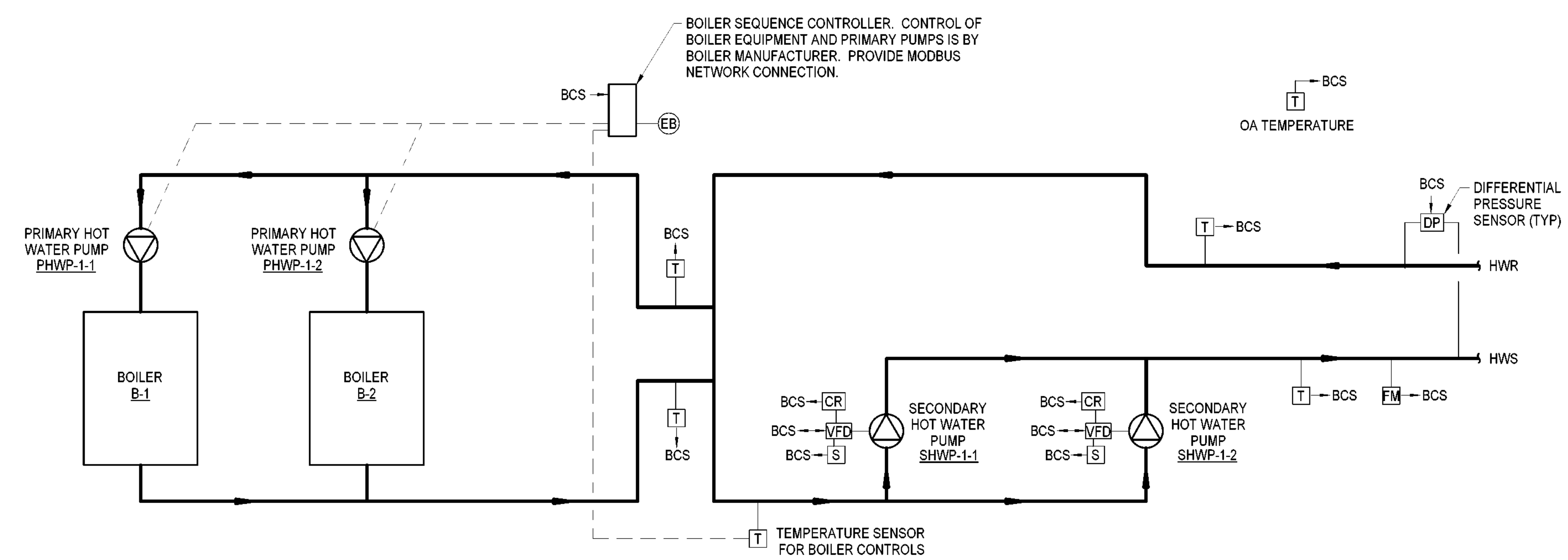
   D. SYSTEM GRAPHIC ANNOTATION: ADD THE FOLLOWING CLARIFYING STATEMENT TO THE BCS GRAPHICS: "SUPPLY TEMPERATURE VARIATION SHALL ONLY OCCUR WHEN SYSTEM PRESSURE IS AT ITS MAXIMUM VALUE." INCLUDE SYSTEM GRAPHIC ICON INDICATING WHETHER OR NOT DISCHARGE TEMPERATURE VARIATION IS ACTIVE WITH "ENABLED" OR "DISABLED".

8. **LOW WATER TEMPERATURE ALARM**: THE BCS CONTROLLER SHALL ANNUNCIATE AN ALARM CONDITION AT THE BCS CENTRAL STATION WHENEVER BUILDING HOT WATER SUPPLY TEMPERATURE IS BELOW 120°F AND THE BOILER SEQUENCE CONTROLLER HAS BEEN ENABLED FOR A PERIOD OF 15 MINUTES.

9. **SECONDARY HOT WATER PUMP FAILURE ALARM**: UPON LOSS OF PROOF OF OPERATION FROM BOTH SECONDARY HOT WATER PUMPS WITH THE BOILER SEQUENCE CONTROLLER ENABLED FOR 5 MINUTES, THE BCS CONTROLLER SHALL ANNUNCIATE AN ALARM CONDITION AT THE BCS CENTRAL STATION.

10. **BOILER SHUT DOWN**: EMERGENCY BOILER SHUT DOWN STATION SHALL DEACTIVATE THE BOILER.

11. **BOILER CONTROLS APPROVAL**: BOILER CONTROLS SHALL BE APPROVED BY THE BOILER MANUFACTURER IN WRITING, BY NOTATION ON THE CONTROL SHOP DRAWINGS.



1 **CONTROL SCHEMATIC FOR HOT WATER SYSTEM**
NO SCALE

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SHEET NAME: HVAC CONTROLS HOT WATER SYSTEM

ORIG SUBMISSION: 2023.05.22

SHEET: **M-704**

PERMIT SET

BCS CONTROLLER INPUT/OUTPUT SUMMARY ERU

	SYSTEM GRAPHIC DISPLAY	OUTPUTS – DIGITAL – START/STOP	ENABLE/DISABLE	OPEN/CLOSE		OUTPUTS – ANALOG – SETPOINT ADJUST	BCS CONTROL			INPUTS – DIGITAL – CURRENT SENSING RELAY	DIFFERENTIAL PRESSURE SWITCH	AUXILIARY CONTACT	ALARM CONTACT	PULSE CONTACT	POSITION FEEDBACK	INPUTS – ANALOG – TEMPERATURE	RELATIVE HUMIDITY	FLOW	PRESSURE	% FULL LOAD AMPS	SOFTWARE – ALARM – STATUS/INTERLOCK	HIGH/LOW LIMIT	RUN TIME TOTALIZATION	VIBRATION	SOFTWARE – BCS – PROPORTIONAL	PROPORTIONAL + INTEGRAL		SOFTWARE – ENERGY MGMT. – SCHEDULED START/STOP	OPTIMUM START STOP	DAY/NIGHT SETBACK	DEMAND LIMIT CYCLE	RESET OPTIMIZATION	ECONOMIZER	CALCULATED POINTS	TRENDING AND ARCHIVING	FAILURE MODE (SEE NOTES 1 AND 2)	NOTES
ENERGY RECOVERY UNIT	●																																				
OUTSIDE AIR DAMPER				●																																O	
SUPPLY AIR DAMPER				●																																O	
EXHAUST AIR INTAKE DAMPER				●																																O	
EXHAUST AIR DISCHARGE DAMPER				●																																O	
PREHEAT COIL CONTROL VALVE							●																			●										O	
COOLING COIL CONTROL VALVE							●																			●										O	
COOLING COIL HUMIDITY																	●																				
COOLING COIL LEAVING AIR TEMPERATURE																●						●															
PREHEAT COIL LEAVING AIR TEMPERATURE																●						●															
SUPPLY FAN START/STOP		●																																		O	
SUPPLY FAN VFD SPEED							●																			●										O	3
SUPPLY FAN STATUS										●											●		●														
EXHAUST FAN START/STOP		●																																		O	
EXHAUST FAN VFD SPEED							●																			●										O	3
EXHAUST FAN STATUS										●											●		●														
ENTHALPY WHEEL START/STOP		●																																			
ENTHALPY RECOVERY WHEEL VFD SPEED							●																			●											
ENTHALPY RECOVERY WHEEL STATUS										●											●		●														
ENTHALPY RECOVERY WHEEL OUTSIDE AIR EAT																●																					
ENTHALPY RECOVERY WHEEL OUTSIDE AIR INLET RH																	●																				
ENTHALPY RECOVERY WHEEL OUTSIDE AIR LAT																●																					
ENTHALPY RECOVERY WHEEL OUTSIDE AIR OUTLET RH																	●																				
ENTHALPY RECOVERY WHEEL EFFICIENCY																																		●			
FREEZESTAT													●																								
DISCHARGE AIR TEMPERATURE																●																					
EXHAUST AIR INLET TEMPERATURE																●																					
EXHAUST AIR RELATIVE HUMIDITY																	●																				
SUPPLY DUCT STATIC PRESSURE																			●																		
EXHAUST DUCT STATIC PRESSURE																			●																		
SUPPLY DUCT HIGH PRESSURE SAFETY													●																								
EXHAUST DUCT HIGH PRESSURE SAFETY													●																								
SUPPLY DUCT LOW PRESSURE SAFETY													●																								
EXHAUST DUCT LOW PRESSURE SAFETY													●																								
SUPPLY AIR FILTER DIFFERENTIAL PRESSURE																			●																		
EXHAUST AIR FILTER DIFFERENTIAL PRESSURE																			●																		
SUPPLY FAN ISOLATION DAMPERS				●																																O	4,5
EXHAUST FAN ISOLATION DAMPERS				●																																O	4,5
DUCTWORK DISTRIBUTION COMPONENTS																																					
EXHAUST AIR CONTROL DAMPERS	●						●																													O	4
EXHAUST AIR AIRFLOW MEASUREMENT SYSTEMS	●																	●								●									●		4
EXHAUST TERMINAL UNITS	●																																			L	4
PRIMARY AIR FLOW							●																														
PRIMARY AIR VALVE CONTROL																		●								●									●		

NOTES:
1. FAILURE MODE: O - ON OR OPEN, C - OFF OR CLOSE, L - LAST COMMAND
2. BCS CONTROLS AND INTERFACES SHALL BE ARRANGED SO THAT EQUIPMENT CONTROLLED BY THE BCS OPERATES AS INDICATED ON FAILURE OF THE BCS CONTROLLER FOR ANY REASON, INCLUDING LOGIC POWER SUPPLY FAILURE, CPU LOCK-UP, OR INTERPOSING RELAY FAILURE. SAFETY AND OPERATIONAL INTERLOCKS SHALL REMAIN IN EFFECT.
3. FAN SHALL FAIL TO 50% SPEED.
4. PROVIDE IDENTICAL CONTROL POINTS FOR IDENTICAL PIECES OF EQUIPMENT.
5. ONE DAMPER PER FAN IN FAN ARRAY.

SEQUENCES OF OPERATION

THE CONTROLS FOR SYSTEM ERU-R-1 SHALL FUNCTION AS FOLLOWS:

1. **SYSTEM START-UP** : THE SYSTEM SHALL BE AUTOMATICALLY STARTED AND STOPPED BY THE BCS CONTROLLER WHENEVER THE HAND-OFF-AUTOMATIC SWITCH IS IN THE AUTOMATIC POSITION, AND MANUALLY STARTED AND STOPPED BY THE HAND POSITION.
2. **DAMPER POSITIONS**: PRIOR TO FAN STARTING, THE EXHAUST AIR DAMPERS, OUTSIDE AIR DAMPER, SUPPLY AIR DAMPER, AND ALL SMOKE AND FIRE AND SMOKE DAMPERS ASSOCIATED WITH THE SYSTEM SHALL BE PROVEN OPEN.
3. **SUPPLY AIR TEMPERATURE CONTROL** : MODULATE THE CHILLED WATER CONTROL VALVE TO MAINTAIN THE SYSTEM LEAVING AIR TEMPERATURE SETPOINT, INITIALLY SET TO 52°F (ADJUSTABLE). IF THE SUPPLY AIR TEMPERATURE IS MORE THAN 5°F (ADJUSTABLE) ABOVE OR BELOW SETPOINT FOR 30 MINUTES (ADJUSTABLE), THE BCS CONTROL SHALL SIGNAL A CRITICAL ALARM.
4. **SUPPLY DUCT STATIC PRESSURE VARIATION** : MODULATE THE SUPPLY FAN VARIABLE FREQUENCY DRIVE TO MAINTAIN SUPPLY DUCT STATIC PRESSURE SETPOINT. THE DISCHARGE SETPOINT SHALL BE VARIED IN 0.1" INCREMENTS BASED ON SUPPLY DAMPER POSITION OF THE ZONE WITH THE GREATEST DEMAND FOR OUTSIDE AIR.
5. **EXHAUST DUCT STATIC PRESSURE VARIATION** : MODULATE THE EXHAUST FAN'S VARIABLE FREQUENCY DRIVE TO MAINTAIN EXHAUST DUCT STATIC PRESSURE SETPOINT AS DETERMINED BY TEST AND BALANCE AND AS SENSED BY THE EXHAUST DUCT STATIC PRESSURE SENSOR. THE EXHAUST DUCT STATIC PRESSURE SETPOINT SHALL BE VARIED IN 0.1" (ADJUSTABLE) INCREMENTS EVERY 10 MINUTES (ADJUSTABLE) BASED ON FLOOR EXHAUST TERMINAL UNIT AND RELIEF AIR DAMPER POSITION OF THE ZONE WITH THE GREATEST DEMAND FOR EXHAUST.
6. **RELIEF AIR DAMPER CONTROL:** EACH FLOOR RELIEF AIR DAMPER SHALL MODULATE TO MAINTAIN RELIEF AIRFLOW SETPOINT AS MEASURED BY AN AIRFLOW MEASUREMENT SYSTEM. RELIEF AIR SETPOINT SHALL BE EQUAL TO 1/3 OF THE ZONE'S AHU OUTSIDE AIRFLOW MINUS THE ZONE EXHAUST TERMINAL UNIT FLOW MINUS 500 CFM (ADJUSTABLE) PRESSURIZATION OFFSET. PRESSURIZATION OFFSET PER ZONE SHALL BE OPTIMIZED DURING TESTING, ADJUSTING & BALANCING.
7. **PREHEAT COIL CONTROL**: UPON A DROP IN OUTSIDE AIR TEMPERATURE BELOW 55°F: MODULATE THE PREHEAT COIL CONTROL VALVE TO MAINTAIN PREHEAT COIL LEAVING AIR TEMPERATURE SETPOINT, AS SENSED BY AN AVERAGING ELEMENT LOCATED IMMEDIATELY DOWNSTREAM OF THE PREHEAT COIL. PREHEAT COIL CONTROLS SHALL REMAIN ACTIVE AT ALL TIMES, INCLUDING UNIT SHUTDOWN.
8. **ENTHALPY WHEEL SPEED CONTROL:**
   A. IF THE CHILLED WATER VALVE IS OPEN AND THE ENTERING OUTSIDE AIR ENTHALPY IS GREATER THAN THE EXHAUST ENTHALPY, THEN OPERATE THE ENTHALPY WHEEL AT MAXIMUM SPEED.
   B. IF THE CHILLED WATER VALVE IS OPEN AND THE ENTERING OUTSIDE AIR ENTHALPY IS LESS THAN THE EXHAUST ENTHALPY, THEN THE ENTHALPY WHEEL WILL STOP.
   C. IF THE CHILLED WATER VALVE IS CLOSED, MODULATE THE ENTHALPY WHEEL TO MAINTAIN A LEAVING AIR TEMPERATURE OF 1°F LESS THAN SYSTEM DISCHARGE AIR TEMPERATURE SETPOINT.

8\. **FREEZE PROTECTION** : A SEPARATE LOW LIMIT SAFETY SENSING AIR ENTERING THE COOLING COIL, SET AT 40°F ADJUSTABLE, SHALL STOP THE SUPPLY AND EXHAUST FANS, CLOSE THE OUTSIDE AIR DAMPERS, AND OPEN THE CHILLED WATER AND PREHEAT VALVES.

9\. **SUPPLY DUCT HIGH PRESSURE SAFETY** : A HIGH PRESSURE SAFETY SENSING SUPPLY DUCT DISCHARGE STATIC PRESSURE SET AT 80% OF THE SUPPLY DUCT PRESSURE RATING SHALL STOP THE SUPPLY FAN.

10\. **EXHAUST DUCT LOW PRESSURE SAFETY** : A LOW PRESSURE SAFETY SENSING EXHAUST DUCT INLET STATIC PRESSURE SET AT 80% OF THE EXHAUST DUCT PRESSURE RATING SHALL STOP THE EXHAUST FAN.

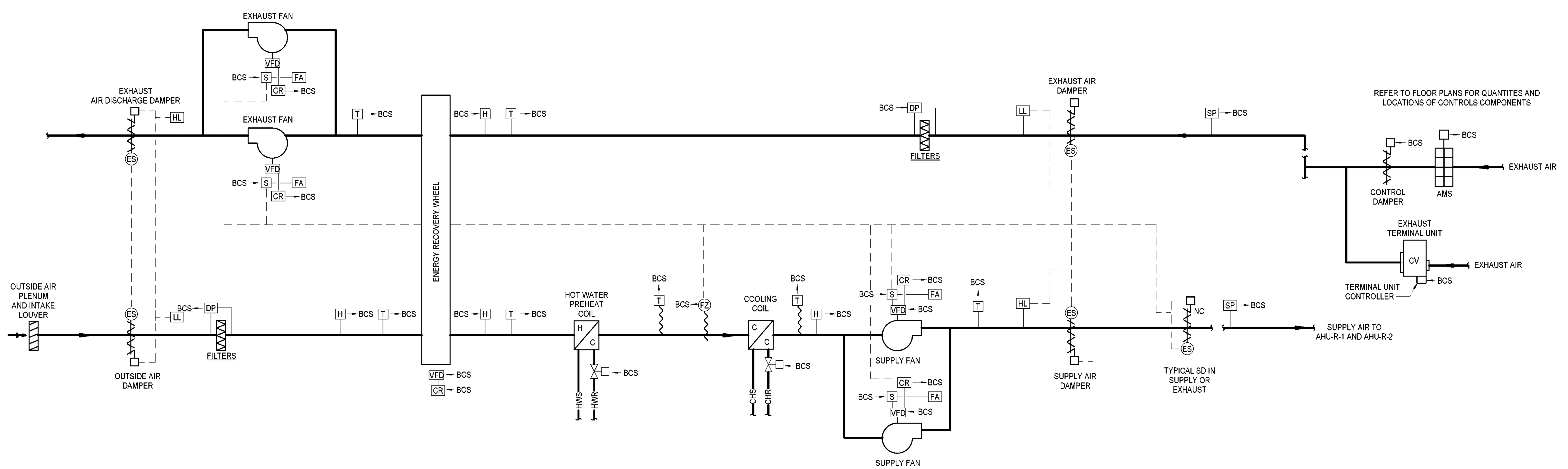
11\. **OUTSIDE AIR DUCT LOW PRESSURE SAFETY:** A LOW PRESSURE SAFETY SENSING OUTSIDE AIR DUCT INLET STATIC PRESSURE SET AT 80% OF THE OUTSIDE AIR DUCT PRESSURE RATING SHALL STOP THE SUPPLY FAN.

12\. **SHUTDOWN** : ON POWER INTERRUPTION OR FAN SHUTDOWN, THE OUTSIDE AIR, RETURN, SMOKE, AND FIRE AND SMOKE DAMPERS, AND CHILLED WATER AND HOT WATER VALVES SHALL CLOSE.

13\. **SMOKE DETECTION**: SMOKE DETECTORS IN THE SUPPLY AND EXHAUST DUCTS DOWNSTREAM OF THE FILTERS SHALL AUTOMATICALLY SHUT DOWN THE FAN.

14\. **FIRE ALARM RELAY**: ON ACTIVATION OF THE FIRE ALARM SYSTEM RELAY OR SMOKE DETECTOR, THE CORRESPONDING FIRE SMOKE DAMPER SHALL CLOSE AND THE AIR HANDLING UNIT SHALL SHUT DOWN.

ZONE	AIR HANDLING UNIT	EXHAUST TERMINAL UNITS
LEVEL 1 WEST	AHU-R-2	ETU-1-1
LEVEL 1 EAST	AHU-R-1	ETU-1-2
LEVEL 2 WEST	AHU-R-2	ETU-2-1
LEVEL 2 EAST	AHU-R-1	N/A
LEVEL 3	AHU-R-1	ETU-3-1, ETU-3-2, ETU-3-3



1 **CONTROL SCHEMATIC FOR ERU**
NO SCALE

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Signed on 05/22/2023 using a Digital Signature.

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Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC CONTROLS ERU

ORIG SUBMISSION: 2023.05.22

SHEET: **M-705**

PERMIT SET

BCS PANEL INPUT/OUTPUT SUMMARY AIR HANDLING UNITS AHU-R-1, AND AHU-R-2

		OUTPUTS								INPUTS													SOFTWARE																
		DIGITAL								DIGITAL							ANALOG						ALARM				BCS			ENERGY MGMT.									
	SYSTEM GRAPHICS DISPLAY	START/STOP	ENABLE/DISABLE	OPEN/CLOSE	ACTIVATE/DEACTIVATE		SETPOINT ADJUST	BCS CONTROL		CURRENT SENSING RELAY	DIFFERENTIAL PRSSURE SWITCH	DAMPER OPEN/CLOSED END SWITCH	AUXILIARY CONTACT	ALARM CONTACT	PULSE CONTACT		TEMPERATURE	RELATIVE HUMIDITY	PRESSURE	FLOW	CARBON DIOXIDE LEVEL		STATUS/INTERLOCK	HIGH/LOW LIMIT	RUN TIME TOTALIZATION		PROPORTIONAL	PROPORTIONAL + INTEGRAL		SCHEDULED START/STOP	OPTIMUM START.STOP	DAY/NIGHT SETBACK	ECONOMIZER	ENERGY METERING	ARCHIVAL SERVER	BAS TREND	AVERAGE VALUE OF ALL INPUTS	FAILURE MODE (SEE NOTES 1 AND 2)	NOTES
AIR HANDLING UNIT	●																																						9
OUTSIDE AIR DAMPER								●																				●										O	
AIRFLOW STATION				●																●																			
RETURN AIR DAMPER								●				●																●										O	7
MIXED AIR TEMPERATURE																	●																						
CHILLED WATER CONTROL VALVE							●	●																				●										C	
COOLING COIL LEAVING AIR TEMPERATURE																	●							●															
SUPPLY FAN START/STOP		●																																				O	6
SUPPLY FAN VFD SPEED							●	●																				●											5
SUPPLY FAN STATUS										●			●										●		●														
SYSTEM DISCHARGE AIR TEMPERATURE																	●							●															
SYSTEM DISCHARGE SMOKE DAMPER STATUS												●																											7
MAIN SYSTEM SMOKE DAMPER OR FIRE SMOKE DAMPER STATUS												●																											7
FREEZESTAT														●																									
DUCT HIGH STATIC PRESSURE SAFETY											●			●																									
RETURN DUCT LOW PRESSURE (SUCTION) SAFETY														●																									
FILTER DIFFERENTIAL PRESSURE																			●					●															
SUPPLY DUCT STATIC PRESSURE																			●					●															8
SUPPLY AIR RELATIVE HUMIDITY																		●						●															
SPACE CARBON DIOXIDE LEVEL																					●			●													●		3
RETURN AIR TEMPERATURE																	●							●															
RETURN AIR RELATIVE HUMIDITY																		●						●															
RETURN AIR CARBON DIOXIDE LEVEL																				●				●															
OUTSIDE AIR TEMPERATURE																					●																		4
OUTSIDE AIR RELATIVE HUMIDITY																		●																					
HUMIDIFIER CONTROL																												●											
RELATIVE HUMIDITY HIGH LIMIT														●				●						●															

NOTES:

1. FAILURE MODE
   - O - ON OR OPEN
   - C - OFF OR CLOSE
   - L - LAST COMMAND
2. WHERE FAILURE MODE IS INDICATED, THE INDICATED POSITION SHALL OCCUR ON FAILURE OF THE BCS CONTROLLER OR ITS OUPUT FOR ANY REASON.
3. SEE PIPING PLANS FOR SENSOR LOCATIONS.
4. LOCATE OUTSIDE AIR TEMPERATURE SENSOR ON A NORTH FACING WALL OUT OF DIRECT SUNLIGHT. ONE OUTSIDE AIR TEMPERATURE SENSOR AND ASSOCIATED CONTROL POINT REQUIRED. SINGLE SENSOR AND CONTROL POINT MAY BE USED FOR ALL SYSTEMS AS REQUIRED.
5. FAN SHALL FAIL TO 50% SPEED.
6. PROVIDE BACNET INTEGRATION OF ALL AVAILABLE POINTS FROM VFD.
7. MONITOR OPEN AND CLOSED STATUS OF DAMPER END SWITCHES FROM TWO SEPARATE END SWITCHES INTALLED ON DAMPER SHAFT.
8. DUCT STATIC PRESSURE SENSORS ARE SHOWN ON THE DUCTWORK FLOORPLANS.
9. PROVIDE GRAPHICS AND TRENDS FOR ALL POINTSTED LISTED IN I/O SUMMARY.

SEQUENCE OF OPERATION

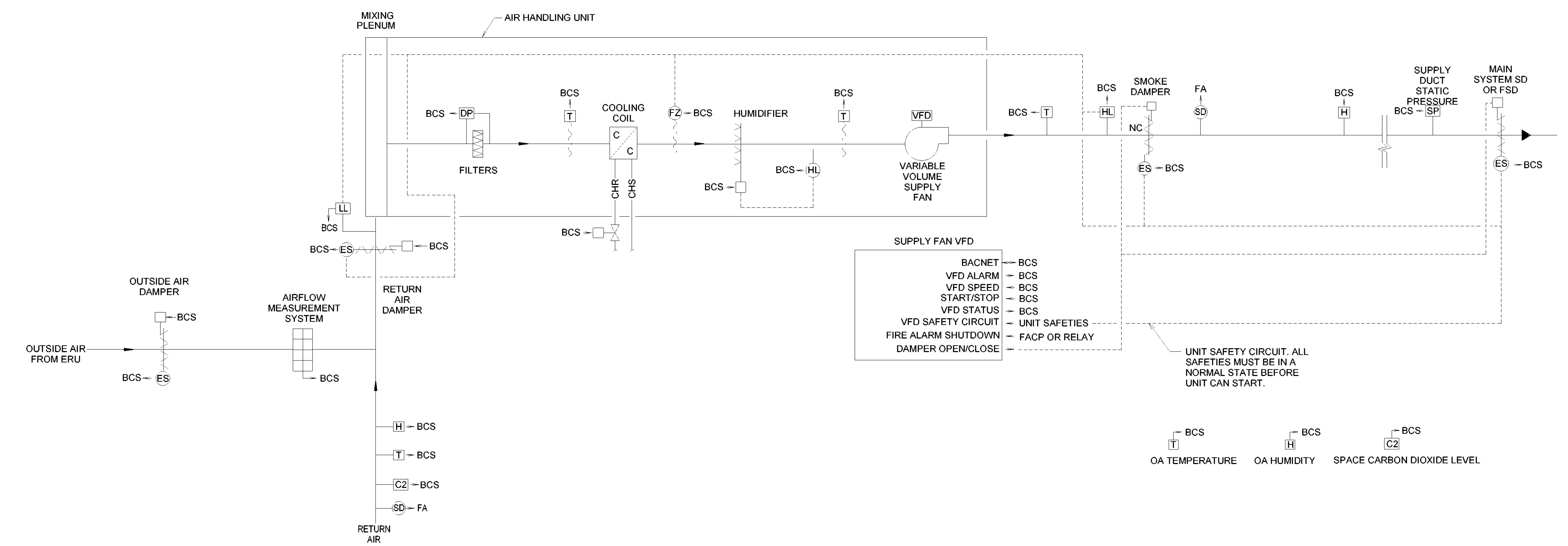
THE CONTROLS FOR THE AIR HANDLING UNITS AHU-R-1, AND & AHU-R-2 SHALL FUNCTION AS FOLLOWS:

1. **SYSTEM START-UP:** THE SYSTEM SHALL BE AUTOMATICALLY STARTED AND STOPPED BY THE BCS CONTROLLER WHENEVER THE SYSTEM IS IN THE MANUAL MODE, OR IN AUTOMATIC MODE AN DANY OF THE BELOW ARE TRUE.
   - A. THE TIME OF DAY IS BETWEEN THE SCHEDULED OCCUPIED START AND TOP TIMES.
   - B. THE SCHEDULE HAS BEEN OVERRIDDEN BY THE OPERATOR.
   - C. ANY ZONE LOCAL OVERRIDE TIMER (INITIATED BY LOCAL OVERRIDE BUTTON) IS NONZERO.
2. **DAMPER AND FAN PRE-START STATUS:** PRIOR TO FAN STARTING, THE SYSTEM DAMPERS AND FANS SHALL HAVE THE FOLLOWING STATUSES:

DAMPER/FAN	STATUS	PROVEN STATUS
OUTSIDE AIR DAMPER	CLOSED	CLOSED
DISCHARGE SMOKE DAMPER	OPEN	OPEN
MAIN ISOLATION DAMPER*	OPEN	OPEN
RETURN AIR DAMPER	OPEN	OPEN FOR 1 MINUTE

*INCLUDES SMOKE AND FIRE/SMOKE DAMPERS
**IF COMPLETE FLOW PATH IS BLOCKED BY BRANCH DAMPERS BEING CLOSED THE UNIT SHALL NOT START.

3. **OPTIMUM START:** THE SYSTEM SHALL START PRIOR TO SCHEDULED OCCUPANCY BASED ON THE TIME NECESSARY FOR THE ZONES TO REACH THEIR OCCUPIED SETPOINTS.
4. **UNIT START-UP (PRE-COOL & RE-HEAT):** ON UNIT START-UP, THE SYSTEM SHALL RUN. IF OUTSIDE AIR TEMPERATURE IS BELOW 55ºF (ADJUSTABLE), CLOSE THE CHILLED WATER VALVE AND MODULATE ALL ZONE LEVEL REHEAT COIL VALVES TO THE MAXIMUM DISCHARGE AIR TEPERATURE SETPOINT. IF THE OUTSIDE AIR TEMPERATURE IS 55ºF (ADJUSTABLE) OR HIGHER, MODULATE THE CHILLED WATER VALVE TO MAINTAIN MINIMUM DISCHARGE AIR TEMPERATURE SENTPOINT. MODULATE THE SUPPLY FAN VARIABLE FREQUENCY DRIVE TO MAINTAIN ALL SUPPLY DUCT STATIC PRSSURE AT OR ABOVE THEIR RESPECTIVE SETPOINTS AS DETERMINED DURING THE TESTING, ADJUSTING AND BALANCING PROCESS. UNIT START-UP SHALL CONTINUE FOR 30 MINUTES (ADJUSTABLE) OR UNTIL RETURN AIR TEMPERATURES ARE WITHIN 2ºF (ADJUSTABLE) OF THE OCCUPIED SPACE TEMPERATURE SETPOINTS FOR A PERIOD OF 5 MINUTES (ADJUSTABLE). UPON COMPLETION OF UNIT START-UP, OPEN THE OUTSIDE AIR DAMPER AND START NORMAL OPERATION.
5. **DISCHARGE AIR TEMPERATURE CONTROL:** MODULATE THE CHILLED WATER VALVE TO MAINTAIN THE SYSTEM DISCHARGE AIR TEMPERATURE SETPOINT.
6. **SUPPLY DUCT STATIC PRESSURE CONTROL:** MODULATE THE SUPPLY FAN VARIABLE FREQUENCY DRIVE TO MAINTAIN SUPPLY DUCT STATIC PRESSURE AT OR ABOVE THEIR RESPECTIVE SETPOINTS, AS DETERMINED DURING THE TESTING, ADJUSTING AND BALANCING PROCESS.
7. **HUMIDIFIER CONTROL:** AIRFLOW SHALL BE PROVEN PRIOR TO ACTIVATION OF HUMIDIFER SYSTEM. MODULATE THE HUMIDIFIER OUTPUT TO MAINTAIN SYSTEM DISCHARGE AIR RELATIVE HUMIDTY SETPOINT. SYSTEM DISCHARGE AIR RELATIVE HUMIDTY SETPOINT SHALL VARY BETWEEN THE LIMITS OF 40% AND 85% RH AS REQUIRED TO MAINTAIN THE AVERAGE SPACE RELATIVE HUMIDITY AT 50% RH (ADJUSTABLE). A HIGH HUMIDITY SAFETY SHALL DISABLE THE HUMIDIFIER IF THE SYSTEM DISCHARGE AIR RELATIVE HUMIDITY EXCEEDS 90% RH
8. **RUN THE STATIC PRESSURE SETPOINT RESET WITH CONSTANT DAT SETPOINT ROUTINE.**
9. **OUTSIDE AIR CONTROL:** FIVE MINUTES AFTER UNIT STARTUP, ALLOW THE OUTSIDE AIR DAMPER TO MODULATE TO MAINTAIN THE MINIMUM OUTDOOR AIR SETPOINT AS MEASUARED BY THE OUTDOOR AIR AIRLFOW MEASUREMENT SYSTEM. EVALYATE THE OUTSIDE AIRE VOLUME ON 5-MINUTE INTERVALS (ADJUSTABLE).
10. **DEMAND CONTROL VENTILATION:** ADJUST THE MINIMUM OUTSIDE AIRFLOW SETPOINT BETWEEN THE LOWER AND UPPER LIMITS IN 10% (ADJUSTABLE) INCREMENTS EVERY 10 MINUTES. IF BOTH THE AVERAGE SPACE AND AVERAGE RETURN AIR CARBON DIOXIDE CONCENTRATIONS ARE BELOW 800 PPM (ADJUSTABLE), REDUCE THE OUTSIDE AIRFLOW SETPOINT. IF EITHER THE AVERAGE SPACE OR AVERAGE RETURN AIR CARBON DIOXIDE CONCENTRATIONS ARE ABOVE 900 PPM (ADJUSTABLE), INCREASE THE OUTSIDE AIRFLOW SETPOINT. IF ANY SPACE OR RETURN AIR CARBON DIOXIDE CONCENTRATION IS ABOVE 1000 PPM FOR 5 MINUTES (ADJUSTABLE), INCREASE THE OUTSIDE AIRFLOW SETPOINT. IF ANY SPACE OR RETURN AIR CARBON DIOXIDE CONCENTRATION IS ABOVE 1000 PPM FOR LONGER THAN 1 HOUR (ADJUSTABLE), INITIATE AN ALARM THROUGH THE BCS.
11. **FREEZE PROTECTION:** A SEPARATE LOW LIMIT SAFETY SENSING AIR ENTERING THE COOLING COIL SET AT 40ºF (ADJUSTABLE), SHALL STOP THE FAN, CLOSE THE OUTSIDE AIR DAMPERS AND OPEN THE CHILLED WATER VALVE AND INITIATE AN ALARM. THIS SEQUENCE SHALL REMAIN OPERATIONAL AT ALL TIMES. BCS SHALL ALARM IF MIXED AIR ENTERING THE COIL REACHES 40ºF (ADJUSTABLE).
12. **HIGH PRESSURE SAFETY:** A HIGH-PRESSURE SAFETY SENSING DISCHARGE STATIC PRSSURE SET AT 20% LESS THAN DUCT PRESSURE RATING SHALL STOP THE FAN.
13. **LOW SUCTION SAFETY:** A LOW-SUCTION SAFETY SENSING INTAKE STATIC PRSSURE SET AT 20% LESS THAN DUCT PRESSURE AT THE MAXIMUM SETPOINT SHALL STOP THE FAN. THE LOW-SUCTION DUCT PRESSURE AT MAXIMUM SETPOINT SHALL BE DETERMINED DURING THE TESTING, ADJUSTING AND BALANCING PROCESS.
14. **UNOCCUPIED SHUTDOWN:** WHEN THE TIME OF DAY EACHES THE UNOCCUPIED STOP TIME, THE SYSTEM SHALL STOP.
    - A. **HEATING UNOCCUPIED SHUTDOWN OVERRIDE:** WHEN ANY 3 TERMINAL UNITS CALL FOR HEATING AND PRIMARY VALVES OPENS, BCS SHALL OVERRIDE THE SUPPLY FAN INTERLOCK AND ALLOW SYSTEM TO RECIRCULATE AIR. AIR HANDLING UNIT HEAITNG AND COOLING COIL CONTROL VALVES SHALL REMAIN CLOSED. IF AFTER 30 MINUTES (ADJUSTABLE) TERMINAL UNITS ARE STILL CALLING FOR HEAT, PRIMARY VALVES ARE OPEN AND RTURN AIR TEMPERATURE IS 54ºF (ADJUSTABLE) OR BELOW, ENGAGE THE ZONE HEATING CIL CONTROL VALVE TO PROVIDE A DISCHARGE AIR TAMPERATURE OF 85ºF (ADJUSTABLE).
    - B. **COOLING UNOCCUPIED SHUTDOWN OVERRIDE:** WHEN ANY 3 TERMINAL UNITS CALL FOR COOLING AND PRIMARY VALVE OPENS, BCS SHALL OVERRIDE THE SUPPLY FAN INTERLOCK AND ALLOW SYSTEM TO RECIRCULATE AIR. AIR HANDLING UNIT COOLING AND HEATING COIL CONTROL VALVES SHALL REMAIN CLOSED. IF AFTER 30 MINUTES (ADJUSTABLE) TERMINAL UNITS ARE STILL CALLING FOR COOLING AND PRIMARY VALVES ARE OPEN, ENGAGE THE AIR HANDLING UNIT COOLING COIL CONTROL VALVE TO PROVIDE A DISCHARGE AIR TEMPERATURE OF 55ºF (ADJUSTABLE).
15. **SHUTDOWN:** ON POWER INTERRUPTION OR FAN SHUTDOWN, CLOSE THE OUTSIDE AIR, RELIEF, SMOKE, AND RETURN DAMPERS, CLOSE THE CHILLED WATER CONTROL VALVE AND THE PREHEAT COIL CONTROL VALVE.
16. **SMOKE DETECTION:** SMOKE DETECTORS AT THE AIR HANDLIGN UNIT SHALL AUTOMATICALLY SHUT DOWN THE FAN.
17. **FIRE ALARM SYSTEM:** ON ACTIVATION OF THE FIRE ALARM SYSTEM RELAY, THE SYSTEM SHALL SHUT DOWN.



1 HVAC CONTROLS VAV AIR HANDLING UNITS
1/8" = 1'-0"

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NORTH CAROLINA PROFESSIONAL SEAL 043322 ENGINEER PAUL JACKSON KITCHENS
Signed on 05/22/2023 using a Digital Signature.

Project Grace
Grace Street
Wilmington, NC 28401
LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME: HVAC CONTROLS AHU

ORIG SUBMISSION: 2023.05.22

SHEET: M-706

PERMIT SET

5/22/2023 10:17:11 AM

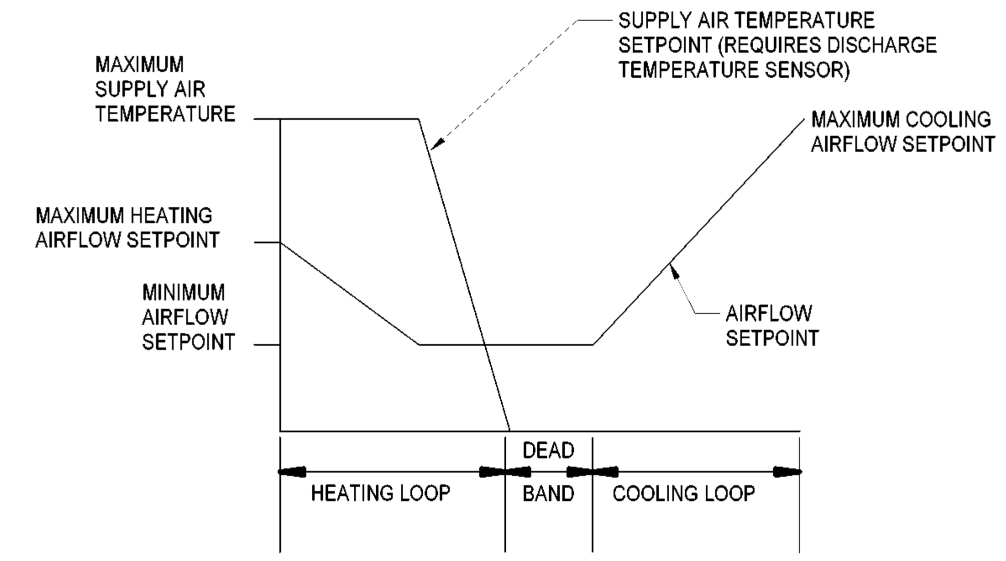
BCS CONTROLLER INPUT/OUTPUT SUMMARY UTILITY METERING AND MISCELLANEOUS

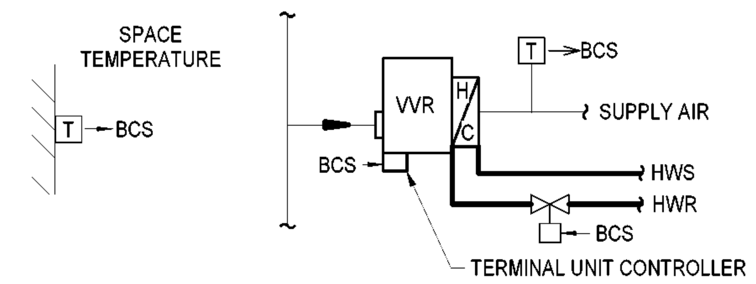
	OUTPUTS								INPUTS												SOFTWARE																	
	DIGITAL				ANALOG				DIGITAL					ANALOG							ALARM					BCS			ENERGY MGMT.									
	SYSTEM GRAPHIC DISPLAY	START/STOP	ENABLE/DISABLE	OPEN/CLOSE	SETPOINT ADJUST	BCS CONTROL			CURRENT SENSING RELAY	DIFFERENTIAL PRESSURE SWITCH	AUXILIARY CONTACT	ALARM CONTACT	PULSE CONTACT	TEMPERATURE	RELATIVE HUMIDITY	CARBON DIOXIDE	PRESSURE	DEWPOINT	KILOWATTS	FLOW	STATUS/INTERLOCK	HIGH/LOW LIMIT	RUN TIME TOTALIZATION	SENSOR FAILURE	COMMUNICATION FAILURE	PROPORTIONAL	PROPORTIONAL + INTEGRAL		SCHEDULED START/STOP	OPTIMUM START/STOP	DEMAND LIMIT CYCLE	ENERGY USE TOTALIZATION	TRENDING AND ARCHIVING	CALCULATED VALUE			FAILURE MODE (SEE NOTE 1)	NOTES
OUTSIDE AIR TEMPERATURE	●													●																			●					2
OUTSIDE AIR RELATIVE HUMIDITY															●																							
OUTSIDE AIR DEW POINT	●																																●	●				2
OUTSIDE AIR CARBON DIOXIDE	●															●																	●					2
EMERGENCY GENERATOR	●																																					
STATUS									●												●		●										●					
GENERAL ALARM												●																					●					
AUTOMATIC TRANSFER SWITCH POSITION											●										●												●					
LOW FUEL LEVEL											●										●												●					
MAIN ELECTRICAL METER	●																		●													●	●					
ELECTRICAL SUBMETERS																			●													●	●					
GAS METER	●																																					
DOMESTIC COLD WATER	●																																					
DOMESTIC COLD WATER FLOW													●									●											●					4
DOMESTIC COLD WATER PRESSURE																	●					●											●					4
DOMESTIC COLD WATER TOTALIZATION																																●	●					4
DOMESTIC WATER METER LEAK DETECTION												●																										4
CIRCULATING PUMP RCP-1-1 STATUS	●										●										●		●															4
DOMESTIC HOT WATER CIRCULATING PUMPS	●																																					4
PUMP RUNNING									●																								●					
FAULT MODE												●																					●					
WATER HEATERS WH-1-1	●																																					4
SETPOINT DISPLAY					●																												●					
OUTLET WATER TEMPERATURE														●																			●					
OVER-TEMPERATURE ALARM																						●											●					
ELEVATOR SUMP PUMP SP-1-1, SP-1-2, SP-1-3	●																																					4
PUMP ON STANDBY											●																						●					
PUMP RUNNING									●																								●					
PUMP FAILURE												●																					●					
TERMINAL UNITS (TYPE VV-R AND VV)	●																																					8
PRIMARY AIR FLOW																				●							●						●					
PRIMARY AIR VALVE CONTROL						●																															O	
HEATING WATER VALVE CONTROL (TYPE VV-R ONLY)						●																					●										L	
DISCHARGE AIR TEMPERATURE (TYPE VV-R ONLY)														●																								
SPACE TEMPERATURE														●								●																
SPACE CARBON DIOXIDE LEVEL																●						●		●														6
EXHAUST AIR TERMINAL UNITS	●																																					8
PRIMARY AIR FLOW																				●							●						●					
PRIMARY AIR VALVE CONTROL						●																															O	

NOTES:
1. FAILURE MODE
   - O - ON OR OPEN
   - C - OFF OR CLOSE
   - L - LAST COMMAND
2. SEE DRAWINGS FOR SENSOR LOCATIONS.
3. PROVIDE ELECTRIC METER, CT'S, CT FUSES, AND METER ENCLOSURE TO BE INSTALLED BY ELECTRICAL CONTRACTOR.
4. PROVIDE IDENTICAL POINTS FOR EACH SIMILAR PIECE OF EQUIPMENT.
5. PROVIDE IDENTICAL MONITORING POINTS FOR EACH ELECTRICAL SUBMETER. REFER TO ELECTRICAL DRAWINGS FOR SUBMETER QUANTITY.
6. POINTS NOT REQUIRED FOR ALL TERMINAL UNITS. REFER TO DRAWINGS M-1001 THROUGH M-1013F FOR CARBON DIOXIDE SENSOR LOCATIONS.
7. TERMINAL UNIT CONTROLS AND INTERFACES SHALL BE ARRANGED SO THAT EQUIPMENT CONTROLLED BY THE BCS OPERATES AS INDICATED ON FAILURE OF THE TERMINAL UNIT CONTROLLER FOR ANY REASON, INCLUDING LOGIC POWER SUPPLY FAILURE, CPU LOCK-UP, OR INTERPOSING RELAY FAILURE. SAFETY AND OPERATIONAL INTERLOCKS SHALL REMAIN IN EFFECT.
8. PROVIDE TERMINAL UNIT CONTROLLER WITH IDENTICAL CONTROL POINTS AND FUNCTIONS FOR EACH TERMINAL UNIT.

SEQUENCE OF OPERATION:

1. ON A RISE IN SPACE TEMPERATURE ABOVE COOLING SETPOINT, EACH TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE TO THE MAXIMUM FLOW. ONCE THE SPACE TEMPERATURE SETPOINT IS MET, THE PRIMARY AIR VALVE SHALL MODULATE THE FLOW TO MAINTAIN THE SPACE CONDITIONS.
2. ON A DROP IN SPACE TEMPERATURE BELOW HEATING SETPOINT, EACH TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE TO THE MINIMUM FLOW.
3. IF THE SPACE TEMPERATURE FALLS THROUGH THE 5°F SPACE TEMPERATURE DEADBAND TO THE HEATING SETPOINT, THE TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE TO MAINTAIN THE MINIMUM HEATING FLOW AND MODULATE THE HOT WATER VALVE TO MAINTAIN LEAVING AIR TEMPERATURE SETPOINT.
4. LEAVING AIR TEMPERATURE SETPOINT SHALL BE VARIED TO MAINTAIN SPACE TEMPERATURE SETPOINT BETWEEN THE LIMITS OF THE AIR HANDLING UNIT SYSTEM DISCHARGE AIR TEMPERATURE SETPOINT AND 20°F ABOVE THE HEATING SPACE TEMPERATURE SETPOINT.
5. ON A FURTHER DROP IN SPACE TEMPERATURE, THE TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE OPEN TO THE MAXIMUM HEATING FLOW TO MAINTAIN THE HEATING SPACE TEMPERATURE SETPOINT WHILE SIMULTANEOUSLY MODULATE THE HOT WATER VALVE TO MAINTAIN LEAVING AIR TEMPERATURE AT 20°F ABOVE THE HEATING SPACE TEMPERATURE SETPOINT.

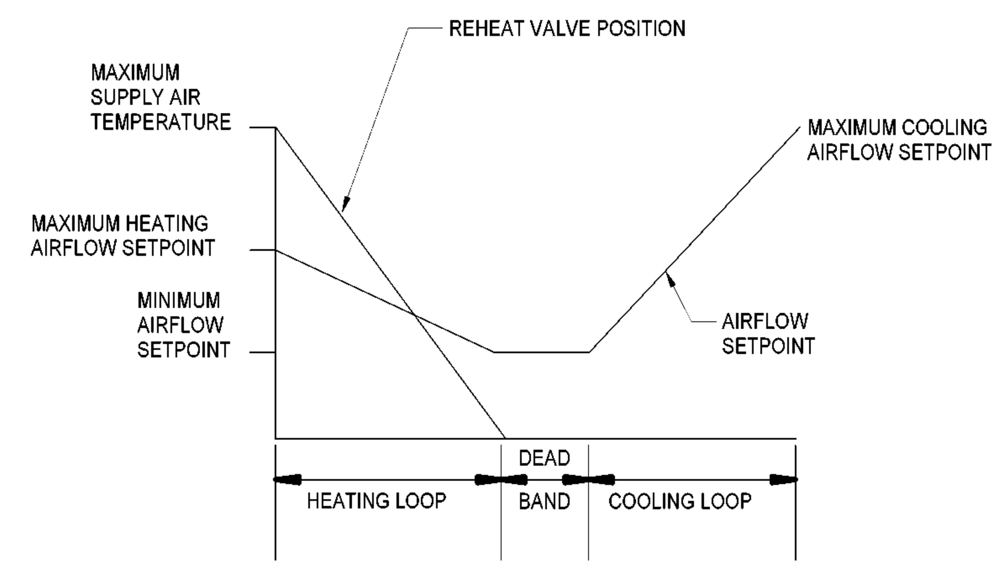


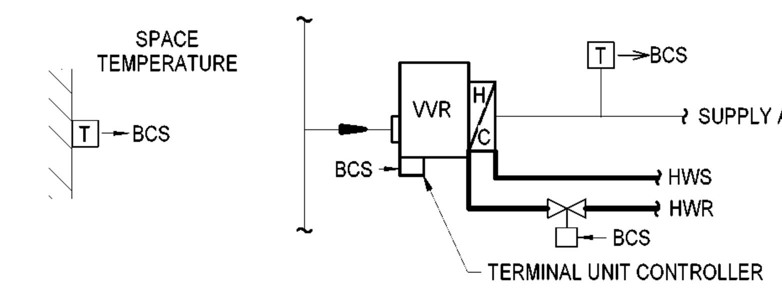


CONTROL DIAGRAM - VV-R-D TYPE TERMINAL UNITS

SEQUENCE OF OPERATION:

1. ON A RISE IN SPACE TEMPERATURE ABOVE COOLING SETPOINT, EACH TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE TO THE MAXIMUM FLOW. ONCE THE SPACE TEMPERATURE SETPOINT IS MET, THE PRIMARY AIR VALVE SHALL MODULATE THE FLOW TO MAINTAIN THE SPACE CONDITIONS.
2. ON A DROP IN SPACE TEMPERATURE BELOW COOLING SETPOINT, EACH TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE TO THE MINIMUM FLOW.
3. IF THE SPACE TEMPERATURE FALLS THROUGH THE 5°F SPACE TEMPERATURE DEADBAND TO THE HEATING SETPOINT, THE TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE TO MAINTAIN THE MINIMUM HEATING FLOW AND MODULATE THE HOT WATER VALVE TO MAINTAIN LEAVING AIR TEMPERATURE SETPOINT.

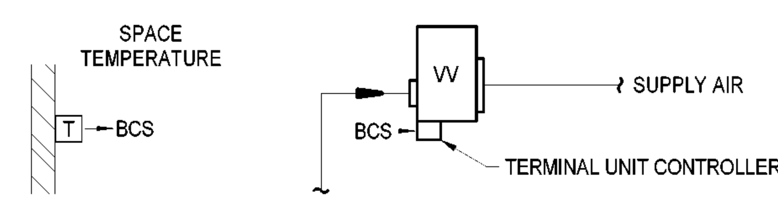




CONTROL DIAGRAM - VV-R TYPE TERMINAL UNITS

SEQUENCE OF OPERATION:

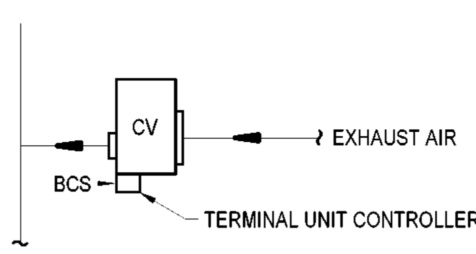
1. VARIABLE VOLUME: EACH TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE BETWEEN THE MINIMUM AND MAXIMUM QUANTITIES INDICATED ON THE DRAWINGS TO MAINTAIN SPACE TEMPERATURE SETPOINT.



CONTROL DIAGRAM - VV TYPE TERMINAL UNITS

SEQUENCE OF OPERATION:

1. CONSTANT VOLUME: EACH TERMINAL UNIT CONTROLLER SHALL MODULATE THE PRIMARY AIR VALVE TO MAINTAIN THE SCHEDULED EXHAUST FLOW.
2. THE BCS SHALL ALARM IF THE EXHAUST AIRFLOW IS MORE THAN 10% BELOW THE MINIMUM EXHAUST FLOW FOR MORE THAN 30 MINUTES.



CONTROL DIAGRAM - CV EA TYPE TERMINAL UNITS

1 MISCELLANEOUS CONTROLS SCHEMATICS

NO SCALE

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NORTH CAROLINA PROFESSIONAL SEAL 043322 ENGINEER PAUL JACKSON KITCHENS

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Project Grace

Grace Street
Wilmington, NC 28401

LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION
0	2023.05.22	PERMIT SET

SHEET NAME:
HVAC CONTROLS - MISCELLANEOUS

ORIG SUBMISSION: 2023.05.22

SHEET: M-707

PERMIT SET

BCS CONTROLLER INPUT/OUTPUT SUMMARY PARKING DECK FANS, ELECTRIC HEATERS, AND BLOWER COIL UNITS

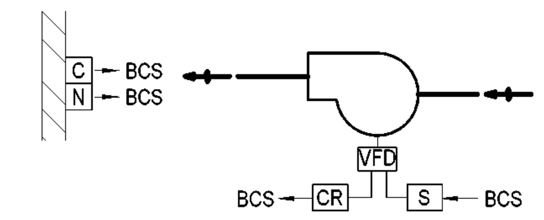
	OUTPUTS								INPUTS														SOFTWARE																	
	DIGITAL				ANALOG				DIGITAL					ANALOG									ALARM					BCS			ENERGY MGMT.									
	SYSTEM GRAPHIC DISPLAY	START/STOP	ENABLE/DISABLE	OPEN/CLOSE	SETPOINT ADJUST	BCS CONTROL			CURRENT SENSING RELAY	DIFFERENTIAL PRESSURE SWITCH	AUXILIARY CONTACT	ALARM CONTACT	PULSE CONTACT	TEMPERATURE	RELATIVE HUMIDITY	CARBON DIOXIDE LEVEL	CARBON MONOXIDE LEVEL	NITROGEN DIOXIDE LEVEL	PRESSURE	DEWPOINT	KILOWATTS	FLOW	STATUS/INTERLOCK	HIGH/LOW LIMIT	RUN TIME TOTALIZATION	SENSOR FAILURE	COMMUNICATION FAILURE	PROPORTIONAL	PROPORTIONAL + INTEGRAL		SCHEDULED START/STOP	OPTIMUM START/STOP	DEMAND LIMIT CYCLE	ENERGY USE TOTALIZATION	TRENDING AND ARCHIVING	CALCULATED VALUE			FAILURE MODE (SEE NOTE 1)	NOTES
PARKING DECK FANS	●																																						O	2
START/STOP		●																																						
STATUS									●																															
VFD SPEED						●																							●											
CARBON MONOXIDE SPACE SENSOR																	●							●																
NITROGEN DIOXIDE SPACE SENSOR																		●						●																
DUCTLESS SPLIT SYSTEMS	●																																						O	
SPACE TEMPERATURE														●										●																
ELECTRIC UNIT HEATERS	●																																						O	
SPACE TEMPERATURE														●										●																
SPACE TEMPERATURE SETPOINT					●																																			
ELECTRIC FLOOR HEATERS	●																																						O	
SPACE TEMPERATURE														●										●																
SPACE TEMPERATURE SETPOINT					●																																			
LOADING DOCK EXHAUST FAN EF-1-1	●																																							
FAN START/STOP		●																																						
FAN STATUS									●																															
SPACE TEMPERATURE						●								●																										
FAN INTAKE CONTROL DAMPER				●		●																																	O	
FAN DISCHARGE CONTROL DAMPER				●		●																																	O	
CARBON MONOXIDE SPACE SENSOR																	●							●																
NITROGEN DIOXIDE SPACE SENSOR																		●						●																

NOTES:
1. FAILURE MODE
   O - ON OR OPEN
   C - OFF OR CLOSE
   L - LAST COMMAND
2. PROVIDE IDENTICAL BCS CONTROL POINTS FOR IDENTICAL PIECES OF EQUIPMENT.

SEQUENCE OF OPERATION:

THE CONTROLS FOR PARKING GARAGE FANS SHALL FUNCTION AS FOLLOWS:

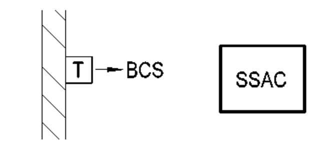
1. THE FAN SHALL BE AUTOMATIALLY STARTED AND STOPPED BY THE BCS CONTROLLER WHENEVER THE VARIABLE FREQUENCY DRIVE IS IN THE AUTOMATIC POSITION, AND MANUALLY STARTED AND STOPPED BY THE HAND POSITION.
2. THE BCS CONTROLLER SHALL OPERATE THE FAN AT MINIMUM SPEED WHEN THE ZONE CARBON MONOXIDE CONCENTRATION IS LESS THAN OR EQUAL TO THE LOWER SETPOINT OF 15 PPM (ADJUSTABLE). THE VCS CONTROLLER SHALL MODULATE THE FAN SPEED BETWEEN THE MINIMUM SPEED AT THE LOWER CARBON MONOXIDE SETPOINT TO THE MAXIMUM SPEED AT THE UPPER CARBON MONOXIDE SETPOINT OF 40 PPM (ADJUSTABLE). THE BCS SHALL SIGNAL AN ALARM IF THE CARBON MONOXIDE CONCENTRATION IS GREATER THAN 100 PPM (ADJUSTABLE).



SEQUENCE OF OPERATION:

THE CONTROLS FOR DUCTLESS SPLIT SYSTEMS SHALL FUNCTION AS FOLLOWS:

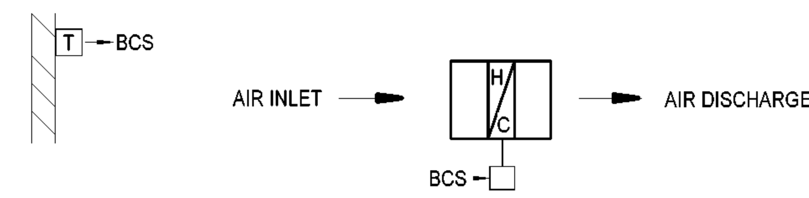
1. PROVIDE CONTROL WIRING BETWEEN WALL-MOUNTED THERMOSTATS, INDOOR FAN-COIL UNITS, AND OUTDOOR CONDENSING UNITS.
2. UNITS SHALL OPERATE UNDER INTERNAL CONTROLS TO MAINTAIN SPACE TEMPERATURE SETPOINT.
3. THE BCS SHALL ANNUNCIATE AN ALARM WITH SPACE TEMPERATURE IS GREATER THAN 78°F (ADJUSTABLE) FOR MORE THAN 15 MINUTES (ADJUSTABLE).



SEQUENCE OF OPERATION:

THE CONTROLS FOR FLOOR HEATERS SHALL FUNCTION AS FOLLOWS:

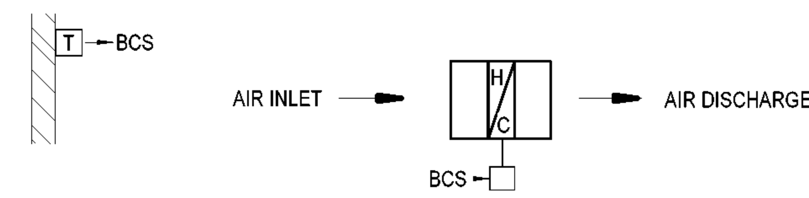
1. PROVIDE CONTROL WIRING BETWEEN FLOOR HEATERS AND CONTROL MODULES.
2. ELECTRIC UNIT HEATERS SHALL OPERATE UNDER INTERNAL CONTROLS TO MAINTAIN SPACE TEMPERATURE AS SENSED BY AN ADJUSTABLE LINE VOLTAGE THERMOSTAT.



SEQUENCE OF OPERATION:

THE CONTROLS FOR ELECTRIC UNIT HEATERS SHALL FUNCTION AS FOLLOWS:

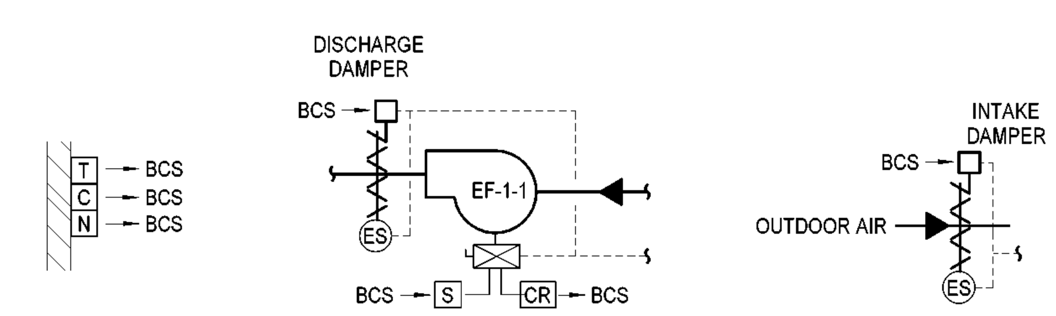
1. PROVIDE CONTROL WIRING BETWEEN HEATER AND LINE VOLTAGE THERMOSTAT.
2. ELECTRIC UNIT HEATERS SHALL OPERATE UNDER INTERNAL CONTROLS TO MAINTAIN SPACE TEMPERATURE AS SENSED BY AN ADJUSTABLE LINE VOLTAGE THERMOSTAT.



SEQUENCE OF OPERATION

THE CONTROLS FOR LOADING DOCK VENTILATION FAN EF-1-1 SHALL FUNCTION AS FOLLOWS:

1. THE FAN SHALL BE AUTOMATICALLY STARTED AND STOPPED BY THE BCS CONTROLLER WHENEVER THE HAND-OFF-AUTOMATIC SWITCH IS IN THE AUTOMATIC POSITION, AND MANUALLY STARTED AND STOPPED BY THE HAND POSITION.
2. PRIOR TO STARTING THE FAN, THE BCS CONTROLLER SHALL OPEN A REMOTE INTAKE CONTROL DAMPER AND DISCHARGE DAMPER. THE DAMPERS SHALL BE PROVEN OPEN BY AN END SWITCH
3. UPON A RISE IN SPACE TEMPERATURE ABOVE 85°F (ADJUSTABLE), THE BCS CONTROLLER SHALL START THE FAN. THE FAN SHALL OPERATE CONTINUOUSLY UNTIL THE SPACE TEMPERATURE DROPS 5°F BELOW THE TEMPERATURE SETPOINT FOR 15 MINUTES.
4. WHEN THE CARBON MONOXIDE CONCENTRATION IS LESS THAN OR EQUAL TO THE LOWER SETPOINT OF 15 PPM (ADJUSTABLE) THE BCS CONTROLLER SHALL COMMAND THE FAN TO BE OFF. UPON A RISE IN CARBON MONOXIDE CONCENTRATION ABOVE 15 PPM (ADJUSTABLE) THE BCS CONTROLLER SHALL COMMAND THE FAN ON. THE BCS SHALL SIGNAL AN ALARM IF THE CARBON MONOXIDE CONCENTRATION IS GREATER THAN 100 PPM (ADJUSTABLE).
5. WHEN THE NITROGEN DIOXIDE CONCENTRATION RISES ABOVE 2.5 PPM (ADJUSTABLE) THE BCS CONTROLLER SHALL COMMAND THE FAN ON. THE BCS SHALL SIGNAL AN ALARM IF THE NITROGEN DIOXIDE CONCENTRATION IS GREATER THAN 3 PPM (ADJUSTABLE).



1 MISCELLANEOUS CONTROLS SCHEMATICS

NO SCALE

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Signed on 05/22/2023 using a Digital Signature.

Project Grace

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Wilmington, NC 28401

LS3P PROJECT: 7701-177600

Δ	DATE	DESCRIPTION

SHEET NAME:
HVAC CONTROLS - MISCELLANEOUS

ORIG SUBMISSION: 2023.05.22

SHEET: **M-708**

PERMIT SET