

## ADDENDUM 1

DATE: April 7, 2016  
PROJECT: MSB Lab AHU L-7 & L-8 Replacement  
RFP NO: 744-R1615  
OWNER: The University of Texas Health Science Center at Houston  
TO: Prospective Proposers

This Addendum forms part of and modifies Proposal Documents dated, March 22, 2016, with amendments and additions noted below.

### 2.6 Pre-Proposal Meeting #2

University will hold a second pre-proposal meeting:

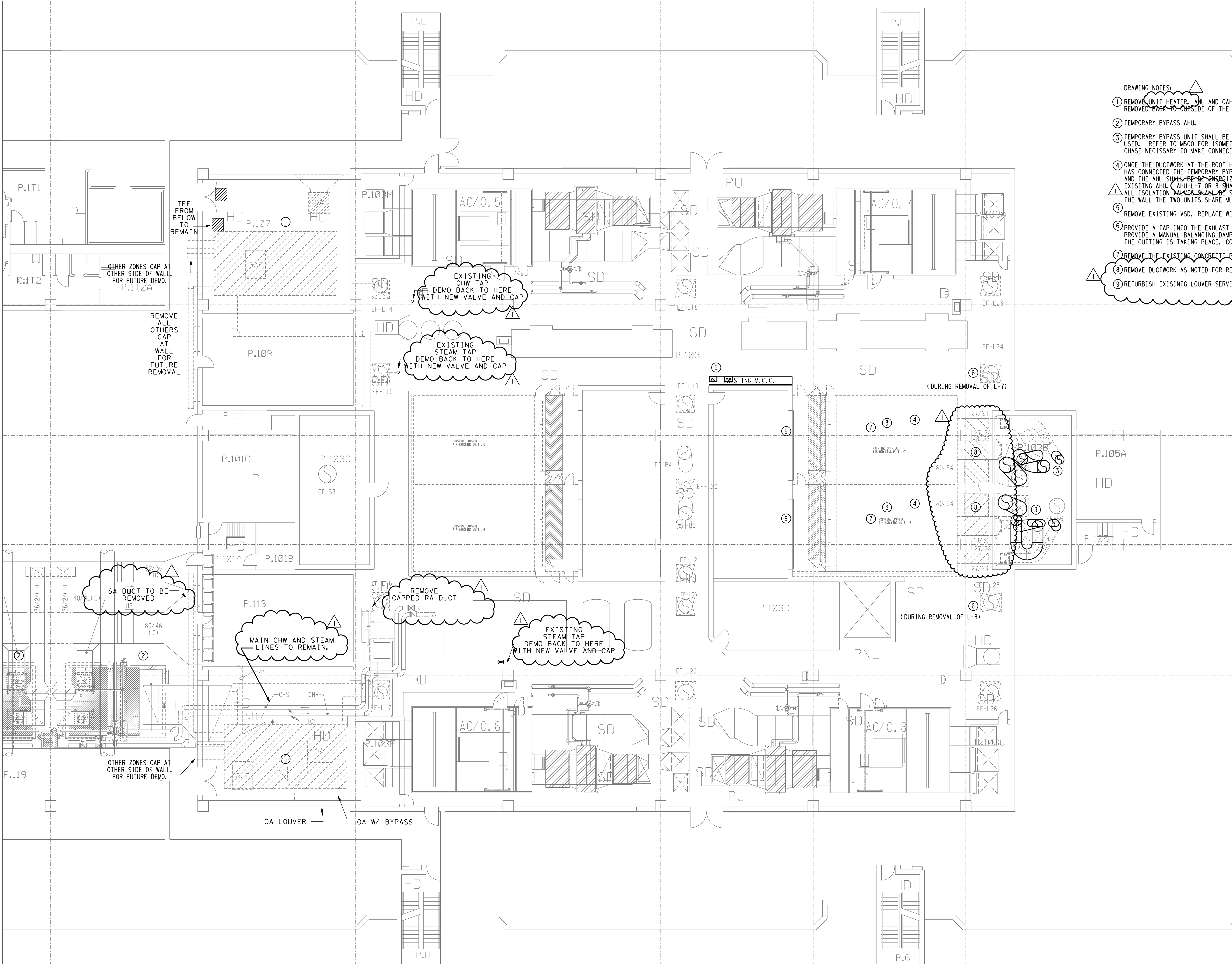
10:00AM, CST on Monday, April 11, 2016  
Leather Lounge of the McGovern Medical School Building  
6431 Fannin Street, Ground Level  
Houston, Texas 77030

The second pre-proposal meeting will allow all Proposers an opportunity to ask University's representatives relevant questions and clarify provisions of this RFP.

Attendance at the second pre-bid meeting is not required. **Please allow time for driving into the Medical Center and parking. Meet near the guard's desk and we will begin the walk-through promptly at 10:00AM CST.**

### APPENDICES THREE AND FOUR:

This addendum also includes modified drawings (pages 2-12) and specifications (pages 13-162) for the project below.

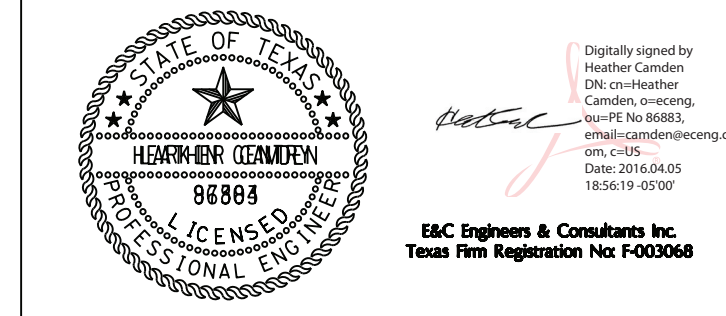


- DRAWING NOTES:**
- REMOVE UNIT HEATER, AHU AND OAHU. ALL PIPING, DUCT, ELECTRICAL AND CONTROLS SERVING THE DEMOLISHED AHU SHALL BE REMOVED BACK TO OUTSIDE OF THE ROOM. PATCH THE WALL TO MEET THE EXISTING FIRE RATING.
  - TEMPORARY BYPASS AHU.
  - TEMPORARY BYPASS UNIT SHALL BE CONNECTED TO THE RISERS AS NOTED ON THE ROOF PLAN. FLEX MAY BE USED. REFER TO M500 FOR ISOMETRIC OF DUCT CONNECTIONS. REMOVE ANY DUCTWORK IN THE CHASE NECESSARY TO MAKE CONNECTIONS.
  - ONCE THE DUCTWORK AT THE ROOF HAS BEEN CONNECTED TO THE RISERS AND THE FLEXIBLE DUCT HAS CONNECTED THE TEMPORARY BYPASS AHUS TO THE RISERS, THE TEMPORARY AHUS SHALL BE ENERGIZED AND THE AHU SHALL BE DE-ENERGIZED. THE BYPASS AHUS ARE SIZED FOR BOTH AHUS TO SERVICE ONE EXISTING AHU. AHU-L-7 OR 8 SHALL BE REPLACED FIRST AND THE OTHER SHALL BE DONE AFTER. ALL ISOLATION VALVES SHALL BE SHUT TO THE AHU AND THE AHU SHALL BE REPLACED AS DETAILED ON M300. THE WALL THE TWO UNITS SHARE MUST REMAIN IN PLACE DURING THE FIRST AHU REPLACEMENT.
  - REMOVE EXISTING VSD. REPLACE WITH NEW VSD. REFER TO ELECTRICAL DRAWINGS.
  - PROVIDE A TAP INTO THE EXHAUST DUCT AS NOTED FOR VENTILLATION DURING CUTTING OF THE EXISTING UNITS. PROVIDE A MANUAL BALANCING DAMPER (LOW LEAK) WITH FLEXIBLE DUCT TO ALLOW FOR MOVEMENT TO WHERE THE CUTTING IS TAKING PLACE. COORDINATE ANY NEEDED SHUT-DOWNS WITH THE OWNER. 12" Ø
  - REMOVE THE EXISTING CONCRETE PAD AND REBAR. REFER TO STRUCTURAL DRAWINGS FOR FURTHER INFO.
  - REMOVE DUCTWORK AS NOTED FOR REPLACEMENT. EXISTING FIRE DAMPERS TO REMAIN.
  - REFURBISH EXISTING LOUVER SERVING THE UNITS AS ADD ALTERNATE 5.

**ENTHOUSE**

ISSUE FOR	Area	Rev.	Date	Description
		03	02-16	FOR BID
		04	04-16	ADDENDUM #1

**E & C**  
**ENGINEERS & CONSULTANTS, INC.**  
 1010 LAMAR, SUITE 650  
 HOUSTON, TEXAS 77002  
 TEL 713/580-8800  
 FAX 713/580-8888



Date: 3/2/16  
 Drawn By: BVG  
 Checked By: REG

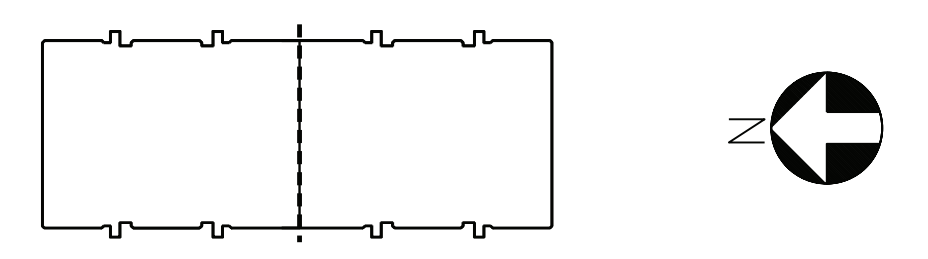
UTHSC Project No.: 730022  
 E & C Project No.: 3302.00  
 File Name:

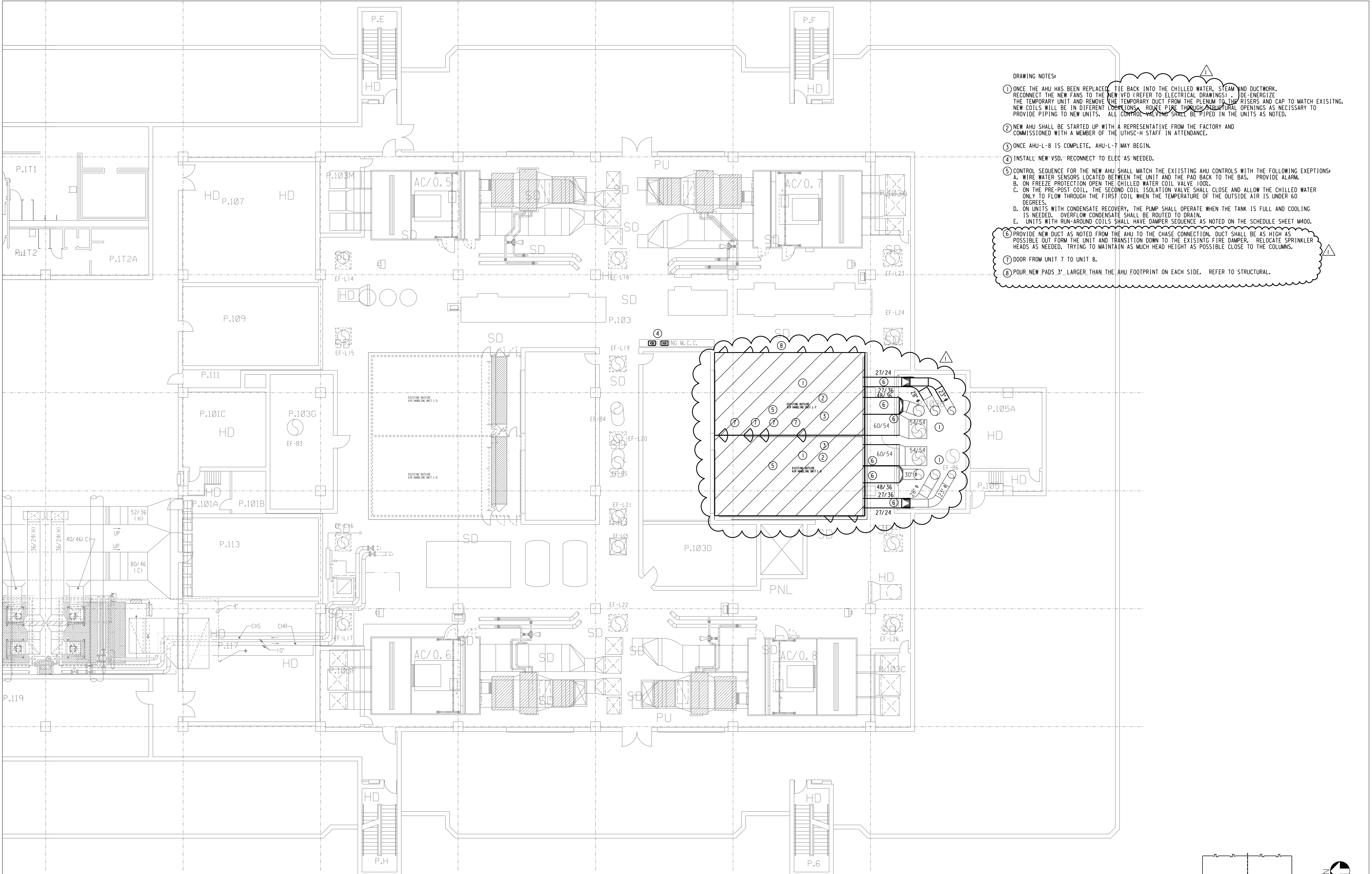


**MEDICAL SCHOOL BUILDING  
 AHU L-7 & 8 REPLACEMENT**

DRAWING TITLE  
**MECHANICAL PH  
 DEMOLITION/  
 BYPASS DRAWING**

DRAWING NO.  
**M108**



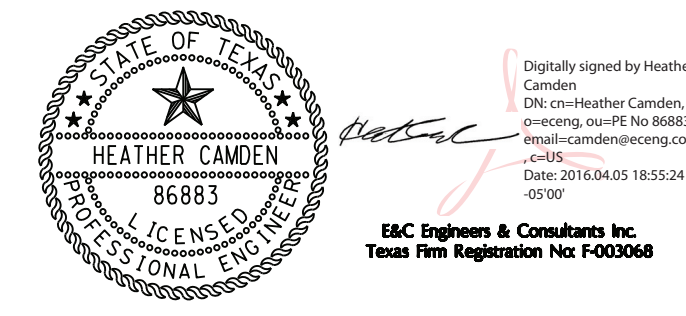


- DRAWING NOTES:
- ① ONCE THE AHU HAS BEEN REPLACED, TIE BACK INTO THE CHILLED WATER, STEAM AND DUCTWORK. RECONNECT THE NEW FANS TO THE NEW VSD (REFER TO ELECTRICAL DRAWINGS). DE-ENERGIZE THE TEMPORARY UNIT AND REMOVE THE TEMPORARY DUCT FROM THE PLENUM TO THE RISERS AND CAP TO MATCH EXISTING. NEW COILS WILL BE IN DIFFERENT LOCATIONS. ROUTE PIPING THROUGH STRUCTURAL OPENINGS AS NECESSARY TO PROVIDE PIPING TO NEW UNITS. ALL CONTROL VALVING SHALL BE PIPED IN THE UNITS AS NOTED.
  - ② NEW AHU SHALL BE STARTED UP WITH A REPRESENTATIVE FROM THE FACTORY AND COMMISSIONED WITH A MEMBER OF THE UTHSC-H STAFF IN ATTENDANCE.
  - ③ ONCE AHU-L-8 IS COMPLETE, AHU-L-7 MAY BEGIN.
  - ④ INSTALL NEW VSD. RECONNECT TO ELEC AS NEEDED.
  - ⑤ CONTROL SEQUENCE FOR THE NEW AHU SHALL MATCH THE EXISTING AHU CONTROLS WITH THE FOLLOWING EXCEPTIONS:
    - A. WIRE WATER SENSORS LOCATED BETWEEN THE UNIT AND THE PAD BACK TO THE BAS. PROVIDE ALARM.
    - B. ON FREEZE PROTECTION OPEN THE CHILLED WATER COIL VALVE 100%.
    - C. ON THE PRE-POST COIL, THE SECOND COIL ISOLATION VALVE SHALL CLOSE AND ALLOW THE CHILLED WATER ONLY TO FLOW THROUGH THE FIRST COIL WHEN THE TEMPERATURE OF THE OUTSIDE AIR IS UNDER 60 DEGREES.
    - D. ON UNITS WITH CONDENSATE RECOVERY, THE PUMP SHALL OPERATE WHEN THE TANK IS FULL AND COOLING IS NEEDED. OVERFLOW CONDENSATE SHALL BE ROUTED TO DRAIN.
    - E. UNITS WITH RUN-AROUND COILS SHALL HAVE DAMPER SEQUENCE AS NOTED ON THE SCHEDULE SHEET M400.
  - ⑥ PROVIDE NEW DUCT AS NOTED FROM THE AHU TO THE CHASE CONNECTION. DUCT SHALL BE AS HIGH AS POSSIBLE OUT FROM THE UNIT AND TRANSITION DOWN TO THE EXISTING FIRE DAMPER. RELOCATE SPRINKLER HEADS AS NEEDED, TRYING TO MAINTAIN AS MUCH HEAD HEIGHT AS POSSIBLE CLOSE TO THE COLUMNS.
  - ⑦ DOOR FROM UNIT 7 TO UNIT 8.
  - ⑧ POUR NEW PADS 3" LARGER THAN THE AHU FOOTPRINT ON EACH SIDE. REFER TO STRUCTURAL.

ENTHOUSE

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ADDENDUM 1		04	04-16	

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Date: 3/2/16  
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UTHSC Project No. 730022  
 E & C Project No. 3302.00  
 File Name

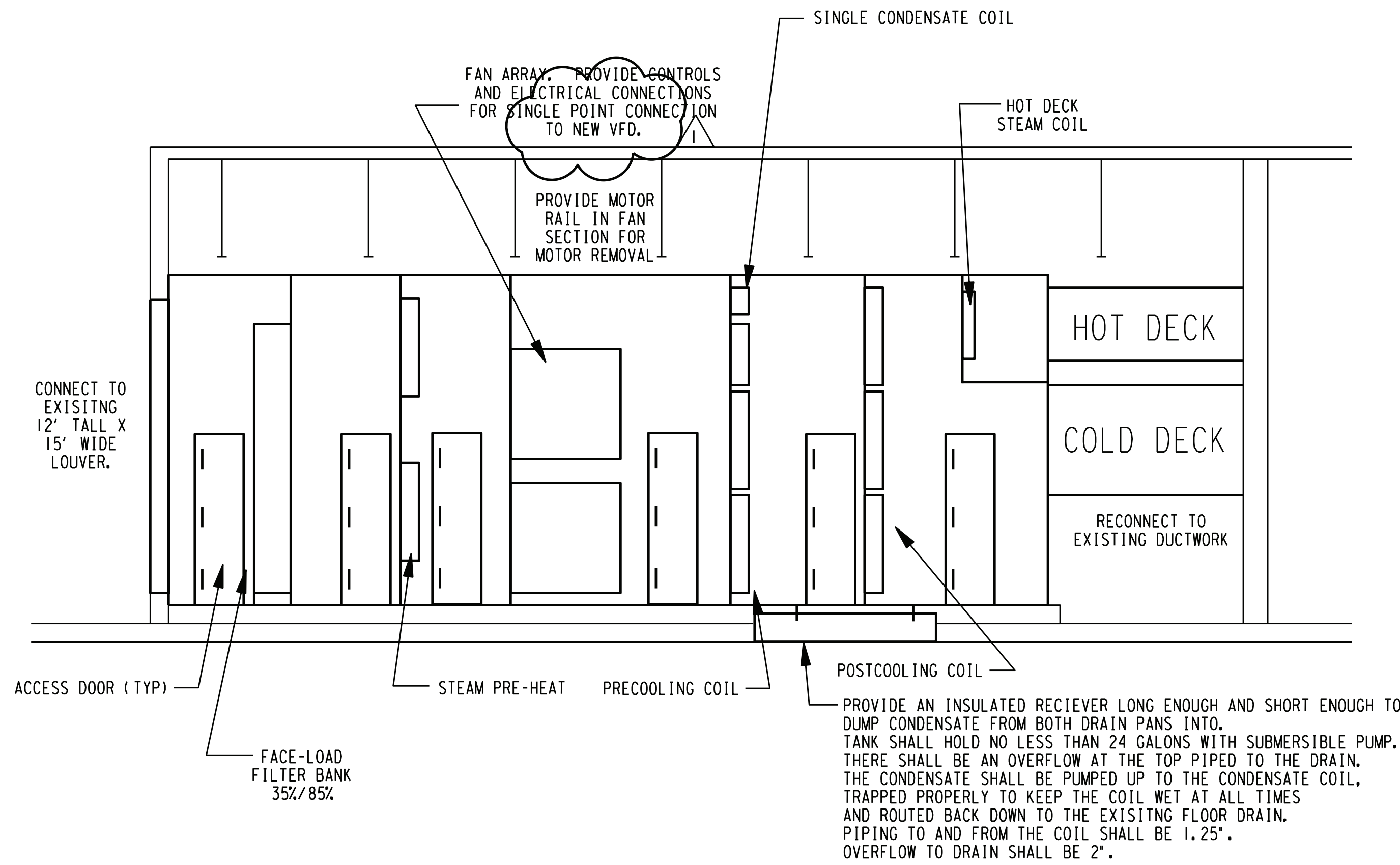


**MEDICAL SCHOOL BUILDING  
 AHU L-7 & 8 REPLACEMENT**

**MECHANICAL PH  
 RENOVATION  
 DRAWING**

DRAWING TITLE  
 DRAWING NO. **M208**

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**03** REPLACEMENT UNIT DETAIL W/  
CONDENSATE RECOVERY  
NOT TO SCALE

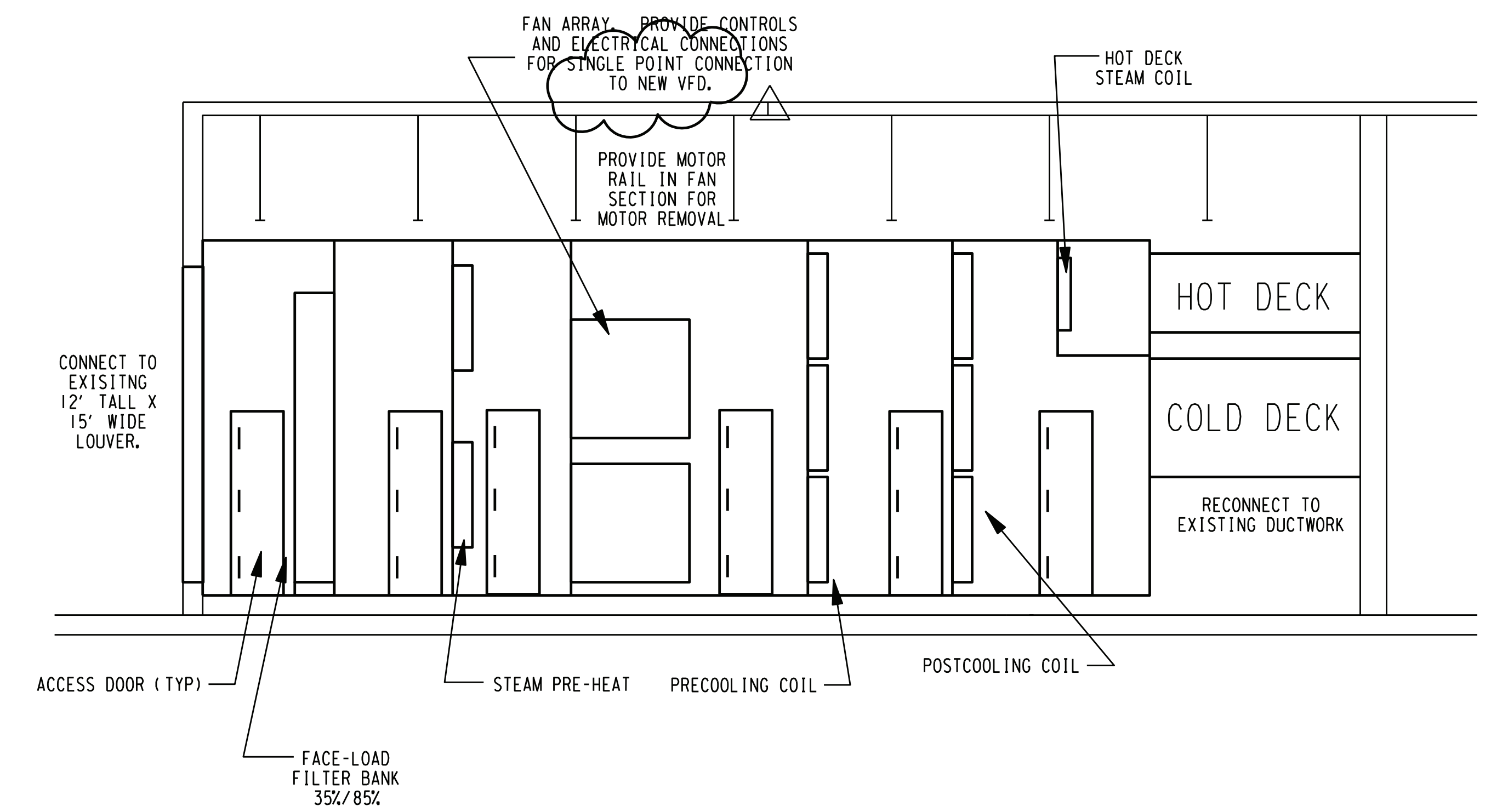
ALL UNITS MAXIMUM DIMENSIONS ARE:  
14' 0" TALL  
36' 0" LONG  
18' 6" WIDE

DUCT PENETRATIONS INTO CHASE APPROXIMATE LOCATIONS - FIELD VERIFY:  
BOTTOM OF HOTDECK L7 EAST - 9' 11"  
BOTTOM OF COLDDECK L7 EAST - 4' 10"  
BOTTOM OF HOTDECK L7 WEST - 9' 11"  
BOTTOM OF COLDDECK L7 WEST - 4' 2"  
BOTTOM OF COLDDECK L8 EAST - 4' 2"  
BOTTOM OF HOTDECK L8 EAST - 9' 11"  
BOTTOM OF COLDDECK L8 WEST - 5' 7"  
BOTTOM OF HOTDECK L8 WEST - 9' 11"

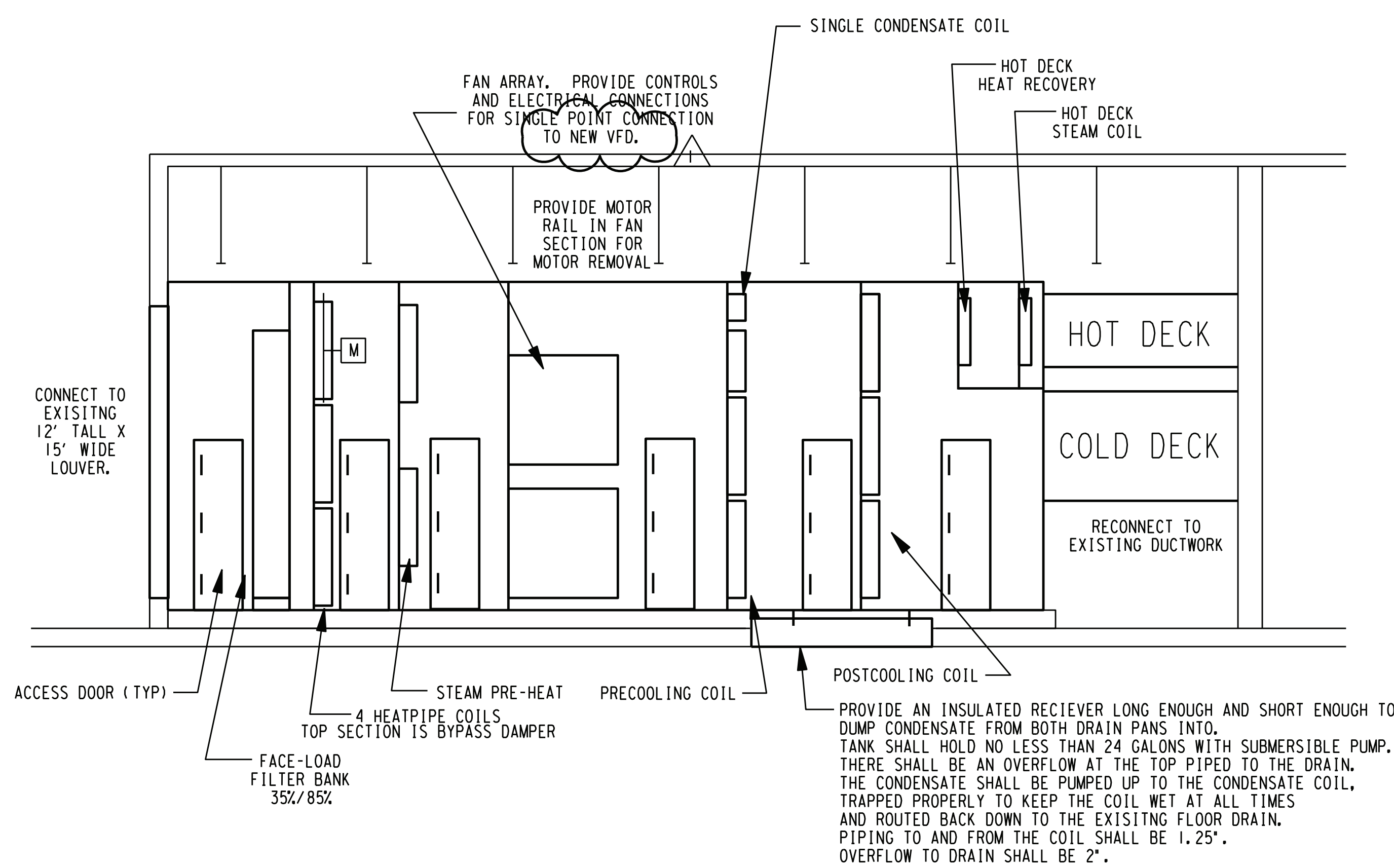
UNIT WILL SIT ON A 6" HOUSEKEEPING PAD.

COIL PIPING IS HOUSED INSIDE THE UNIT.  
THERE SHALL BE ONE PIPING INLET TO THE AHU  
ON EACH SIDE SERVED FROM THE TOP OF THE UNIT.  
THE MANIFOLD SHALL DROP AND COIL  
ISOLATION AND BALANCING VALVES SHALL BE  
ACCESSED INSIDE THE UNIT.  
COILS SHALL BE INTERNALLY DEMOUNTABLE TO BE  
REMOVED FROM INSIDE THE UNIT FORWARD AND  
OUT THE CLOSEST ACCESS DOOR.

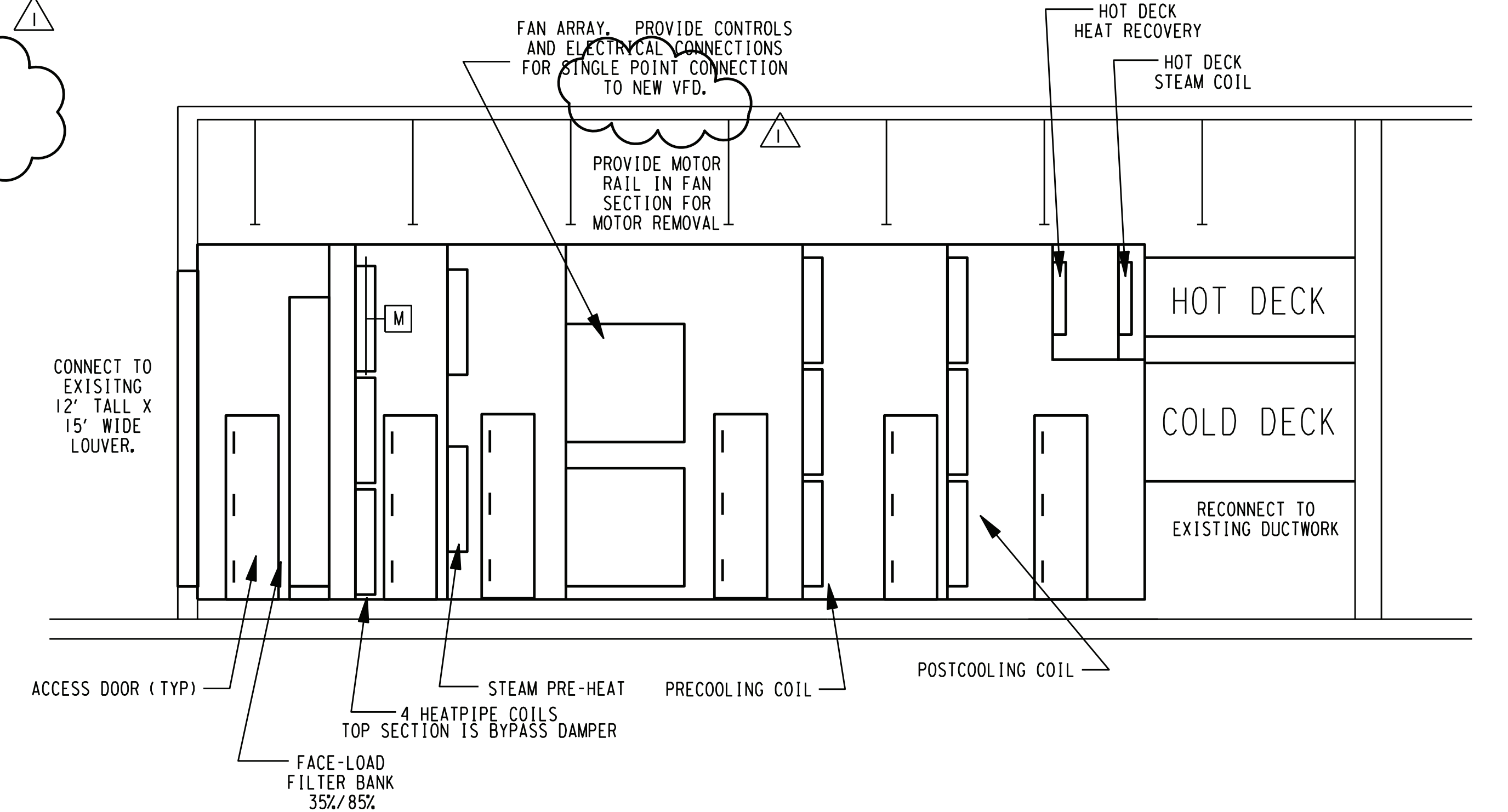
REFER TO THE FLOOR PLANS TO NOTE WHERE DOORS  
ARE REQUIRED TO BE ON ONE OR BOTH SIDES OF THE UNIT.



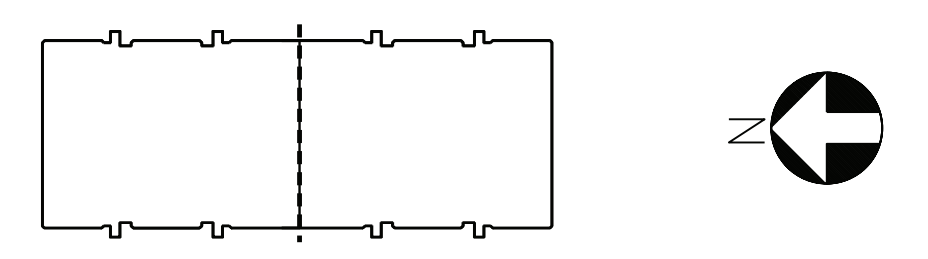
**01** REPLACEMENT UNIT DETAIL  
NOT TO SCALE



**04** REPLACEMENT UNIT DETAIL W/  
HEATPIPE AND CONDENSATE RECOVERY  
NOT TO SCALE



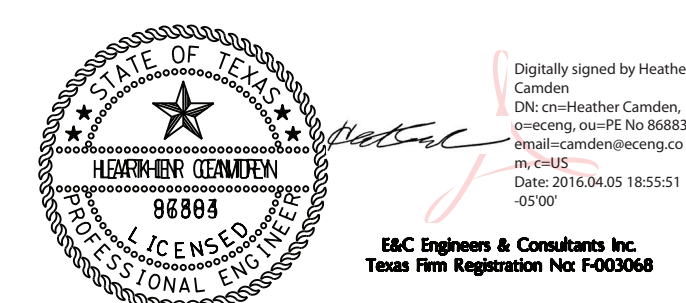
**02** REPLACEMENT UNIT DETAIL W/ HEATPIPE  
NOT TO SCALE



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	03	02-16	FOR BID
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UTHC Project No.: 730022  
E & C Project No.: 3302.00  
File Name:



**MEDICAL SCHOOL BUILDING  
AHU L-7 & 8 REPLACEMENT**

DRAWING TITLE  
**MECHANICAL  
AHU DETAILS**

DRAWING NO.  
**M300**

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**AIR HANDLING UNIT SCHEDULE - REPLACEMENT**

UNIT INFORMATION		
UNIT NO.	AHU-L7	AHU-L8
OPERATION TYPE	NORMAL	NORMAL
LOCATION	SOUTH PENTHOUSE (BLUE CHASE)	SOUTH PENTHOUSE (BLUE CHASE)
MANUFACTURER (BASIS OF DESIGN)	TEMPROL	TEMPROL
TYPE	WELDED FRAME OR BUILT ON SITE	WELDED FRAME OR BUILT ON SITE
CONFIGURATION	FANWALL DUAL DUCT	FANWALL DUAL DUCT
SERVICE	BLUE CHASE EAST	BLUE CHASE WEST
SUPPLY FAN DESIGN INFORMATION		
DESIGN SET FAN AIR QUANTITY	79,800	79,800
MAX OA	79,800	79,800
TOTAL STATIC PRESSURE (IN.W.G.)	5.50	5.50
BASIS OF DESIGN	TEMPROL FAN ARRAY 6@ PF11-27	TEMPROL FAN ARRAY 6@ PF11-27
FAN DESCRIPTION	6 @ 27" MAXIMUM DIAMETER	6 @ 27" MAXIMUM DIAMETER
FAN TYPE	PLUG FAN ARRAY (PF)	PLUG FAN ARRAY (PF)
FAN RPM	1696	1696
BRKE HP	16.9 MAX/FAN	16.9 MAX/FAN
NOMINAL MOTOR HP	20 MAXIMUM / FAN	20 MAXIMUM / FAN
NOMINAL MOTOR RPM	1750 MAX	1750 MAX
VOLTAGE/PHASE	480/3	480/3
EMERGENCY POWER REQUIRED (YES/NO)	NO	NO
VFD REQUIRED	YES - NEW 125HP	YES - NEW 125HP
DRIVE ARRANGEMENT TYPE	DIRECT	DIRECT
COOLING COIL DESIGN INFORMATION		
COIL POSITION	PRE COOLING	PRE COOLING
COIL DESCRIPTION	6@5WC-4-48X84X4-8CU	6@5WC-4-48X84X4-8CU
CASE MATERIAL	16 GA. 304 S.S.	16 GA. 304 S.S.
QUANTITY OF COILS	3LH/3RH	3LH/3RH
COIL AIRFLOW	79800	79800
MAX FACE VELOCITY	475.0	475.0
MINIMUM NUMBER ROWS	4	4
MINIMUM NUMBER OF FINS PER INCH	8	8
MAXIMUM AIR PRESSURE DROP	0.42	0.42
ENTERING AIR TEMP (DB) (°F)	98.0	98.0
ENTERING AIR TEMP (WB) (°F)	80.0	80.0
LEAVING AIR TEMP (DB) (°F)	67.5	67.5
LEAVING AIR TEMP (WB) (°F)	65.3	65.3
ENTERING WATER TEMP (°F)	50.1	50.1
LEAVING WATER TEMP (°F)	62.0	62.0
MINIMUM COIL LATENT HEAT (MHB)	1,858,928.0	1,858,928.0
MINIMUM COIL SENSIBLE HEAT (MBH)	2,504,646.0	2,504,646.0
MINIMUM COIL TOTAL HEAT (MBH)	4,363,574.0	4,363,574.0
MAX WATER FLOW (GPM)	731.2	731.2
CHILLED WATER TEMP DIFFERENCE (°F)	11.9	11.9
MAX WATER PRESSURE DROP (FT OF WATER)	10.11	10.11
TUBE MATERIAL / FIN MATERIAL	CU / CU	CU / CU
UV LIGHTS (YES/NO)	YES	YES
COOLING COIL DESIGN INFORMATION		
COIL POSITION	POST COOLING	POST COOLING
COIL DESCRIPTION	6@5WC-4-48X84X4-8CU	6@5WC-4-48X84X4-8CU
CASE MATERIAL	16 GA. 304 S.S.	16 GA. 304 S.S.
QUANTITY OF COILS	3LH/3RH	3LH/3RH
COIL AIRFLOW	79800	79800
MAX FACE VELOCITY	475.0	475.0
MINIMUM NUMBER ROWS	4	4
MINIMUM NUMBER OF FINS PER INCH	8	8
MAXIMUM AIR PRESSURE DROP	0.42	0.42
ENTERING AIR TEMP (DB) (°F)	67.5	67.5
ENTERING AIR TEMP (WB) (°F)	65.3	65.3
LEAVING AIR TEMP (DB) (°F)	52.7	52.7
LEAVING AIR TEMP (WB) (°F)	52.7	52.7
ENTERING WATER TEMP (°F)	42.0	42.0
LEAVING WATER TEMP (°F)	50.1	50.1
MINIMUM COIL LATENT HEAT (MHB)	1,687,739.0	1,687,739.0
MINIMUM COIL SENSIBLE HEAT (MBH)	1,285,264.0	1,285,264.0
MINIMUM COIL TOTAL HEAT (MBH)	2,973,003.0	2,973,003.0
MAX WATER FLOW (GPM)	731.2	731.2
CHILLED WATER TEMP DIFFERENCE (°F)	8.1	8.1
MAX WATER PRESSURE DROP (FT OF WATER)	10.36	10.36
TUBE MATERIAL / FIN MATERIAL	CU / CU	CU / CU
UV LIGHTS (YES/NO)	YES	YES
HEATING COIL DESIGN INFORMATION		
COIL POSITION	PREHEAT	PREHEAT
COIL DESCRIPTION	4@9NS-48X78X1-4CU	4@9NS-48X78X1-4CU
CASE MATERIAL	16 GA. 304 S.S.	16 GA. 304 S.S.
QUANTITY OF COILS	4	4
COIL AIRFLOW IN FULL HEATING	79,800	79,800
MAX FACE VELOCITY AT FULL HEATING	767	767
MINIMUM NUMBER OF ROWS	1	1
MINIMUM NUMBER OF FINS PER INCH	4	4
MAXIMUM AIR PRESSURE DROP AT FULL HEAT	0.18	0.18
ENTERING AIR TEMP (DB) (°F)	52.5	52.5
LEAVING AIR TEMP (DB) (°F)	52.5	52.5
STEAM PRESSURE	10#	10#
CONDENSATE RATE	347#/HR	347#/HR
MINIMUM COIL SENSIBLE HEAT (MBH)	3,314,717.0	3,314,717.0
TUBE MATERIAL / FIN MATERIAL	CU/AL	CU/AL
UV LIGHTS (YES/NO)	NO	NO
HEATING COIL DESIGN INFORMATION		
COIL POSITION	REHEAT	REHEAT
COIL DESCRIPTION	2@9NS-48X84X1-6CU	2@9NS-48X84X1-6CU
CASE MATERIAL	16 GA. 304 S.S.	16 GA. 304 S.S.
QUANTITY OF COILS	2	2
COIL AIRFLOW IN FULL HEATING	40,000	40,000
MAX FACE VELOCITY AT FULL COOLING	714	714
MINIMUM NUMBER OF ROWS	1	1
MINIMUM NUMBER OF FINS PER INCH	6	6
MAXIMUM AIR PRESSURE DROP AT FULL HEAT	0.2	0.2
ENTERING AIR TEMP (DB) (°F)	52.5	52.5
LEAVING AIR TEMP (DB) (°F)	96.1	96.1
STEAM PRESSURE	10#	10#
CONDENSATE RATE	2052#/HR	2052#/HR
MINIMUM COIL SENSIBLE HEAT (MBH)	1,955,674.0	1,955,674.0
TUBE MATERIAL / FIN MATERIAL	CU/CU	CU/CU
UV LIGHTS (YES/NO)	NO	NO
FILTER SECTION		
2" - 30% PLEATED PRE-FILTER	YES	YES
2" - 85% FINAL FILTER	YES	YES
NOTES		
UNIT SHALL BE PROVIDED WITH FACTORY INSTALLED JUNCTION BOXES AUXILIARIES, RECEPTACLES, SERVICING LIGHTS, ETC. RE: ELECTRICAL DRAWINGS FOR FURTHER INFORMATION.		
FACTORY INSTALLED JUNCTION BOXES ARE FOR CONNECTION BY DIVISION 26. DIVISION 26 IS NOT TO PENETRATE AIR HANDLING UNIT HOUSING. WIRING FROM JUNCTION BOX TO LOAD INSIDE AIR HANDLING UNIT SHALL BE BY THE MANUFACTURER.		
ALL POWER WIRING BETWEEN VARIABLE FREQUENCY DRIVES, MOTOR CONTROLLERS AND MOTORS SHALL BE COMPLETED BY THE AIR HANDLING UNIT MANUFACTURER.		
INFORMATION SHOWN IS PER UNIT.		

**ENERGY RECOVERY COILS SCHEDULE - ALTERNATE # 1**

LOCATION	DESIGN CFM	AIR HANDLING UNIT COIL										HOT DECK COIL										REMARKS										
		ENT. AIR		LVG. AIR		TOTAL MBH	GPM (1)	"H" x "L" IN.	NO. OF COILS	MIN. F. A. SO. FT.	MAX. FACE VEL. FPM	NO. OF ROWS	FIN SERIES	MAX. P. D.		ENT. AIR		LVG. AIR		TOTAL MBH	GPM (1)		"H" x "L" IN.	NO. OF COILS	MIN. F. A. SO. FT.	MAX. FACE VEL. FPM	NO. OF ROWS	FIN SERIES	MAX. P. D.			
		DB °F	WB °F	DB °F	WB °F									AIR IN.	—	DB °F	WB °F	DB °F	WB °F										AIR IN.	—		
AHU-L-7	53,200	98.0	80	88.5	77.5	671	—	84X48	4	112	475	6	8	0.57	—	REHEAT	40,000	52.7	52.7	68.2	--	671	—	84X60	2	60.0	571	6	8	0.78	—	THE HEATPIPE WRAP-AROUND SYSTEM SHALL BE VERIFIED BY THE MANUFACTURER TO NOT REQUIRE A PUMP. THE COIL PRESSURE DROP MUST NOT EXCEED THE NOTED TOTAL.
AHU-L-8	53,200	98.0	80	88.5	77.5	671	—	84X48	4	112	475	6	8	0.57	—	REHEAT	40,000	52.7	52.7	68.2	--	671	—	84X60	2	60.0	571	6	8	0.78	—	

ALTERNATE #1 - WRAP-AROUND HEAT PIPE COIL UNIT, SHALL REQUIRE A DIFFERENT FAN DUE TO THE INCREASED STATIC PRESSURE THROUGH THE COILS. THE COOLING COILS SHALL NOT CHANGE, SO THAT IF THERE IS A FAILURE IN THE HEAT-PIPE, THE COILS SHALL BE ABLE TO ACHIEVE THE FULL CAPACITY OF THE SYSTEM REQUIREMENTS.

THE FANS FOR THE UNITS WITH WRAP-AROUND COILS SHALL BE:  
 60 PF10-27  
 1782 RPM  
 15.9 MAX BHP/FAN  
 20 MAX HP/FAN  
 1750 HP MOTOR  
 480/3 PHASE  
 NO EMERGENCY POWER  
 NEW 125HP VFD  
 DIRECT-DRIVE

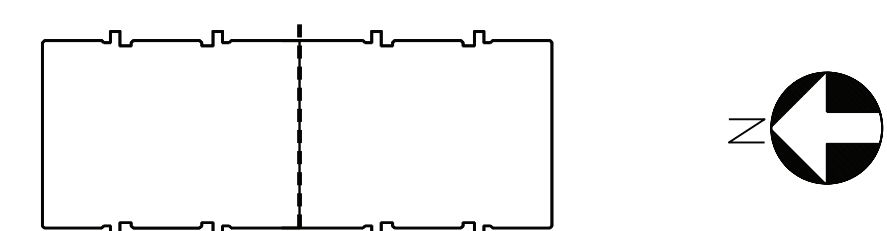
THE BYPASS DAMPER SHALL BE FULL OPEN IN FULL COOLING MODE. THE BYPASS DAMPER SHALL CLOSE AS THE UNIT REQUIRES REHEAT. THE DAMPER SHALL BE SEQUENCED TO FULLY MODULATE TO MAINTAIN STATIC PRESSURE ACROSS THE DAMPER OF 0.57". THIS SHALL ENSURE THE MAXIMUM AMOUNT OF AIR WILL TRAVEL THROUGH THE HEAT PIPES WITHOUT INCREASING THE STATIC PRESSURE OF THE UNIT ABOVE THE ABILITIES OF THE FAN.

**COIL SCHEDULE - ALTERNATE #2 - CONDENSATE**

THE TOP EXTERIOR PRE-COOLING COIL IN THE CONDENSATE RECOVERY UNITS SHALL BE REPLACED BY THE FOLLOWING TWO COILS		
UNIT NO.	AHU-L7	AHU-L8
COOLING COIL DESIGN INFORMATION		
COIL POSITION	COOLING - CONDENSATE	COOLING - CONDENSATE
COIL DESCRIPTION	1@5WC-8-6X84X6-8CU	1@5WC-8-6X84X6-8CU
CASE MATERIAL	16 GA. 304 S.S.	16 GA. 304 S.S.
QUANTITY OF COILS	3LH/3RH	3LH/3RH
COIL AIRFLOW	1370	1370
MAX FACE VELOCITY	391	391
MINIMUM NUMBER ROWS	8	8
MINIMUM NUMBER OF FINS PER INCH	8	8
MAXIMUM AIR PRESSURE DROP	0.42	0.42
ENTERING AIR TEMP (DB) (°F)	98.0	98.0
ENTERING AIR TEMP (WB) (°F)	80.0	80.0
LEAVING AIR TEMP (DB) (°F)	67.4	67.4
LEAVING AIR TEMP (WB) (°F)	66.7	66.7
ENTERING WATER TEMP (°F)	55.0	55.0
LEAVING WATER TEMP (°F)	72.1	72.1
MINIMUM COIL LATENT HEAT (MHB)	25,521.0	25,521.0
MINIMUM COIL SENSIBLE HEAT (MBH)	43,076.0	43,076.0
MINIMUM COIL TOTAL HEAT (MBH)	68,597.0	68,597.0
MAX WATER FLOW (GPM)	8.0	8.0
CHILLED WATER TEMP DIFFERENCE (°F)	17.1	17.1
MAX WATER PRESSURE DROP (FT OF WATER)	6.2	6.2
TUBE MATERIAL / FIN MATERIAL	CU / CU	CU / CU
UV LIGHTS (YES/NO)	YES	YES
COOLING COIL DESIGN INFORMATION		
COIL POSITION	COOLING	COOLING
COIL DESCRIPTION	1@5WC-4-42X84X4-8CU	1@5WC-4-42X84X4-8CU
CASE MATERIAL	16 GA. 304 S.S.	16 GA. 304 S.S.
QUANTITY OF COILS	3LH/3RH	3LH/3RH
COIL AIRFLOW	11,930	11,930
MAX FACE VELOCITY	487.0	487.0
MINIMUM NUMBER ROWS	4	4
MINIMUM NUMBER OF FINS PER INCH	8	8
MAXIMUM AIR PRESSURE DROP	0.42	0.42
ENTERING AIR TEMP (DB) (°F)	98.0	98.0
ENTERING AIR TEMP (WB) (°F)	80.0	80.0
LEAVING AIR TEMP (DB) (°F)	67.8	67.8
LEAVING AIR TEMP (WB) (°F)	65.5	65.5
ENTERING WATER TEMP (°F)	50.1	50.1
LEAVING WATER TEMP (°F)	60.7	60.7
MINIMUM COIL LATENT HEAT (MHB)	273,027.0	273,027.0
MINIMUM COIL SENSIBLE HEAT (MBH)	370,848.0	370,848.0
MINIMUM COIL TOTAL HEAT (MBH)	643,875.0	643,875.0
MAX WATER FLOW (GPM)	131.8	131.8
CHILLED WATER TEMP DIFFERENCE (°F)	10.6	10.6
MAX WATER PRESSURE DROP (FT OF WATER)	10.1	10.1
TUBE MATERIAL / FIN MATERIAL	CU / CU	CU / CU
UV LIGHTS (YES/NO)	YES	YES

**PUMP SCHEDULE - ALTERNATE #2 - CONDENSATE**

UNIT NO.	LOCATION	SERVICE	TYPE	GPM	FT. HEAD	SHUT OFF HEAD FT. H <sub>2</sub> O	DESIGN PRESSURE PSI	MOTOR					REMARKS
								BHP	HP	RPM	VOLTS @ 60 HZ	PH	
CP-L7	CONDENSATE RECEIVER	CONDENSATE	SUBMERSIBLE	8.5	20.0	22.0	150	4.0	1/6	3450	120	I	SIMILAR TO FLINT & WALLING ECP062S
CP-L8	CONDENSATE RECEIVER	CONDENSATE	SUBMERSIBLE	8.5	20.0	22.0	150	4.0	1/6	3450	120	I	SIMILAR TO FLINT & WALLING ECP062S



P:\33000\3302.vm\3302.ms.dgn

ISSUE FOR	Date	Description
Approved	03-02-16	FOR BID
	04-04-16	ADDENDUM #1

**E & C** ENGINEERS & CONSULTANTS, INC.  
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 Date: 2016.04.05 10:37:07  
 Texas Notary Registration No: F00060

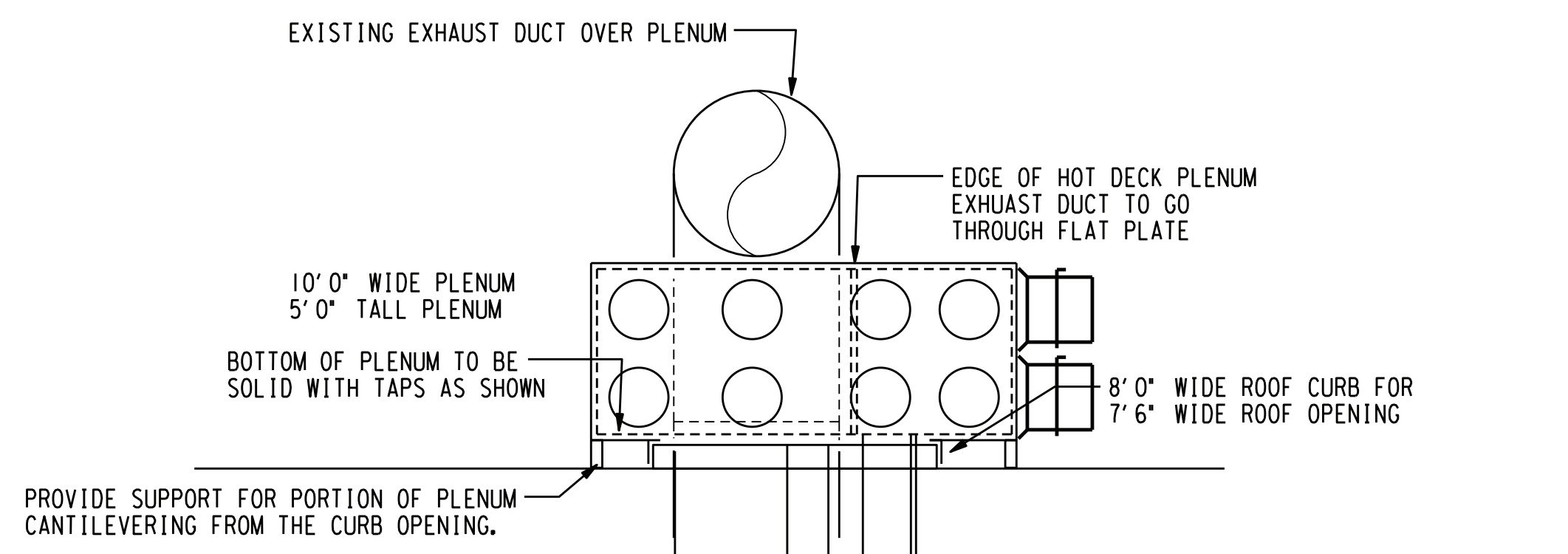
Date: 3/27/16  
 Drawn By: BVG  
 Checked By: REG  
 UTHSC Project No.: 730022  
 E & C Project No.: 3302.00  
 File Name:

**UTHealth**  
 The University of Texas  
 Health Science Center at Houston

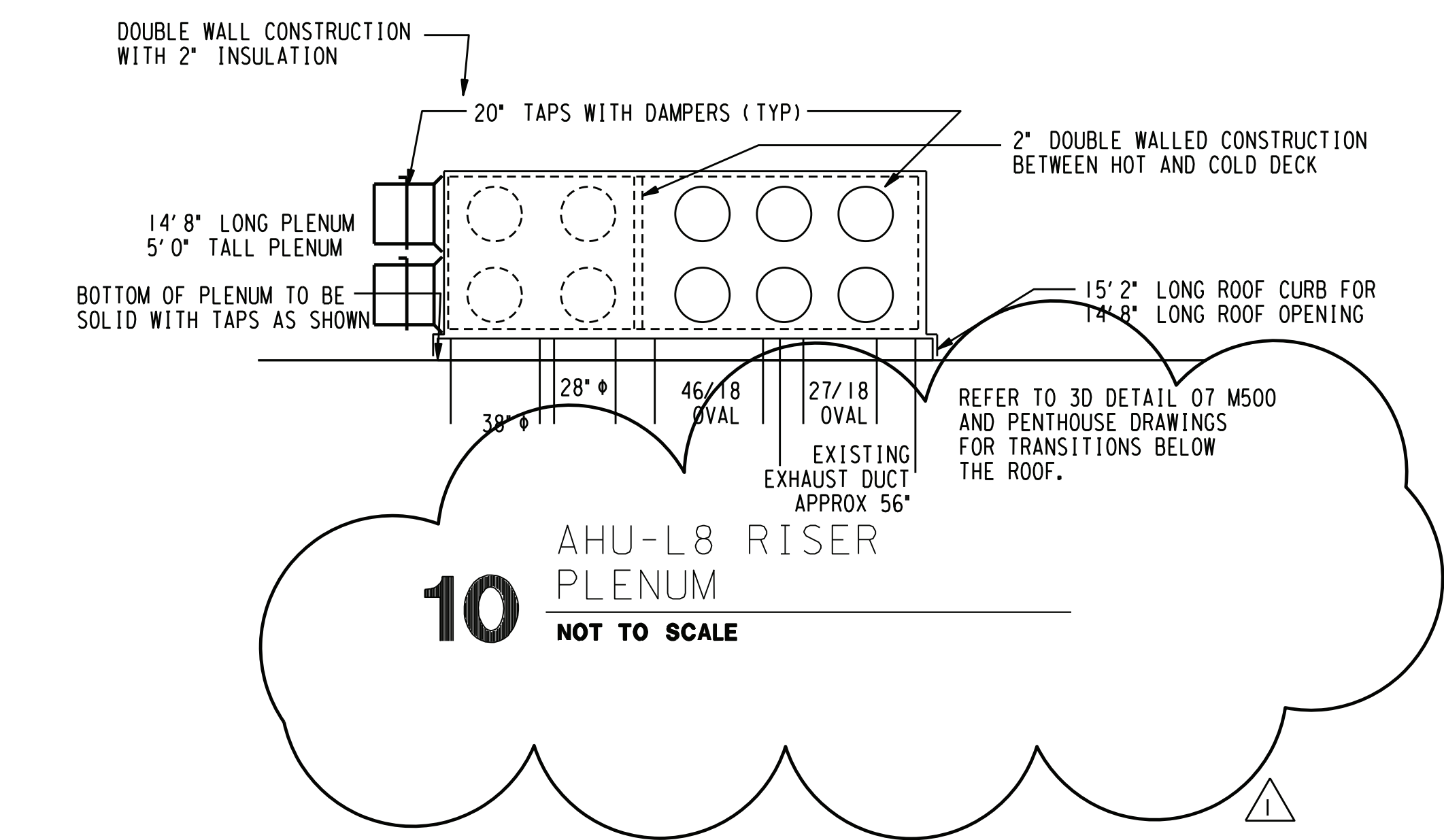
**MEDICAL SCHOOL BUILDING  
 AHU L-7 & 8 REPLACEMENT**

DRAWING TITLE  
**MECHANICAL SCHEDULES**

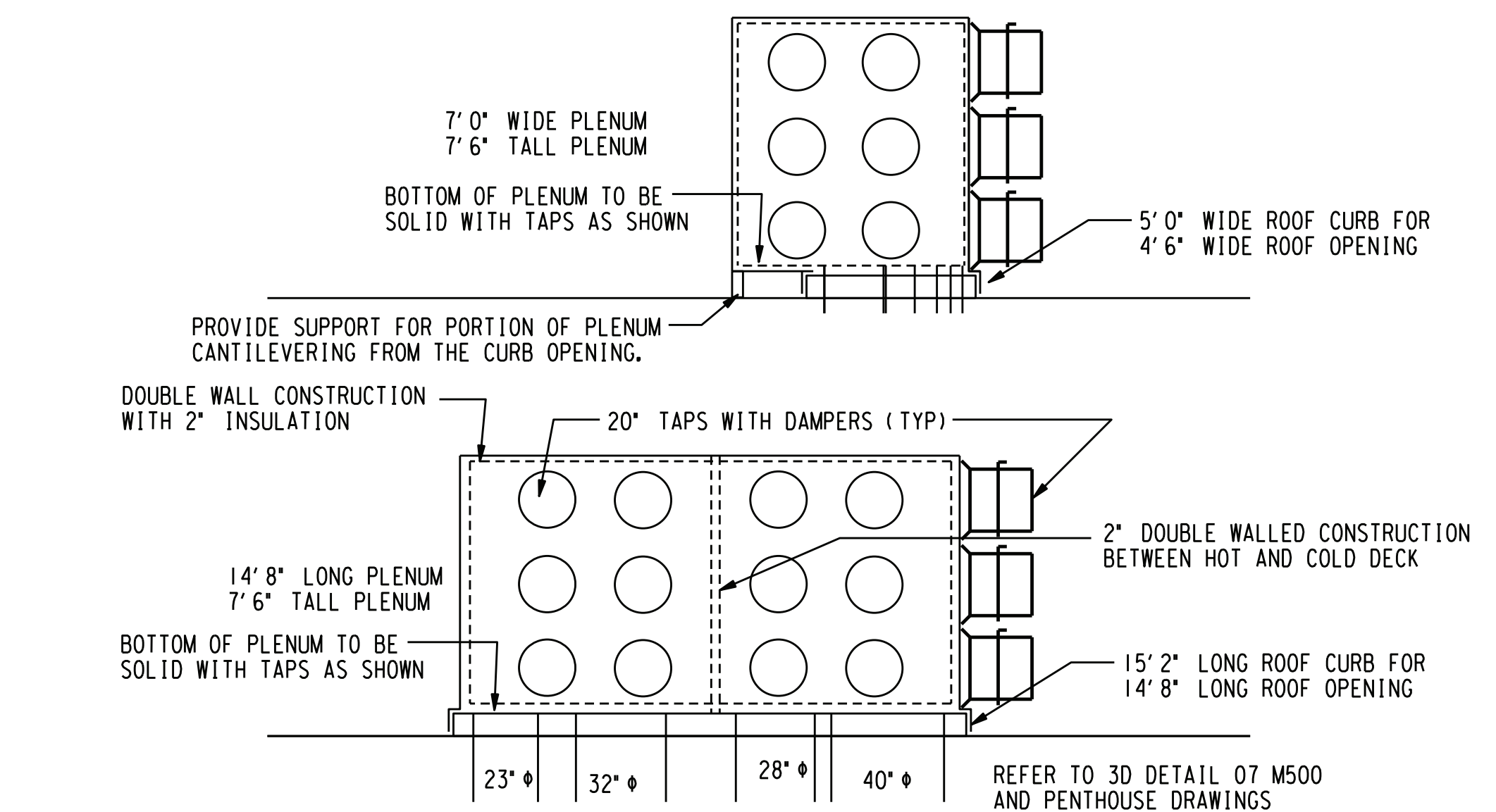
DRAWING NO.  
**M400**



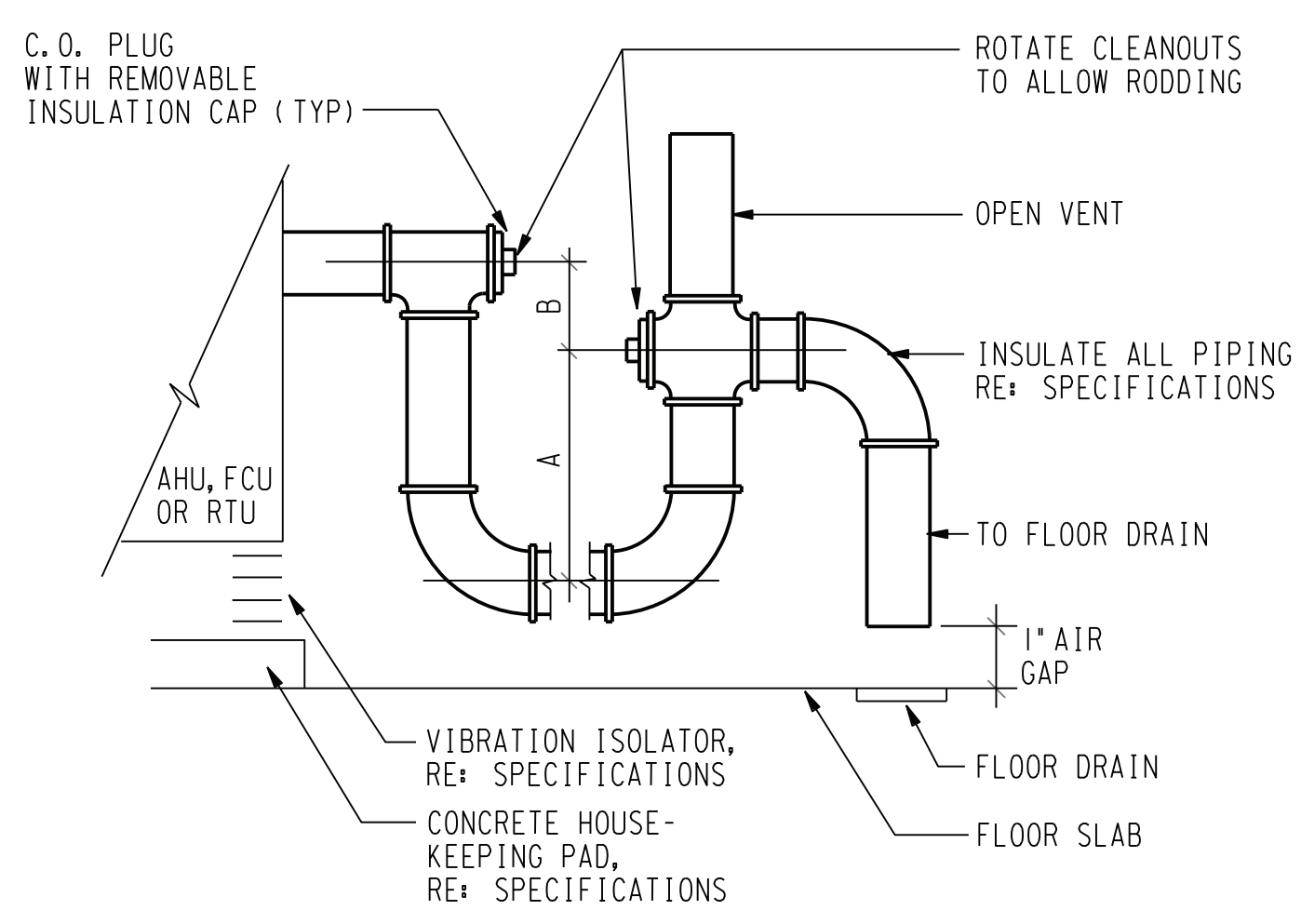
**10** AHU-L8 RISER PLENUM  
NOT TO SCALE



**11** AHU-L7 RISER PLENUM  
NOT TO SCALE

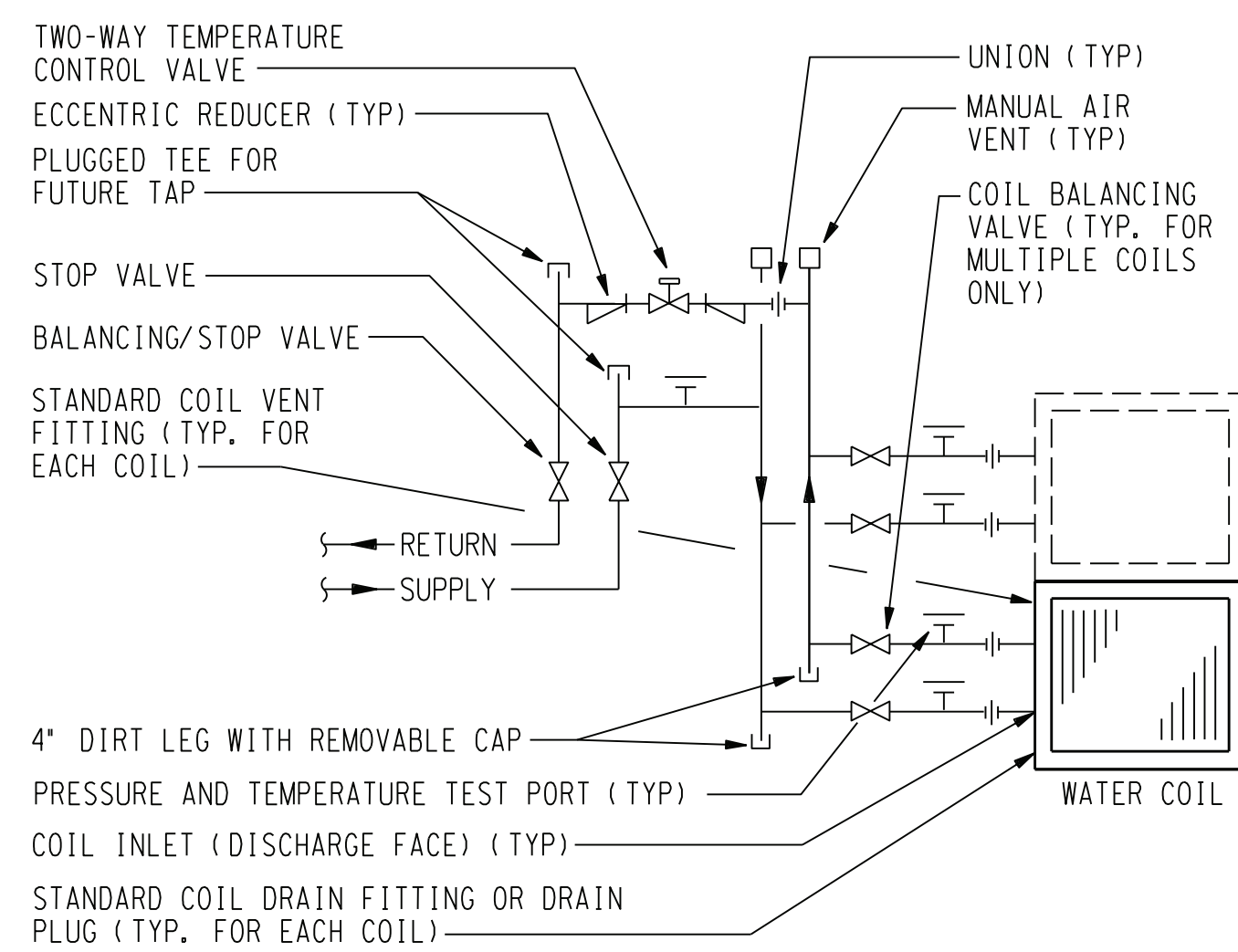


**12** TYPICAL HOLD-DOWN LAY-OUT - RE: STRUCTURE  
NOT TO SCALE



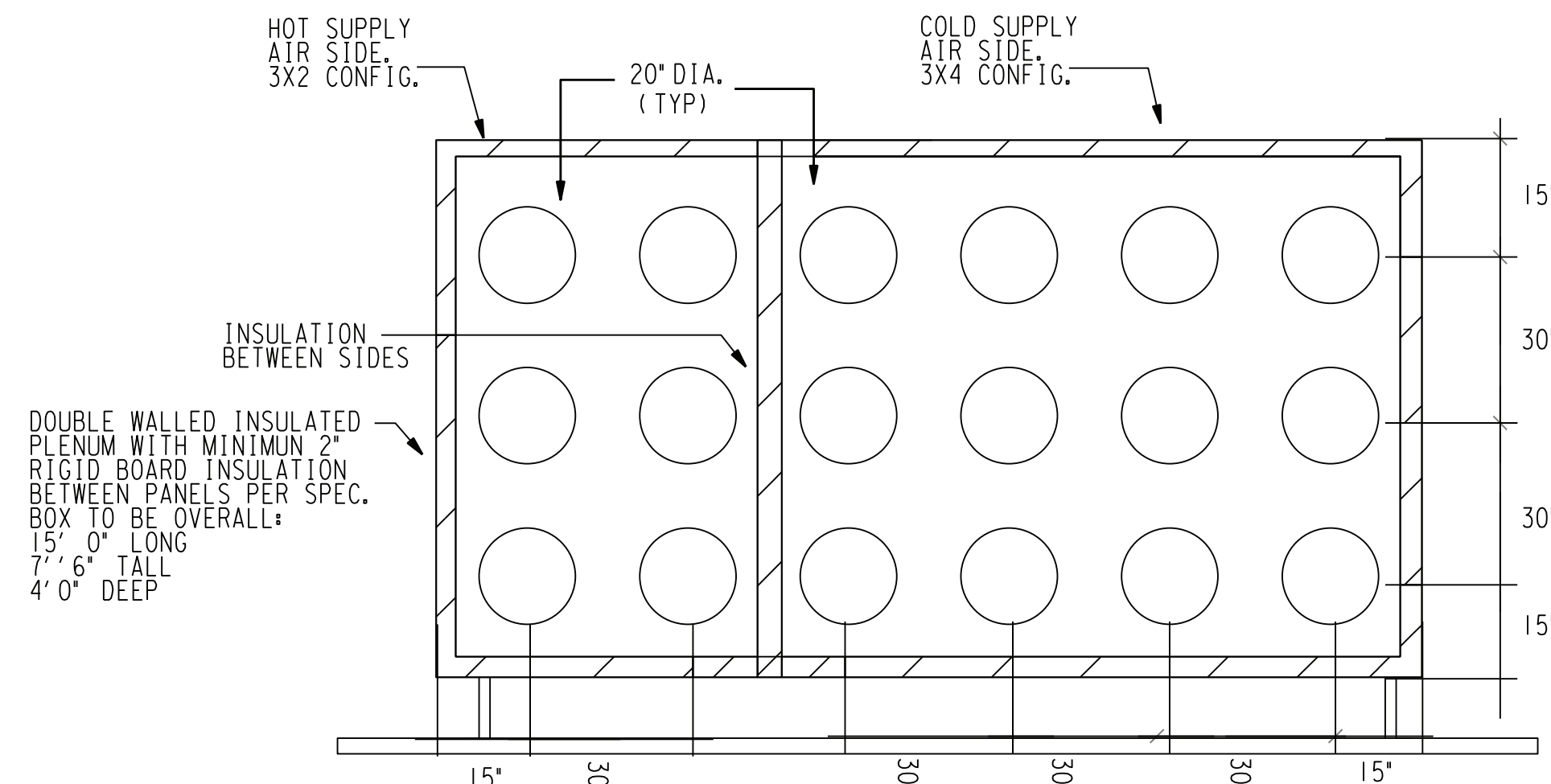
A - MINIMUM =  $B/2 + 1/2'$   
B - MINIMUM = UNIT FAN DISCHARGE PRESSURE + 2'

**7** TYPICAL CONDENSATE DRAIN PIPING  
NOT TO SCALE

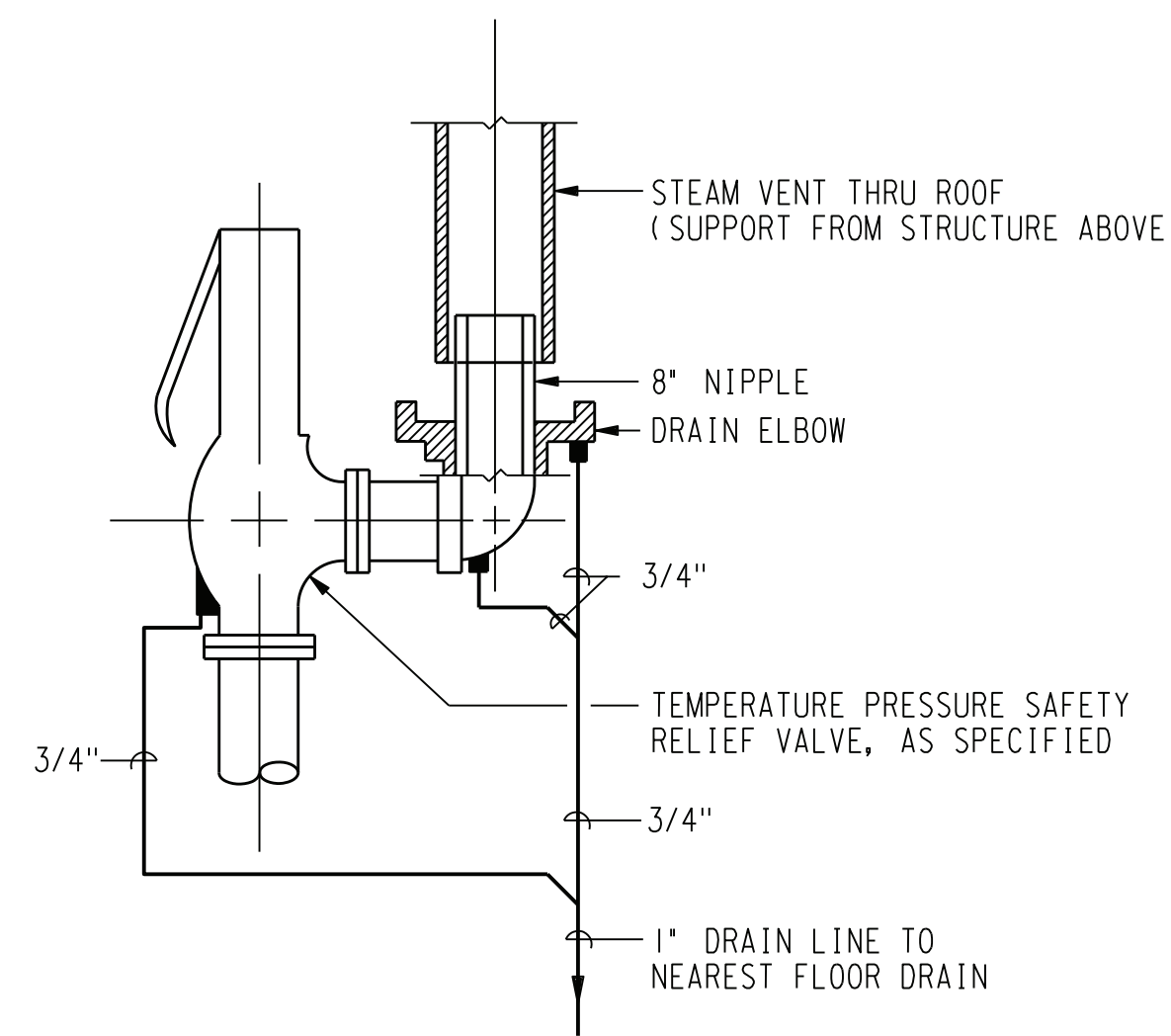


NOTES:  
1. INSULATE ALL PIPING, VALVES, FITTINGS AND ACCESSORIES. RE: SPECIFICATIONS.  
2. INSTALL TEST PORTS IN EASILY ACCESSIBLE LOCATIONS WITH MINIMUM OF 12\"/>

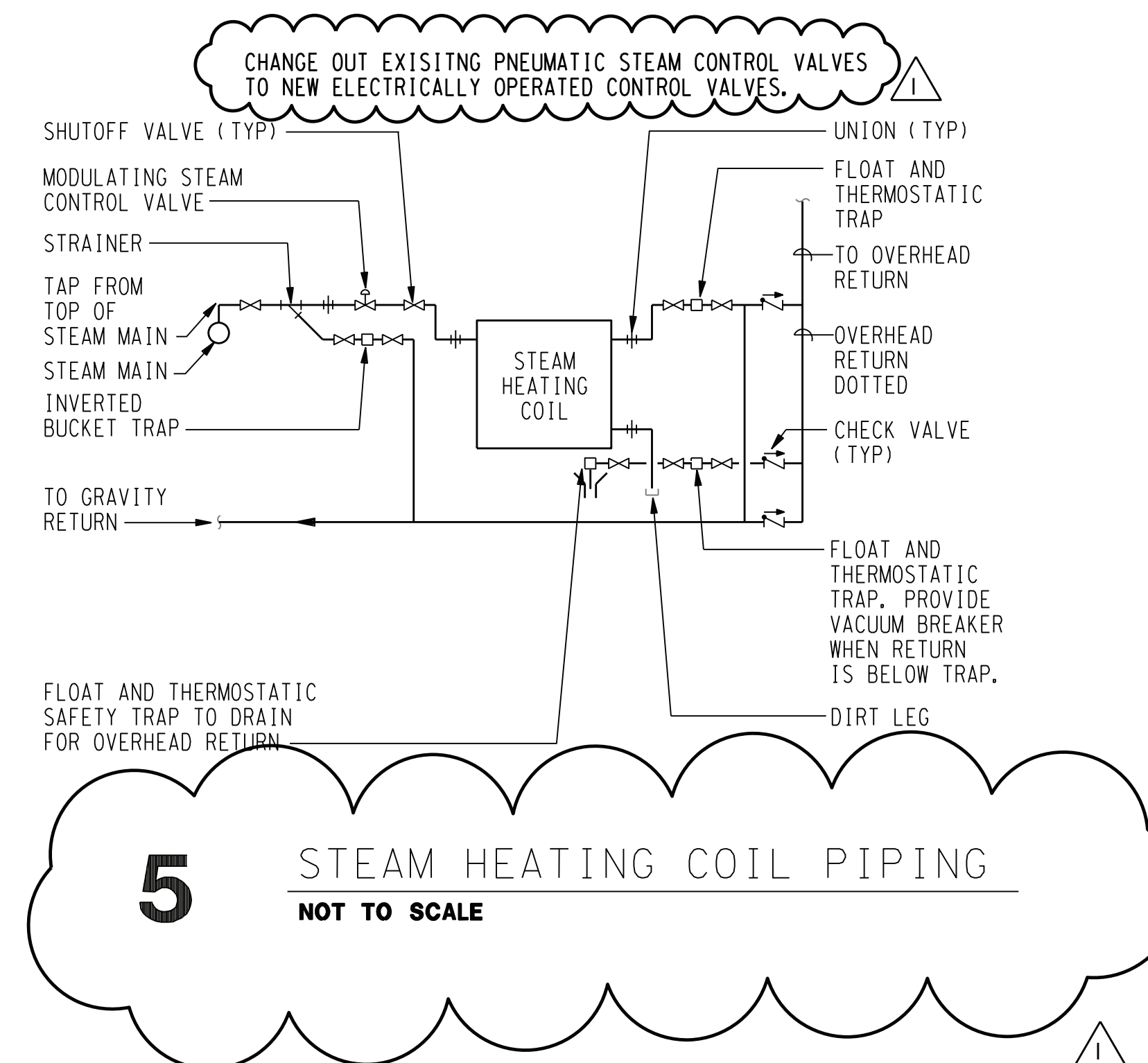
**8** TYPICAL AIR HANDLING UNIT COIL PIPING  
NOT TO SCALE



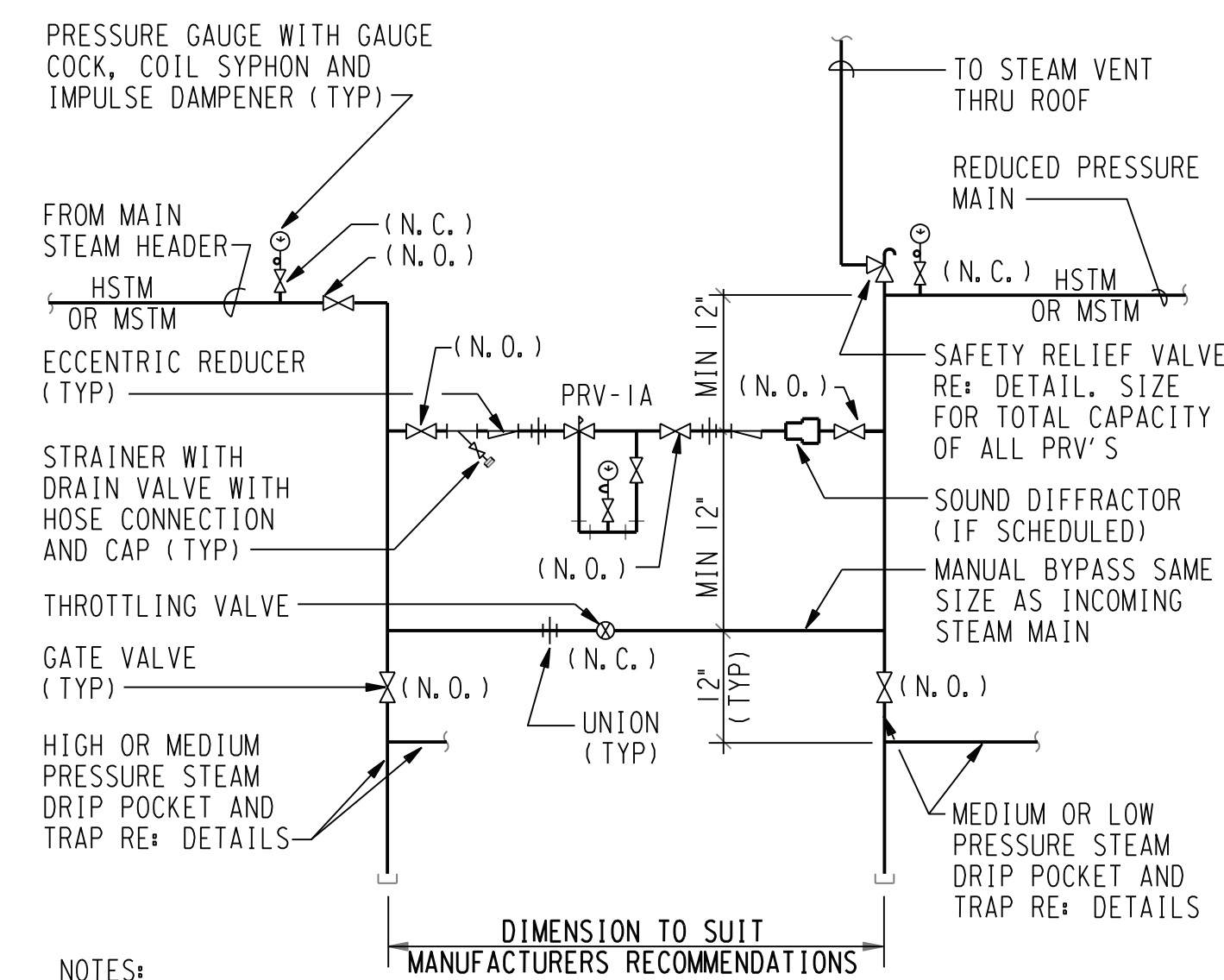
**9** TYPICAL ROOFTOP PLENUM  
NOT TO SCALE



**6** TYPICAL STEAM SAFETY RELIEF VALVE  
NOT TO SCALE

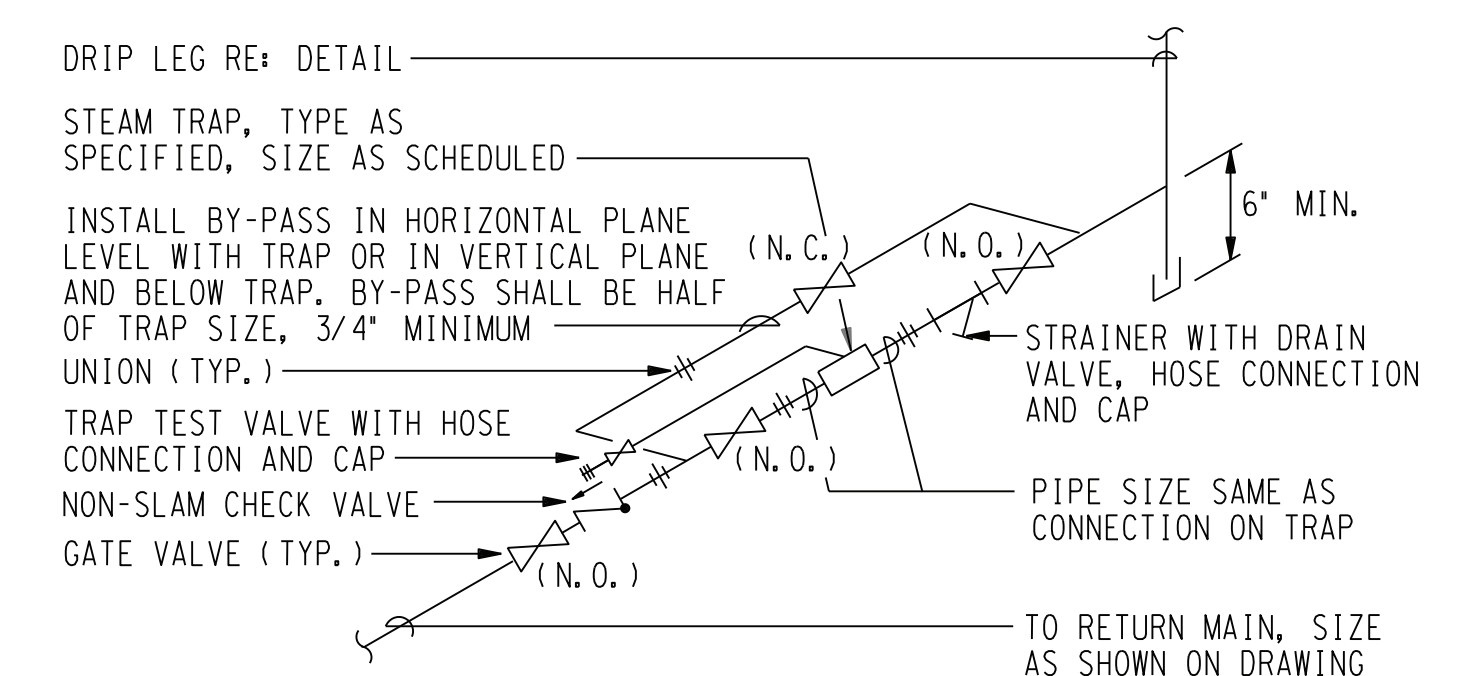


**5** STEAM HEATING COIL PIPING  
NOT TO SCALE



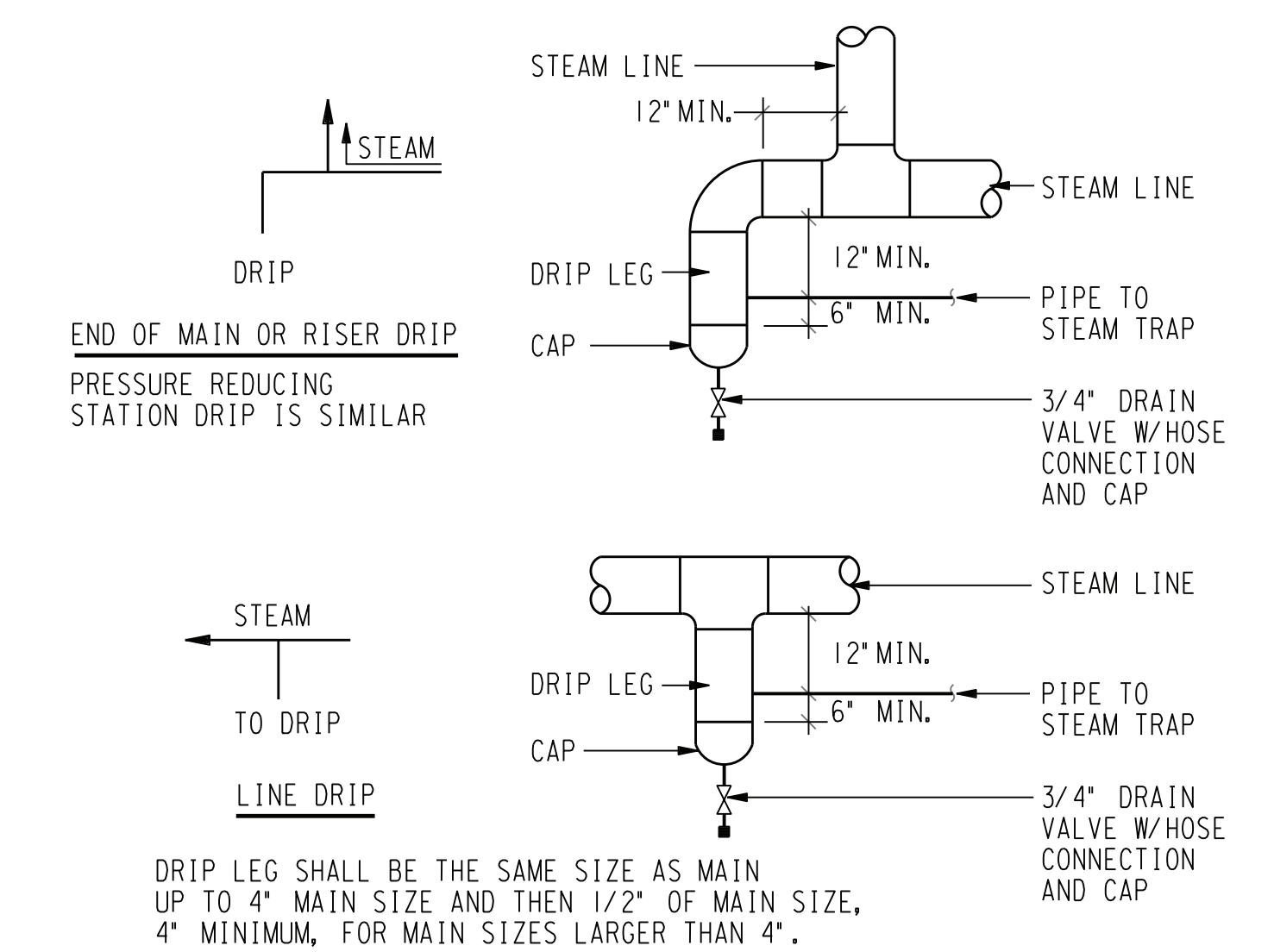
NOTES:  
1. SIZE PRV-1A SIZED FOR 100% OF REDUCED PRESSURE STEAM LOAD.  
2. HIGH PRESSURE TO MEDIUM PRESSURE OR MEDIUM PRESSURE TO LOW PRESSURE. DO NOT USE FOR HIGH PRESSURE TO LOW PRESSURE.

**4** TYPICAL SINGLE STAGE STEAM PRESSURE REDUCING STATION  
NOT TO SCALE

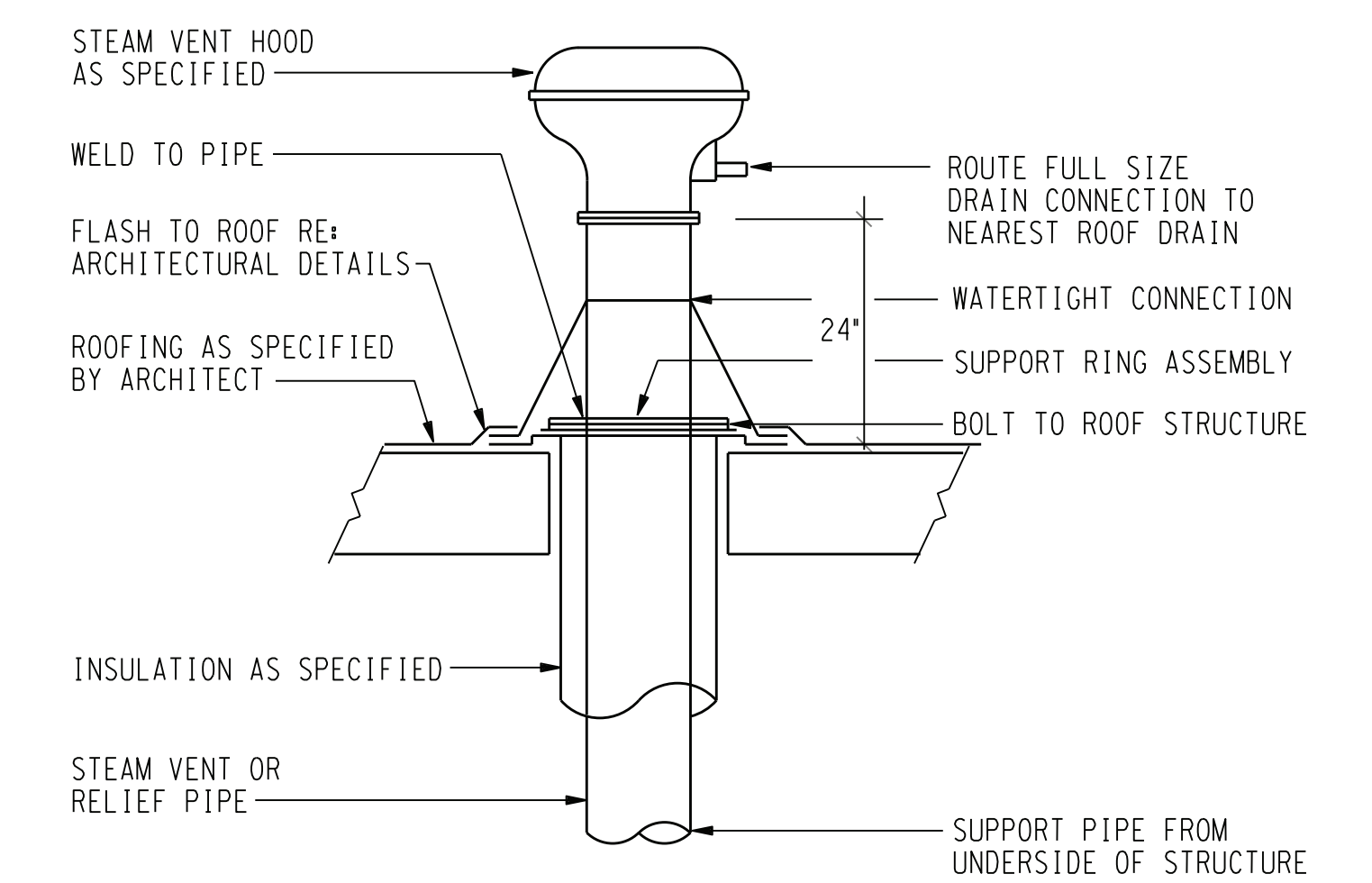


NOTES:  
1. BY-PASS IS NOT REQUIRED ON THE TRAP PROVIDED FOR THE DRIPPING OF LOW PRESSURE SUPPLY MAINS (15 PSIG OR LESS).  
2. CHECK VALVE IS NOT REQUIRED FOR LOW PRESSURE STEAM SYSTEM WITH GRAVITY RETURN.

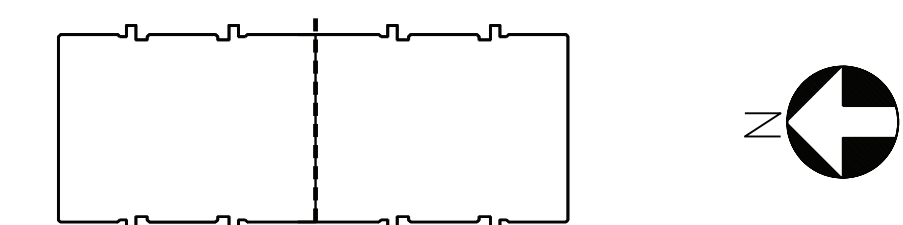
**3** TYPICAL STEAM DRIP TRAP PIPING  
NOT TO SCALE



**2** TYPICAL STEAM DRIP TRAP POCKETS  
NOT TO SCALE



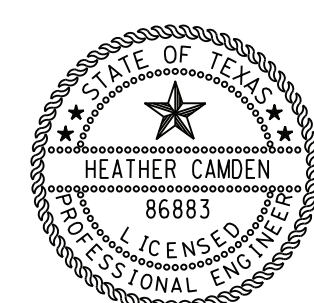
**1** TYPICAL STEAM VENT THRU ROOF ASSEMBLY  
NOT TO SCALE



ISSUE FOR:	Revised Date	Description
FOR BID	03-02-16	
ADDENDUM	04-04-16	

**E & C**

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Date: 2016.04.16 16:50:04 -0500

Date: 3/2/16  
Drawn By: DV  
Checked By: HEC

UTHC Project No.: 730022  
E & C Project No.: 3302.00  
File Name:



**MEDICAL SCHOOL BUILDING  
AHU L-7 & 8 REPLACEMENT**

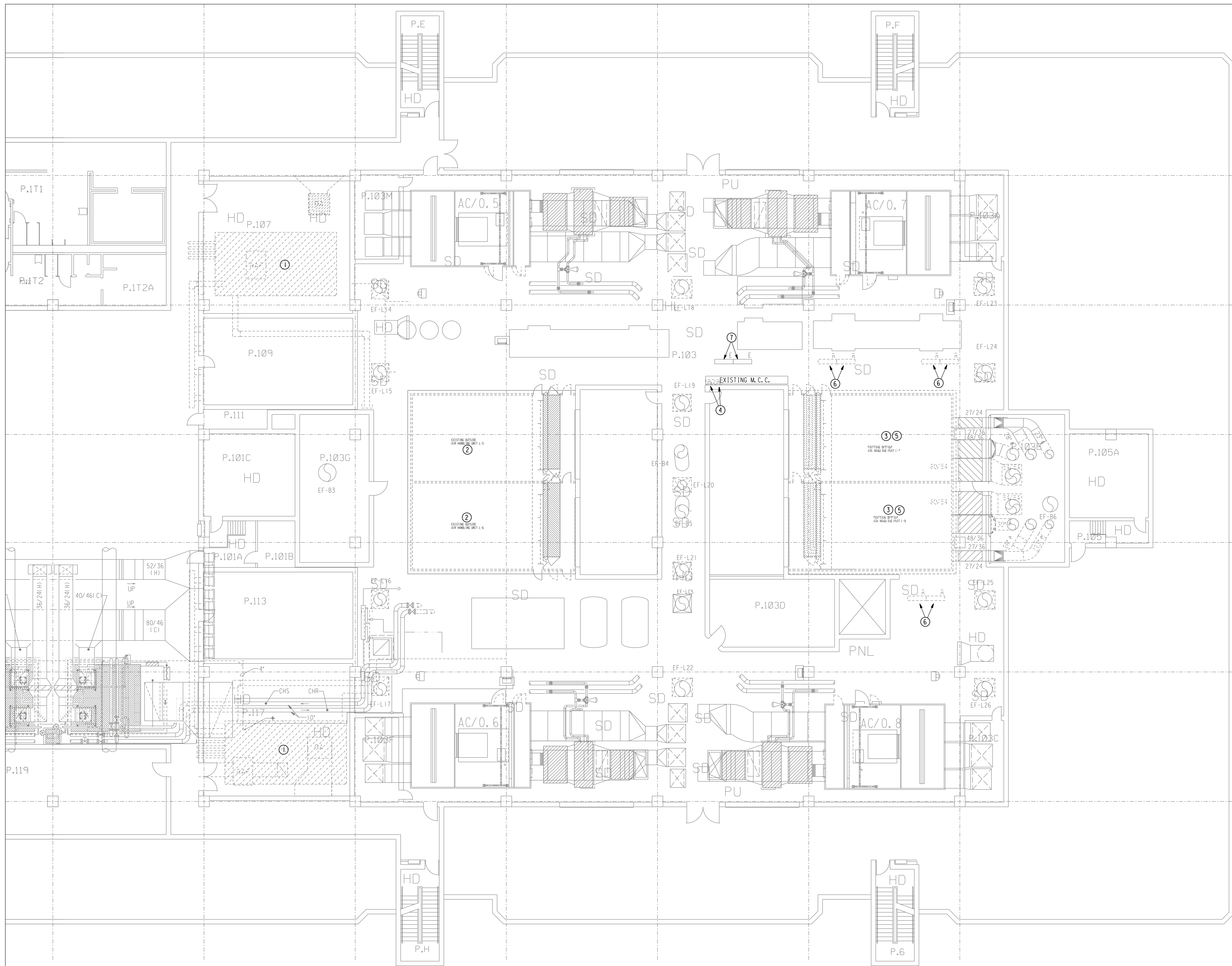
DRAWING TITLE  
**MECHANICAL  
DETAILS**

DRAWING NO.  
**M501**

ABBREVIATIONS	
A	AMPS, AIR (COMPRESSED)
AAP	AREA ALARM PANEL
AB	ABOVE
AC	ALTERNATING CURRENT, AIR COMPRESSOR
A/C	AIR CONDITIONING
ACC	AIR COOLED CHILLER
ACCU	AIR COOLED CONDENSING UNIT
AD	ACCESS DOOR, AIR DRYER
ADJ	ADJUSTABLE
AF	ABOVE FINISHED CEILING
AFF	ABOVE FINISHED FLOOR
AFIC	ABOVE FINISHED GRADE
AHU	AIR HANDLING UNIT
AIC	AMPERES INTERRUPTING CAPACITY
AL	ALUMINUM
ALT	ALTERNATE
AM	AMBIENT
AND	AND
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
AP	ACCESS PANEL, ALARM PANEL
APD	AIR PRESSURE DROP
ARCH	ARCHITECTURAL
ARI	AMERICAN REFRIGERATION INSTITUTE
ASHRAE	AMERICAN SOCIETY OF HEATING AND REFRIGERATION AND AIR CONDITIONING ENGINEERS
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
ATP	AUTOMATIC TRAP PRIMER
ATS	AUTOMATIC TRANSFER SWITCH
ATT(S)	(ATTENUATOR(S))
AUTO	AUTOMATIC VALVE
AUX	AUXILIARY
AV	AREA VALVE, ACID VENT
AVR	ACID VENT THRU ROOF
AW	AWNING
AWW	AMERICAN WELDING SOCIETY
AWWA	AMERICAN WATER WORKS ASSOCIATION
BC	BELOW COUNTER
BFD	BOILER FEED DEAREATOR
BFP	BOILER FEED PUMP, BACKFLOW PREVENTER
BFV	BOILER FEED VALVE
BH	BOILER WATER
BH	BOX HYDRANT
BLDG	BUILDING
BM	BEAM, BENCH MARK
BOB	BOTTOM OF BEAM
BOF	BOTTOM OF FOOTING
BOH	BOTTOM OF HUB
BOP	BOTTOM OF PIPE
BOS	BOTTOM OF STRUCTURE
BKT	BRACKET
BS	BLAST STEEL
BSMT	BASEMENT
BT	BATH TUB, BREAK TANK
CA	CALIBRATING BALL VALVE
BW	BACKWATER VALVE
CA	CELSIUS, CONDUIT
CB	CONTROL AIR, COMPRESSED AIR CABINET
CB	CATCH BASIN
CC	CENTER CENTER
CD	CEILING DIFFUSER
CDF	CONDENSER WATER PUMP
CDN	CONDENSER RETURN
CDH	CONDENSER WATER SUPPLY
CF	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CFG	CUBIC FEET PER SECOND
CG	CEILING GRILL
CH	CHILLED WATER PUMP
CHS	CHILLED WATER SUPPLY
CHV	CHECK VALVE
CI	CAST IRON
CIP	CAST IN PLACE
CIRC	CIRCULATING
CL	CENTER LINE
CLM	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CMR	CLEANOUT
COL	COLUMN
COMB	COMBINATION
COMP	COMPRESSOR
COND	CONCRETE, CONCENTRIC
COND	CONDENSER, CONDENSATE
CONN	CONNECT
CONST	CONSTRUCTION
CONT	CONTINUOUS, CONTROLLER
CONTR	CONTRACTOR
CONV	CONVERTER
CORR	CORROSION
CO2	CARBON DIOXIDE
CP	CAST IRON PIPE INSTITUTE
CPVC	CHLORINATED POLYVINYL CHLORIDE
CPUC	CPU CHILLER
CR	CONDENSATE RETURN
CRU	COMPUTER ROOM A/C UNIT
CRV	CATHODE RAY TUBE
CRS	CONDENSATE RETURN UNIT
CSS	CENTRAL SERVICE SINK
CT	Cooling Tower
CTR	CENTER
CU FT	CUBIC FEET
CV	CAPACITY INDEX
CV	CONTROL VALVE, CHECK VALVE
CW	COLD WATER
CVRH	CONSTANT VOLUME REHEAT
D	DEPTH, DRAIN
DB	DRY BULB
DBL	DOUBLE
DC	DIRECT CURRENT, DOUBLE DUCT
DD	CONSTRAIN, DOUBLE DUCT
DDC	DIRECT DIGITAL CONTROL
DEP	DEIONIZED WATER PUMP
DEPT	DEPARTMENT
DESG	DESIGN
DET	DETAIL
DI	DUCTILE IRON, DRAIN INLET, DIAPHRAGM
DIA	DIAMETER
DIFF	DIFFUSER
DIR	DIMENSION
DIR	DEIONIZED WATER RETURN
DISC	DISCONNECTED WATER SUPPLY
DIST	DISTRIBUTION
DIV	DIVISION
DL	DOOR LOUVER
DMH	DRAIN MANHOLE
DN	DOWN
DR	DIFFERENTIAL PRESSURE
DSP	DAMPER
DS	DOUBLE SUCTION, DOWN SPOUT
DW	DOUBLE DUCT
DWS	DISHWASHER, DISTILLED WATER
DWC	DRINKING WATER COOLER
DWV	DOMESTIC WATER HEATER
DWV	DRINKING WATER RETURN
DWV	DRINKING WATER SUPPLY
DWV	DIRECT EXPANSION FAN COIL UNIT
E	EAST
(E)	EXISTING
EAT	ENTERING AIR TEMPERATURE
EC	ELECTRICAL CONTRACTOR
ECC	ECCENTRIC
EDB	ENTERING DRY BULB
EH	EXHAUST
EL	ELEVATION, EXPANSION LOOP
ELEC	ELECTRIC, ELECTRICAL
ELEV	ELEVATOR
ENCL	ENCLOSURE
ENGR	ENGINEER
EPA	ENVIRONMENTAL PROTECTION AGENCY
EQ	EQUAL
EQV	EQUIVALENT
EQVUB	END SUCTION
ES	EXPANSION TANK
ETR	EXISTING TO REMAIN
EVAC	EVACUATION PUMP
EVAP	EVAPORATOR
EW	ENTERING WET BULB
EWB	ENTERING WATER COOLER
EWT	ENTERING WATER TEMPERATURE
EXP	EXPLOSION PROOF
EXCV	EXCAVATE, EXCAVATION
EXH	EXHAUST
EXIST	EXISTING
EXP	EXPANDED
EXT	EXTERNAL
F	FAHRENHEIT, FAN, FIRE, FEMALE
F to F	FACE TO FACE
F & E	FURNITURE & EQUIPMENT
FAB(D)	FIRE ALARM (D)
FACP	FIRE ALARM CONTROL PANEL
FBO	FURNISHED BY OTHERS
FCD	FLOOR CLEAN OUT
FCS	FLOOR CONTROL STATION
FCVA	FLOOR CONTROL VALVE ASSEMBLY
FD	FIRE DAMPER, FLOOR DRAIN
FDN	FOUNDATION
FDS	FIRE DEPARTMENT STAMPESE
FDE	FIRE DEPARTMENT CONNECTION
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUISHER CABINET
FF	FLOOR FINISH, FINISHED FLOOR
FFE	FINISHED FLOOR ELEVATION
FG	FINISHED GRADE
FH	FIRE HOSE
FHC	FIRE HOSE CABINET
FHR	FIRE HOSE RACK
FHW	FIRE HOSE VALVE
FIN	FINISH
FIXT	FIXTURE
FL	FULL LOAD AMPERES
FLEX	FLEXIBLE
FLR	FLOOR
FM	FACTORY MUTUAL
FO	FUEL OIL PUMP
FOD	FUEL OIL RETURN
FOR	FUEL OIL SUPPLY
FOS	FUEL OIL VALVE
FPC	FAN POWER MIXING BOX, FIRE PUMP
FV	FIRE VALVE
FV	FIRE PUMP CONTROLLER
FPT	FEMALE PIPE THREAD
FR	FLOOR REGISTER
FRM	FRAME
FRZR	FREEZER
FRZ	FUSED SWITCH, FLOW SWITCH, FIRE SPRINKLER, FLOOR SINK
FSC	FIRE SUPPRESSION CONTROL PANEL
FT	FOOT, FOOTING
FTR	FINNED TUBE RADIATION
FURN	FURNITURE
FURND	FURNISHED
FUT	FUTURE
FVC	FIRE VALVE CABINET
FVNR	FULL-VOLTAGE, NON-REVERSING
FVR	FULL-VOLTAGE, REVERSING
G	GAS
GA	GAGE
GAL	GALLON
GALV	GALVANIZED
GB	GRADE BEAM
GC	GENERAL CONTRACTOR
GCO	GRADE CLEAN OUT
GEN	GENERATOR
GSK	GASKET
OPNG	OPENING
GL	GLASS
GLV	GLOBE VALVE
GND	GROUND
GOVT	GOVERNMENT
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GR	GRILLE
GRAD	GRADE
GRV	GRAVITY ROOF VENT
GSH	GRAND SENSIBLE HEAT
GTH	GRAND TOTAL HEAT
GV	GATE VALVE
GW	GREASE WASTE
H	HIGH
H-O-A	HIGH HEIGHT, HUMIDIFIER
H STAT	HUMIDISTAT/SENSOR
HR	HORIZONTAL
HRT	HORIZONTAL RETURN
HD	HEAD, HUB DRAIN, HEAT DETECTOR
HE	HEAT EXCHANGER
HGR	HANGER
HKP	HOUSEKEEPING PAD
HND	HAND DRAIN
HORIZ	HORIZONTAL
HPT	HORSEPOWER, HIGH PRESSURE
HP	HIGH POINT
HR	HOT WATER RETURN
HRT	HOT WATER RETURN
HSC	HORIZONTAL SPLIT CASE
HST	HIGH PRESSURE STEAM
HSTZ	HORIZONTAL SINGLE-ZONE, BLOW-THRU
HSZDT	HORIZONTAL, SINGLE-ZONE, DRAW-THRU
HTG	HEATING
HTR	HEATER
HUM	HUMIDITY
HVAC	HOT WATER/GAS UNIT HEATER
HVC	HEATING, VENTILATING & AIR CONDITIONING
HVU	HEATING AND VENTILATING UNIT
HW	HOT WATER
HWB	HOT WATER BOILER
HWC	HOT WATER COIL
HWP	HEATING WATER PUMP
HWT	HOT WATER RETURN
HWS	HOT WATER RETURN
HZ	HERTZ
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IR	IRRIGATION
IF	INTERMITTENT FAN VAV
IN	INCH
INCD	INCANDESCENT
IND	INCLUSIVE
INSUL	INSULATE, INSULATION
INT	INTERNAL, INTERIOR
INVT	INVERT
IPS	IRON PIPE SIZE
JAN	JANITOR
JCB	JUNCTION BOX
JPC	JOCKEY PUMP
JPC	JOCKEY PUMP CONTROLLER
JST	JOIST
JCT	JOINT
K	KITCHEN EQUIPMENT CONTRACTOR
KN	KNOCKOUT
KVA	KILOVOLT-AMPS
KW	KILOWATT
KWH	KILOWATT-HOUR
L	LENGTH, LONG, LAVATORY
LAB	LAB AIR
LAC	LABORATORY AIR COMPRESSOR
LAV	LAVATORY
LAT	LEAVING AIR TEMPERATURE, LATENT
LB(S)	POUND(S)
LCD	LIQUID CRYSTAL DISPLAY
LDB	LEAVING DRY BULB
LDD	LEAVING DRY BULB
LED	LIGHT EMITTING DIODE
LE	LEAK
LG	LAB GAS OUTLET
LH	LEFT HAND
LOC	LOCATION, LIMIT OF CONSTRUCTION
LP	LOW PRESSURE
LPT	LOW POINT
LRA	LOCKED ROTOR AMPS
LSTM	LOW PRESSURE STEAM
LTC	LIGHTING
LW	LAB VACUUM
LVL	LEVEL
LVP	LABORATORY VACUUM PUMP
LW	LAUNDRY LET WATER
LWB	LEAVING WET BULB
LWCO	LOW WATER CUT OFF
LWT	LEAVING WATER TEMPERATURE
M	METER, MALE, MEN
MAG	MEDICAL AIR COMPRESSOR
MAX	MAXIMUM
MBH	THOUSANDS OF BTU'S
MCC	MECHANICAL CONTRACTOR
MCB	MAIN CIRCUIT BREAKER
MCP	MECHANICAL PANEL
MDP	MAIN DISTRIBUTION PANEL
MECH	MECHANICAL
MEMB	MEMBRANE
M/E/P	MECHANICAL/ELECTRICAL/PLUMBING
MEZZ	MEZZANINE
MFR	MANUFACTURER
M/O	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MON	MONITOR SWITCH
MS	MALE PIPE THREAD
MS	MONITOR SWITCH
MSB	MAIN SWITCHBOARD
MSGR	MAIN SWITCHGEAR
MSM	MECHANICAL PRESSURE STEAM
MTG	MOUNTING
MU	MAKE-UP
MV	MECHANICAL VACUUM
MVA	MEGA VOLT-AMPS
MVD	MECHANICAL VOLUME DAMPER
MVP	MEDICAL VACUUM PUMP
MZU	MULTI-ZONE UNIT
N	NORTH, NITROGEN
NA	NOT ACCEPTABLE
NAT	NATURAL
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NF	NON-FUSED
NFS	NON-FUSED SWITCH
NI	NOT IN CONTRACT
NO	NUMBER
N.O.	NORMALLY OPEN
NOM	NOMINAL
NTS	NOT TO SCALE
O	OXYGEN
OA	OUTSIDE AIR
OAF	OUTSIDE AIR FAN
OBD	OPPOSED BLADE DAMPER
OC	ON CENTER
OC	ON CENTER EACH WAY
OD	OUTSIDE DIAMETER
OFF	OFFICE
OPH	OPERATING HAND
OPNG	OPENING
OSKY	OUTSIDE STEEL & YOLK
OZ	OUNCE
P	PUMP, POLE, PLUMBING EQUIPMENT
PB	PUSH-BUTTON
PC	PLUMBING CONTRACTOR, PERSONAL COMPUTER
PCR	PUMPED CONDENSATE RETURN
PCH	PRIMARY CHILLED WATER PUMP
PCH	PRIMARY CHILLED WATER RETURN
PCHS	PRIMARY CHILLED WATER SUPPLY
PCH	PUMPED COLD WATER
PD	PRESSURE DROP
PEND	PENDANT
PER	PERMANENT
PH	PHASE
PH	PHASE
PHWR	PRIMARY HEATING WATER PUMP
PHWS	PRIMARY HEATING WATER RETURN
PHWS	PRIMARY HEATING WATER SUPPLY
PKG	PACKAGE, PARKING
PL	PILOT LIGHT
PLMB	PLUMBING
PNEU	PNEUMATIC
UN	UNDERWRITER'S LABORATORIES, INC.
UN	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SUPPLY
V	VOLT, VENT
V/D	VOICE/DATA
VAC	VACUUM, VARIABLE
VAV	VARIABLE AIR VOLUME
VAV	VARIABLE AIR VOLUME
VDF	VOLUME DAMPER
VEL	VELOCITY
VERT	VERTICAL
VEST	VESTIBULE
VFD	VARIABLE FREQUENCY
VOL	VOLUME
VP	VACUUM PUMP
VPR	VARIABLE AIR VOLUME REHEAT
VSBZT	VERTICAL SINGLE ZONE BLOW THRU
VSZBT	VERTICAL SINGLE ZONE DRAW THRU
W	WATT, WIDTH, WASTE, WEST, WIRE, WOMEN
W/O	WITHOUT
WB	WET BULB
WC	WATER CLOSET
WCO	WALL CLEANOUT
WH	WATER HEATER, WALL
WM	WATER METER
WPD	WEATHERPROOF
WS	WATER PRESSURE DROP
WS	WATER SOFTENER
WT	WATER TIGHT, WEIGHT
WF	WELDED WIRE FABRIC
XP	EXPLOSION PROOF
Z	ZONE
ZV	ZONE VALVE

ELECTRICAL SYMBOLS (ALL SYMBOLS SHOWN ARE NOT NECESSARILY USED ON THE DRAWINGS)	
<b>ONE LINE/RISER DIAGRAMS</b>	
	TRANSFORMER, TYPE AND RATINGS AS NOTED
	SWITCH, RATING AS SHOWN
	FUSE, RATING AS SHOWN
	CIRCUIT BREAKER, RATINGS AS SHOWN, 3 POLE UNLESS NOTED OTHERWISE
	DRAINOUT CIRCUIT BREAKER, RATINGS AS SHOWN, 3 POLE (UNLESS NOTED OTHERWISE)
	SHUNT TRIP
	GROUND FAULT RELAY
	KIRK-KEY INTERLOCK
	AMMETER, RANGE AS SHOWN
	AMMETER SWITCH
	VOLTMETER, RANGE AS SHOWN
	VOLTMETER SWITCH
	FULL FUNCTION METER
	CURRENT TRANSFORMER, RATED AS SHOWN
	POTENTIAL TRANSFORMER, RATING AS SHOWN
	GROUND CONNECTION
	LIGHTING ARRESTOR
	GENERATOR SET
	AUTOMATIC TRANSFER SWITCH
	HOA OR SS AS NOTED
<b>FIRE ALARM</b>	
	FIRE ALARM CONTROL PANEL (FLUSH/SURFACE)
	FIRE ALARM REMOTE ANNUNCIATOR (FLUSH/SURFACE)
	FIRE ALARM AUDIO VISUAL SIGNAL, WALL MOUNTED
	FIRE ALARM VISUAL SIGNAL, WALL MOUNTED
	FIRE ALARM AUDIO SIGNAL, WALL MOUNTED
	FIRE ALARM CEILING SPEAKER
	HEAT DETECTOR
	AREA SMOKE DETECTOR
	DUCT SMOKE DETECTOR, 'RA' DENOTES RETURN AIR, 'SA' DENOTES SUPPLY AIR
	SMOKE DETECTOR REMOTE INDICATOR STATION
	FIREFIGHTER'S COMMUNICATION JACK
	STAIRWAY EMERGENCY TELEPHONE
	ELEVATOR LOBBY EMERGENCY SIGN
	FIRE ALARM MANUAL PULL STATION
	FIRE ALARM MANUAL PULL STATION WITH FIREMAN'S JACK
	SPRINKLER WATER FLOW SWITCH
	VALVE SUPERVISORY SWITCH
	MAGNETIC DOOR HOLDER
	ELECTRIC DOOR LOCK
	FIRE ALARM RELAY
	HALON CONTROL PANEL
<b>COMMUNICATIONS</b>	
	NEW VOICE WALL OUTLET, 'N' DENOTES PAY PHONE, 'DOT' INDICATES ABOVE COUNTER
	EXISTING VOICE WALL OUTLET TO REMAIN
	NEW DATA WALL OUTLET
	RELOCATED EXISTING DATA WALL OUTLET
	EXISTING DATA WALL OUTLET TO REMAIN
	EXISTING DATA WALL OUTLET TO BE REMOVED AND REUSED AS APPLICABLE
	COMBINATION VOICE/DATA WALL OUTLET
	INTERCOM MASTER STATION
	INTERCOM STAFF STATION
	INTERCOM EQUIPMENT PANEL
	CEILING MOUNTED SPEAKER
	PAGING HORN
	PAGING SYSTEM MICROPHONE
	PAGING SYSTEM TERMINAL CABINET
<b>LIGHTING/SWITCHES</b>	
	NEW INCANDESCENT OR HID LIGHTING FIXTURE, LETTER DENOTES TYPE, 'H' PREFIX DENOTES HID
	RELOCATED EXISTING INCANDESCENT OR HID LIGHTING FIXTURE, LETTER DENOTES TYPE WHERE APPLICABLE
	EXISTING INCANDESCENT OR HID LIGHTING FIXTURE TO REMAIN
	EXISTING INCANDESCENT OR HID LIGHTING FIXTURE TO BE REMOVED AND REUSED AS APPLICABLE
	NEW EXIT SIGN, ARROWS AS INDICATED, LETTER DENOTES TYPE
	RELOCATED EXISTING EXIT SIGN, ARROWS AS INDICATED
	EXISTING EXIT SIGN TO REMAIN, ARROWS AS INDICATED
	EXISTING EXIT SIGN TO BE REMOVED AND REUSED AS APPLICABLE
	NEW FLUORESCENT LIGHTING FIXTURE, LETTER DENOTES TYPE, 'F' PREFIX DENOTES FLUORESCENT
	RELOCATED EXISTING FLUORESCENT LIGHT FIXTURE, LETTER DENOTES TYPE WHERE APPLICABLE
	EXISTING FLUORESCENT LIGHT FIXTURE TO REMAIN
	EXISTING FLUORESCENT LIGHT FIXTURE TO BE REMOVED AND REUSED AS APPLICABLE
	LIGHT FIXTURE ON EMERGENCY CIRCUIT
	NEW SWITCH, SPST, 20A, 120V/277V
	RELOCATED EXISTING SWITCH
	EXISTING SWITCH TO REMAIN
	EXISTING SWITCH TO BE REMOVED AND REUSED AS APPLICABLE
	SWITCH, 20A, 120V/277V, '2' DENOTES DPST, '3' DENOTES THREE-WAY, '4' DENOTES FOUR-WAY
	SWITCH, SPDT, CENTER OFF, MOMENTARY CONTACT, 'L' DENOTES TOGGLE, 'LR' DENOTES ROCKER
	SWITCH, SPST, 20A, 120V/277V, 'K' DENOTES KEY NO CIRCUMSTANCES SHALL THE VOLTAGE DROP BE WORSE THAN 3% FOR ANY BRANCH CIRCUIT AND 2% FOR ANY FEEDER.
	DIMMER CONTROL SWITCH, 1000 WATT UNLESS OTHERWISE NOTED

RECEPTACLES/OUTLETS	
	SIMPLEX WALL RECEPTACLE, NEMA 5-20R, 20A, 125V
	NEW DUPLEX WALL RECEPTACLE, NEMA 5-15R, 15A, 125V OR NEMA 5-20R, 20A, 125V, REI SPECIFICATIONS, DOT INDICATES ABOVE COUNTER
	RELOCATED EXISTING DUPLEX RECEPTACLE
	EXISTING DUPLEX RECEPTACLE TO REMAIN



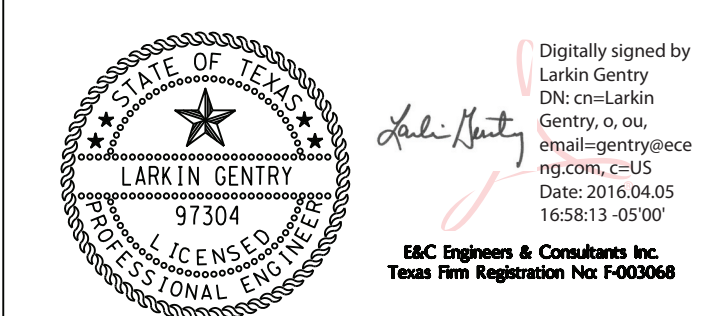
- GENERAL NOTES:**
- A. RE: EOOD FOR MORE GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS.
- DRAWING NOTES:**
- ① EXISTING MECHANICAL EQUIPMENT TO BE REMOVED. DISCONNECT POWER AND REMOVE BACK TO PANEL SERVING. TURN BREAKER OFF AND LABEL SPARE.
  - ② EXISTING MECHANICAL UNIT TO REMAIN.
  - ③ EXISTING MECHANICAL UNIT TO BE REMOVED AND REPLACED WITH SAME HORSEPOWER NEW UNIT. RE: MECHANICAL PLANS FOR MORE INFORMATION ON SCOPE OF MECHANICAL WORK. EXISTING POWER AND CIRCUITING FOR MOTOR TO REMAIN AND BE RECONNECTED TO NEW UNIT. RE: ELECTRICAL RENOVATION PLAN FOR MORE INFORMATION.
  - ④ EXISTING VSD DRIVES TO BE REMOVED. DRIVES SERVE EXISTING MECHANICAL EQUIPMENT THAT IS BEING REPLACED. REMOVE DRIVES AND MAINTAIN CIRCUITING FROM PANEL SERVING AND TO EQUIPMENT FOR RECONNECTING TO NEW DRIVES AND NEW EQUIPMENT. RE: ALTERATION PLAN FOR MORE INFORMATION.
  - ⑤ EXISTING 120V CIRCUIT SERVING UNIT LIGHTING AND RECEPTACLES SHALL BE DISCONNECTED AND REMAIN FOR RECONNECTION TO NEW UNIT. RE: ALTERATION PLAN FOR MORE INFORMATION.
  - ⑥ EXISTING LIGHT FIXTURE TO BE REMOVED AND REPLACED WITH NEW FIXTURE. ALL EXISTING CIRCUITING AND SWITCHING SHALL REMAIN.
  - ⑦ EXISTING LIGHT FIXTURE TO REMAIN.

**ENTHOUSE**

Area	Rev.	Date	Description
		03-02-16	FOR BID

**E & C**

**ENGINEERS & CONSULTANTS, INC.**  
 1010 LAMAR, SUITE 650  
 HOUSTON, TEXAS 77002  
 TEL 713/580-8800  
 FAX 713/580-8888



Date  
3/2/16  
 Drawn By  
RLG  
 Checked By  
RLG

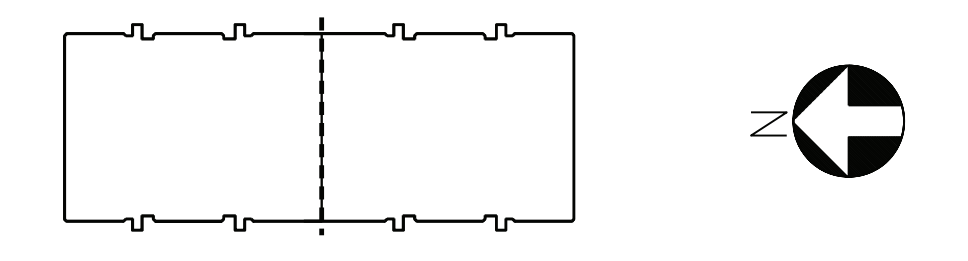
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730022  
 E & C Project No.  
3302.00  
 File Name



**MEDICAL SCHOOL BUILDING  
 AHU L-7 & 8 REPLACEMENT**

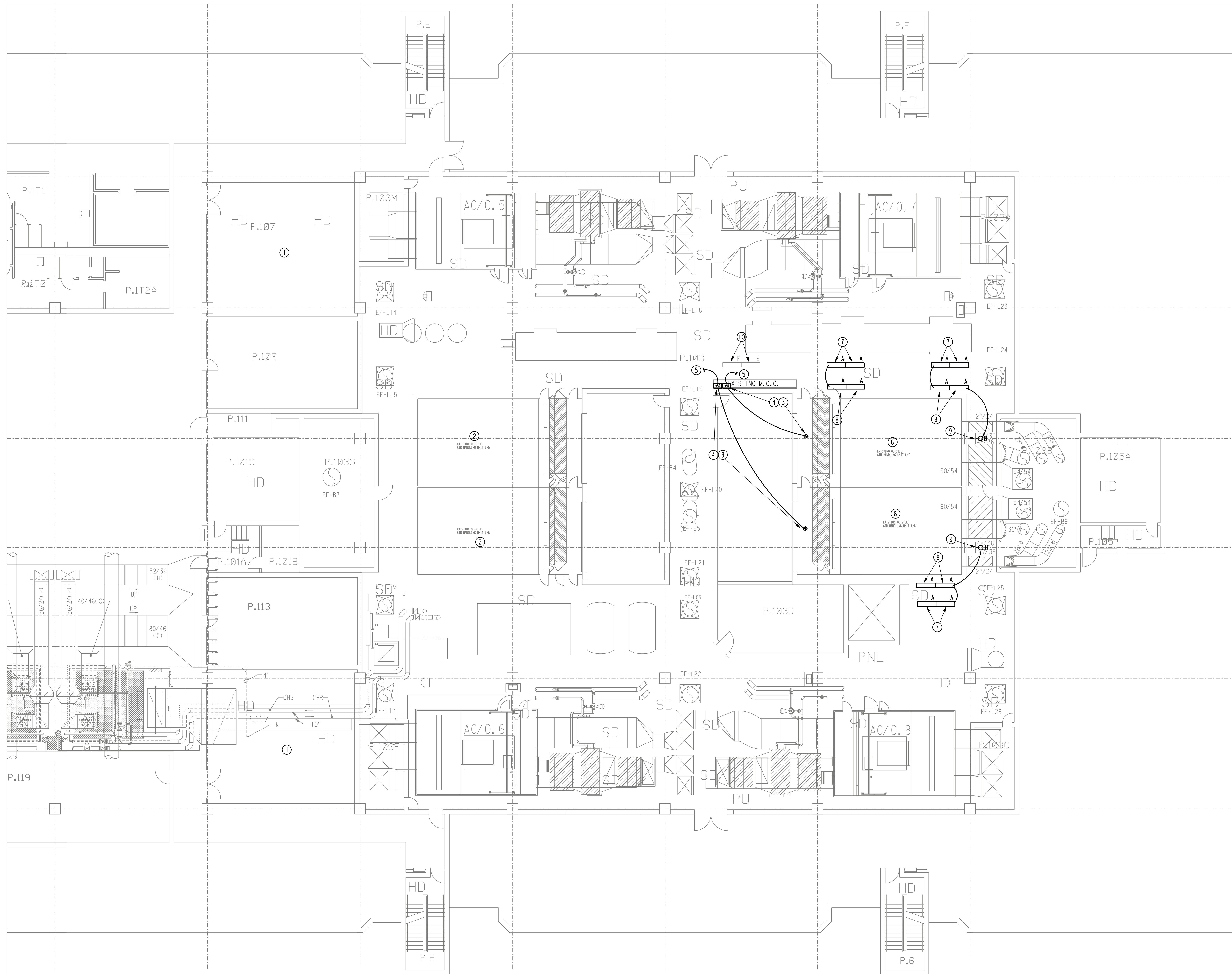
**ELECTRICAL PH  
 DEMOLITION  
 DRAWING**

DRAWING TITLE  
 DRAWING NO.  
**E108**



1330013302.v03.02 EPCENT.dgn





- GENERAL NOTES:**
- A. RE: E000 FOR MORE GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS.
  - B. TYPE A: LENSED LED STRIP LIGHT, 4 FEET LONG, 3500K, MEDIUM LUMEN OUTPUT, FIXED OUTPUT DRIVER, UNIVERSAL VOLTAGE BALLAST, CHAIN HANGER ACCESSORY, COLUMBIA LIGHTING \* LCL4-35ML-EU-CSHC OR EQUAL BY COOPER, LITHONIA, OR OTHERS.
  - C. TYPE B: JUNCTION BOX MOUNTED LED FIXTURE, MOUNTED TO COLUMN, FROSTED GLASS GLOBE, ALUMINUM HOUSING, 5000 K, HUBBELL INDUSTRIAL \* VL15PIG-VBLU15 OR EQUAL BY COOPER, LITHONIA, OR OTHERS.
- DRAWING NOTES:**
- ① NO WORK AT THIS UNIT.
  - ② EXISTING MECHANICAL UNIT TO REMAIN.
  - ③ NEW MECHANICAL UNIT OF SAME HORSEPOWER AS EXISTING UNIT TO BE RECONNECTED. RE: MECHANICAL PLANS FOR MORE INFORMATION ON SCOPE OF MECHANICAL WORK. EXISTING POWER AND CIRCUITING FOR MOTOR TO REMAIN AND BE RECONNECTED TO NEW UNIT. EXTEND EXISTING CIRCUITING AS REQUIRED.
  - ④ NEW VSD DRIVES FOR NEW EQUIPMENT. NEW DRIVES SERVE NEW MECHANICAL EQUIPMENT. RECONNECT CIRCUITING FROM PANEL SERVING AND TO NEW EQUIPMENT AS REQUIRED.
  - ⑤ EXISTING HOMERUN TO REMAIN. CAPTURE HOMERUN AND CIRCUIT TO NEW VSD AND MECHANICAL EQUIPMENT AS REQUIRED IN NOTES 3 AND 4.
  - ⑥ EXISTING 120V CIRCUIT SERVING UNIT LIGHTING AND RECEPTACLES SHALL BE RECONNECT TO NEW UNIT. NO MORE THAN 1440 WATTS ON A CIRCUIT.
  - ⑦ NEW LIGHT FIXTURE TO REPLACE EXISTING FIXTURE. ALL EXISTING CIRCUITING AND SWITCHING SHALL REMAIN. RE: GENERAL NOTES FOR TYPE.
  - ⑧ NEW LIGHT FIXTURE. EXTEND EXISTING CIRCUITING AND SWITCHING TO SERVE NEW FIXTURE. CHAIN HANG FIXTURE AT SAME ELEVATION AS EXISTING FIXTURES. NO MORE THAN 3000 WATTS ON A CIRCUIT. RE: GENERAL NOTES FOR TYPE.
  - ⑨ NEW LIGHT FIXTURE. EXTEND EXISTING CIRCUITING AND SWITCHING TO SERVE NEW FIXTURE. SURFACE MOUNT FIXTURE AT 8 FEET A.F.F. NO MORE THAN 3000 WATTS ON A CIRCUIT. RE: GENERAL NOTES FOR TYPE.
  - ⑩ EXISTING LIGHT FIXTURE TO REMAIN.

**ENTHOUSE**

Area	Rev.	Date	Description
		03-02-16	FOR BID

**E & C**

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Digitally signed by Larkin Gentry, DN: cn=Larkin Gentry, o=Engineers & Consultants, Inc., ou=Houston, st=TX, email=larkin.gentry@ecinc.com, c=US, Date: 2016.04.05 16:38:37 -0500  
 E&C Engineers & Consultants Inc. Texas Professional Engineer No. 97304

Date: 3/2/16  
 Drawn By: RLG  
 Checked By: RLG

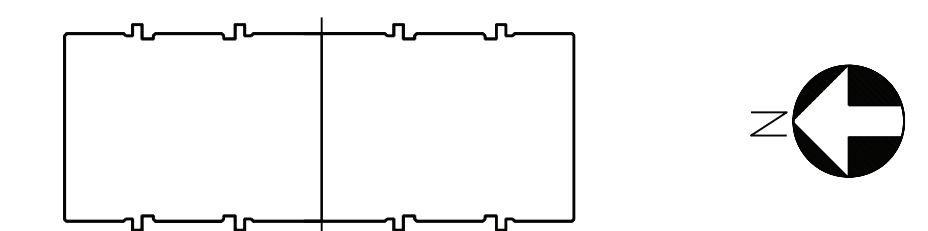
UTHSC Project No. 730022  
 E & C Project No. 3302.00  
 File Name



**MEDICAL SCHOOL BUILDING  
 AHU L-7 & 8 REPLACEMENT**

**ELECTRICAL PH  
 RENOVATION  
 DRAWING**

**E208**



# GENERAL NOTES

**I. DESIGN CRITERIA**

**A. GENERAL BUILDING CODE**

- The Documents are based on the requirements of the International Building Code 2009.
- Hanging Ceiling and Mechanical Loads: An allowance of 20 PSF has been made for hanging ceiling and mechanical equipment loads such as duct work and sprinkler pipes.

**B. LIVE LOADS**

- Design Live Loads are based on the more restrictive of the uniform load listed below or the concentrated load listed acting over an area 2.5 feet.
  - Roofs: 20 PSF
- Reduction of Live Loads:
  - Live loads have been reduced using the standard procedure from the building code.

**C. WIND LOADS**

- Wind pressures are based on the provisions of the American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures, ASCE 7-10 and the following criteria:
  - Ultimate design wind speed (Vult): 140 MPH (3 second gust)
  - Building risk category: II
  - Wind exposure category: B

Notes:

- Pressures act normal to the surface. Positive pressures act towards the surface and negative pressures act away from the surface.
- Design pressure for components and cladding shall not be less than 16 PSF acting in either direction normal to the surface.
- The design pressures listed above are calculated using a value of Kd of 0.85. The values must be increased by 18% unless load combinations specified in ASCE 7-10 are used in design.

**II. NON-DESTRUCTIVE EVALUATION**

**A. ITEMS EMBEDDED IN CONCRETE STRUCTURES**

- Items embedded in concrete structures shall not be damaged during repair work or installation of new members requiring post-installed anchors. Embedded items may include mild reinforcement, prestressing reinforcement, dowels, embedded connections, electrical conduits, plumbing, etc.
- Items embedded in concrete shall be located by non-destructive evaluation prior to performing any work. Contractor shall mark on the structure the location of embedded items prior to casting in concrete.
- Contractor shall not start fabrication of new members until items embedded in concrete have been located. Contact Engineer if existing embedded items interfere with location of post-installed anchors specified in drawings.

**III. SELECTIVE DEMOLITION**

**A. RESPONSIBILITY OF THE CONTRACTOR FOR STABILITY OF THE STRUCTURE DURING DECONSTRUCTION / DEMOLITION**

- It is the responsibility of the Contractor to maintain the stability and safety of all structural elements during the demolition process.

**B. MATERIAL OWNERSHIP**

- Except for items or materials indicated to be reused, salvaged, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site. The materials removed shall be disposed in a proper and legal manner per federal/state or local ordinances.

**C. QUALITY ASSURANCE**

- Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- Regulatory Requirements: Comply with governing Owner, Local, State, Federal, and EPA notifications and regulations before beginning selective deconstruction / demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

**D. PROJECT CONDITIONS**

- Conduct selective demolition so Owner's operations will not be disrupted. Provide not less than 72-hour notice to Owner of activities that will affect Owner's operations.
- Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
- Owner assumes no responsibility for condition of areas to be selectively demolished.
  - Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
  - Before selective demolition, Owner will remove items within space as needed.
- If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. These materials shall be removed as disposed as approved by governing agency.
- Storage or sale of removed items or materials on-site will not be permitted.
- Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations. Maintain fire-protection facilities in service during selective demolition operations.
- All areas outside of demolition scope to be protected from damage by contractor. Restore areas subject to incidental damage to their pre-demolition condition.

**E. PREPARATION**

- Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.
- Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of adjacent facilities.
- Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.
- Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and to prevent unexpected or uncontrolled movement or collapse of construction being demolished. Strengthen or add temporary supports when required during progress of selective demolition.

**F. EXECUTION OF SELECTIVE DEMOLITION**

- General: Demolish existing construction as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - Use cutting methods least likely to damage construction to remain or adjoining construction.
  - Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
  - Maintain adequate ventilation when using cutting torches.
  - Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, slabs, or framing.
  - Dispose of demolished items and materials promptly.
- Existing Facilities: Comply with Owner's requirements for using and protecting other building facilities during selective demolition operations.

**G. DISPOSAL OF DEMOLISHED MATERIALS**

- General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- Burning: Do not burn demolished materials.
- Disposal: Transport demolished materials off Owner's property and legally dispose of them.

**IV. CONCRETE**

**A. <CONCRETE REPAIR MATERIALS> <CLASSES OF CONCRETE>**

- Concrete shall conform to the following requirements:

Classes of Concrete Matrix							
Location	Comp Strength PSI	Type	Exposure Class	Max W/C Ratio	Air Content	Max Agg. Size (in.)	Notes
Housekeeping Pads	3,000	LWC	-	0.45	-	3/4	
Infill	4,000	NWC	CI	0.45	-	1	

**B. HORIZONTAL CONSTRUCTION JOINTS IN CONCRETE POURS**

- There shall be no horizontal construction joints in any concrete pours unless shown on the drawings. The Engineer shall approve all deviations or additional joints in writing.

**C. REINFORCING STEEL**

- All Reinforcing Steel shall be ASTM A 615 Grade 60 unless noted otherwise on the drawings or in these notes.
- Deformed Welded Wire Reinforcement: ASTM A 497, yield strength 70,000 PSI.

**D. PLACEMENT OF WELDED WIRE REINFORCEMENT**

- Whenever welded wire reinforcement is specified as reinforcement, it shall be continuous across the entire concrete surface (and not interrupted by beams or girders) and properly lapped per ACI 318, 12.18 and 12.19.

**E. REINFORCEMENT IN TOPPING SLABS**

- Provide minimum reinforcement as noted below in all topping slabs unless specified otherwise on the drawings.
  - Welded smooth wire reinforcement 6x6-W2.9xW2.9.

**F. REINFORCING STEEL COVERAGE**

- Reinforcing steel coverage should conform to the requirements specified on the drawings. Cover in structural members not specified in the details shall conform to the requirements of ACI 318 unless specified otherwise on the drawings.

**V. STRUCTURAL STEEL**

**A. MATERIAL**

- Hot Rolled Structural Members: All hot rolled steel plates, shapes, sheet piling, and bars shall be new steel conforming to ASTM Specification A 6.
- ASTM Specification and Grade: Clearly mark the grade of steel on each piece, with a distinguishing mark visible from floor surfaces, for the purpose of field inspection of proper grade of steel. Unless noted otherwise on the drawings, structural steel shall be as follows:
  - W- and WT-Shapes: ASTM A 992.
  - Plates: All plates shall conform to ASTM A 36 unless noted otherwise on the drawings.
  - Angles, Bent Plates: ASTM A 36.
  - Other Steel: Any other steel not indicated otherwise shall conform to ASTM A 992 or ASTM A 572, Grade 50, except plates and angles that shall be ASTM A 36.

**B. STRUCTURAL BOLTS AND THREADED FASTENERS**

- A 325 Bolts: All bolts in structural connections shall conform to ASTM A 325 Type 1, unless indicated otherwise on the drawings.

**C. WELDING**

- Unless noted otherwise, electrodes for welding shall conform to E70XX (SMAW), F7XX-EXXX (SAW), E70S-X (GMAW), or E7XT-X (FGAW).

**D. GROUT**

- Grout below structural steel base plates shall be non-metallic, non-shrink grout with a minimum strength of 8,000 psi.

**VI. STEEL DECK**

- Attachment of Deck:
  - Minimum Attachment at Supports: Steel deck units shall be welded to the support members with 5/8" diameter puddle welds at each end of sheet and each intermediate support at each low flange, unless noted otherwise. At members parallel to deck span, spacing of puddle welds shall be 12". A shear connector welded through the deck can replace a required deck weld.
  - Minimum Attachment at Side Laps: Side laps of adjacent units shall be fastened by welding, sheet metal screws, or button punching at a maximum of one-half the span or 36", whichever is less, unless noted otherwise.

**VII. SPECIAL INSPECTIONS**

- The Owner's testing laboratory shall provide special inspection services in accordance with the International Building Code for the Items Listed below. Special inspection shall be performed by an independent testing laboratory employed by the Owner.
- The Special Inspector shall furnish inspection reports to the Engineer of Record
- Once corrections are performed by the Contractor, the special inspector shall submit a final report to the Engineer that to the best of the Special Inspector's knowledge the work is in accordance with the construction documents and applicable workmanship.
  - Steel Construction:
    - Welding Inspection
      - Periodic verification of welding procedure
      - Periodic verification of material type and grade
      - Periodic verification of welder qualifications
      - Continuous verification of fillet welds
    - High-Strength Bolting
      - Periodic verification of bolt size, location and torque
    - Steel members
      - Continuous verification of size and strength
  - Concrete Construction:
    - Continuous Inspection of Reinforcing Steel Placing
      - Verify size, clearances and proper ties
    - Periodic Inspection of concrete mix
      - Verify mix design meets strength and exposure
    - Continuous Inspection of concrete placement/sampling
      - Include sampling for slump, strength and temperature

**VIII. SUBMITTALS**

**A. SUBMITTAL LIST AND SCHEDULE**

- The Contractor shall prepare a detailed list and schedule of all submittal items to be sent to the Structural Engineer prior to the start of construction. This list shall be updated and revised and kept current as the job progresses. The submittal list shall be organized as shown below:

**B. SUBMITTALS TO BE PROVIDED TO STRUCTURAL ENGINEER**

- The following submittals shall be provided:
  - Concrete mix.
  - Structural steel.
  - Roof (sheet metal, flashing etc...)

Notes:

(SAS) Items marked thus shall have the shop drawings and delegated design submittals (including calculations) sealed per the project specifications by an engineer registered in the state where the project is located.

(REC) Items marked thus shall be submitted to Engineer for Record Only and will not have the Engineer's shop drawing stamp affixed.

- Submittal Requirements:
  - All shop drawings must be reviewed and electronically stamped by the Contractor prior to submittal.
  - Contractor shall provide the submittal in electronic portable document format (PDF) per the Specifications.
  - The omission from the shop drawings of any materials required by the Contract Documents to be furnished shall not relieve the Contractor of the responsibility of furnishing and installing such materials, regardless of whether the shop drawings have been reviewed and approved.

**C. REPRODUCTION**

- The use of electronic files or reproductions of these contract documents by any contractor, subcontractor, erector, fabricator, or material supplier in lieu of preparation of shop drawings signifies their acceptance of all information shown hereon as correct, and obligates themselves to any job expense, real or implied, arising due to any errors that may occur hereon.

**IX. MISCELLANEOUS**

**A. CONTRACT DOCUMENTS**

- It is the responsibility of the Contractor to obtain all Contract Documents and latest addenda and to submit these documents to all subcontractors and material suppliers prior to the submittal of shop drawings, fabrication of any structural members, and erection in the field.
- The contract structural drawings and specifications represent the alteration made to the structure, and, except where specifically shown, do not indicate the method or means of construction. The Contractor shall supervise and direct the work and shall be solely responsible for all construction means, methods, procedures, techniques, and sequence.
- Openings through floors, roofs, and walls for ducts, piping, and/or conduit shall be coordinated by the contractor. Contractor shall verify sizes and locations of holes and openings with the Mechanical, Electrical, Plumbing, and Fire Protection drawings and the respective subcontractors.

**B. DRAWING CONFLICTS**

- The Contractor shall compare the Architectural and Structural drawings and report any discrepancy between each set of drawings and within each set of drawings to the Architect and Engineer prior to the fabrication and installation of any structural members.

**C. CONFLICTS IN STRUCTURAL REQUIREMENTS**

- Where conflict exists among the various parts of the contract documents drawings, and general notes, the strictest requirements, as indicated by the Engineer, shall govern.

**D. EXISTING CONDITIONS**

- The Contractor shall verify all dimensions and conditions of the existing building at the job site and report any discrepancies from assumed conditions shown on the drawings to the Engineer prior to the fabrication and erection of any members. Existing dimensions shown on the drawings are for general reference only and should not be used for final construction or detailing.
- Existing construction shown on the drawings was obtained from existing construction documents and limited site observation. These drawings of existing construction are available for contractor use and shall be referenced for familiarization with existing conditions. However, the available drawings of existing construction are not necessarily complete. The contractor is responsible for being knowledgeable on information presented in available drawings and shall field verify all pertinent information.
- Demolition, cutting, drilling, etc. of existing work shall be performed with great care so as not to jeopardize the structural integrity of the existing building. If any architectural, structural, or MEP members not designated for removal interfere with the new work, the Owner shall be notified immediately and approval obtained prior to removal of those members.

**E. STEEL UTILITIES**

- The contractor shall perform a survey to locate all existing utilities (including underground utilities) prior to the start of construction and take care to protect utilities that are to remain in service. Existing civil, mechanical, electrical, plumbing, and emergency protection system servicing any areas outside the work area are to be maintained in operable condition throughout the duration of construction. Contractor shall make necessary temporary connections to maintain existing utilities in service during the work. Temporary, localized interruption of these systems shall require approval by the Owner.

**F. THE CONTRACTOR SHALL PROVIDE DUST, ODOR, AND NOISE PROTECTION, AND SAFETY MEASURES AS NECESSARY FOR THE DURATION OF CONSTRUCTION. PROVIDE ALL MEASURES NECESSARY TO PROTECT THE EXISTING STRUCTURE, BUILDING INTERIOR, FACILITY PATRONS, AND OTHER PERSONS DURING CONSTRUCTION.**

**G. THE CONTRACTOR SHALL REPAIR ALL DAMAGE CAUSED DURING CONSTRUCTION WITH SIMILAR MATERIALS AND WORKMANSHIP TO RESTORE CONDITIONS TO LEVELS ACCEPTABLE TO THE OWNER.**

**E. ADJACENT BUILDINGS AND PROPERTY**

- The Contractor shall ensure that all construction methods used will not cause damage to the adjacent buildings and property. This shall include all foundation installation.

**F. RESPONSIBILITY OF THE CONTRACTOR FOR STABILITY OF THE STRUCTURE DURING CONSTRUCTION**

- Structural elements of the project have been designed by the Structural Engineer to resist the required code vertical and lateral forces that could occur in the final structure only. The ability of the structural frame to resist the required code forces derives from the complete installation of the new structural elements. It is the responsibility of the Contractor to provide all required bracing during construction to maintain the stability and safety of all structural elements during the construction.

**G. RESPONSIBILITY OF THE CONTRACTOR FOR CONSTRUCTION LOADS**

- The structural elements has have been designed for the loads identified within these < drawings that are anticipated to be applied to the structure once work is completed. The Contractor shall not overload the structure during construction. The Contractor shall be responsible for checking the adequacy of the structure to support any applied construction loads. The Structural Engineer is not responsible to design or check the structure for loads applied to the structure for any construction activity.

**H. THE STRUCTURAL ENGINEER'S ROLE DURING CONSTRUCTION**

- The Engineer shall not have control nor charge of, and shall not be responsible for, construction means, methods, techniques, sequences, or procedures, for safety precautions and programs in connection with the work, for the acts or omission of the Contractor, Subcontractor, or any other persons performing any of the work, or for the failure of any of them to carry out the work in accordance with the contract documents.

**I. MAINTENANCE STATEMENT**

- All structures require periodic maintenance to extend lifespan and to ensure structural integrity from exposure to the environment. A planned program of maintenance shall be established by the building owner. This program shall include such items such as but not limited to painting of structural steel, protective coating for concrete, sealants, caulked joints, expansion joints, control joints, spalls and cracks in concrete, and

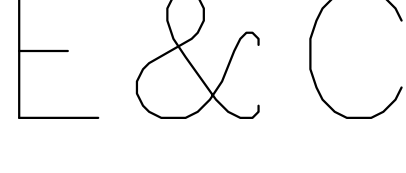
pressure washing of exposed structural elements exposed to a salt environment or other harsh chemicals.

**X. DRAWING INTERPRETATION**

**A. DRAWING VIEWS LABELED AS "TYPICAL"**

- Partial plans, elevations, sections, details, or schedules labeled with "Typical" at the beginning of their title shall apply to all situations occurring on the project that are the same or similar to those specifically shown. The applicability of the content of these views to locations on the plan can be determined from the title of the views. Such views shall apply whether or not they are keyed in at each location. Decisions regarding applicability of these "Typical" views shall be determined by the Structural Engineer.

ISSUE FOR:	Date	Description
Area Rev.	04-04-16	ADDENDUM 1

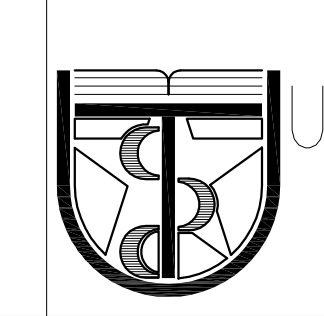


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Date 4/01/16  
Drawn By JL  
Checked By JL  
RF

UTHSC Project No. 730022  
E & C Project No. 3302.00  
File Name

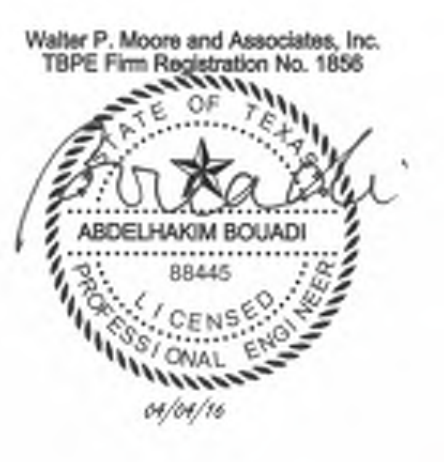
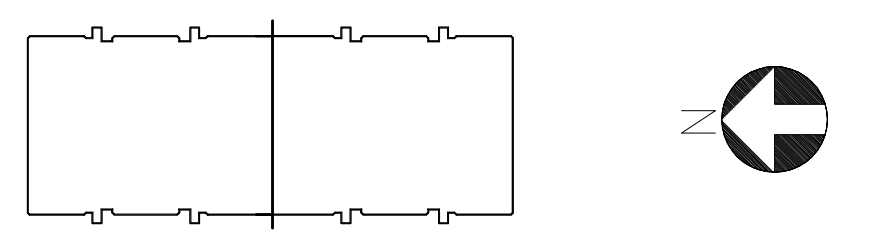


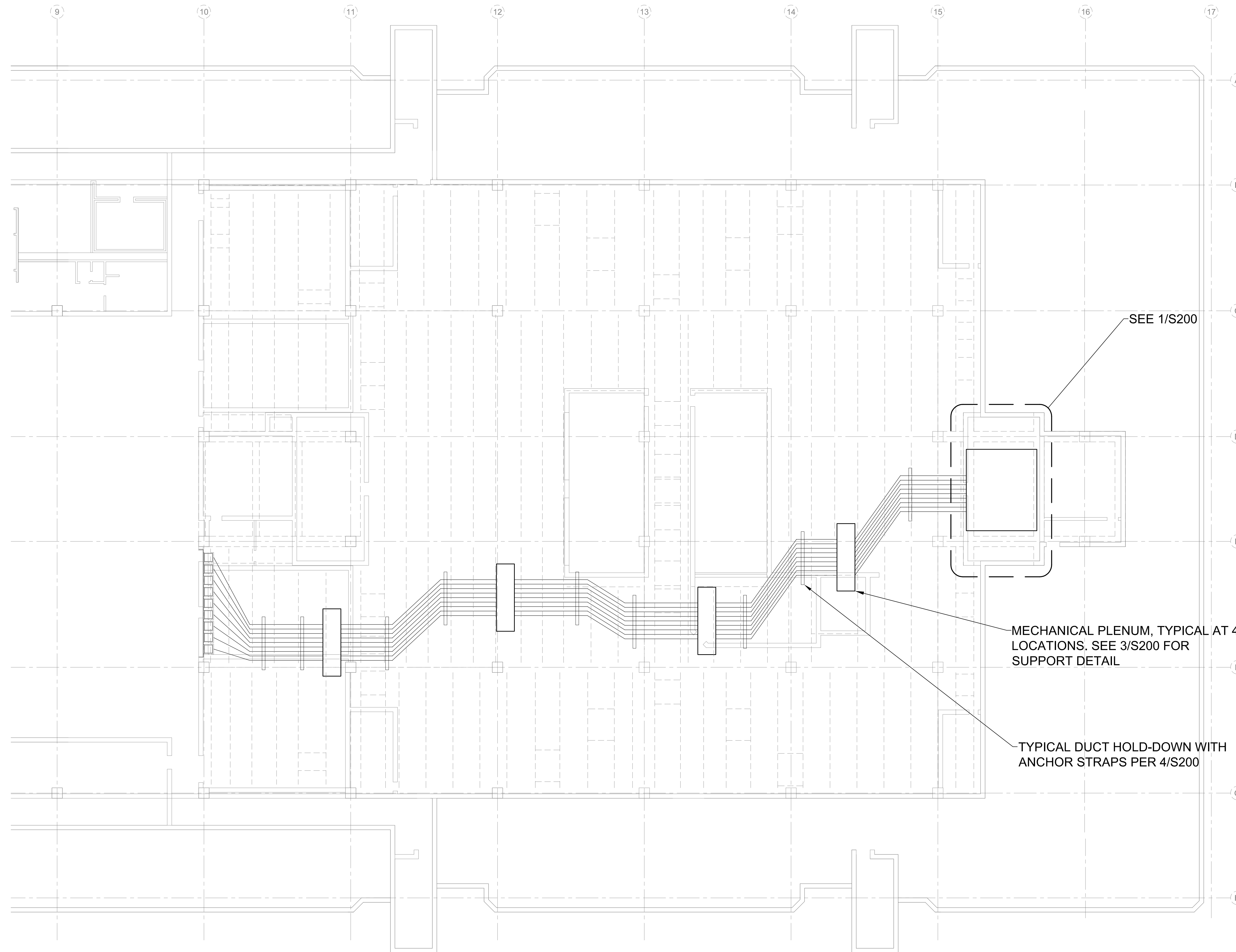
UNIVERSITY OF TEXAS HOUSTON  
HEALTH SCIENCE CENTER

MEDICAL SCHOOL BUILDING  
AHU L-7 & 8 REPLACEMENT

DRAWING TITLE  
**GENERAL NOTES**

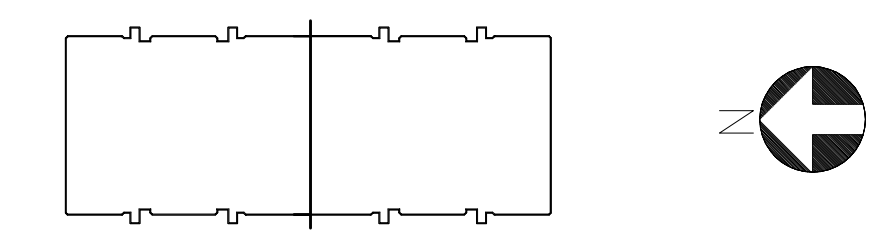
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**5000**





NOTES:  
 1. SEE MECHANICAL DRAWINGS FOR LOCATIONS OF ALL ROOFTOP PLENUMS, DUCTS, AND DUCTS HOLD-DOWNS.

**1** PENTHOUSE ROOF PLAN  
 NTS



Area	Rev.	Date	Description
	04-04-16		ADDENDUM 1

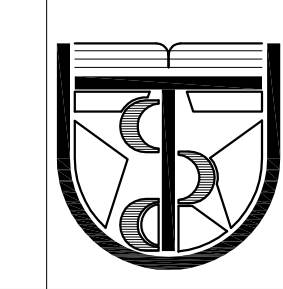
**E & C**

ENGINEERS & CONSULTANTS, INC.  
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Date 4/01/16  
 Drawn By JL  
 Checked By RF

UTHSC Project No. 730022  
 E & C Project No. 3302.00  
 File Name

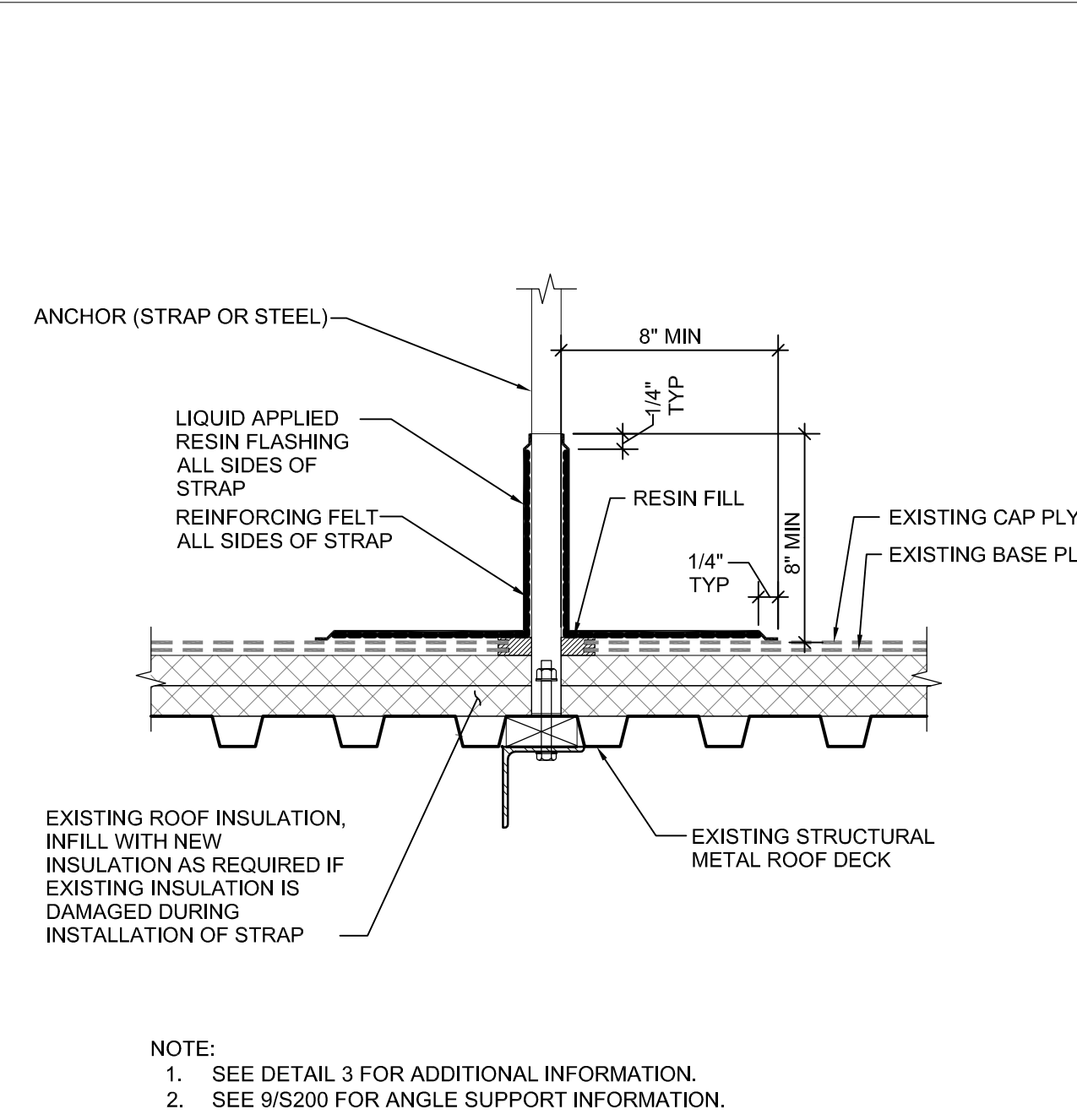


UNIVERSITY OF TEXAS HOUSTON  
 HEALTH SCIENCE CENTER

MEDICAL SCHOOL BUILDING  
 AHU L-7 & 8 REPLACEMENT

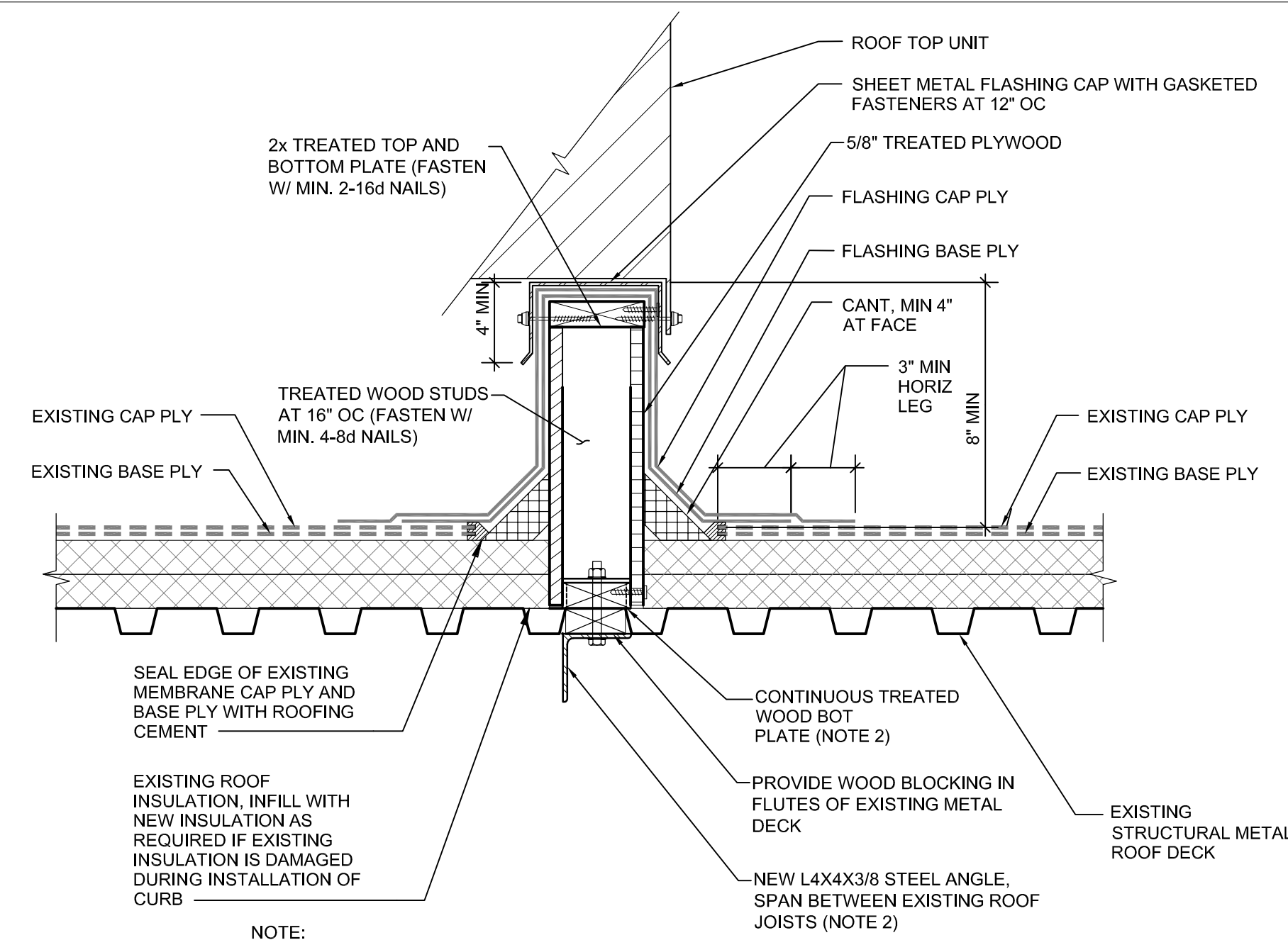
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 PLAN

DRAWING NO.  
 S100



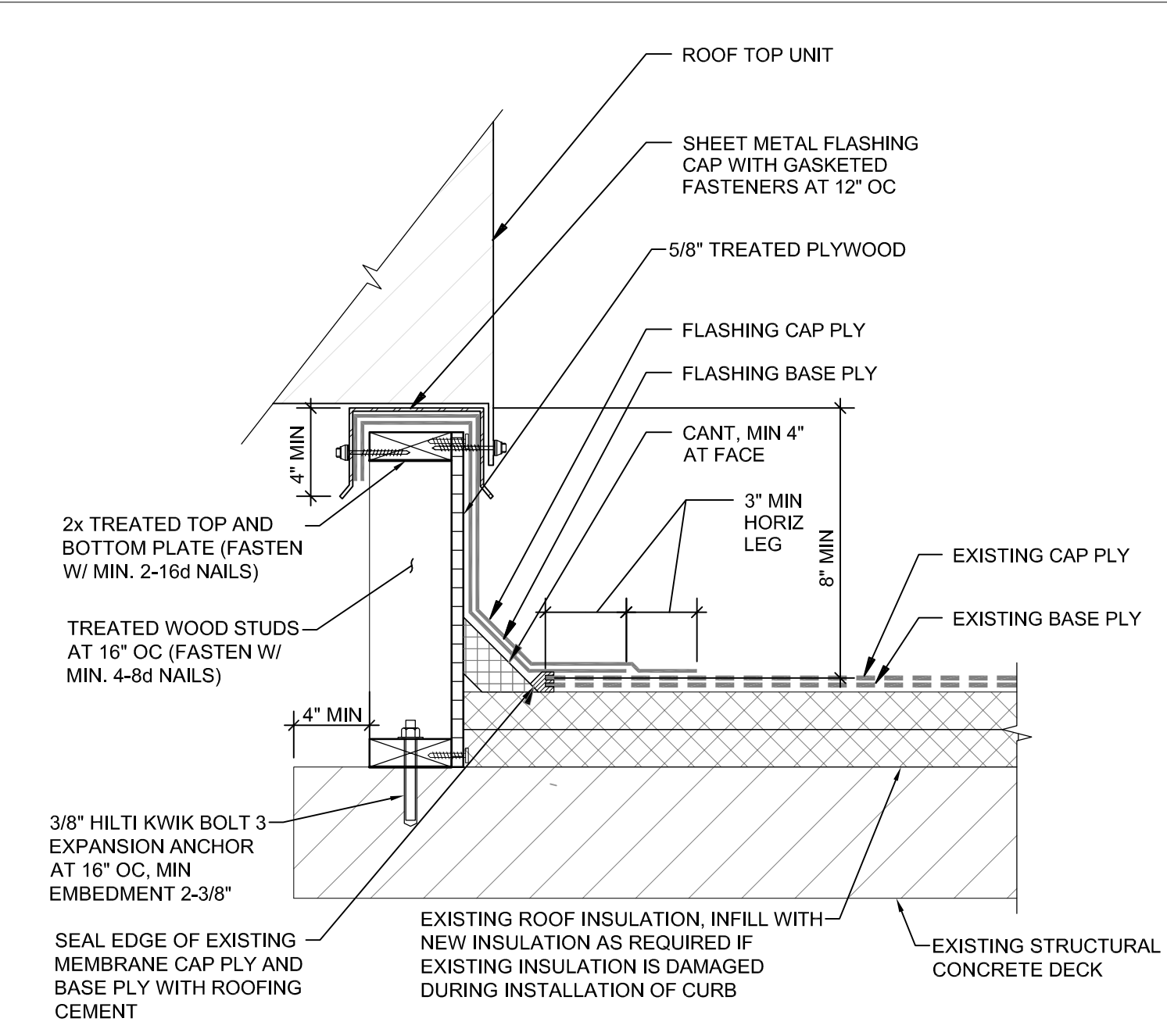
NOTE:  
1. SEE DETAIL 3 FOR ADDITIONAL INFORMATION.  
2. SEE 9/S200 FOR ANGLE SUPPORT INFORMATION.

**4** TYPICAL ANCHOR CONNECTION TO ROOF STRUCTURE  
1-1/2" = 1'-0"



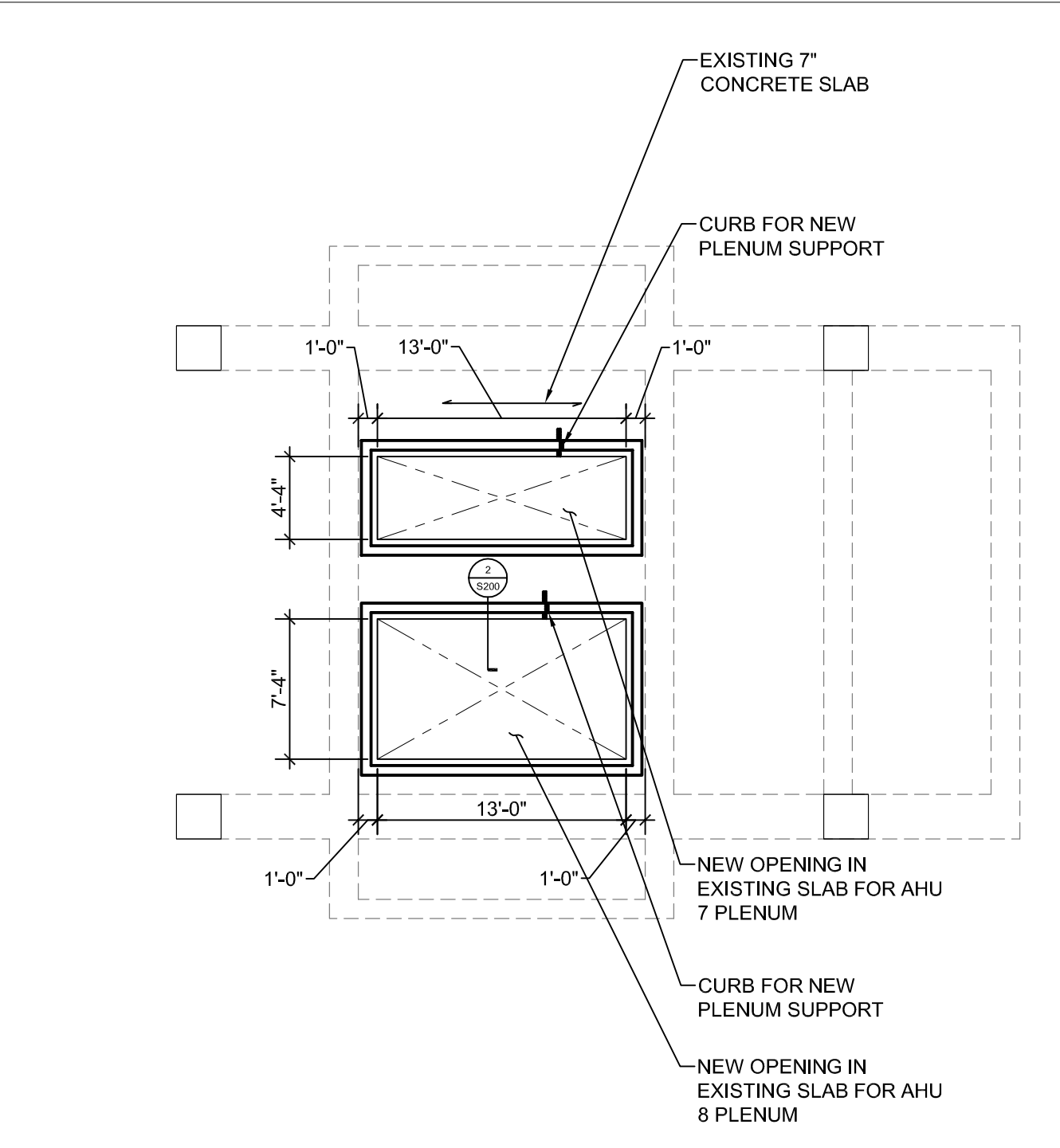
NOTE:  
1. ANCHORAGE OF PLENUM TO CURB BY MECHANICAL CONTRACTOR.  
2. CONNECT SUPPORT ANGLE TO CURB WITH 1/2" DIA. A307 BOLTS AT 16" O.C. PROVIDE PLATE WASHER AT BOTTOM PLATE.  
3. SEE 9/S200 FOR ANGLE SUPPORT INFORMATION.

**3** CURB DETAIL AT STEEL DECK - PLENUM WITHOUT ROOF OPENING  
1-1/2" = 1'-0"

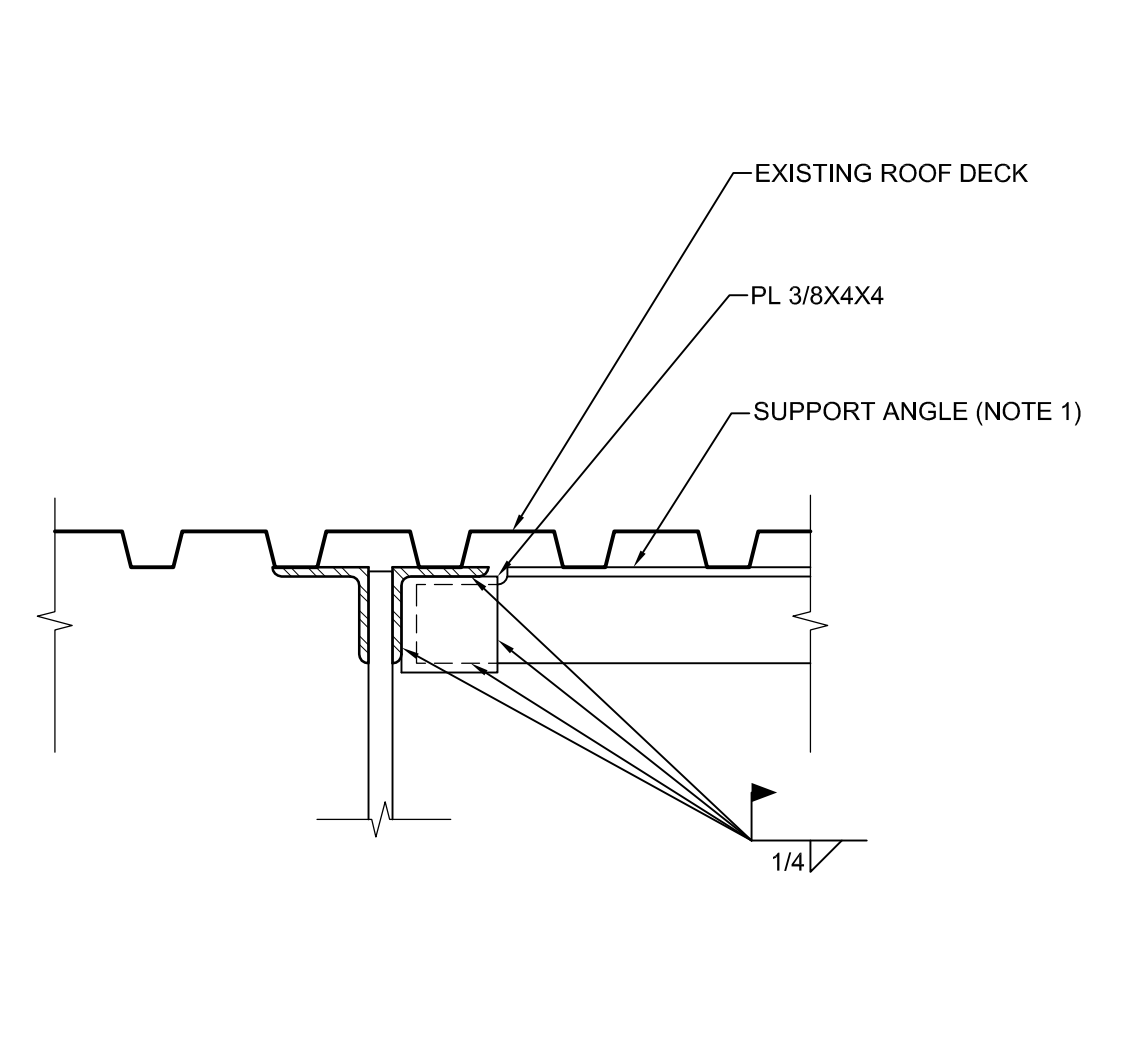


NOTE:  
1. ANCHORAGE OF PLENUM TO CURB BY MECHANICAL CONTRACTOR.  
2. CONNECT SUPPORT ANGLE TO CURB WITH 1/2" DIA. A307 BOLTS AT 16" O.C. PROVIDE PLATE WASHER AT BOTTOM PLATE.  
3. SEE 9/S200 FOR ANGLE SUPPORT INFORMATION.

**2** CURB DETAIL AT CONCRETE SLAB - WITH ROOF PENETRATION  
1-1/2" = 1'-0"

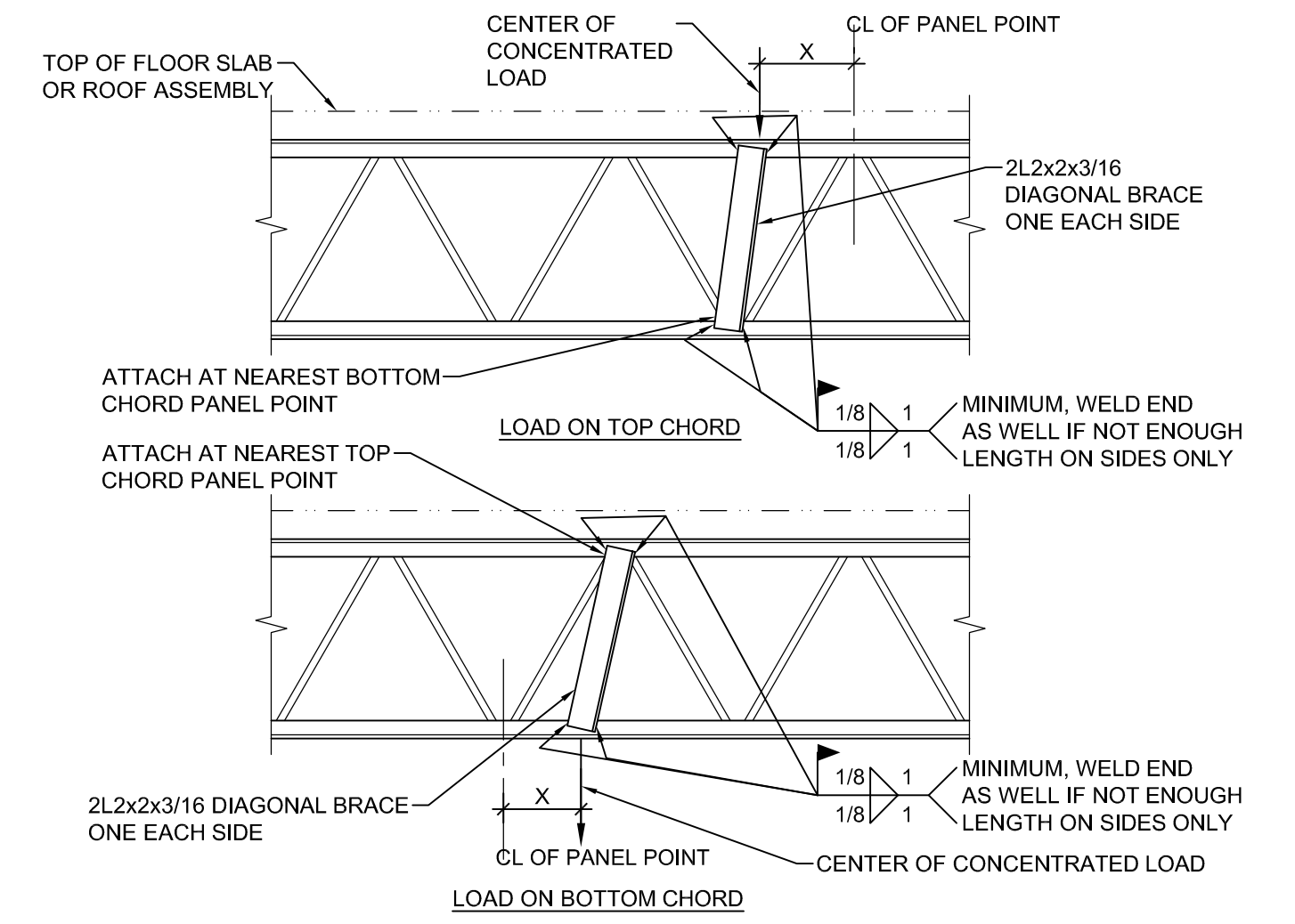


**1** PARTIAL PLAN - PENTHOUSE  
1/8" = 1'-0"



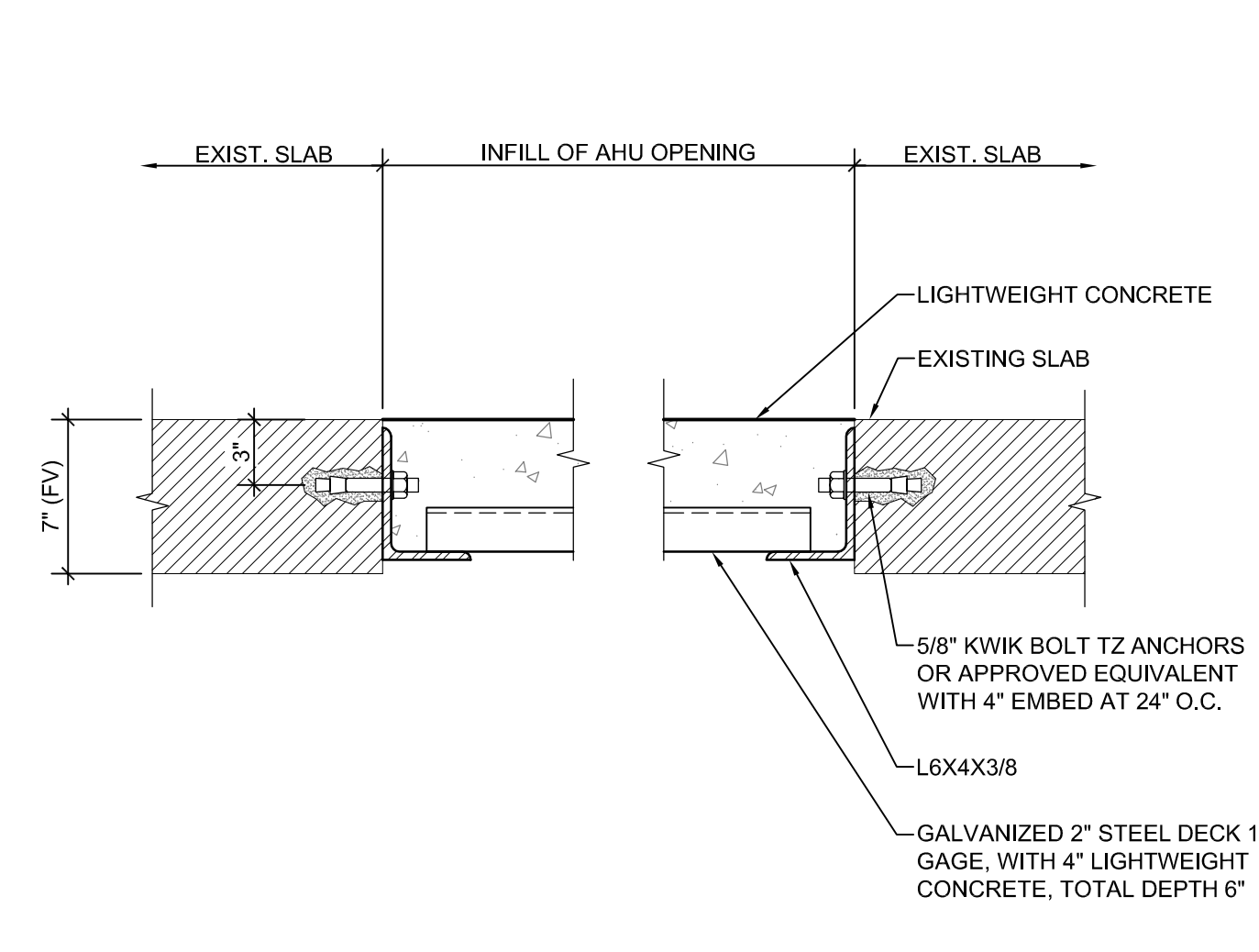
NOTES:  
1. SEE DETAILS 3&4/S200 FOR INFORMATION ABOUT SUPPORT ANGLE.  
2. APPLY THIS DETAIL AT ALL LOCATIONS OF ITEMS BEARING ON EXISTING STEEL ROOF DECK.  
3. SEE PLAN AND MEP DRAWINGS FOR LOCATIONS OF ANY ITEMS REQUIRING SUCH SUPPORT.  
4. SEE DETAIL 8/S200 FOR JOIST REINFORCEMENT AT LOCATION OF EACH NEW ANGLE.

**9** ATTACHMENT OF SUPPORT ANGLE TO EXISTING JOISTS  
1-1/2" = 1'-0"



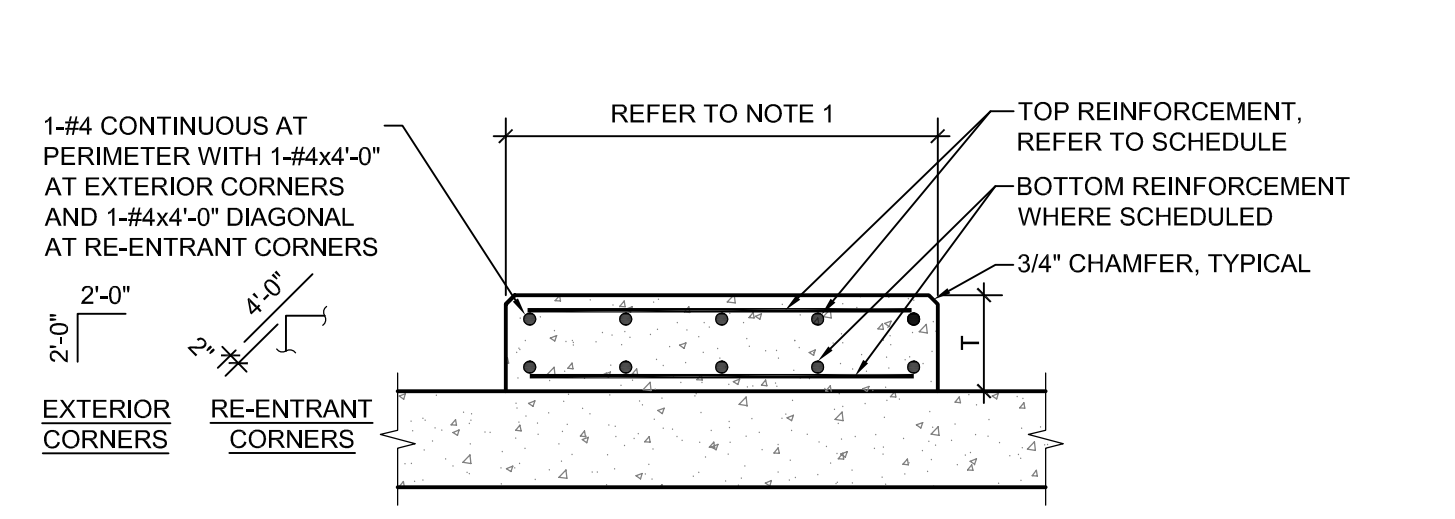
NOTES:  
1. DIAGONAL BRACE IS NOT REQUIRED FOR "X" LESS THAN THREE INCHES.  
2. PROVIDE DIAGONAL BRACE AT LOCATION OF CONCENTRATED LOADS SUCH AS PARTITIONS, HEAVY PIPES, MECHANICAL UNITS, HEAVY LIGHTS AND ANY OTHER CONCENTRATED LOADS AND AS NOTED ELSEWHERE IN THE STRUCTURAL DRAWINGS. LOADS MUST BE APPLIED CONCENTRICALLY TO JOIST BOTTOM CHORD.

**8** TYPICAL STIFFENING OF JOIST FOR CONCENTRATED LOADS  
NO SCALE



NOTES:  
1. THIS DETAIL IS TO BE APPLIED AT THE AREAS OF SLAB OPENING (SHOWN ON 1/S200) WHICH WILL NEED TO BE INFILLED UPON COMPLETION OF WORK.  
2. DECK SHALL NOT SPAN MORE THAN 8'-0".  
3. FASTEN DECK TO STEEL SUPPORTS PER SDI REQUIREMENTS PRIOR TO POURING CONCRETE.  
4. APPLY FIREPROOFING AS REQUIRED TO MEET FLOOR RATING.

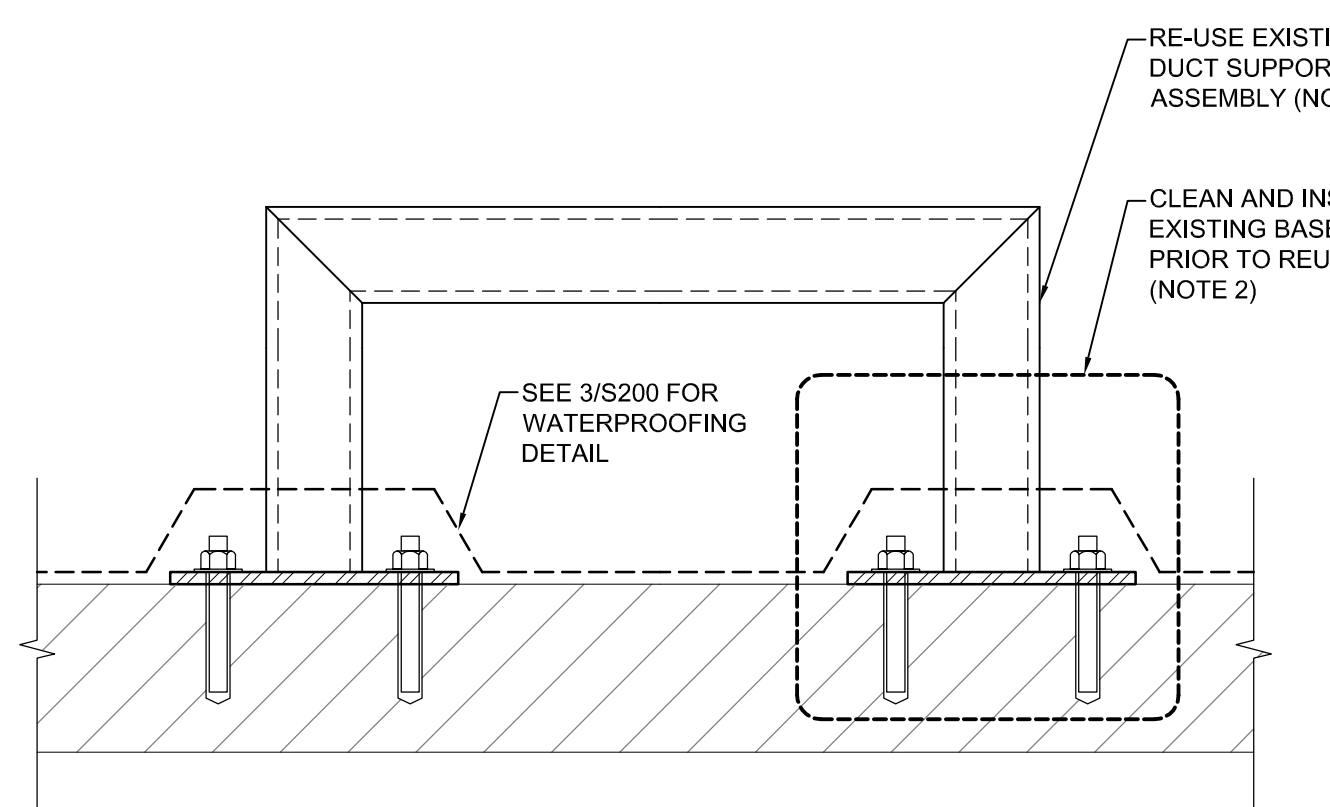
**7** INFILL OF SLAB OPENING  
1-1/2" = 1'-0"



PAD THICKNESS	TOP REINFORCEMENT	BOTTOM REINFORCEMENT
T = 4"	WWR 4x4-W2.9xW2.9 OR #3@12" EACH WAY	NONE
4" < T <= 6"	WWR 4x4-W4xW4 OR #4@18" EACH WAY	NONE
6" < T <= 8"	WWR 4x4-W6xW6 OR #4@12" EACH WAY	NONE

NOTES:  
1. REFER TO ARCHITECTURAL OR MEP DRAWINGS FOR HOUSEKEEPING PAD PLAN DIMENSIONS AND THICKNESS (4" MINIMUM THICKNESS).  
2. CONTRACTOR SHALL COORDINATE DIMENSIONS AND OTHER SPECIAL REQUIREMENTS WITH EQUIPMENT MANUFACTURERS AND PROVIDE WHERE REQUIRED WHETHER SHOWN ON STRUCTURAL DRAWINGS OR NOT.  
3. HOUSEKEEPING PAD IS TO BE USED TO REPLACE THE EXISTING CONCRETE PAD AT THE PENTHOUSE FLOOR LEVEL, SUPPORTING UNITS 7&8.

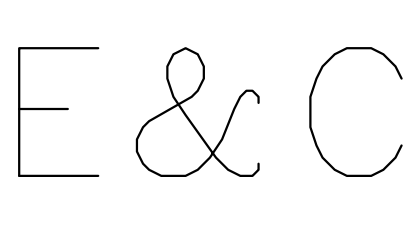
**6** TYPICAL HOUSEKEEPING PAD OVER SLAB  
NO SCALE



NOTES:  
1. PROVIDE TEMPORARY SUPPORT OF DUCT IN ORDER TO REMOVE EXISTING DUCT SUPPORT FRAME WITHOUT DAMAGING.  
2. PREPARATION OF EXISTING BASE INCLUDES THE FOLLOWING:  
A. CLEANING OF ALL DEBRIS, RUST, CORROSION  
B. MEASURE TO VERIFY MIN. 1/2" THICKNESS  
C. RE-COAT WITH MECHANICALLY APPLIED GALVANIZING  
D. INSTALL TO SLAB WITH 4-HILTI HIT HY 200 ANCHORS  
3. AS AN ALTERNATIVE, THE CONTRACTOR MAY SHOP FABRICATE AND INSTALL NEW BASE PLATES TO EXISTING FRAME AFTER SUBMITTING SUCH TO ENGINEER FOR APPROVAL IN ACCORDANCE WITH SPECIFICATIONS.

**5** EXISTING DUCT SUPPORT AT CONCRETE ROOF  
1-1/2" = 1'-0"

Area	Rev.	Date	Description
	04-04-16		ADDENDUM 1



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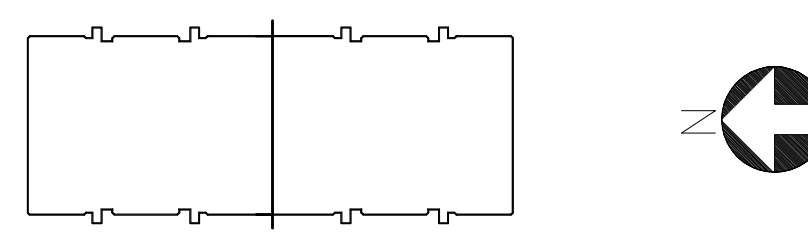
Date 4/01/16  
Drawn By JL  
Checked By RF

UTHSC Project No. 730022  
E & C Project No. 3302.00  
File Name



MEDICAL SCHOOL BUILDING  
AHU L-7 & 8 REPLACEMENT

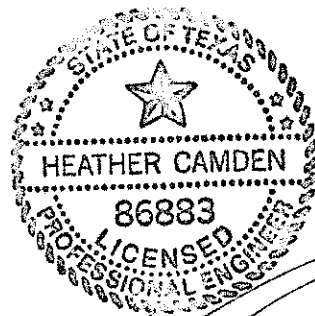
DRAWING TITLE  
DETAILS  
DRAWING NO.  
S200



INDEX: Division 23-Mechanical

23 00 00	Basic Mechanical Requirements	
23 05 13	Motors	
23 05 16	Expansion Compensation	
23 05 29	Sleeves, Flashings, Supports and Anchors	
23 05 48	Vibration Isolation	
23 05 53	Mechanical Identification	
23 05 93	Testing, Adjusting and Balancing	
23 05 93A	Preparation for System Testing, Adjusting and Balancing	
23 06 20	Hydronic Specialties	
23 07 13	Ductwork Insulation	
23 07 16	Equipment Insulation	
23 07 19	Piping Insulation	
23 09 23	Direct Digital Control Systems	Addendum 1
23 20 00A	Piping, Valves and Fittings	
23 21 00	Hydronic Piping	
23 22 00	Steam and Steam Condensate Piping	
23 22 00A	Steam and Steam Condensate Specialties	
23 29 23	Variable Speed Drives	
23 31 00	Ductwork	
23 33 00	Ductwork Accessories	
23 41 00	Filters	
23 73 23	Air Handling Units and Outside Air Handling Units	Addendum 1
23 82 16	Air Coils	Addendum 1
Pictures –		Addendum 1

E&C Engineers & Consultants, Inc.  
TX Firm Registration No: F-003068  
Date: 04/04/2016  
Engineer of Record: Heather Camden  
State: Texas  
License no: 86883



*Heather Camden*  
4.4.2016

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SECTION 23 09 23  
DIRECT DIGITAL CONTROL SYSTEMS

PART 1 GENERAL

1.00 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
- C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

- A. Control equipment.
- B. Software.

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Section 23 21 00 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, gage taps, flow meters.
- B. Section 23 22 00 - Steam and Steam Condensate Piping: Installation of control valves, flow switches, temperature sensor sockets, gage taps, flow meters.
- C. Section 23 33 00 - Ductwork Accessories: Installation of automatic dampers, smoke detectors. Connection of damper end switches.

1.04 RELATED SECTIONS

- A. Section 23 09 43 - Pneumatic Control Systems.
- B. Section 23 09 93. - Sequence of Operation.
- C. Section 26 05 00 - Equipment Wiring Systems.

1.05 REFERENCES

- A. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.
- B. ASME MC85.1 - Terminology for Automatic Control.
- C. NEMA EMC1 - Energy Management Systems Definitions.

1.06 DEFINITIONS

- A. Ensure terminology used in submittals conforms to ASHRAE 85.

1.07 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to the existing Metasys Campus Building Management System.

- B. Central and remote hardware, software, and interconnecting wire and conduit.
- C. Terminal unit controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, pneumatic or electric unless indicated otherwise.
- D. Damper Motors and Valve Operators: Pneumatic & Electronic.
- E. **The DDC systems shall be installed by JCI under a direct contract with the General Contractor. JCI shall provide "open-book" pricing to the General Contractor and OFPC per the existing UTHSC-H/JCI agreement.**
- F. **All sensors that are installed in insulated pipe or ductwork shall be installed with standoffs to allow proper insulation of all materials and continuation of vapor barriers.**
- G. NOTE ALL CONTROL CONDUIT SHALL BE COLOR CODED BLUE.**

1.08 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Shop Drawings:
  - 1. Trunk cable schematic showing programmable control unit locations, and trunk data conductors.
  - 2. List of connected data points, including connected control unit and input device.
  - 3. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
  - 4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
  - 5. Descriptive data and sequence of operation of operating, user, and application software.
  - 6. Provide one additional submittal above that which is asked for in Division 1 to be distributed by UTHSC-H to the IT department for verification.
- C. Product Data: Provide data for each system component and software module.
- D. Manufacturer's Installation Instructions: Include for all manufactured components.

1.09 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01 77 00.
- B. Accurately record actual location of control components, including panels, thermostats, and sensors.
- C. Revise shop drawings to reflect actual installation and operating sequences.
- D. Include data specified in "Submittals" in final "Record Documents" form.

1.10 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01 77 00.



- B. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.
  - C. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
  - D. Include graphics of the controlled system as they appear on the system graphics with variable, adjustable and fixed points with showing identified and numbered systems, system components and devices.
  - E. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- 1.11 QUALIFICATIONS
- A. Manufacturer: JCI controls.
  - B. Installer: JCI controls
  - C. Design system software under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas.
  - D. Watchdog system shall be supplied and installed by approved manufacturers listed within description below.
- 1.12 PRE-INSTALLATION CONFERENCE
- A. Convene a conference one week prior to commencing work of this Section, under provisions of Section 01200.
  - B. Require attendance of parties directly affecting the work of this Section.
- 1.13 COORDINATION
- A. Coordinate work under provisions of Section 00 10 05.
  - B. Ensure installation of components is complementary to installation of similar components in other systems.
  - C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
  - D. Coordinate the startup and control sequence verification with the test and balance agent.
  - E. Ensure system is completed and commissioned.
- 1.14 WARRANTY
- A. Provide five year warranty under provisions of the Owners Special Conditions.
  - B. Warranty: Include coverage for field programmable micro-processor based units.
- 1.16 EXTRA MATERIALS
- A. Submit maintenance materials under provisions of Section 01 77 00.

- B. Provide two of each type of exposed sensor under provisions of Section 01 77 00.
- C. Provide spare controllers/hardware equal to the greatest of 5% or 2 units. The controllers include, but are not limited to the ~~NCE~~, NAE, FEC(X610), VMA, IOM(X710) and BTCTV.

1.17 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
  - 1. Limiting use of software to equipment provided under these specifications.
  - 2. Limiting copying.
  - 3. Preserving confidentiality.
  - 4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.00 MANUFACTURERS OF CONTROLS

- A JCI (other than Watchdog system)

2.01 GENERAL DESCRIPTION

- A The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks. Prior to submittal update equipment to the latest technology and coordinate with the Engineer.
- B The Building Management System shall consist of the following:
  - 1 Standalone Network Automation Engine(s)
  - 2 Field Equipment Controller(s)
  - 3 Input/Output Module(s)
  - 4 Local Display Device(s)
  - 5 Portable Operator's Terminal(s)
  - 6 Distributed User Interface(s)
  - 7 Network processing, data storage and communications equipment
  - 8 Other components required for a complete and working BMS
- C The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- D System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

- 1 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- 2 The System shall maintain all settings and overrides through a system reboot.
- 3 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

## 2.02 BMS ARCHITECTURE

### A Automation Network

- 1 The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
- 2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
- 3 The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
- 4 Network Automation Engines (NAE) shall reside on the automation network.
- 5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

### B Control Network

- 1 Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
  - (a) BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9
    - (i) The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
    - (ii) The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
  - (b) LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
  - (c) The Johnson Controls N2 Field Bus.
- 2 Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
- 3 DDC Controllers shall reside on the control network.
- 4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
- 5 A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
- 6 The PICS shall be submitted 10 days prior to bidding.

C Integration

1 BACnet Protocol Integration - BACnet

- (a) The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.
- (b) A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
- (c) The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.03 USER INTERFACE

A Dedicated Web Based User Interface

B Operating System Software

- 1 Windows XP Professional or Windows Vista. Verify operating system with the user to ensure the system will be compatible with the current systems.
- 2 Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
- 3 Provide software registration cards to the Owner for all included software.
- 4 Upgrade the Metasys server software to the latest version.

2.04 DISTRIBUTED WEB BASED USER INTERFACE

A All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.

B The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser.

C Laptop minimum hardware requirements:

- 1 256 MB RAM
- 2 2.0 GHz Clock Speed Pentium 4 Microprocessor
- 3 40.0 GB Hard Drive.
- 4 1 Keyboard with 83 keys (minimum).
- 5 SVGA 1024x768 resolution display with 64K colors and 16 bit color depth
- 6 Mouse or other pointing device

2.05 USER INTERFACE APPLICATION COMPONENTS

A Operator Interface

- 1 An integrated browser based client application shall be used as the user operator interface program.

- 2 The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.
- 3 All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
- 4 The user interface software shall provide help menus and instructions for each operation and/or application.
- 5 The system shall support customization of the UI configuration and a home page display for each operator.
- 6 The system shall support user preferences in the following screen presentations:
  - (a) Alarm
  - (b) Trend
  - (c) Display
  - (d) Applications
- 7 All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
- 8 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
  - (a) User access for selective information retrieval and control command execution
  - (b) Monitoring and reporting
  - (c) Alarm, non-normal, and return to normal condition annunciation
  - (d) Selective operator override and other control actions
  - (e) Information archiving, manipulation, formatting, display and reporting
  - (f) FMS internal performance supervision and diagnostics
  - (g) On-line access to user HELP menus
  - (h) On-line access to current FMS as-built records and documentation
  - (i) Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications
- 9 The system shall support a list of application programs configured by the users that are called up by the following means:
  - (a) The Tools Menu
  - (b) Hyperlinks within the graphics displays
  - (c) Key sequences
- 10 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator

workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

B Navigation Trees

- 1 The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
- 2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
- 3 The navigation trees shall be "dockable" to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

C Alarms

- 1 Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
  - (a) Log date and time of alarm occurrence.
  - (b) Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
  - (c) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
  - (d) Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
  - (e) Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
  - (f) Any attribute of any object in the system may be designated to report an alarm.
- 2 The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
- 3 The FMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav.files.
- 4 The FMS shall annunciate application alarms at minimum, as required by Part 3.

D Reports and Summaries

- 1 Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

- (a) All points in the BMS
  - (b) All points in each BMS application
  - (c) All points in a specific controller
  - (d) All points in a user-defined group of points
  - (e) All points currently in alarm
  - (f) All points locked out
  - (g) All BMS schedules
  - (h) All user defined and adjustable variables, schedules, interlocks and the like.
- 2 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
  - 3 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
  - 4 The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
- E Schedules
- 1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
    - (a) Weekly schedules
    - (b) Exception Schedules
    - (c) Monthly calendars
  - 2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
  - 3 It shall be possible to define one or more exception schedules for each schedule including references to calendars
  - 4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
  - 5 Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
  - 6 Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
  - 7 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.
- F Password

- 1 Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
  - 2 Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.
  - 3 The system shall allow each user to change his or her password at will.
  - 4 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
  - 5 A minimum of five levels of access shall be supported individually or in any combination as follows:
    - (a) Level 1 = View Data
    - (b) Level 2 = Command
    - (c) Level 3 = Operator Overrides
    - (d) Level 4 = Database Modification
    - (e) Level 5 = Database Configuration
    - (f) Level 6 = All privileges, including Password Add/Modify
  - 6 A minimum of 100 unique passwords shall be supported.
  - 7 Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
  - 8 The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
- G Screen Manager
- 1 The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.
- H Dynamic Color Graphics
- 1 The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
  - 2 The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.
    - (a) The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
  - 3 Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:



- (a) All graphics shall be fully scalable
  - (b) The graphics shall support a maintained aspect ratio.
  - (c) Multiple fonts shall be supported.
  - (d) Unique background shall be assignable on a per graphic basis.
  - (e) The color of all animations and values on displays shall indicate if the status of the object attribute.
- 4 Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
  - 5 Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
    - (a) The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
    - (b) In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.
  - 6 Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
  - 7 The graphics shall be submitted for review no later than one month prior to the beginning of testing and balancing. Coordinate with the Mechanical and General Contractor.
- I Historical trending and data collection
- 1 Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
    - (a) Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:
      - Defined time interval
      - Upon a change of value
    - (b) Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
  - 2 Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
  - 3 The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.
- J Trend data viewing and analysis

- 1 Provide a trend viewing utility that shall have access to all database points.
- 2 It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
- 3 The trend viewing utility shall have the capability to define trend study displays to include multiple trends
- 4 Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
- 5 Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
- 6 Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
- 7 Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.
- 8 The Display shall support the user's ability to change colors, sample sizes, and types of markers.

K Database Management

- 1 The System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.
- 2 Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.
- 3 The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
  - (a) Backup
  - (b) Purge
  - (c) Restore
- 4 The Database Manager shall support four tabs:
  - (a) Statistics – shall display Database Server information and Trend, Alarm (Event), and Audit information on the Metasys Databases.
  - (b) Maintenance – shall provide an easy method of purging records from the Metasys Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.
  - (c) Backup – Shall provide the means to create a database backup file and select a storage location.
  - (d) Restore – shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.
- 5 The Status Bar shall appear at the bottom of all Metasys Database Manager Tabs and shall provide information on the current database activity. The following icons shall be provided:

- (a) Ready
  - (b) Purging Record from a database
  - (c) Action Failed
  - (d) Refreshing Statistics
  - (e) Restoring database
  - (f) Shrinking a database
  - (g) Backing up a database
  - (h) Resetting internet information Services
  - (i) Starting the Metasys Device Manager
  - (j) Shutting down the Metasys Device Manager
  - (k) Action successful
- 6 The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.
- 7 The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- 8 The Monitoring Settings window shall have the following sections:
- (a) General – Shall allow the user to set and review scan intervals and start times.
  - (b) Email – Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.
  - (c) Warning – shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.
  - (d) Alarm – shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.
  - (e) Database login – Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.
- 9 The Monitoring Settings Taskbar shall provide the following informational icons:
- (a) Normal – Indicates by color and size that all databases are within their limits.
  - (b) Warning - Indicates by color and size that one or more databases have exceeded their Warning limit.
  - (c) Alarm - Indicates by color and size that one or more databases have exceeded their Alarm limit.
- 10 The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

L Demand Limiting and Load Rolling

- 1 The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.
- 2 The System shall support both Sliding Window and Fixed Window methods of predicting demand.
- 3 The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system.
  - (a) Low Setting – Sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.
  - (b) Medium Setting – Sheds loads earlier over a longer amount of time than the Low Setting. Increases the time the equipment is on and decreases the probability of exceeding the Tariff Target over the Low Setting.
  - (c) High Setting – Sheds loads earlier over a longer amount of time than the Medium Setting. Minimizes the probability of exceeding the Tariff Target.
- 4 The System shall have both a Shed Mode and a Monitor Only Mode of operation.
  - (a) When the Shed Mode is engaged, the System shall actively control the Demand.
  - (b) When the Monitor Mode is engaged, the System will simulate the shedding action but will not take any action.
- 5 The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.
- 6 The Demand Limiting program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
- 7 The Demand Limiting program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the maximum allowed average power during the current interval.
- 8 The System shall support a Maximum Shed Time for each load as determined by the user. The system shall restore the load before the Maximum Shed time has expired.
- 9 The System shall support a Minimum Shed Time for each load as determined by the user. The system shall not restore the load sooner than the Minimum Shed Time has expired.
- 10 The System shall support a Minimum Release Time for each load as determined by the user. The System shall not shed the load until it has been off for the Minimum Release time.
- 11 The System shall support three user defined options if the meter goes unreliable.
  - (a) Shedding – The currently shed loads will be released as their Maximum shed Times expire.
  - (b) Maintain the Current Shed Rate – The System will use the Demand Limiting shed rate that was present when the meter went unreliable.
  - (c) Use Unreliable Meter Shed Rate – the system will control to a user defined Unreliable Shed Rate target.

- 12 The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.
- 13 The Load Rolling program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
- 14 The Load Rolling program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the amount of power by which the demand must be reduced.
- 15 The System shall provide the user with a Load Tab that displays all of the Demand Limiting and Load Rolling parameters for any selected load.
- 16 The System shall provide the user with a Load Summary that displays all of the loads associated with the Demand Limiting and Load Rolling programs. Status Icons for each load shall indicate:
  - (a) Load is Offline
  - (b) Load is Disabled
  - (c) Load is Shed
  - (d) Load is Locked
  - (e) Load is in Comfort Override
- 17 The Load Summary shall include a Load Summary Runtime view listing the following load conditions:
  - (a) Load Priority
  - (b) Shed Strategy
  - (c) Load Rating
  - (d) Present Value
  - (e) Ineligibility Status
  - (f) Active Timer
  - (g) Time Remaining
  - (h) Last Shed Time

## 2.06 PORTABLE OPERATOR TERMINAL

- A For systems that do not provide full access to systems configuration and definition via the Browser Based user interface the BMS Contractor shall provide a portable operator terminal for programming purposes. The terminal shall be configured as follows:
  - 1 Laptop Computer Manufacturer – Dell, Compaq or HP latest technology at the time of submittal
  - 2 1 GB RAM (minimum) – Windows 2000 or XP Professional
  - 3 1.8 GHz Clock Speed Pentium 4 Microprocessor (800 MHz minimum)
  - 4 80 GB Hard Drive (minimum)
  - 5 (1) CD-ROM Drive CD/RW, 32x speed

- 6 (1) Serial (1) Parallel (2) USB ports
- 7 1 Keyboard with 83 keys (minimum).
- 8 Integral touch pad and cordless mouse.
- 9 10" SVGA 1024x768 resolution color display
- 10 Two PCMCIA Type II or one Type III card slot
- 11 Complete operator workstation software package, including any hardware or software.
- 12 Original printed manuals for all software and peripherals.
- 13 Original installation disks or CD for all software, device drivers, and peripherals
- 14 Software registration cards for all included software shall be provided to the Owner.
- 15 Carrying case
- 16 Spare battery.
- 17 External power supply/battery charger

B Software

- 1 Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.
- 2 When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.
- 3 When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.

2.07 NETWORK AUTOMATION ENGINES (NAE)

A Network Automation Engine

- 1 The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
- 2 Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
  - (a) The NAE shall have the capability to communicate directly with the Johnson Control N2 Field Bus devices through the automation network via a Serial to Ethernet Converter (SECVT).
- 3 User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
  - (a) The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
  - (b) The NAE shall support up a minimum of four (4) concurrent users.

- (c) The web based user shall have the capability to access all system data through one NAE.
  - (d) Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
  - (e) Systems that require the user to address more than one NAE to access all system information are not acceptable.
  - (f) The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
  - (g) Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
  - (h) The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
    - (i) Configuration
    - (ii) Commissioning
    - (iii) Data Archiving
    - (iv) Monitoring
    - (v) Commanding
    - (vi) System Diagnostics
  - (i) Systems that require workstation software or modified web browsers are not acceptable.
  - (j) The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- 4 Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
- 5 Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
- 6 Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
- 7 The NAE shall include troubleshooting LED indicators to identify the following conditions:
- (a) Power - On/Off
  - (b) Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
  - (c) Ethernet Connection Speed – 10 Mbps/100 Mbps
  - (d) FC Bus A – Normal Communications/No Field Communications
  - (e) FC Bus B – Normal Communications/No Field Communications

- (f) Peer Communication – Data Traffic between NAE Devices
  - (g) Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
  - (h) Bat Fault – Battery Defective, Data Protection Battery Not Installed
  - (i) 24 VAC – 24 VAC Present/Loss Of 24VAC
  - (j) Fault – General Fault
  - (k) Modem RX – NAE Modem Receiving Data
  - (l) Modem TX – NAE Modem Transmitting Data
- 8 Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
- (a) Two (2) USB port
  - (b) Two (2) URS-232 serial data communication port
  - (c) Two (2) RS-485 port
  - (d) One (1) Ethernet port
- 9 Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
- 10 Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
- (a) During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
  - (b) Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
- 11 Certification – The NAE shall be listed by Underwriters Laboratories (UL).
- 12 Controller network – The NAE shall support the following communication protocols on the controller network:
- (a) The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
    - (i) The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
    - (ii) The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
    - (iii) A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.



- (iv) The Conformance Statements shall be submitted 10 days prior to bidding.
    - (v) The NAE shall support a minimum of 100 control devices.
  - (b) The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
    - (i) All LonWorks controls devices shall be LonMark certified.
    - (ii) The NAE shall support a minimum of 255 LonWorks enabled control devices.
  - (c) The NAE shall support the Johnson Controls N2 Field Bus.
    - (i) The NAE shall support a minimum of 100 N2 control devices.
    - (ii) The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
    - (iii) The Bus shall employ a master/slave protocol where the NAE is the master.
    - (iv) The Bus shall employ a four (4) level priority system for polling frequency.
    - (v) The Bus shall be optically isolated from the NAE.
    - (vi) The Bus shall support the Metasys Integrator System.
- 13 User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
  - (a) The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
  - (b) The NAE shall support a minimum of two (2) concurrent users.
  - (c) The web based user shall have the capability to access all system data through one NAE.
  - (d) Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
  - (e) Systems that require the user to address more than one NAE to access all system information are not acceptable.
  - (f) The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
  - (g) Systems that support UI Graphics from a central data base or require the graphics to reside on the user's personal computer are not acceptable.
  - (h) The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
    - (i) Configuration
    - (ii) Commissioning

- (iii) Data Archiving
  - (iv) Monitoring
  - (v) Commanding
  - (vi) System Diagnostics
- (i) Systems that require workstation software or modified web browsers are not acceptable.

~~2.08 NETWORK CONTROL ENGINE~~

- ~~A The Network Control Engine (NCE) shall be a fully user-programmable, supervisory controller. The NCE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.~~
- ~~B The Network Control Engine (NCE) shall be a fully user-programmable, digital controller that includes a minimum of 33 I/O points.~~
- ~~C Automation Network The NCE shall reside on the automation network and shall support a subnet of 32 Field controllers.~~
- ~~D User Interface Each NCE shall have the ability to deliver a web-based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web-based UI.~~
- ~~1 The web-based UI software shall be imbedded in the NCE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.~~
  - ~~2 The NCE shall support a minimum of two (2) concurrent users.~~
  - ~~3 The NCE shall have the capability of generating web-based UI graphics. The graphics capability shall be imbedded in the NCE.~~
  - ~~4 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.~~
  - ~~5 The web-based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
    - ~~(a) Configuration~~
    - ~~(b) Commissioning~~
    - ~~(c) Data Archiving~~
    - ~~(d) Monitoring~~
    - ~~(e) Commanding~~
    - ~~(f) System Diagnostics~~~~
  - ~~6 Systems that require workstation software or modified web browsers are not acceptable.~~
  - ~~7 The NCE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.~~

- ~~E~~ The NCE shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
- ~~F~~ The NCE shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.
- ~~G~~ The NCE shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
- ~~H~~ The NCE shall support the following number and types of inputs and outputs:
- ~~1~~ Ten Universal Inputs shall be configured to monitor any of the following:
    - ~~(a)~~ Analog Input, Voltage Mode
    - ~~(b)~~ Analog Input, Current Mode
    - ~~(c)~~ Analog Input, Resistive Mode
    - ~~(d)~~ Binary Input, Dry Contact Maintained Mode
    - ~~(e)~~ Binary Input, Pulse Counter Mode
  - ~~2~~ Eight Binary Inputs shall be configured to monitor either of the following:
    - ~~(a)~~ Dry Contact Maintained Mode
    - ~~(b)~~ Pulse Counter Mode
  - ~~3~~ Four Analog Outputs shall be configured to output either of the following:
    - ~~(a)~~ Analog Output, Voltage Mode
    - ~~(b)~~ Analog Output, Current Mode
  - ~~4~~ Seven Binary Outputs shall output the following:
    - ~~(a)~~ 24 VAC Triac
  - ~~5~~ Four Configurable Outputs shall be configured to output either of the following:
    - ~~(a)~~ Analog Output, Voltage Mode
    - ~~(b)~~ Binary Output, 24 VAC Triac Mode
- ~~I~~ The NCE shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
- ~~1~~ The SA Bus shall be a Master Slave/Token Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
  - ~~2~~ The SA Bus shall support a minimum of 10 devices.
  - ~~3~~ The SA Bus shall operate at a maximum distance of 1,200 Ft. between the NCE and the furthest connected device.

~~J — The NCE shall have the capability to execute complex control sequences involving direct-wired I/O points as well as input and output devices communicating over the Field Trunk or the SA Bus.~~

~~K — The NCE shall support, but not be limited to, the following applications:~~

- ~~1 — Central Equipment including chillers and boilers~~
- ~~2 — Lighting and electrical distribution~~
- ~~3 — Built-up air handling units for special applications~~
- ~~4 — Power generation and energy monitoring equipment~~
- ~~5 — Interfaces to security and fire detection systems~~

~~L — The NCE shall support a Local Controller Display (DIS1710) either as an integral part of the NCE or as a remote device communicating over the SA Bus.~~

- ~~1 — The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.~~
- ~~2 — The Display shall allow the user to view monitored points without logging into the system.~~
- ~~3 — The Display shall allow the user to view and change setpoints, modes of operation, and parameters.~~
- ~~4 — The Display shall provide password protection with user adjustable password timeout.~~
- ~~5 — The Display shall be menu driven with separate paths for:
  - ~~(a) — Input/Output~~
  - ~~(b) — Parameter/Setpoint~~
  - ~~(c) — Overrides~~~~
- ~~6 — The Display shall use easy-to-read English text messages.~~
- ~~7 — The Display shall allow the user to select the points to be shown and in what order.~~
- ~~8 — The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.~~
- ~~9 — The display shall be a minimum of 4 lines and a minimum of 20 characters per line~~
- ~~10 — The Display shall have a keypad with no more than 6 keys.~~
- ~~11 — The Display shall be panel mountable.~~

~~M — The NCE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NCE size and capability shall be sufficient to fully meet the requirements of this Specification.~~

~~N — The NCE shall employ an industrial single board computer.~~

~~O — Each NCE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.~~

~~P — The NCE shall include an integrated, hardware-based, real-time clock.~~

- ~~Q~~ The NCE shall employ nonvolatile Flash memory to store all programs and data. The NCE shall employ a data protection battery to save data and power the real-time clock when primary power is interrupted.
- ~~R~~ The NCE shall provide removable, color coded, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.
- ~~S~~ The NCE shall include troubleshooting LED indicators to identify the following conditions:
- ~~1~~ Power
  - ~~2~~ Fault
  - ~~3~~ SA Bus
  - ~~4~~ FC Bus
  - ~~5~~ Modem TX
  - ~~6~~ Modem RX
  - ~~7~~ Battery Fault
  - ~~8~~ Ethernet
  - ~~9~~ 10 LNK
  - ~~10~~ 100 LNK
  - ~~11~~ Run
  - ~~12~~ Peer Com
- ~~T~~ Communications Ports The NCE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry standard computers, modems, and portable operator's terminals.
- ~~1~~ USB port
  - ~~2~~ RS-232 serial data communication port
  - ~~3~~ RS-485 port
  - ~~4~~ RJ-45 Ethernet port
  - ~~5~~ RJ-12 jack
- ~~U~~ Diagnostics The NCE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Control Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
- ~~V~~ Power Failure In the event of the loss of normal power, The NCE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
- ~~1~~ During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

- ~~2— Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.~~
- ~~W— Certification— The NCE shall be listed by Underwriters Laboratories (UL). File E107041, CCN PAZX, UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A~~
- ~~X— Field Controller Bus— The NCE shall support the following communication protocols on the Field Controller Bus:~~
- ~~1— The NCE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.~~
- ~~(a) The NCE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.~~
- ~~(b) The NAE shall be tested and certified as a BACnet Building Controller (B-BC).~~
- ~~(c) A BACnet Protocol Implementation Conformance Statement shall be provided for the NCE.—~~
- ~~(d) The Conformance Statements shall be submitted 10 days prior to bidding.~~
- ~~(e) The NCE shall support a minimum of 32 control devices.—~~
- ~~2— The NCE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10 on the Field Controller Bus (LonWorks Network).~~
- ~~(a) All LonWorks controls devices shall be LonMark certified.~~
- ~~(b) The NCE shall support a minimum of 32 LonWorks enabled control devices.—~~
- ~~3— The NCE shall support the N2 devices on the Field Controller Bus (Johnson Controls N2 Bus).~~
- ~~(a) The NCE shall support a minimum of 32 N2 control devices.~~
- ~~(b) The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.~~
- ~~(c) The Bus shall employ a master/slave protocol where the NCE is the master.~~
- ~~(d) The Bus shall employ a four (4) level priority system for polling frequency.~~
- ~~(e) The Bus shall be optically isolated from the NCE.—~~
- ~~(f) The Bus shall support the Metasys Integrator System.~~

2.002.08 DDC SYSTEM CONTROLLERS

A Field Equipment Controller (FEC X610)

- 1 The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
- (a) The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
- (i) The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

- (ii) The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
  - (iii) A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
  - (iv) The Conformance Statement shall be submitted 10 days prior to bidding.
- 2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences.  
Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
  - 3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
  - 4 The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
  - 5 The FEC shall include a removable base to allow pre-wiring without the controller.
  - 6 The FEC shall include troubleshooting LED indicators to identify the following conditions:
    - (a) Power On
    - (b) Power Off
    - (c) Download or Startup in progress, not ready for normal operation
    - (d) No Faults
    - (e) Device Fault
    - (f) Field Controller Bus - Normal Data Transmission
    - (g) Field Controller Bus - No Data Transmission
    - (h) Field Controller Bus - No Communication
    - (i) Sensor-Actuator Bus - Normal Data Transmission
    - (j) Sensor-Actuator Bus - No Data Transmission
    - (k) Sensor-Actuator Bus - No Communication
  - 7 The FEC shall accommodate the direct wiring of analog and binary I/O field points.
  - 8 The FEC shall support the following types of inputs and outputs:
    - (a) Universal Inputs - shall be configured to monitor any of the following:
      - (i) Analog Input, Voltage Mode
      - (ii) Analog Input, Current Mode
      - (iii) Analog Input, Resistive Mode
      - (iv) Binary Input, Dry Contact Maintained Mode

- (v) Binary Input, Pulse Counter Mode
  - (b) Binary Inputs - shall be configured to monitor either of the following:
    - (i) Dry Contact Maintained Mode
    - (ii) Pulse Counter Mode
  - (c) Analog Outputs - shall be configured to output either of the following
    - (i) Analog Output, Voltage Mode
    - (ii) Analog Output, current Mode
  - (d) Binary Outputs - shall output the following:
    - (i) 24 VAC Triac
  - (e) Configurable Outputs - shall be capable of the following:
    - (i) Analog Output, Voltage Mode
    - (ii) Binary Output Mode
- 9 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
- (a) The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
  - (b) The FC Bus shall support communications between the FECs and the NAE.
  - (c) The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
  - (d) The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
  - (e) The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
- 10 The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
- (a) The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
  - (b) The SA Bus shall support a minimum of 10 devices per trunk.
  - (c) The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- 11 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
- 12 The FEC shall support, but not be limited to, the following:
- (a) Hot water, chilled water/central plant applications
  - (b) Built-up air handling units for special applications
  - (c) Terminal units



- (d) Special programs as required for systems control
- 13 The FEC shall support a Local Controller Display (DIS1710) either as an integral part of the FEC or as a remote device communicating over the SA Bus.
  - (a) The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
  - (b) The Display shall allow the user to view monitored points without logging into the system.
  - (c) The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
  - (d) The Display shall provide password protection with user adjustable password timeout.
  - (e) The Display shall be menu driven with separate paths for:
    - (i) Input/Output
    - (ii) Parameter/Setpoint
    - (iii) Overrides
  - (f) The Display shall use easy-to-read English text messages.
  - (g) The Display shall allow the user to select the points to be shown and in what order.
  - (h) The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.
  - (i) The display shall be a minimum of 4 lines and a minimum of 20 characters per line
  - (j) The Display shall have a keypad with no more than 6 keys.
  - (k) The Display shall be panel mountable.

2.102.09 FIELD DEVICES

- A Input/Output Module (IOM X710)
  - 1 The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
  - 2 The IOM shall communicate with the FEC over the FC Bus or the SA Bus.
  - 3 The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
    - (a) The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
    - (b) The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
    - (c) A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

- (d) The Conformance Statement shall be submitted 10 days prior to bidding.
- 4 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
- 5 The IOM shall have a minimum of 4 points to a maximum of 17 points.
- 6 The IOM shall support the following types of inputs and outputs:
  - (a) Universal Inputs - shall be configured to monitor any of the following:
    - (i) Analog Input, Voltage Mode
    - (ii) Analog Input, Current Mode
    - (iii) Analog Input, Resistive Mode
    - (iv) Binary Input, Dry Contact Maintained Mode
    - (v) Binary Input, Pulse Counter Mode
  - (b) Binary Inputs - shall be configured to monitor either of the following:
    - (i) Dry Contact Maintained Mode
    - (ii) Pulse Counter Mode
  - (c) Analog Outputs - shall be configured to output either of the following
    - (i) Analog Output, Voltage Mode
    - (ii) Analog Output, current Mode
  - (d) Binary Outputs - shall output the following:
    - (i) 24 VAC Triac
  - (e) Configurable Outputs - shall be capable of the following:
    - (i) Analog Output, Voltage Mode
    - (ii) Binary Output Mode
- 7 The IOM shall include troubleshooting LED indicators to identify the following conditions:
  - (a) Power On
  - (b) Power Off
  - (c) Download or Startup in progress, not ready for normal operation
  - (d) No Faults
  - (e) Device Fault
  - (f) Normal Data Transmission
  - (g) No Data Transmission
  - (h) No Communication

~~B~~ Networked Thermostat

- ~~1 The Networked Thermostat shall be capable of controlling a four pipe fan coil system with multi-speed fan control.~~
- ~~2 The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.~~
- ~~3 The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
  - ~~(a) The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).~~
  - ~~(b) A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.~~
  - ~~(c) The Conformance Statement shall be submitted 10 days prior to bidding.~~~~
- ~~4 The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.~~
- ~~5 The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
  - ~~(a) Two line, 8 character backlit display~~
  - ~~(b) LED indicators for Fan, Heat, and Cool status~~
  - ~~(c) Five (5) User Interface Keys
    - ~~(i) Mode~~
    - ~~(ii) Fan~~
    - ~~(iii) Override~~
    - ~~(iv) Degrees C/F~~
    - ~~(v) Up/Down~~~~
  - ~~(d) The display shall continuously scroll through the following parameters:
    - ~~(i) Room Temperature~~
    - ~~(ii) System Mode~~
    - ~~(iii) Schedule Status — Occupied/Unoccupied/Override~~
    - ~~(iv) Applicable Alarms~~~~~~
- ~~6 The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
  - ~~(a) Integral Indoor Air Temperature Sensor~~
  - ~~(b) Duct Mount Air Temperature Sensor~~
  - ~~(c) Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator~~
  - ~~(d) Two configurable binary inputs~~~~
- ~~7 The Networked Thermostat shall provide the flexibility to support any one of the following outputs:~~

- ~~(a) Three Speed Fan Control~~
- ~~(b) Two On/Off~~
- ~~(c) Two Floating~~
- ~~(d) Two Proportional (0 to 10V)~~
- ~~8 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.~~
- ~~9 The Networked Thermostat shall provide the flexibility to adjust the following parameters:~~
  - ~~(a) Adjustable Temporary Occupancy from 0 to 24 hours~~
  - ~~(b) Adjustable heating/cooling deadband from 5° F to 30° F~~
  - ~~(c) Adjustable heating/cooling cycles per hour from 4 to 8~~
- ~~10 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.~~
- ~~G Networked Thermostat (TEG-26X7)~~
  - ~~1 The Networked Thermostat shall be capable of controlling a pressure dependant Variable Air Volume System or other similar zoning type systems employing reheat.~~
  - ~~2 The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.~~
  - ~~3 The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.~~
    - ~~(a) The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).~~
    - ~~(b) A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.~~
    - ~~(c) The Conformance Statement shall be submitted 10 days prior to bidding.~~
  - ~~4 The Networked Thermostat shall be capable of remote read/write and parameter adjustment from the web based User Interface (UI) through an NAE.~~
  - ~~5 The Networked Thermostat shall include an intuitive UI providing plain text messages.~~
    - ~~(a) Two line, 8 character backlit display~~
    - ~~(b) LED indicators for Heating, and cooling status~~
    - ~~(c) Three (3) User Interface Keys~~
      - ~~(i) Override~~
      - ~~(ii) Up~~
      - ~~(iii) Down~~
    - ~~(d) The display shall continuously scroll through the following parameters:~~
      - ~~(i) Room Temperature~~
      - ~~(ii) System Mode~~

~~(iii) — Schedule Status — Occupied/Unoccupied/Override~~

~~(iv) — Applicable Alarms~~

~~6 — The Networked Thermostat shall provide the flexibility to support any one of the following inputs:~~

~~(a) — Integral Indoor Air Temperature Sensor~~

~~(b) — Duct Mount Air Temperature Sensor~~

~~(c) — Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator~~

~~(d) — Two configurable binary inputs~~

~~7 — The Networked Thermostat shall provide the flexibility to support either of the following outputs:~~

~~(a) — Two On/Off or Floating~~

~~(b) — Two Proportional (0 to 10V)~~

~~8 — The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.~~

~~9 — The Networked Thermostat shall provide the flexibility to adjust the following parameters:~~

~~(a) — Adjustable Temporary Occupancy from 0 to 24 hours~~

~~(b) — Adjustable heating/cooling deadband from 0° F to 5° F~~

~~(c) — Adjustable heating/cooling cycles per hour from 4 to 8~~

~~10 — The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.~~

~~D — Networked Thermostat (TEC-26X5)~~

~~1 — The Networked Thermostat shall be capable of controlling a two-pipe fan coil with a single-speed fan.~~

~~2 — The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.~~

~~3 — The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.~~

~~(a) — The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).~~

~~(b) — A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.~~

~~(c) — The Conformance Statement shall be submitted 10 days prior to bidding.~~

~~4 — The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.~~

~~5 — The Networked Thermostat shall be capable of remote read/write and parameter adjustment from the web-based User Interface (UI) through an NAE.~~

~~6 — The Networked Thermostat shall include an intuitive UI providing plain text messages.~~

- ~~(a) Two line, 8 character backlit display~~
- ~~(b) LED indicators for Fan and Cool status~~
- ~~(c) Five (5) User Interface Keys
  - ~~(i) Mode~~
  - ~~(ii) Fan~~
  - ~~(iii) Override~~
  - ~~(iv) Up~~
  - ~~(v) Down~~~~
- ~~7 The display shall continuously scroll through the following parameters:
  - ~~(i) Room Temperature~~
  - ~~(ii) System Mode~~
  - ~~(iii) Schedule Status Occupied/Unoccupied/Override~~
  - ~~(iv) Applicable Alarms~~~~
- ~~8 The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
  - ~~(a) Integral Indoor Air Temperature Sensor~~
  - ~~(b) Duct Mount Air Temperature Sensor~~
  - ~~(c) Indoor Air Temperature Sensor with Occupancy Override and LED Indicator~~
  - ~~(d) Two configurable binary inputs~~~~
- ~~9 The Networked Thermostat shall provide the flexibility to support either of the following outputs:
  - ~~(a) One (1) fan control~~
  - ~~(b) One Proportional (0 to 10V)~~~~
- ~~10 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.~~
- ~~11 The Networked Thermostat shall provide the flexibility to adjust the following parameters:
  - ~~(a) Adjustable Temporary Occupancy from 0 to 24 hours~~~~
- ~~12 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.~~
- ~~E VAV Modular Assembly (VMA 16X0)
  - ~~1 The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.~~
  - ~~2 The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.~~~~

- ~~(a) The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).~~
- ~~(b) A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.~~
- ~~(c) The Conformance Statement shall be submitted 10 days prior to bidding.~~
- ~~3 The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.~~
- ~~4 The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.~~
- ~~5 The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.~~
- ~~6 The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.~~
- ~~7 The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.~~
- ~~8 The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.~~
- ~~9 Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.~~
- ~~10 The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.~~
- ~~11 Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.~~
- ~~12 The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.~~
- ~~13 Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.~~
- ~~14 The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.~~
- ~~15 The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.~~
- ~~16 The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.~~

- ~~17—Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.~~
- ~~(a)—Absolute temperature loop error~~
  - ~~(b)—Signed temperature loop error~~
  - ~~(c)—Absolute airflow loop error~~
  - ~~(d)—Signed airflow loop error~~
  - ~~(e)—Average damper actuator duty cycle~~
- ~~18—The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:~~
- ~~(a)—Unreliable space temperature sensor~~
  - ~~(b)—Unreliable differential pressure sensor~~
  - ~~(c)—Starved box~~
  - ~~(d)—Actuator stall~~
  - ~~(e)—Insufficient cooling~~
  - ~~(f)—Insufficient heating~~
- ~~19—The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.~~
- ~~20—The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.~~
- ~~21—The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.~~
- ~~22—Inputs:~~
- ~~(a)—Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
    - ~~(i)—0-10 VDC Sensors~~
    - ~~(ii)—1000ohm RTDs~~
    - ~~(iii)—NTC Thermistors~~~~
  - ~~(b)—Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."~~



~~(c) For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.~~

~~(d) Provide side loop application for humidity control.~~

### ~~23 Outputs~~

~~(a) Analog outputs shall provide the following control outputs:~~

~~(i) 0-10 VDC~~

~~(b) Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.~~

~~(c) For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.~~

### ~~24 Application Configuration~~

~~(a) The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.~~

### ~~25 Sensor Support~~

~~(a) The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.~~

~~(b) The VMA shall support an LCD display room sensor.~~

~~(c) The VMA shall also support standard room sensors as defined by analog input requirements.~~

~~(d) The VMA shall support humidity sensors defined by the AI side loop.~~

### ~~FB~~ Network Sensors (NS-XXX700X)

- 1 The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
  - (a) Zone Temperature
  - (b) Zone Humidity
  - (c) Zone Setpoint
  - (d) Discharge Air Temperature
- 2 The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
- 3 The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
  - (a) The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
  - (b) A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.
  - (c) The Conformance Statement shall be submitted 10 days prior to bidding.
- 4 The Network Zone Sensors shall include the following items:

- (a) A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint
  - (b) An LED to indicate the status of the Override feature
  - (c) A button to toggle the temperature display between Fahrenheit and Celsius
  - (d) A button to initiate a timed override command
  - (e) Available in either surface mount or wall mount
  - (f) Available with either screw terminals or phone jack
- 5 The Network Discharge Air Sensors shall include the following:
- (a) 4 inch or 8 inch duct insertion probe
  - (b) 10 foot pigtail lead
  - (c) Dip Switches for programmable address selection
  - (d) Ability to provide an averaging temperature from multiple locations
  - (e) Ability to provide a selectable temperature from multiple locations

2.112.10 SYSTEM TOOLS

- A General: The control contractor shall provide the TAB Agent a means to manipulate the control systems. The control contractor will provide hardwire interfacing and all software to allow communication to stand alone controllers and the ability to globally command valves, terminal boxes, temperature settings, dampers, turn systems on and off, and will permanently store daily all coefficients established. If the schedule demands more teams, the control contractor will supply the TAB agency with multiple hardware interfaces and the appropriate software.
- B System Configuration Tool (SCT)
- 1 The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE) or a Network Integration Engine (NAE).
  - 2 The configuration tool shall provide an archive database for the configuration and application data.
  - 3 The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.
  - 4 The configuration tool shall include the following features:
    - (a) Basic system navigation tree for connected networks
    - (b) Integration of Metasys N1, LonWorks, and BACnet enabled devices
    - (c) Customized user navigation trees
    - (d) Point naming operating parameter setting
    - (e) Graphic diagram configuration
    - (f) Alarm and event message routing
    - (g) Graphical logic connector tool for custom programming

- (h) Downloading, uploading, and archiving databases
- 5 The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:
  - (a) BACnet Devices
  - (b) LonWorks devices
  - (c) N2 Bus devices
  - (d) Metasys N1 networks
- 6 The configuration tool shall be capable of programming the Field Equipment Controllers.
  - (a) The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.
  - (b) The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.
  - (c) The configuration tool shall contain a library of standard applications to be used for configuration.
- 7 The configuration tool shall be capable of programming the field devices.
  - (a) The configuration tool shall provide the capability to configure, simulate, and commission the field devices.
  - (b) The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.
  - (c) The configuration tool shall contain a library of standard applications to be used for configuration
- 8 A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.
  - (a) The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).
  - (b) The wireless use of configuration tool shall be the same as a wired connection in every respect.
  - (c) The wireless connection shall use the Bluetooth Wireless Technology.
- C Wireless MS/TP Converter (BTCVT)
  - 1 The converter shall provide a temporary wireless connection between the SA or FC Bus and a wireless enabled portable PC.
  - 2 The converter shall support downloading and troubleshooting FEC and field devices from the PC over the wireless connection.
  - 3 The converter shall employ Bluetooth Wireless Technology.
  - 4 The converter shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.

- 5 The converter shall operate over a minimum of thirty three (33) feet within a building.
  - 6 The converter shall have LED indicators to provide information regarding the following conditions:
    - (a) Power - On/Off
    - (b) Fault – Fault/No Fault
    - (c) SA/FC Bus – Bus Activity/ No Bus Activity
    - (d) Blue – Bluetooth Communication Established/ Bluetooth Communication Not Established
  - 7 The SWCVT shall comply with FCC Part 15.247 regulations for low-power unlicensed transmitters.
- D Handheld VAV Balancing Sensor (ATV7003)
- 1 The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.
  - 2 The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.
  - 3 The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
  - 4 The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.
  - 5 The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.
  - 6 The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.
  - 7 The sensor shall include the following
    - (a) 5 foot retractable cable
    - (b) Laminated user guide
    - (c) Nylon carrying case
  - 8 The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47 and be available for the TAB contractor to properly test the balancing of the system.

2.122.11 INPUT DEVICES

- A General Requirements
- 1 Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.
- B Temperature Sensors
- 1 General Requirements:

- (a) Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- (b) The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
- (c) The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Chilled Water	± .5°F.
<del>Room Temp</del>	<del>± .5°F.</del>
Duct Temperature	± .5°F.
All Others	± .75°F.

~~2 Room Temperature Sensors~~

- ~~(a) Room sensors shall be constructed for either surface or wall box mounting.~~
- ~~(b) Room sensors shall have the following options when specified:~~
  - ~~(i) A momentary override request push button for activation of after-hours operation.~~
  - ~~(ii) Analog thermometer.~~

~~3 Room Temperature Sensors with Integral Display~~

- ~~(a) Room sensors shall be constructed for either surface or wall box mounting.~~
- ~~(b) Room sensors shall have an integral LCD display and four button keypad with the following capabilities:~~
  - ~~(i) Display room air temperatures. A common input shall be used for both the controller input and the display.~~
  - ~~(ii) Timed override request push button with LED status for activation of after-hours operation.~~
  - ~~(iii) Display controller mode.~~
  - ~~(iv) Password selectable adjustment of setpoint and override modes.~~

42 Thermo wells

- (a) When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
- (b) Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
- (c) Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
- (d) Thermo wells shall be constructed of 316 stainless steel.

53 Outside Air Sensors

- (a) Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
- (b) Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
- (c) Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

64 Duct Mount Sensors

- (a) Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement. Sensors shall be installed so that the box sits on the outside of the duct insulation.
- (b) Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- (c) For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

75 Averaging Sensors

- (a) For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
- (b) For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
- (c) Capillary supports at the sides of the duct shall be provided to support the sensing string.
- (d) Only platinum sensors shall be used.

C Humidity Sensors

- 1 The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
- 2 The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 0-10 V, 0-100% linear proportional output.
- 3 The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 2% for general applications and 1% for process control between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
- 4 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
- 5 A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
- 6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

- 7 Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.
- D Dew Point Sensors
- 1 The sensor shall be a solid-state type, dew point sensor. The sensor element shall resist service contamination.
  - 2 The dew point transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 0-10 V, 0-100% linear proportional output.
  - 3 The humidity transmitter shall meet the following overall accuracy of 2 degrees, including lead loss and Analog to Digital conversion.
  - 4 Outside air relative dew point sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
  - 5 Transmitters shall be shipped factory pre-calibrated.
  - 6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
  - 7 Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.
- E Differential Pressure Transmitters
- 1 Provide digital displays to all DP transmitters.
  - 2 General Air and Water Pressure Transmitter Requirements:
    - (a) Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
    - (b) Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
    - (c) Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
    - (d) A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
  - 3 Low Differential Water Pressure Applications (0" - 20" w.c.)
    - (a) The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
    - (b) The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
      - (i) .01-20" w.c. input differential pressure range.
      - (ii) 4-20 mA output.

- (iii) Maintain accuracy up to 20 to 1 ratio turndown.
    - (iv) Reference Accuracy: +0.2% of full span.
  - (c) Acceptable Manufacturers: Setra and Mamac.
- 4 Medium to High Differential Water Pressure Applications (Over 21" w.c.)
  - (a) The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:
    - (i) Differential pressure range 10" w.c. to 300 PSI.
    - (ii) Reference Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability).
  - (b) Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
  - (c) Acceptable Manufacturers: Setra and Mamac.
- 5 Building Differential Air Pressure Applications (-1" to +1" w.c.)
  - (a) The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - (b) The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - (i) -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
    - (ii) 4-20 mA output.
    - (iii) Maintain accuracy up to 20 to 1 ratio turndown.
    - (iv) Reference Accuracy: +0.2% of full span.
  - (c) Acceptable Manufacturers: Johnson Controls and Setra.
- 6 Low Differential Air Pressure Applications (0" to 5" w.c.)
  - (a) The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - (b) The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - (i) (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
    - (ii) 4-20 mA output.
    - (iii) Maintain accuracy up to 20 to 1 ratio turndown.



- (iv) Reference Accuracy: +0.2% of full span.
    - (c) Acceptable Manufacturers: Johnson Controls and Setra.
  - 7 Medium Differential Air Pressure Applications (5" to 21" w.c.)
    - (a) The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
      - (i) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
      - (ii) Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
      - (iii) Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
    - (b) Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
    - (c) Acceptable manufacturers: Johnson Controls and Setra.
- F Flow Monitoring
- 1 Air Flow Monitoring
    - (a) Static Pressure Traverse Probe
      - (i) Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
      - (ii) Acceptable manufacturers: Cleveland Controls
    - (b) Shielded Static Air Probe
      - (i) A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.
  - 2 Water Flow Monitoring
    - (a) Water flow meters are specified under Hydronic Specialties 23 06 20 and are required to be able to be monitored by the JCI Metasys system. Provide a monitoring point and alarm for each Onicon meter provided.
- G Power Monitoring Devices
- 1 Current Measurement (Amps)
    - (a) Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be

- converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
- (b) Current Transformer – A split core current transformer shall be provided to monitor motor amps.
    - (i) Operating frequency – 50 - 400 Hz.
    - (ii) Insulation – 0.6 Kv class 10Kv BIL.
    - (iii) UL recognized.
    - (iv) Five amp secondary.
    - (v) Select current ration as appropriate for application.
    - (vi) Acceptable manufacturers: Veris Industries
  - (c) Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
    - (i) 6X input over amp rating for AC inrushes of up to 120 amps.
    - (ii) Manufactured to UL 1244.
    - (iii) Accuracy: +.5%, Ripple +1%.
    - (iv) Minimum load resistance 30kOhm.
    - (v) Input 0-20 Amps.
    - (vi) Output 4-20 mA.
    - (vii) Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
    - (viii) Acceptable manufacturers: Veris Industries

~~H Refrigerant Leak Detectors~~

- ~~1 The refrigerant leak detector shall be a standalone device and shall provide a SPDT output to directly energize the refrigeration room exhaust ventilation fans. The detector shall include a sensor or sensors connected to a control panel. Two relay contacts at the control panel shall provide trouble and alarm indication to the Facility Management System. The alarm relay contact shall also directly energize the exhaust fans.~~
- ~~2 The refrigerant leak detector shall sense the type of refrigerant used in the specified chillers. Multiple sensors shall be required to detect different refrigerants and/or provide proper sensing coverage for the area of the refrigeration room.~~
- ~~3 Acceptable manufacturers: Johnson Controls, MSA Instruments~~

H Smoke Detectors

- 1 Ionization type air duct detectors shall be furnished as specified elsewhere in Division 16 for installation under Division 15. All wiring for air duct detectors shall be provided under Division 16, Fire Alarm System.

J Status and Safety Switches

- 1 General Requirements

- (a) Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2 Current Sensing Switches

- (a) The current sensing switch shall have adjustable thresholds and be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- (b) Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- (c) Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
- (d) Acceptable manufacturers: Veris Industries

3 Air Filter Status Switches

- (a) Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
- (b) A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
- (c) Provide appropriate scale range and differential adjustment for intended service.
- (d) Acceptable manufacturers: Johnson Controls, Cleveland Controls

4 Air Flow Switches

- (a) Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
- (b) Acceptable manufacturers: Johnson Controls, Cleveland Controls

5 Air Pressure Safety Switches

- (a) Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
- (b) Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
- (c) Acceptable manufacturers: Johnson Controls, Cleveland Controls

6 Water Flow Switches

- (a) Water flow switches shall be equal to the Johnson Controls P74.

7 Low Temperature Limit Switches

- (a) The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

- (b) The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
  - (c) For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
  - (d) The low temperature limit switch shall be equal to Johnson Controls A70.
- 8 Pressure transducers on Glycol heat recovery system
- (a) Pressure transducers shall have LCD display.

2.132.12 OUTPUT DEVICES

A Actuators

1 General Requirements

- (a) Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.

2 Electronic Damper Actuators

- (a) Electronic damper actuators shall be direct shaft mount.
- (b) Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
- (c) Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
- (d) Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
- (e) Acceptable manufacturers: Johnson Controls, Mamac.

3 Electronic Valve Actuators

- (a) Electronic valve actuators shall be manufactured by the valve manufacturer.

- (b) Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
- (c) Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
- (d) Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
- (e) Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
- (f) Acceptable manufacturers: Johnson Controls

#### B Control Dampers

- 1 The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.
- 2 All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- 3 All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
- 4 Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
- 5 Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers

are Johnson Controls D-7250 D-1250 or D-1300, Ruskin CD50, and Vent Products 5650.

- 6 One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls D-1600, Ruskin CD36, and Vent Products 5800.
- 7 Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

~~C—AUTOMATIC LAB/VIVARIUM EXHAUST FAN AND MANIFOLD BLEED DAMPERS/OPERATOR:~~

- ~~1—Provide all required operators for the heavy duty round butterfly control automatic dampers as shown on the drawings and required by the Sequence of Operation.~~
- ~~2—Dampers shall be 316 stainless steel construction. Dampers shall be butterfly type consisting of circular blade, mounted to axle within formed flanged frame. Frame shall be constructed of steel channel and shall have full circumference blade stop located in air stream. Damper shaft shall be continuous, solid cold rolled steel extending through entire diameter of damper and beyond damper bearing a minimum of 6 inches. Axle shall be supported in sealed, relubricable ball bearings mounted to damper frame. Damper frame and blade shall be fabricated from hot rolled steel. Damper frame shall be minimum 10 gauge. Damper flanges shall be minimum 1 1/2" wide. Provide bolt holes in both flanges. Minimum blade thickness shall be 1/4". Axle diameter shall be minimum 3/4". Dampers shall be Ruskin model CDR92 or approved equal.~~
  - ~~(a)—Maximum system pressure: 10" WG.~~
  - ~~(b)—Maximum damper velocity 6000 fpm.~~
- ~~3—Damper operator shall be piston type operator with bracket for location outside the air stream in ambient air conditions. Operators shall be of sufficient size and torque to operate the respective damper effectively. Provide dampers selected for the sequence equal to Series 90 Bray actuator with a bracket fabricated by Century Instrument and Machine Co. in Houston and using 80 psi control air. The device shall include integral porting to reduce external tubing, lubricated acetal piston guides, two pneumatic connection ports and body designed for external installations~~

DC Control Relays

- 1 Control Pilot Relays
  - (a) Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
  - (b) Mounting Bases shall be snap-mount.
  - (c) DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
  - (d) Contacts shall be rated for 10 amps at 120VAC.
  - (e) Relays shall have an integral indicator light and check button.
  - (f) Acceptable manufacturers: Johnson Controls, Lectro
- 2 Lighting Control Relays
  - (a) Lighting control relays shall be latching with integral status contacts.

- (b) Contacts shall be rated for 20 amps at 277 VAC.
- (c) The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.
- (d) Lighting control relays shall be controlled by:
  - (i) Pulsed Tri-state Output – Preferred method.
  - (ii) Pulsed Paired Binary Outputs.
  - (iii) A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the “dry-contact” type.
- (e) The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

#### ED Control Valves

- 1 All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
- 2 Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Valves up to 46” shall be modulating characterized ball valves only. Modulating water valves shall be sized per manufacturer’s recommendations for the given application. In general, valves (2 or 3-way) serving **variable** flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving **constant** flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
- 23 Valves 5” and larger shall be Neles Segment Control Valves with flanged body, face to face acc to ISA S75.04 and DIN/IEC Part 3-2 ANSI 150. Standard construction with drive shaft with ANSI Keyway to Actuator ASTM A216 Gr WCB Body, SS+Cobalt Hard Facing, PTFE Vrings, live loaded. Provide Valvcon LADCW 1000U2Y-UP-Weathertight, 1000Torque (inlbs), Universal Power and H23415 Linkage Kit.
- 34 Ball valves shall be characterized and used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
- 45 Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.

56 Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

67 Acceptable manufacturers: Johnson Controls, Bray.

#### FE Electronic Signal Isolation Transducers

- 1 A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
- 2 The signal isolation transducer shall provide ground plane isolation between systems.
- 3 Signals shall provide optical isolation between systems.
- 4 Acceptable manufacturers: Advanced Control Technologies

#### GF External Manual Override Stations

- 1 External manual override stations shall provide the following:
  - (a) An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.
  - (b) A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
  - (c) A Status LED shall illuminate whenever the output is ON.
  - (d) An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.
  - (e) Contacts shall be rated for a minimum of 1 amp at 24 VAC.

#### HG Electronic/Pneumatic Transducers

- 1 Electronic to Pneumatic transducers shall provide:
  - (a) Output: 3-15 PSIG.
  - (b) Input: 4-20 mA or 0-10 VDC.
  - (c) Manual output adjustment.
  - (d) Pressure gauge.
  - (e) External replaceable supply air filter.
  - (f) Acceptable manufacturers: Johnson Controls, Mamac

### 2.142.13 MISCELLANEOUS DEVICES

#### A Local Control Panels

- 1 All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an



assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.

- 2 In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
- 3 All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
- 4 Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
- 5 All wiring shall be neatly installed in plastic trays or tie-wrapped.
- 6 A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.
- 7 Label control panels as required by section 23 05 29.

#### B Power Supplies

- 1 DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
- 2 Input: 120 VAC +10%, 60Hz.
- 3 Output: 24 VDC.
- 4 Line Regulation: +0.05% for 10% line change.
- 5 Load Regulation: +0.05% for 50% load change.
- 6 Ripple and Noise: 1 mV rms, 5 mV peak to peak.
- 7 An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
- 8 A power disconnect switch shall be provided next to the power supply.

#### C Thermostats

- 1 Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.
- 2 Actuation / Control Type
- 3 Primary Equipment
  - (a) Controls shall be provided by equipment manufacturer as specified herein.
  - (b) All damper and valve actuation shall be electric.
- 4 Air Handling Equipment
  - (a) All air handlers shall be controlled with a HVAC-DDC Controller

(b) All damper and valve actuation shall be electric.

5 Terminal Equipment:

(a) Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.

(b) All Terminal Units shall be controlled with HVAC-DDC Controller)

PART 3 EXECUTION

3.01 TRAINING

A. The contractor shall provide 10 days or 80 hours of off-site digital controls classroom training. Dates to be coordinated with UTHSC-H personnel.

END OF SECTION

SECTION 23 73 23  
AIR HANDLING UNITS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
- C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

- A. Packaged air handling units.
- B. Factory installed fans.
- C. Dampers.
- D. Filters.
- E. Coils.
- F. Drives.

1.02 RELATED SECTIONS

- A. Section 23 00 00- Basic Mechanical Requirements.
- B. Section 23 05 13 - Motors.
- C. Section 21 05 48 - Vibration Isolation.
- D. Section 23 07 13 - Ductwork Insulation.
- E. Section 23 82 16 - Air Coils.
- F. Section 23 41 00 - Filters.
- G. Section 23 31 00 - Ductwork.
- H. Section 23 33 00 - Ductwork Accessories: Flexible duct connections.

1.03 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. AMCA 99 - Standards Handbook.

- D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- E. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
- G. AMCA 500 - Test Methods for Louver, Dampers, and Shutters.
- H. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- I. ARI 430 - Central-Station Air-Handling Units.
- J. ARI 435 - Application of Central-Station Air-Handling Units.
- K. ARI 610 - Central System Humidifiers.
- L. NEMA MG1 - Motors and Generators.
- M. NFPA 70 - National Electrical Code.
- N. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- O. UL 900 - Test Performance of Air Filter Units.

#### 1.04 SUBMITTALS

- A. Submit under provisions of Section 23 00 00.
- B. Include with the initial submittal a letter signed by the manufacturer's national sales manager (or any corporate officer) and the production manager, acknowledging that this equipment is intended for a University of Texas facility and that all specification requirements shall be complied with. Submit copy of letter to OFPC engineer.
- C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics, connection requirements, and .
- D. Product Data:
  - 1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics and connection requirements.
  - 2. Provide data of filter media, filter performance data, filter assembly, and filter frames as tested and certified per ASHRAE standards.
  - 3. Provide fan curves with specified operating point clearly plotted, as tested and certified per AMCA standards. Ratings to include system effects. Bare fan ratings will not satisfy this requirement, but shall be submitted for comparison purposes.
  - 4. Submit sound power level data for both fan outlet and casing radiation at rated capacity, as tested and certified per AMCA standards.
  - 5. Provide data on all coils as tested and certified per ARI standards.

6. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
7. All materials shall have NFPA-90 rating of 25/50 or better.

E. Manufacturer's Installation Instructions.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 23 00 00.
- B. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation of the Owner's RCM.

1.09 EXTRA MATERIALS

- A. Furnish under provisions of Section 23 00 00.
- B. Provide two sets of belts and three sets of filters for each unit. One set of filters is to be installed when unit is started up, and shall be protected from construction debris with additional media either at the first bank of filters, or covering each air intake (outside air and return air). The second set of filters is to be installed when test and balance activities begin. At substantial completion, OFPC RCM shall inspect filters to determine if the third set should be installed or delivered to campus operations personnel. Tag to identify associated unit.

#### 1.11 SCHEDULES ON DRAWINGS:

- A. In general, all capacities of equipment, and motor and starter characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Insofar as is possible, all items of the same type (i.e., pumps, fans, etc.) shall be by the same manufacturer. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is installed.

#### 1.12 REQUIREMENTS OF BIDDING:

- A. This is the first two AHUs to be replaced of 16 total units. UTHSC-H would like to enter into a contract with the manufacturer of the AHUs supplied with this phase for future phases to make the AHUs alike. For this reason, we are asking the AHU manufacturers to provide not only the cost of the AHUs as a separate line-item for the bid, but also provide information for future pricing to include the percentage over factory pricing at which future units specific to these 16 AHUs will be sold to UTHSC-H with the agreement that the representative will provide UTHSC-H with the pricing information from the factory each phase of the project.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Temtrol.
- B. Thermal.
- C. York Custom.
- D. Air Enterprises.
- E. Trane Custom/[AirZone/Energy Labs](#).
- F. **NOTE:** Units must meet the size restrictions. In addition, each manufacturer must verify the shipping and delivery sizes of the components and coordinate exactly how the units will get to the building's penthouse and ultimately get to the location of the replacement.
- G. Substitutions: Under provisions of Section 23 00 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

#### 2.02 GENERAL DESCRIPTION

- A. Configuration: Fabricate with fan and coil sections as scheduled plus accessories, including sections as detailed per unit.
- B. Performance Base: Sea level conditions.

- C. Fabrication: Conform to AMCA 99 and ARI 430 in the absence of direction in this specification.
- D. Performance: Refer to schedule in drawings.

2.03 AIR HANDLER CASING AND GENERAL CONSTRUCTION:

- A. Unit casing exterior (walls and roof) shall be a minimum 18-gauge thickness galvanized steel insulated internally, throughout (double wall construction with no thru metal). Internal insulation shall have an R-value of at least 10, with foil facing, neoprene or anti-microbial hardcoat protected unless specifically noted otherwise, and shall be fire and fungus proof. Foam may be used as an alternate as long as it is also anti-microbial protected and fire and fungus proof. All internal insulation shall be protected with solid galvanized sheet metal, of a minimum of 20-gauge thickness. All sheet metal joints throughout the air handler, and between panelized sections, shall be gasketed with closed cell, soft rubber gaskets, fabricated from neoprene, EPDM, or other approved material. Internal walls and roof outside shall be sealed such that there is no passage of air from inside the unit to the outer casing.
- B. Individual panels of the fan section shall be removable without compromising the integrity of the unit. Casing assembly shall be configured to eliminate all thru-metal in portions of the unit subject to below ambient temperatures. Where fasteners are used in the assembly of the unit components, they shall not extend from the outside of the unit into the air stream. If all components of the fan section can be removed through the door, removable panels will not be necessary.
- C. Drain pan liners shall be constructed of No. 14-gauge 316-L-L stainless steel or heavier as standard with the manufacturer, and shall be non-skid. Drain pan shall be non-skid and extend up to the fan section on draw-thru units. Entire drain pan, and shall be insulated with R-8 rigid insulation. Drain pans shall be sloped to the outside edge of the unit. On units over six feet wide, slope to each side of the unit. The insulation shall be installed and sealed as is appropriate for the equipment construction.
- D. Unit shall have a complete perimeter channel base of at least 6" galvanized steel or 6" carbon steel with marine quality primer. The unit manufacturer shall provide a condensate drain trap calculation that ensures there will be ample trapping height when the unit is sitting on a 5-1/2" concrete pad. Base channels shall be sized no less than 6", but shall be extended to provide proper trapping. All floors shall be insulated with R-10 insulation with 14-gauge non-skid galvanized floor (or equivalent aluminum). An 18-gauge galvanized sheet shall enclose and form a vapor barrier for the insulation on the bottom of the unit. If a foamed-in-place closed cell insulation is used, the lower metal enclosure may be eliminated. All points of contact between the floor, vapor barrier and structure shall be thermally isolated with gasketing of closed cell soft rubber or EPDM.
- E. Access doors shall be provided to allow access to both sides (upstream and downstream) of the filter racks, into the fan section, and both sides of all coils. Access doors shall be double wall, insulated the same as wall panels, and the opening framed with thermal break construction. Door size shall be at least 18" wide and full height of the panel up to 5' 0" tall. The construction of the access doors shall equal or exceed the quality and quantity of the air handler casing materials as specified herein. Each door shall have a minimum of an 8-inch by 6-inch double-glazed view window, capable of withstanding the total developed pressure of the unit. The doors shall be hinged using either heavy-duty stainless butt hinges, or a continuous stainless steel piano hinge, extending along the entire edge of the door, except for a maximum of two inches at each end. If butt hinges are used, provide two per door for up to 36" high doors and three per door for longer doors. There shall be a minimum of two

latches on doors longer than 18," and three latches in doors over 36" long. Latches shall be Ventlok 310, heavy-duty latch, or approved equal. All access doors shall open against air pressure.

- F. Coils in the air-handling units shall be individually removable from within the unit so that they may be removed through the access doors without removing any unit panels or piping exterior to the unit and shall not be used to provide structural stability for the casing. All coils shall be arranged for and piped to provide counterflow operation. The coils shall be completely enclosed within the coil housing of the air unit casing. All penetrations of the air handler casing shall be neatly sealed using a resilient sealant. Hinged gasketed quick access doors of adequate size for a man to enter shall be provided for each space between coils, filters and other components. Stacked coils shall have intermediate drain pans with at least 1" rigid drain piping and pipe supports to main drain pan.
- G. Panels shall be reinforced with sufficient internal bracing to prevent excessive deflection of the panels. Maximum deflection at any joint on the unit casing shall be limited to L /250th of the overall panel width or height.
- H. Panel construction shall provide the following acoustical performance.

a. Sound Transmission Loss (dB) per ASTM E-90 & E-413

Octave	2	3	4	5	6	7	STC+
Coated Liner	22	26	37	44	53	55	39
Solid Liner	22	38	49	50	57	62	42

b. Sound Absorption Coefficients per ASTM C-423 & E-795

Octave	2	3	4	5	6	7	NRC+
No liner	.26	.71	1.09	1.02	.96	.83	.95
Coated Liner	.25	.79	1.06	1.06	1.04	.78	1.00

The above ratings represent minimum performance. Unit manufacturer shall submit full sound performance data to the project sound consultant for evaluation.

~~Unit shall be finally configured to not exceed the room NC values in Section-13 48 00.~~

- I. Provide a unit housing, including joints, seams, and access doors, that will not condense moisture on the external surfaces of this housing when subjected to a surrounding ambient environment of 82°F dry-bulb/75°F dew-point temperature air.
- J. Equivalent aluminum material may be used where galvanized steel panel components are called for.
- K. Provide sealable test ports on either side of each filter bank and each coil section, in inlet plenum and discharge plenum, and suction and discharge side of all fans. Ports shall be equal to Ventfabrics test port Model 699-2.



2.04 FANS:

- A. Shall be both dynamically and statically balanced. Housed fans shall be equipped with quick opening access doors in the fan scroll. Motors shall be high efficiency type per Section 23 05 13. The motor mounting for each unit shall be an integral part of the fan support frame. The fan/motor unit shall be mounted on spring isolators within the air handler casing. Housed fans shall have an appropriately designed fabric duct vibration isolator installed within the air handler casing. The unit shall be supplied with a factory installed and sealed flange for connection to ductwork. Units shall be direct drive only.
- B. The fan unit bearings shall be of the antifriction type, either ball or roller, lubricated at the factory, and shall be equipped with means for lubrication with a grease fitting on the outside of the bearing housing. Both inboard and outboard bearings shall be the same, identical size. The bearings shall be a catalogued type as manufactured by Fafnir, SKF, Sealmaster, or approved equal, and stocked locally. Bearings shall have an L-10 minimum life of 200,000 hours. Intermediate bearings will not be acceptable. Grease fittings for bearings shall be remotely mounted within line of sight of the bearing, where possible. Where it is not possible, then the fitting shall be mounted where it is most easily accessible for service. The tubing used for removing the fitting shall be stainless steel, installed with a strain relief pigtail approximately 4 inches in diameter and located on the drive side of the assembly.
- C. After assembly, the unit manufacturer shall balance the fan (per ANSI/AMCA 204-96 fan application category BV-3) at design fan speed with belts and drives in place to a vibration velocity less than or equal to 0.157 inches (0.100 inches for direct-drive applications) per second measured on horizontal, vertical, and axial planes at each bearing pad. Vibration amplitudes are in inches/second peak velocity. All values recorded are to be filter-in at the fan speed.
- D. Plug fans installed in walk-in units shall be provided with a safety cage around the wheel or with a fan shut down switch in the access door. Cage shall be large enough to allow working room for wheel and bearing service and shall have removable sections to allow wheel removal.
- E. Direct drive fans shall have fan wheels cut to provide proper matching of the motor and fan rpm.
- F. Multiple Fan/Motor VFD Control: The fan array shall consist of multiple fan and motor "cubes", spaced in the air way tunnel cross section to provide uniform airflow and velocity profile across the entire airway tunnel section and components contained therein. Each fan cube shall be individually wired to a control panel containing power lock-disconnects for individual motor(s) and VFD(s) controlling respective fan motors in the fan array. Refer to Specifications Section 23 2923 – "Variable Frequency Drives" for requirements. Controls shall allow ~~two-three~~ of the ~~four-six~~ fans to shut down if the unit is at minimum airflow for stable operation and less air is required.

2.05 DAMPERS

- A. Damper Leakage: Section with factory built, factory mounted outside and return air dampers of galvanized steel and edge seals in galvanized frame, with galvanized steel axles in self-lubricating nylon bearings, in opposed blade arrangement with damper blades positioned across short air opening dimension. ~~Provide removable, full width rack for supporting freeze protection thermostat, with removable end panel to permit rack removal.~~

Maximum 4 CFM/Sq. Ft. at 4 inch WG differential pressure. Dampers shall be sized for 2000 fpm maximum face velocity.

- B. Isolation Dampers: Factory mounted isolation dampers downstream of the fan section shall be governed by the low-leakage damper specification in section 23 33 00.
- C. Face and Bypass Dampers (Heat Recovery Units): Factory mounted in casing field mounted with access doors, of galvanized steel blades, and edge seals, galvanized steel frame, and axles in self-lubricating nylon bearings, arranged to match coil face with bypass, blank-off and division sheets, external linkage, access doors, and adjustable resistance plate. Dampers shall be low-leakage type.

#### 2.06 DRIVES:

- B. Variable speed drives: See Section 23 29 23. Drive shall be supplied by the VFD manufacturer and shall be connected in the field. The AHU manufacturer shall coordinate with the drive manufacturer to ensure the motor will not over-amp in bypass mode.

#### 2.07 COILS:

- G. Refer to Section 23 82 16 - Air Coils, and Unit Schedules for requirements.

#### 2.08 FILTERS:

- A. Units shall have a 30%/85% filter bank. Refer to Section 23 41 00 - Filters, and Unit Schedules for requirements.

#### 2.10 ELECTRICAL

- A. Fan motors shall be factory mounted and wired to an external disconnect switch adjacent to the motor access door. Fan motors shall be interlocked with fan access door to shut down when door is opened.
- B. Vapor proof lights (mounted at 88" above floor or as high as possible for units shorter than 88") shall be provided in each compartment. Lights shall have a switch at each door into the compartment with access doors. Provide two GFI convenience outlets evenly spaced on the long dimension of the unit. Wire lights and outlets to two external 120v, 20a power connections (one for each service) for connection by Division 26.
- C. All wiring shall be 600v rated type MTW/THWN stranded copper in EMT or LiquidTite conduit (max 3 feet). All junction boxes shall be UL approved and gasketed.
- D. Motors – Motors shall be provided to match the direct-drive requirements of the AHU without overamping in bypass mode. See Section 23 05 13 for additional requirements.
- E. Motor/VFD/Fan – The fan wheel shall be cut so that maximum motor/fan rpm does not exceed the motor rated horsepower when the variable frequency drive is placed into bypass.

#### 2.11 FINISH

- A. All external parts of the unit shall be Brite G-90 galvanized. No painting will be required.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Field assembly of the unit shall be the responsibility of the manufacturer.
- B. Install in conformance with ARI 435.
- C. Assemble high pressure units by bolting sections together.

### 3.02 TESTING

- A. Units with cabinet mounted fans shall be tested and certified at rated conditions using AMCA 210 and AMCA 300 test procedures with fan mounted in the cabinet. Bare fan data will not be accepted.
- B. Casing Deflection Test
  - 1. Deflection limit of  $L/250$  shall be demonstrated in the factory prior to shipping and witnessed by a representative of the Owner's Test and Balance Consultant.
  - 2. 'L' is defined as the height of the largest panel on the sides, width across the top of the largest panel on the unit, and the smaller of width or height of the largest panel for the ends. These are known as the governing panels.
  - 3. That portion of the unit after the fan discharge shall be tested at positive pressure. The remainder of the unit shall be tested at negative pressure.
  - 4. Measurements shall be taken at mid point of 'L' using dial indicators reading in 1/1000ths. Mounting of dial indicators shall be independent of the unit casing. Multiple measurements shall be made. Dial indicator shall be mounted at mid point of 'L'. Measurements shall then be spaced along the sides, ends and top at mid point and quarter points of the negative section and the positive section. Spacing shall be adjusted to fall on nearest flange or panel joint. Any section of less than five feet shall require only one measurement at the center.
  - 5. Unit shall be furnished with proper blank offs to facilitate the pressure testing.
  - 6. In order to reduce the number of pressure cycles, it is recommended that multiple dial indicators be used at the measurement points. Separate set-ups will be required for the positive pressure tests and the negative pressure tests.
- C. Casing Leakage Test. With unit set in place, leveled and ready to receive duct work connections, unit shall be tested for casing leakage by sealing all openings and pressurizing to 2.5 times rated pressure (defined as total static pressure of unit) or 10" WG, whichever is smaller. Maximum allowable leakage rate is 1.5% of rated unit flow. Test is to be performed by the manufacturer using flow measurement devices and shall be witnessed by a representative of the Owner's Test & Balance firm.
- D. Fan/Motor Vibration Test. With the unit set in place, leveled, and ductwork attached, the manufacturer shall perform a final dynamic vibration trim balance to verify the fan/motor vibration velocity limit over the following operating speed range: Fans with

VFDs shall be checked from 40 to 110% of the rated fan speed. Constant speed fans shall be checked at 100% of rated fan speed. 'Lock-out' ranges may be used to correct up to two ranges of excess vibration. The span of each 'lock-out' range shall be limited to an effective fan speed of 50 RPM. Any 'lock-out' range used shall be clearly identified in the test report and shall be prominently displayed on a typed, laminated legend mounted inside the VFD controller cabinet. This testing shall be witnessed by a representative of the Owner's Test and Balance firm.

- E. Failure of the leakage and/or deflection test shall require sealing and bracing of the unit and retesting until criteria is met. Failure of the trim balance to confirm vibration limit shall require rebalancing and re-testing until criteria is met. Contractor shall bear all costs involved in the modifications, balancing, and re-testing, including travel and hourly costs associated with the representatives of the Owner's Test and Balance firm.

END OF SECTION

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SECTION 23 82 16

AIR COILS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

- A. Section 23 00 00 – Basic Mechanical Requirements
- B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
- C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

- A. Water coils.
- B. Refrigerant coils.

1.02 RELATED SECTIONS

- A. Section 23 00 00 - Basic Mechanical Requirements.
- B. Section 23 07 19 - Piping Insulation.
- C. Section 23 06 20.13 - Hydronic Specialties.
- D. Section 23 22 00.A - Steam and Steam Condensate Specialties.
- E. Section 23 31 00 - Ductwork: Installation of duct coils.
- F. Section 23 09 23 - Direct Digital Control Systems.

1.03 REFERENCES

- A. ANSI/ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. ANSI/NFPA 70 - National Electrical Code.
- C. ANSI/UL 1096 - Electric Central Air Heating Equipment.
- D. SMACNA - HVAC Duct Construction Standards, Metal and Flexible.

1.04 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 00 00.
- B. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- C. Submit product data under provisions of Section 23 00 00.
- D. Submit product data indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

- E. Submit manufacturer's installation instructions under provisions of Section 23 00 00.
- F. Submit manufacturer's certificate under provisions of Section 23 00 00 that coils are tested and rated in accordance with ANSI/ARI 410.

#### 1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 23 00 00.
- B. Store and protect products under provisions of Section 23 00 00.
- C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- D. Protect coils from entry of dirt and debris with pipe caps or plugs.

### PART 2 PRODUCTS

#### 2.01 CHILLED WATER COILS:

- A. Water coil capacities, pressure drops and selection procedures shall be certified for the capacity scheduled in accordance with ARI Standard 410-87. Non-certified coils will not be accepted.
- B. Chilled water and heating water coils shall be of the extended surface type meeting all conditions and having the minimum face area and pressure drops scheduled on the Drawings, and shall have same-end supply and return connections unless otherwise indicated. Coils shall be constructed of copper tubes 5/8" O.D. with .035" thick minimum wall thickness and copper fins permanently bonded to the tubes by mechanical expansion. Coils shall have a maximum of 8 fins per inch, and a maximum of 6 rows. If additional cooling capacity is necessary, the additional capacity shall be provided by an additional coil, with an additional access section between the coils, and the coils shall be piped in series, counterflow to the direction of air flow. Copper fins on plate coils shall be .006" thick. Heating coil construction shall be similar, except fins may be aluminum material.
- C. All coil headers and connections shall be of I.P.S. brass or heavy gauge seamless hard drawn copper tubing with penetrations for connection of core tubing by die-formed intrusion process with resulting contact depth between the header wall and core tubing of not less than .090". Joints between core tubing and header shall be of recess swage design to allow a large mating area for build up of brazing materials to give increased strength to the joint. Supply and return connection of brass or copper shall be terminated with National Pipe Threads with wrench flats.
- D. Coils shall be designed and certified by the manufacturer to operate to scheduled face velocity plus 10% without moisture carry over. Each cooling, and heating coil section shall be provided with a ~~30416-L~~ Stainless Steel frame/casing, including tube sheets, no lighter than 16 gauge. Frame members shall extend over the ends and edges of the coils and shall be constructed with formed holes for tubes, permitting free expansion and contraction of coil sections while supported by an extended surface of the frame. Intermediate tube support

sheets of 316-L stainless steel shall be provided in all coils having tube lengths in excess of 48": on long coil sections the spacing of coil supports shall not exceed 48". All intermediate supports shall be welded to coil frame members and fabricated with formed tube holes to support the penetrating tubes. Heating coil construction shall be similar, except casting frame and intermediate supports may be G90 galvanized material.

- E. Condensate from chilled water coils shall be piped to the nearest convenient floor drain. The pipe size shall be the full size of the connection or 1" minimum diameter whichever is larger, insulated as specified for chilled water piping. A trap of a minimum depth of 6 inches, or as noted on the drawings, shall be provided in this drain line to prevent the escape or entry of air through the drain piping.
- G. Pressure test all coils to 350 psi under water.

## 2.02 STEAM COILS:

- A. All steam coils shall be 5/8" or 1" O.D. seamless copper tubes having 0.035" minimum wall thickness. Coil shall have 0.008" thick aluminum fins -suitable for use with steam at a maximum temperature of 300 degrees F. and a maximum pressure of 200 psig. Coils shall vertical or horizontal tube type. Coil headers shall be cast iron or I.P.S. brass or as specified hereinafter for chilled water coils. Coils shall have one row, and a maximum of 8 fins per inch. Frames and rails shall be ~~hot-dipped galvanized~~ 304 stainless steel.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- C. Support coil sections independent of piping on steel channel or double angle frames and secure to casings. Provide frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Provide airtight seal between coil and duct or casing.
- D. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- E. Make connections to coils with unions and flanges.
- F. On water coils, provide shut-off valve on supply line and lock shield balancing valve on return line. Locate water supply at bottom of supply header and return water connection at top. Provide float operated automatic air vents at high points complete with stopvalve. Ensure water coils are drainable and provide drain connection at low points.
- G. On water heating coils, and chilled water cooling coils, connect water supply to leaving air side of coil (counterflow arrangement).
- H. For cooling coils where air velocity exceeds 500 ft/min (2.5 m/sec), provide three break moisture eliminators of 24 gage (0.60 mm) copper.
- I. Provide drain pan and drain connection for cooling coils. Fabricate drain pan from minimum 18 gage 316L stainless steel. Extend ~~3 inches from face of coil entering air side,~~ 18 inches from face of coil leaving air side or through to the fan section on coils directly in front of the fan. Pipe drain pans individually to floor drain with water seal trap.

- J. In steam coils, install vacuum breaker in steam line at header. Install steam traps with outlet minimum 12 inches below coil return connection.
- K. Insulate headers located outside air flow as specified for piping. Refer to Section 23 07 19.

END OF SECTION

- o o o -



Pictures of AHU in P117:





Pictures of AHU room P107:







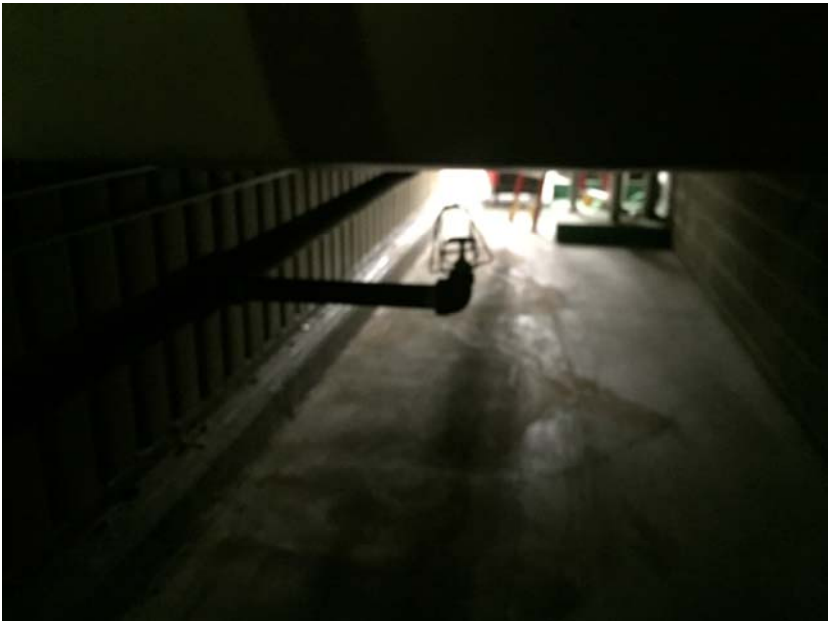




Under Ducts from AHU 7&8 to chase wall:







Showing buss duct above hot deck and plumbing piping between hot & cold deck:



Pipes running to both sides of ducts:

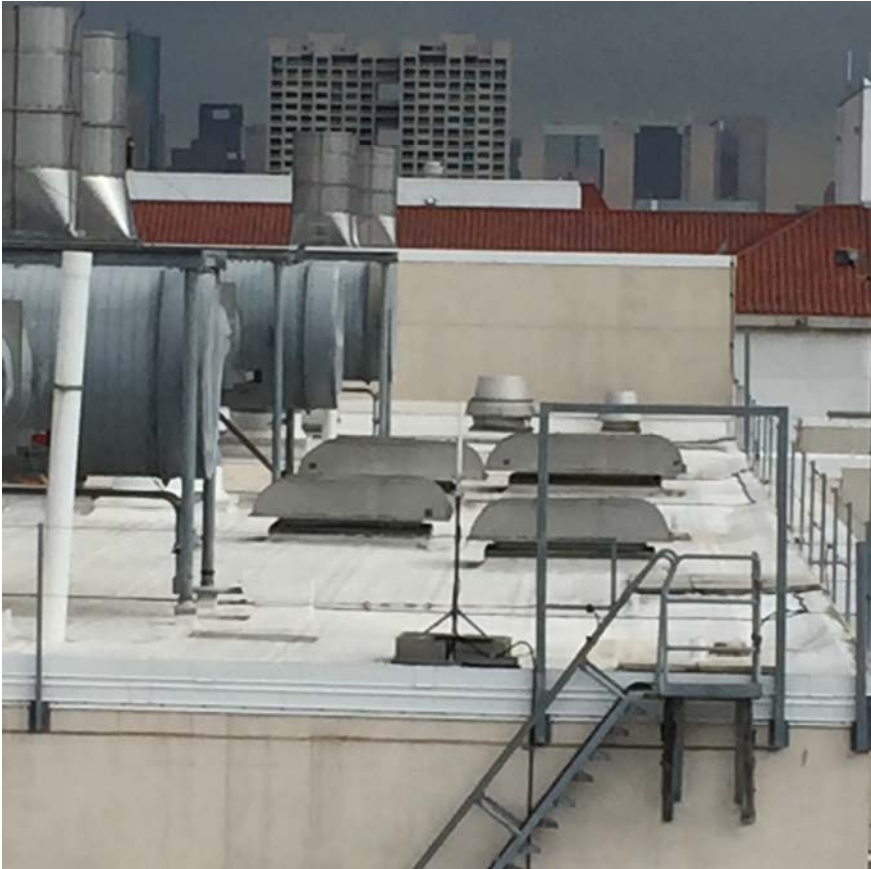


Existing VFDs to replace:



Roof Pictures:





Duct penetration where new opening will be required:







Roof penetration area:



Taps for bypass unit



Outside air for bypass unit:



Areas on roof where new plenums will be located and flex will run:





Existing swing arm on high roof:



Existing AHU curb:



Existing detail of AHU to wall

Existing pipe connections to AHU: Some will have to be extended or relocated as needed:









Existing Ducts against columns:



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SECTION 00 01 05.06

CERTIFICATIONS PAGE

ELECTRICAL ENGINEERS CERTIFICATION

1.01 The signature and seal appearing below is limited to the authentication of the below listed specification sections:

**Division 26 – Electrical**

26 00 00	Basic Electrical Requirements
26 00 00.01	Electrical Demolition
26 05 00	Basic Electrical Materials and Method
26 05 19	Cable, Wire and Connectors, 600 Volts
26 05 26	Grounding
26 05 29	Securing and Supporting Methods
26 05 33	Raceways, Conduit and Boxes
26 05 53	Electrical Identification
26 27 26	Wiring Devices and Floor Boxes
26 51 00	Interior and Exterior Lighting

**ALL SECTIONS ADDED IN ADDENDUM #1.**



By: *Larkin Gentry* 4-5-16

E&C Engineers  
1010 Lamar, Suite 650  
Houston, TX 77002  
TBPE Firm Registration No. F-003068

END OF CERTIFICATIONS PAGE

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SECTION 26 00 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. General Requirements specifically applicable to Division 26.
- B. The Contractor shall be responsible for:
  - 1. The work included consists of furnishing all materials, supplies, equipment and tools, and performing all labor and services necessary for installation of a completely functional power, lighting, fire alarm and signaling systems. Complete systems in accordance with the intent of Contract Documents.
  - 2. Coordinating the details of facility equipment and construction for all Specification Divisions, which affect the work covered under this Division.
  - 3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
  - 4. Temporary power service and lighting for construction. Coordinating all shutdown dates and schedules with Owner's Representative and obtain all work-permits required by Owner.
- C. Intent of Drawings:
  - 1. The Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every device or raceway in its exact location, unless specifically dimensioned. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceway, subject to prior review by the Owner and Engineer. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
  - 2. The intent of the Drawings is to establish the type of systems and functions, but not to set forth each item essential to the functioning of the system. The drawings and specifications are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Review pertinent drawings and adjust the work to conditions shown. In case of doubt as to work intended, or where discrepancies occur between drawings, specifications, and actual conditions, immediately notify the Architect/Engineer and the Owner's representative, and propose a resolution.

1.2 RELATED WORK

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project electrical systems and equipment.
  - 1. Division 01 Sections included in the project specifications.
  - 2. The contract.

1.3 DESIGN CRITERIA

- A. Equipment and devices to be installed outdoors or in enclosures where the temperatures are not controlled shall be capable of continuous operation under such conditions per manufacturer's requirements.
- B. Compliance by the Contractor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.

- C. Electrical components shall be UL listed and labeled.

#### 1.4 REFERENCE CODES AND STANDARDS, REGULATORY REQUIREMENTS

- A. Standards of the following organizations as well as those listed in Division 01, may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.

1. Association of Edison Illuminating Companies (AEIC)
2. American National Standards Institute (ANSI)
3. Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. National Electrical Code (NEC)
6. National Electrical Manufacturers Association (NEMA)
7. Electrical Safety in the Workplace
8. National Fire Protection Association (NFPA)
9. Underwriter's Laboratories (UL)
10. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

- B. Work, materials and equipment must comply with the latest rules and regulations of the following.

1. National Electrical Code (NEC)
2. Electrical Safety in the Workplace
3. Occupational Safety and Health Act (OSHA)
4. American with Disability Act (ADA)
5. American Society for Testing and Materials (ASTM)
6. University of Texas (UT) System
7. Applicable state and federal codes, ordinances and regulations

- C. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's representative in writing and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified shown.

- D. Contractor shall obtain permits and arrange inspections required by codes applicable to this Section and shall submit written evidence to the Owner and Engineer that the required permits, inspections and code requirements have been secured.

#### 1.5 SUBMITTALS

- A. Submit the following in addition to and in accordance with the requirements of Division 01 for submittal requirement.

1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of it are clearly indicated and non-applicable portions clearly deleted or crossed out.
3. All schematic, connection and/or interconnection diagrams in accordance with the latest edition of NEMA.
4. Provide submittals as required by individual specification Section.

- B. Provide the following with each submittal:
  - 1. Catalog cuts with manufacturer's name clearly indicated. Applicable portions shall be circled and non-applicable portions shall be crossed out.
  - 2. Line-by-line specification review by equipment manufacturer and contractor with any exceptions explicitly defined.
- C. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads should be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.
- D. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.
  - 1. Itemize equipment and material by specification Section number; include manufacturer and identifying model or catalog numbers.
  - 2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
  - 3. If a satisfactory replacement is not submitted within a two-week period, owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to owner.
- E. As-Built Record Drawings: The Contractor shall maintain a master set of As-Built Record Drawings that show changes and any other deviations from the drawings. The markups must be made as the changes are done. At the conclusion of the job, these As-Built Record Drawings shall be transferred to AutoCad electronic files, in a format acceptable to the Owner, and shall be complete and delivered to the Owner's Representative prior to final acceptance. Refer to 01210 Project Administration for other requirements.

#### 1.6 SAFETY

- A. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of Project Safety Manual (PSM).
  - 1. The Contractors shall be responsible for training all personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.
  - 2. The Contractor shall secure all electrical rooms, to limit access, prior to energizing any high voltage (480V or higher) equipment and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is on going near energized equipment. The Contractor shall cover all energized live parts when work is not being done in the equipment. This includes lunch and breaks.
  - 3. The Contractor shall strictly enforce OSHA lock out/tag out procedures. Initial infractions shall result in a warning; a second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

#### 1.7 SHORING AND EQUIPMENT SUPPORTS

- A. The Contractor shall provide all permanent and temporary shoring, anchoring, and bracing required to make all parts absolutely stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.
- B. The Contractor shall adequately support all freestanding panels, motor control centers, enclosures, and other equipment. This shall include bolting to the floor or solid structural steel to prevent tipping. Install free-standing electrical equipment on 4" thick concrete housekeeping pads that are provided by others. Under no condition shall equipment be fastened to non-rigid building steel (i.e., removable platform steel gratings, handrails, etc.).
- C. The Contractor shall provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. At no time shall the

Contractor mount or suspend equipment from other disciplines' supports.

#### 1.8 TEMPORARY POWER REQUIREMENTS

- A. Provide power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up/testing of permanent electric-powered equipment prior to its permanent connection to electrical system. Provide proper overload protection. Ground fault circuit interrupters (GFCI) are to be used on all 120-volt, single-phase, 15 and 20 amp receptacle outlets where portable tools and equipment are used. Ground fault circuit interrupters shall be tested weekly by the Contractor.
- B. Temporary power feeders shall originate from a distribution panel. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord.
- C. Branch circuits shall originate in an approved receptacle or panelboard. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord. Each branch circuit shall have a separate equipment grounding conductor.
- D. All receptacles shall be of the grounding type and electrically connected to the grounding conductor.
- E. Provide temporary lighting by factory-assembled lighting strings or by manually-assembled units. All lamps for general lighting shall be protected from accidental contact or breakage. Protection shall be provided by installing the lights a minimum of 7 feet from the work surface or by lamp holders with guards. Branch circuits supplying temporary lighting shall not supply any other load. Provide sufficient temporary lighting to ensure proper workmanship by combined use of day lighting, general lighting, and portable plug-in task lighting. Comply with OSHA required foot-candle levels and submit plan for approval by the owner.
- F. For temporary wiring over 600 volts, suitable fencing, barriers, or other effective means shall be provided to prevent access of anyone other than authorized and qualified personnel.
- G. Temporary power cords shall be kept off the ground or floor. The Contractor shall provide temporary supports as required to keep temporary cords off the ground or floor.

#### 1.9 SUBSTITUTION OF MATERIALS AND EQUIPMENT:

- A. Refer to Uniform General Conditions and Supplementary General Conditions for substitution of materials and equipment.
- B. The intent of the Drawings and/or Specifications is neither to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).
- C. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the Architect/Engineer is final.
- D. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.
- E. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard



are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

- F. All equipment installed on this project shall have local representation; local factory authorized service, and a local stock of repair parts.
- G. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.
- H. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.
- I. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.
- J. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

## PART 2 - PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

- A. Materials and Equipment: Labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Materials shall be of a standard industrial quality if no specifications or specific model numbers are given.
- B. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- C. All materials shall be new and unused.
- D. Provide non-metallic material in corrosive areas or as otherwise specified.

## PART 3 - EXECUTION

### 3.1 WORKMANSHIP

- A. Install work in compliance with NEC latest edition.
- B. Install material and equipment in accordance with manufacturers' instructions. Provide calibrated torque wrenches and screwdrivers and tighten all terminals, lugs, and bus joints using it.
- C. Comply with startup procedures as defined by Construction Manager and Owner.
- D. Arrange electrical work in a neat, well-organized manner. Do not block future connection points of electrical service. Install all electrical work parallel or perpendicular to building lines unless noted otherwise, properly supported with purpose-designed apparatus, in a neat manner.
- E. Apply, install, connect, erect, use, clean, adjust, and condition materials and equipment as recommended by the manufacturers in their published literature.
- F. Make opening through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.

### 3.2 SERVICE CONTINUITY

- A. Maintain continuity of electric service to all functioning portions of process or buildings during the

hours of normal use. Phase construction work to accommodate Owner's occupancy requirements.

- B. Arrange temporary outages for cutover work with the Owner. Keep the outages to a minimum number and minimum length of time.
- C. All service outages shall be requested in writing a minimum of two weeks prior to the date. Owner reserves the right to postpone shutdowns up to 24 hours prior to the shutdown at no additional cost. Outage requests shall include a schedule of the work to be performed and the time requirements.
- D. The Contractor shall obtain all appropriate Owner permits for working in equipment.

### 3.3 HAZARDOUS LOCATIONS

- A. Equipment, wiring, devices, and other components located within hazardous areas to be of appropriate type per NFPA requirements.
- B. Ground exposed non-current carrying parts of entire electrical system in hazardous areas, in accordance with NEC and as instructed by Owner.

### 3.4 SLEEVES AND SEALS

- A. Provide sealing and/or fire stopping where electrical equipment passes through walls, ceilings, and floors. Seals shall be watertight and/or fire rated as applicable.

### 3.5 CONSTRUCTION REVIEW

- A. The Engineer or Owner's representative will review and observe installation work to insure compliance by the Contractor with requirements of the Contract Documents.
- B. Review, observation, assistance, and actions by the Engineer or Owner's representative shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The review and observation activities shall not relieve the Contractor from the responsibilities of these Contract Documents.
- C. The fact that the Engineer or Owner's representative do not make early discovery of faulty or omitted work shall not bar the Engineer or Owner's representative from subsequently rejecting this work and insisting that the Contractor make the necessary corrections.
- D. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the Engineer or Owner's representative for an increase in the Contract price, or for any payment on account of increased cost, damage, or loss.

### 3.6 WARRANTY

- A. Provide warranties in accordance with the requirements of Uniform General and Supplementary Conditions (UGC).

END OF SECTION

SECTION 26 00 00.01

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electrical demolition for remodeling.
- B. Electrical/control portion of HVAC work covered by Division 23 pertaining electrical demolition shall follow the requirement set forth by this specification.

1.2 RELATED WORK

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for minor electrical demolition for remodeling.
  - 1. Section 26 00 00 - Basic Electrical Requirements.
- B. In the event of conflict regarding minor electrical demolition requirements between this Section and any other Section, the provisions of this Section shall govern.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: as specified in individual Sections.
- B. Provide all materials necessary for work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. All demolitions or modifications to existing systems shall be coordinated through Owner's Representative. Demolition drawings are based on casual field observation and existing record documentations. Therefore the accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements and circuiting arrangements are as shown on Drawings and abandoned wiring and equipment serve only abandoned facilities. The Contractor shall be responsible for reporting discrepancies to Engineer before disturbing existing installation.
- B. Beginning of demolition means Contractor accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal. Provide temporary wiring and connections to maintain remaining systems in service during demolition and/or modification. Owner reserves the right up to 24 hours prior to any scheduled event to delay or suspend shutdowns or outages to more convenient times at no additional cost.
- B. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. No work shall begin without proper permits and authorizations. Disable system only to make switchovers and connections. Obtain permission from Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- C. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Provisions for manual fire watch shall be provided in areas where services are interrupted. Make temporary connections to maintain service in areas adjacent to work area.
- D. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Notify Owner

at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

### 3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new plan drawings.
- B. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes full length from source to device. Cut embedded or concealed conduit flush with walls and floors, and patch surfaces.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- D. Disconnect and remove abandoned panelboards and distribution equipment.
- E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
- H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- I. Extend existing installations using materials and methods compatible with existing electrical installation or as specified.
- J. The level of completion shall be demonstrated to Owner's Representative.
- K. Where equipment is indicated to be demolished and returned to Owner, the Contractor shall include the delivery of this equipment to the Owner's site storage area. Remove with care all equipment to be relocated. Repair or replace of newly damaged equipment is the responsibility of the Contractor.

### 3.4 CLEANING AND REPAIR

- A. The Contractor shall follow Owner's clean work policy and shall include the removal of trash and demolished material from the building or work area at the end of the each day and removal from the site once a week.
- B. The Contractor shall be responsible for repairing adjacent construction and finishes damaged during demolition and/or modification. The Contractor shall be responsible for the removal of ceiling tiles required in the demolition work. The Contractor shall be responsible for the replacement of damaged tiles and reinstallation of the ceiling prior to final acceptance.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.

### 3.5 DISPOSITION OF MATERIAL AND EQUIPMENT

- A. Review with the Owner materials that have been removed and are no longer required, to determine any which the Owner may desire to keep. Deliver those materials that the Owner desires to the Owner's specified location.
- B. For those materials not required by the Owner, dispose of them in accordance with applicable regulations.

END OF SECTION

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SECTION 26 05 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Hinged cover enclosures and cabinets
- B. Contactors
- C. Control relays
- D. Push buttons, and selector switches
- E. Terminal blocks and accessories
- F. Penetration sealing systems (fire stops)
- G. Electrical/control portion of HVAC work covered by Division 23 pertaining basic electrical materials and methods shall follow the requirement set forth by this specification.

1.2 APPLICABLE CODES AND STANDARDS

- A. NFPA 70, National Electrical Code (latest edition)
- B. American National Standard, National Electrical Safety Code, (latest edition)
- C. Applicable publications of NEMA, ANSI, IEEE, and ICEA
- D. Underwriters Laboratories, Inc. Standards (UL)
- E. Federal, city, state, and local codes and regulations having jurisdiction
- F. OSHA requirements
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. NEMA WD 1 – General-Purpose Wiring Devices
- I. UL 98 - Enclosed Switches

1.3 INTENT

- A. This Section is not, and shall not be interpreted to be, a complete listing of all materials or equipment that is Contractor furnished and erected. It is intended to clarify and further define the Contractor scope of work, procurement, and responsibilities for those incidental materials that are not specified by other specifications, but important to a complete and operational system.
- B. The Contractor shall furnish all equipment and materials, whether or not specified in other Sections of specification and on drawings, for installation and connection required to place equipment into satisfactory operating service. The Contractor shall review the Drawings and specifications for clarification of his responsibility in the handling and installation of equipment and material. Where applicable, and not in contradiction with the Drawings and specifications, the Contractor shall install and connect the equipment in accordance with the manufacturer's recommendations and instructions.
- C. All materials and equipment shall be of types and manufacturer specified wherever practical. Should materials or equipment so specified be unattainable, the Contractor shall submit the description and manufacturer's literature, reason for substitution request and shall secure the approval of the Engineer before substitution of other material or equipment is purchased. This Section establishes performance requirements and the quality of equipment acceptable for use and shall in no way be construed to limit procurement from other manufacturer.

1.4 SUBMITTALS

- A. Provide submittals in addition and in accordance with Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.
- B. Submit manufacturer's literature and specification data sheets for each type of basic material, which is applicable to the project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit. Damaged materials shall be removed from project site.
- B. In their factory-furnished coverings, store materials in a clean, dry indoor space, which provides protection against the weather.

PART 2 - PRODUCTS

2.1 ENCLOSURES AND CABINETS

- A. Enclosures and cabinets for all Contractor furnished electrical equipment and devices shall be suitable for the location and environmental conditions and shall be of the NEMA type as shown in Table 26 05 00-1. Exceptions shall be specifically designated on the Drawings.

Table 26 05 00-1 Enclosures		
Location	Environment	Enclosure Type
Indoor Utility	Dry, subject to dust, falling dirt and dripping non-corrosive liquids	NEMA 12
Indoor	Clean, Dry	NEMA 1
Outdoor	Subject to windblown dust and rain, splashing water, and hose-directed water	NEMA 4
Indoor	Wet, subject to hose-directed water	NEMA 4
Outdoor	Subject to falling rain, sleet, and external ice formation	NEMA 3R
Indoor or Outdoor	Subject to corrosion, windblown dust and rain, splashing water and hose-directed water	NEMA 4X

- B. Enclosures shall have the following properties:
  - 1. Hinged Cover Enclosures: NEMA 250.
    - a. Type 1: Steel.
    - b. Type 4: Steel with gasket door, rain tight.
    - c. Type 4X: Stainless steel, (polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas).
    - d. Type 12: Steel with gasketed door, dust-tight.
- C. Finish: Exterior, manufacturer's standard gray enamel finish; interior, white enamel finish.
- D. Covers: Continuous hinge, held closed by flush latch operable by hasp and staple for padlock. Where required for NEMA ratings, gaskets shall be neoprene rubber.
- E. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14-gauge steel, white enamel finish.



- F. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.
- G. Forced Ventilation: Where indicated, provide 115V single-phase fan motor, filtered with air plenum, finger guard, and stainless steel grille. Washable aluminum filter, accessible for cleaning from outside the enclosure; 20,000-hour continuous operation without lubrication or service. Provide matching exhaust grille assembly. Mount fan in lower side corner, exhaust grille in opposite upper side corner.

## 2.2 CONTACTORS

- A. Acceptable Manufacturers
  - 1. General Electric Company
  - 2. Square D Company
  - 3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.
- B. Contactors: NEMA ICS 2; electrically held or mechanically held as indicated on Drawings. Two-wire control for electrically held contactors and three-wire control for mechanically held contactors.
- C. Enclosure: NEMA 1 unless indicated otherwise on Drawings.
- D. Control Transformer: Provide when indicated on Drawings. Minimum capacity shall be 100 VA. Provide primary and secondary fuse protection.
- E. Coil operating voltage; 110 volts, 60 Hz or as per drawings.
- F. Size: NEMA ICS 2; size as indicated on Drawings.
- G. Contacts: As indicated on Drawings; 600 Volts, 60 Hz.
- H. Provide solderless pressure wire terminals on bus terminals suitable for mounting in panelboard as indicated on Drawings.

## 2.3 CONTROL RELAYS

- A. Acceptable Manufacturers
  - 1. General Electric Type CR120A
  - 2. Cutler-Hammer Type M-300
  - 3. Square D Company
  - 4. Allen-Bradley
  - 5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.
- B. Provide magnetic control relays, NEMA Class A: A300 (300 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts, and meeting the requirements of NEMA ICS 2.
- C. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a solid-state timer attachment adjustable from 0.2 to 60 seconds (minimum) or with range as indicated. Provide with field convertible from ON delay to OFF delay and vice versa.
- D. Where latching (mechanically held) relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

## 2.4 PUSH BUTTONS, AND SELECTOR SWITCHES

- A. Acceptable Manufacturers
  - 1. Allen-Bradley

2. Square D
  3. Cutler Hammer
  4. Seimens
  5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.
- B. For non-hazardous, indoor, dry locations, including control panels, and individual stations, provide heavy duty, NEMA 13, oil tight type pushbuttons, indicating lights, selector switches, and stations for these devices.
- C. For non hazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, NEMA 4, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4 watertight enclosures. Provide special gasketing required to make complete station watertight.
- D. For hazardous locations, provide control station listed by UL for Class I, Divisions 01 and 02, Groups C and D; Class II, Division 01 and 02, Groups E, F, and G. Specific type shall be in accordance with area classification as indicated on the Drawings.
- E. For corrosive locations, provide nonmetallic components and enclosures meeting NEMA Type 4X.
- F. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide push-button stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Nameplates shall be as specified in Section 26 05 53.
- G. Utilize selector switches having standard operating levers. All indicating lights shall be LED type, push-to-test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

## 2.5 TERMINAL BLOCKS AND ACCESSORIES

- A. Signal And Control Terminals
1. Acceptable Manufacturers
    - a. Phoenix Contact
    - b. Buchanan
    - c. Weidmüller
    - d. Entrelec
    - e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 23 00 00 and Division 01 for substitution requirement.
  2. Signal and Control Terminals: Modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts. Minimum terminal width of 0.24-inch, capable of holding two No. 12 or two No. 14 AWG conductors in each connector. Terminal identification numbers shall be thermoset characters (black) on a white background. Provide 25 percent spare terminals.
- B. Power Terminals
1. Acceptable Manufacturers
    - a. Buchanan
    - b. IlSCO
    - c. Square D Company

- d. Burndy
  - e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.
2. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts, size as required. Provide 25 percent spare terminals.

## 2.6 PENETRATION SEALING SYSTEMS (FIRE STOPS)

- A. Provide penetration sealing where conduit, cable tray, etc. pass through rated walls, ceilings, and floors. See Section 07840, Fire Stopping, and Section 07900, Joint Sealants, for sealing requirements and systems.

## 2.7 UL LISTING

- A. All equipment and materials shall be new and conform to the requirements of this Section. All equipment and materials shall be UL listed, and shall bear their label whenever standards have been established and level service is regularly furnished. All equipment and materials shall be of the best grade of their respective kind for the purpose.

## PART 3 - EXECUTION

### 3.1 FABRICATION - CONTROL ENCLOSURES AND CABINETS

- A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

### 3.2 INSTALLATION - ENCLOSURES AND CABINETS

- A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.
- B. Provide accessory feet for freestanding equipment enclosures.
- C. Install trim plumb.

### 3.3 ERECTION OF EQUIPMENT

- A. Manufacturer's Installation Instructions: Where furnished or called for by the manufacturer equipment manufacturer's installation instructions shall be considered a part of this specification and fully complied with. Where the Contractor damages the finishing coat of paint in existing or completed areas, he shall refinish with matching paint.
- B. Mounting Heights: Individual safety switches and buttons and devices shall normally be installed at the following mounting heights, when not specified on the Drawings.
  - 1. Safety Switches: 6 feet 0 inches (to top).
  - 2. Pushbuttons: 4 feet 0 inches (to center).
  - 3. Control Panels: 6 feet 0 inches (to top).
- C. Mounting: Equipment and control devices shall be supported independent of conduit connections. Panels or cabinets shall be mounted on metal frame supports independently of equipment. Control devices and metal enclosures shall be bolted or welded to steel channel or steel plate. All electrical equipment and devices not covered by the above, such as miscellaneous switches, thermostats, duct switches, temperature switches, floats, photoelectrical devices, and similar electrical devices shall be located and set as suitable for the application. Where control panels are provided as part of the equipment racks mounted on the floor, they shall be provided to support conduits and flexible connections to control panels.

### 3.4 COORDINATION

- A. Exact location of all electrical equipment, devices and fixtures shall be determined in field by contractor and verified by Engineer's field representative prior to installation.

END OF SECTION

## SECTION 26 05 19

### CABLE, WIRE AND CONNECTORS, 600 VOLT

#### PART 1 - GENERAL

##### 1.1 WORK INCLUDED

- A. Building wire.
  - 1. Power distribution circuitry.
  - 2. Control system circuitry.
  - 3. Lighting circuitry.
  - 4. Appliance and equipment circuitry.
  - 5. Motor-branch circuitry.
  - 6. Other systems circuitry as designated.
- B. Cable.
- C. Wiring connections and terminations.
- D. Electrical/control portion of HVAC work covered by Division 23 pertaining to 600 volt cable, wire and connectors shall follow the requirements set forth by this specification.

##### 1.2 REFERENCES

- A. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- B. ANSI/UL 83 – Thermoplastic-Insulated Wire and Cables
- C. NFPA 70 – National Electrical Code, latest edition
- D. NEFA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- E. Where application of National Electrical Code, trade association standards or publications appears to be in conflict with the requirements of this Section, the Architect/Engineer shall be asked for an interpretation.

##### 1.3 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirements.
- B. Submit manufacturer's literature and specification data sheets for each item of cable, wire and connectors.
- C. Qualification of cable and wire manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years experience.

##### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire or connectors shall be removed from project site.
- B. Store cable, wire and connectors in a clean, dry indoor space in their factory-furnished coverings, which provides protection against the weather.

#### PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS

- A. Generally, cable, wire and connectors shall be of manufacturer's standard materials, as indicated by published product information.
- B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 copper with insulation as noted below. Minimum size for control shall be #14 copper.
- C. The conductors of wires and cables shall be of copper (tinned where specified), and have conductivity in accordance with the standardization rules of the IEEE. The conductor and each strand shall be round and free of kinks and defects.
- D. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the NEC. Conductors intended as a neutral shall be colored solid white, or identified as required by the NEC. All motor or equipment power wiring shall be colored according to Section 26 05 53, Electrical Identification.
- E. Use crimp type compression lugs for all wiring termination's, except on breakers or terminal strips in panel boards.

## 2.2 BUILDING WIRE

- A. Thermoplastic-insulated Building Wire: NEMA WC 5.
- B. Rubber-insulated Building Wire: NEMA WC 3.
- C. Feeders and Branch Circuits, all sizes: 98% conductivity copper, soft-drawn, stranded conductor, 600 volt insulation, THHN/THWN-2 Use XHHW-2 conductors where installed in conduit underground. Use of aluminum conductors is acceptable for conductors #1/0 and above. All conductor sizes shown on plans are based on copper cable. If aluminum conductor is selected, the contractor is responsible for sizing the conductor to match or exceed the equivalent capacity of the copper conductor. Conduit size shall also be adjusted to suit the aluminum conductors.

## 2.3 REMOTE CONTROL AND SIGNAL CABLE

- A. 600 Volt Insulation Control Cable for Class 1 Remote Control and Signal Circuits, Type TC:
  - 1. Individual Conductors: 14 AWG, stranded copper, XHHW insulation. Rated 90 degrees C dry, 75 degrees C wet, color-coded per ICEA Method 1 plus one green equipment grounding conductor.
  - 2. Assembly: Bundle wrapped with cable tape and covered with an overall PVC jacket. Cable shall pass IEEE-1202 vertical tray ribbon-burner flame test (210,000 BTU) VW-1.
- B. Instrumentation Cable
  - 1. 300 Volt Instrumentation Cable, Multiple Pairs, Overall Shield, Type PLTC:
    - a. Individual Conductors: 18 AWG, stranded, tinned copper, flame retardant polyethylene or PVC insulated, rated 105 degrees C, black and white numerically printed and coded pairs.
    - b. Assembly: Individual twisted pairs having a 100 percent coverage aluminum-polyester shield and 20 AWG stranded tinned copper drain wire. Conductor bundle shall be shielded with 100 percent coverage overall aluminum-polyester shield complete with 20 AWG drain wire. All group shields completely isolated from each other. Bundle wrapped with cable tape and covered with an overall flame retardant PVC jacket. Cable shall pass IEEE-383 vertical tray flame test (70,000 BTU) UL1581.
- C. Life Safety Systems Cable
  - 1. All life safety system wiring shall be installed in dedicated conduit or raceway with adequate separation/shielding from all other systems.

2. Life safety systems wiring shall be as specified in the Section 28 31 00 - Fire Alarm and Smoke Detection Systems.

D. Security/Access Control/CCTV Cable

1. All security/access control wiring shall be installed in dedicated conduits.
2. Security/access control wiring shall be rated and as specified below:

Circuit Type	No. of Conductors	Conductor Specifications	Cable Specifications
20 mA Current Loop	2	18-gauge, stranded copper	2 cables, 1 twisted pair each required
Card Reader Coaxial	--	18-gauge, solid copper, center conductor	Schlage Model No. SE9284PL or Anicom 5910PL
Contact Circuits	2	18-gauge, stranded copper	Nonshielded, twisted
CCTV Coaxial	--	--	Belden 89259 plenum rated, or approved equal

3. All security/access control power circuit wiring shall comply with paragraph 2.2. Building Wire of this Section.

- D. Plenum Cable for Class 3 Remote Control and Signal Circuits: 98% conductivity copper conductor, 300 volt insulation, rated 60 degree C, UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.4 WIRING CONNECTIONS AND TERMINATIONS

- A. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. Select from only following types, classes, kinds and styles.

1. Type:
  - a. Solderless pressure connectors
  - b. Crimp.
  - c. Threaded.
  - d. Insulated spring wire connectors with plastic caps for 10 AWG and smaller.
2. Class: Insulated.
3. Material: Copper (for CU to CU connection).
4. Style:
  - a. Insulated terminals. Use ring-terminal for control wiring. Use flange (fork) spade compression terminal for termination of stranded conductors at wiring devices, including ground connection.
  - b. Split bolt-parallel connector.
  - c. Pigtail connector.
  - d. Pre-insulated multi-tap connector.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Installer must examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 GENERAL WIRING METHODS

- A. Install electrical cable, wire and connectors as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and as required to ensure that products serve the intended functions.
- B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface. Do not install the conductors until raceway system is complete and properly cleaned.
- C. Cables shall be selected on the basis of their purpose and UL listing. Generally, use Types THWN-2 and THHN-2 in building interiors and other dry locations. Outdoors and underground in raceways, use Type XHHW-2. Conductors subject to abrasion, such as in lighting poles, shall be Type XHHW-2.
- D. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 50' in length (100' for 277 volt) no conductor smaller than a No. 10 wire shall be used. The sizing of all wire except remote control wire shall be accomplished in the case of both feeder and branch circuits by conforming to the following provisions. Separate neutral conductors shall be provided for each phase of the same size for 120V/277V single-phase application for heavy electrical loads, computer loads, loads fed from isolated transformers, lab equipment, clinic equipment, dedicated circuits, unless noted otherwise on drawings. Voltage drop on feeders and branch circuits shall not exceed NEC requirement.
- E. Remote control wires shall be no smaller than No. 14 conductors. Control wires shall be run in separate conduits. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code requires the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of the Owner's duly authorized representative.
- F. Splice branch circuits only in accessible junction or outlet boxes. Control cable shall never be spliced except the final connection to field devices. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings.
- G. Wiring Within An Enclosure: Contractor shall bundle ac and dc wiring separately within an enclosure. The Contractor shall utilize panel wire-ways when they are provided. Where wireways are not provided the Contractor shall neatly tag, bundle wires and secure to sub-panel at a minimum of every three inches with T&B Type TC5355 heavy duty mounting bases.
- H. Do not band any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors.

### 3.3 WIRING INSTALLATION IN RACEWAYS

- A. Wire and cable shall be pulled into clean dry conduit. Do not exceed manufacturer's recommended values for maximum pulling tension.
- B. Pull conductors together where more than one is being installed in a raceway.
- C. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.



- D. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.
- E. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- F. Place an equal number of conductors for each phase of a circuit in same raceway.
- G. Provide separate conduit or raceway for line and load conductors of motor starters, safety disconnect switches, and similar devices. Those devices shall not share the same raceway.
- H. All conduits shall contain a green grounding conductor. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.

### 3.4 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage during construction. Do not install cable before the completion of raceway system.
- B. Cable above ceilings shall be in conduit or raceways. Cables, conduits and raceways shall not be laid on ceiling tiles or strapped to ceiling wire.
- C. Use suitable cable fittings and connectors.
- D. It shall be the Contractor's responsibility to accurately measure all cable runs before the cable is cut. The Contractor shall furnish all tools and equipment, have sufficient properly trained personnel and shall exercise necessary care to ensure that the cable is not damaged during installation. Cable found to be damaged before installation shall not be installed. Cable damage during installation shall be removed and replaced. Repairs to cables can only be done with written permission from the Owner's Representative and only under special circumstances.
- E. Care shall be exercised with cables entering or leaving cable trays that all cable bend radii shall not be less than the recommended minimum and that cables are not left to rest unprotected on any sharp edge or corner.
- F. PVC jacketed cable shall not be installed or worked in any way at temperatures below 32 degrees F, unless cable has been previously stored in a heated area 48 hours prior to being pulled and transported to a heated pulling area.
- G. Each cable entering an enclosure shall have its conductors bundled together and identified with the cable number. All groups of conductors within an enclosure shall be shaped and formed to provide a neat appearance to facilitate future additions or rework. All control conductors shall be numbered and shall be labeled at each termination with this number, using markers designed for the application.
- H. Multi-Conductor Cable Installation: Fire alarm cable shall be routed in a separate conduit only.
- I. Instrument Cable: Instrument cable shall, when conduit installation is required be installed in rigid steel conduit. They shall not be spliced at any point. The shields and drain wires of shielded signal cables shall be grounded only at one point as indicated on the Drawings.

### 3.5 WIRING CONNECTIONS AND TERMINATIONS

- A. Install splices, taps and terminations, which have equivalent-or-better mechanical strength and insulation as the conductor. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- B. Keep conductor splices and taps accessible and to a minimum, and in junction boxes only. Control circuit conductors shall terminate at terminal blocks only. Splices below grade shall only be in handholes or manholes and shall be made watertight with epoxy resin type splicing kits similar to Scotchcast.
- C. Use splice, tap and termination connectors, which are compatible with the conductor material.
- D. Thoroughly clean wires before installing lugs and connectors.
- E. Terminate spare conductors with electrical tape and label as spare.

- F. Power and Lighting Circuits: Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.
- G. Use split bolt connectors for copper wire splices and taps, 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- H. Connections for all wire sizes in motor terminal boxes where the motor leads are furnished with crimped-on lugs shall be made by installing ring type compression terminals on the motor branch circuit ends and then bolting the proper pairs of lugs together. First one layer of No. 33 scotch tape reversed (sticky side out), then a layer of rubber tape, then two layers of No. 33 half-lapped.
- I. Identify conductors per Section 26 05 53 - Electrical Identification.

### 3.6 FIELD QUALITY CONTROL

- A. Torque test conductor connections and terminations to manufacturer's recommended values.
- B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.
- C. Conductors in vertical conduits or raceways shall be supported in the manner set forth in the appropriate section of the latest revision of the National Electrical Code. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.
- D. Conductors may be run in parallel on sizes 1/0 to 500 MCM inclusive provided all paralleled conductors are the same size, length, and type of insulation. Except as otherwise shown on drawings, no more than three conductors may be run in parallel, and they shall be so arranged and terminated as to insure equal division of the total current between all conductors involved. Where parallel connection is contemplated, approval of the Owner's representative must be obtained before installation is made.

### 3.7 TESTING AND ACCEPTANCE

- A. Before final acceptance, the Contractor shall make voltage, insulation, and load tests, necessary to demonstrate to the Owner's representative the satisfactory installation and proper performance of all circuits.
- B. Test feeder conductors clear of faults. Insulation-resistance test shall be conducted per NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems. Test results below 50 megohms shall be cause for rejection of the wiring installation. Replace and retest all such rejected conductor.
- C. At the completion of this project, the Contractor shall provide for the Owner three (3) complete and finally corrected sets of working drawings. These sets of working drawings shall be new, unused and in good condition, and shall include the nature, destination, path, size and type of wire and all other characteristics for complete identification of each and every conduit and circuit.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Power system grounding.
- B. Electrical equipment and raceway grounding and bonding.

1.2 RELATED WORK

- A. Lightning protection.

1.3 REFERENCES

- A. NFPA 70 – National Electrical Code, latest edition
- B. ANSI/UL 467 – Electrical Grounding and Bonding Equipment
- C. ANSI/IEEE STD 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems
- D. IEEE 81 – Guide for Measuring Earth Receptivity, Ground Impedance and earth Surface Potential of a ground System
- E. IEEE 1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
- F. ANSI/TIA/EIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

1.4 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment to grounding electrodes. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operations. Concrete encased electrodes shall be connected as the most effective grounding electrodes. Provide a completely grounded system in accordance with Article 250 of the NEC.
- B. Ground each separately-derived system neutral to separate ground buses that are installed in nearest electrical rooms. Transformer, UPS systems, power conditioners, inverters, or other power supplies are separately derived systems. Standby or emergency generators are separately derived systems if the neutral is bonded to the generator frame and if there is no direct connection of the generator neutral conductor to the service neutral conductor.
- C. Refer to telecom plans for grounding requirements for telecom systems.
- D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath, ground bus in electrical rooms and IT rooms, metal frame of the building or structure, ground ring, lightning down lead conductor, grounding conductor in raceways and cables, receptacle ground connectors, and metal underground water pipe.
- E. Bonding jumpers shall be installed around non-metal fittings or insulating joints to ensure electrical continuity. Bonding shall be provided where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

1.4 SUBMITTALS

- A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

2.1 MATERIALS AND EQUIPMENT

- A. Grounding system components shall be as required to comply with the design and construction of the system indicated. Components shall be as indicated in manufacturer's submittal data.
- B. Ground conductors shall be stranded tinned, annealed copper cable of the sizes indicated on drawings. Bond grounding conductors at both ends of metallic conduit.
- C. Grounding clips shall be Steel City Type G, or equal.
- D. Ground Rods shall be copper-encased steel, 3/4" diameter, minimum length 10 feet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install ground system as indicated, in accordance with the applicable requirements of the National Electrical Code and the National Electrical Contractors Association's "Standard of Installation".
- B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Install test wells as required per drawings.
- C. In feeder and branch circuits, provide a separate, insulated equipment grounding conductor. Terminate each end on a grounding lug, bus, or bushing.
- D. Connect grounding electrode conductors to metal water pipe where metal pipe is available and accessible using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- E. Install fusion welded ground connectors where they are concealed or inaccessible.
- F. Ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the cover plate; or by the use of an approved grounding yoke type receptacle.
- G. No strap grounding clamps shall be used; connections requiring bolting shall be made up with monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.
- H. Install external ground wire on liquid tight flexible metal conduit with grounding bushings.
- I. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors. .
- J. The neutral of each transformer shall be bonded to system ground at one point only. This point shall be ahead of the first secondary protective device.

3.2 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION

SECTION 26 05 29

SECURING AND SUPPORTING METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Raceway, cable tray, and equipment supports
- B. Fastening hardware
- C. Coordinate location of concrete equipment pads

1.2 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry. Support systems shall be sized adequately to support an additional 25% for future loads

1.3 COORDINATION

- A. Coordinate with other trades where conduit and cable tray supports are in the same location as piping, ductwork, and work of other trades and where supports are furnished and installed under other Divisions. Supporting from the work or supports of other Contractors shall not be allowed except by express, written permission of the Owner.

1.4 SUBMITTALS

- A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Support Channel:
  - 1. All non-corrosive locations: Hot-dip galvanized steel.
  - 2. Corrosive locations: Nonmetallic fiberglass.
- B. Hardware:
  - 1. All non-corrosive locations: Hot-dip galvanized steel.
  - 2. Corrosive locations: Stainless steel threaded rod, attachments and fasteners shall be used with fiberglass supports.
- C. Threaded Rod: used for rack support from structure above; 3/8-inch minimum diameter.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, or beam clamps. Do not use spring steel clips and clamps. Provide necessary calculations to select proper support materials for electrical equipment, raceway, and cable tray supports. Provide cable tray supports for cable tray filled to 125 percent capacity per NEC.
- B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NEC for installation of supporting devices. Install supports with spacing in compliance with NEC requirements.

- C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors in solid masonry walls; or concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.
- E. Do not use powder actuated anchors without written permission from the Engineer.
- F. Do not drill structural steel members without written permission from the Structural Engineer.
- G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- H. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.
- I. Install surface mounted cabinets and panelboards with a minimum of four anchors. Provide strut channel supports to stand cabinet 1-5/8 inches off wall. Utilize "Post Bases" where support channel is attached to structural floor.
- J. Provide extra care in supporting PVC conduit to protect it from potential damage.
- K. Use fiberglass for nonmetallic raceway systems supports in areas subject to corrosives.
- L. All supports in contact with floor using stanchion type support shall be solidly bolted to the permanent structural floor.
- M. Conduit supports shall have at a minimum, the bottom support member constructed of double strut. This horizontal member shall be double-nutted, and the supporting all-thread rod shall be trimmed to one inch below lowest nut.
- N. Conduit entering/exiting cable tray shall be attached to the tray rail by means of unistrut bolted to the rail and standard manufacturer's accessories. Conduit shall only enter/exit tray horizontally supported within three feet of the tray, and extended into the tray two inches. Conduit shall be terminated with a grounding bushing, and bonded to the tray ground wire. (The attachment to the tray shall not be considered a support.)
- O. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- P. Install freestanding electrical equipment on 4-inch concrete pads. Pad shall be a minimum four inches larger than equipment. No crevices shall be left around the pads. Equipment includes but not limited to the following:
  - 1. Motor Control Centers
  - 2. Static Transfer Switches
  - 3. Floor mounted VFDs
  - 4. Floor mounted transformers
  - 5. Switchboards, 1200A and larger
- Q. Do not anchor supports to columns. Where panelboards, cables, or conduits are routed on the face of a column provide "column hugging" channel supports.

### 3.2 TOUCH-UP

- A. Touch-up all scratches on securing and supporting system, and paint the ends of channel after cutting with an approved zinc chromate or 90 percent zinc paint.

END OF SECTION



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SECTION 26 05 33

RACEWAYS, CONDUITS AND BOXES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Raceways:

1. Surface metal raceways.
2. Multi-outlet assemblies.
3. Wireways.
4. Indoor service poles.

B. Conduit:

1. Rigid metal conduit and fittings. (RGS)
2. Intermediate metal conduit and fittings. (IMC)
3. Electrical metallic tubing and fittings. (EMT)
4. Flexible metal conduit and fittings.
5. Liquid-tight flexible metal conduit and fittings.
6. Non-metallic conduit and fittings. (underground use only)
7. PVC coated rigid steel conduit.

C. Boxes:

1. Wall and ceiling outlet boxes.
2. Pull and junction boxes.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining raceway, conduit and boxes shall follow the requirement set forth by this specification.

1.2 REFERENCES

- A. NFPA 70 – National Electrical Code, latest edition
- B. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
- C. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated
- B. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies
- E. EMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
- F. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. ANSI/NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
- I. ANSI/UL 1 – Flexible Metal Conduit
- J. ANSI/UL 5 – Surface Metal Raceways and Fittings
- K. ANSI/UL 360 – Liquid-tight Flexible Steel Conduit
- L. ANSI/UL 467 – Electrical Grounding and Bonding Equipment
- M. ANSI/UL 651 – Schedule 40 and 80 Rigid PVC Conduit (underground use only)

- N. ANSI/UL 797 – Electrical Metal Tubing
- O. ANSI/UL 870 – Wireways, Auxiliary Gutters and Fittings
- P. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated galvanized Rigid Steel Conduit and Intermediate Metal Conduit
- Q. NEMA VE 1 – Metallic Cable Tray Systems
- R. UL 6 – Rigid Metal Conduit
- S. ANSI/UL 5C – Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits
- T. ANSI/UL 498 – Attachment Plugs and Receptacles
- U. ANSI/UL 943 – Ground Fault Circuit Interrupters

### 1.3 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Section 01330, Submittal Procedures.
- B. Shop drawings consisting of a complete list of equipment and materials, which will be used for the project, including manufacturer's descriptive and technical literature, catalog cuts and installation instructions.
- C. Sealing/fire stopping materials and details.

### 1.4 STORAGE AND HANDLING

- A. Handle materials carefully to avoid damage, breaking, denting and scoring. Damaged equipment or materials shall not be installed.
- B. Store materials in a clean dry space and protected from the weather.

## PART 2 - PRODUCTS

### 2.1 SURFACE METAL RACEWAY

- A. Surface metal raceway shall be factory pre-assembled galvanized steel complete including bases, removable covers, receptacles, end plates, elbows, connectors and fittings, to exact length to match the length of the cabinets, casework, utility chases, and shelving as indicated on laboratory and furniture shop drawings, and work bench details, as applicable.
- B. Size shall be as shown on the Drawings. The length shown on electrical drawings is diagrammatic only and is not accurate for fabrication of raceway Sections. Refer to shop drawings, architectural plans, elevations, and details.
- C. Finish shall be ANSI-61 gray enamel .
- D. Covers shall be field removable by use of a standard screwdriver, without marring the extrusion or cover finish. Raceway with two covers must allow each cover to be removed separately without access into the compartment(s) enclosed by the other cover.
- E. Provide a permanent, integral, grounded metallic dividing barrier to isolate the wiring compartments in the multi-outlet raceway system per drawing as applicable. Provide divider with fittings that maintain the separation of the raceway wiring compartments.
- F. Provide device brackets for mounting standard single-gang or two-gang devices within the raceway system. Devices shall have the capacity of mounting flush or in conjunction with device faceplates.
- G. Provide receptacles for the respective power systems as indicated on the drawings. Refer to Section 26 27 26 Wiring Devices for device specifications.

### 2.2 MULTI-OUTLET ASSEMBLY

- A. Multi-outlet assembly shall be two-piece sheet metal channel with fitted, removable cover suitable for use as a multi-outlet assembly.

- B. Size shall be as indicated on the Drawings.
- C. Provide receptacles mounted as shown on Drawings.
- D. Finish shall be ANSI-61 gray enamel.
- E. Provide couplings, elbows, outlet and device boxes, and connectors designed for use with multi-outlet system.

### 2.3 WIREWAYS

- A. Wireways shall be of steel construction general purpose for indoor spaces and rain tight for outdoor applications with knockouts.
- B. Size shall be as indicated on Drawings.
- C. Cover shall be hinged or screw applied as indicated on Drawings. Rain tight wireways shall be provided with full gasketing.
- D. Fittings shall be so constructed to continue the "lay-in" feature through the entire installation.
- E. Provide all sheet metal parts with a rust inhibiting phosphating primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

### 2.4 CONDUIT AND FITTINGS

- A. Conduit and fittings for all electrical systems on this project shall include the following:
  - 1. Electrical power and lighting feeders
  - 2. Electrical power and lighting circuits
  - 3. Telephone systems
  - 4. Control systems (other than HVAC)
  - 5. Fire alarm and signaling systems
  - 6. Other electrical systems
- B. For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the same type indicated.
- C. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, unless grounding bushings are required by N.E.C. Article 250. Grounding bushings shall have insulated throats.
- D. Rigid and intermediate metal conduit shall be hot-dipped galvanized. Fittings shall be threaded type. Expansion fittings shall be OZ Type DX.
- E. Electrical metallic tubing shall be galvanized. Fittings shall be all steel compression type. Expansion fittings shall be OZ Type TX.
- F. Flexible metal conduit and fittings shall be zinc-coated steel.
- G. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid-tight covering of flexible polyvinyl chloride (PVC). It shall be furnished with a sealing O-ring where entering an enclosure subject to moisture. Where O-Rings are used, ground type bushings shall be used in the box or enclosure.
- H. Nonmetallic conduit and fittings shall be suitable for temperature rating of conductor but not less than 90°C. Nonmetallic conduit and fittings shall be molded of high impact PVC compound having noncombustible, nonmagnetic, non-corrosive and chemical resistant properties and shall be of the same manufacturer. Where located outdoors and above ground, the conduit and fittings shall be UV resistant. Solvent cement shall be of the same manufacturer as the conduit and shall be of the brush-on type. Spray solvents are prohibited. PVC coated metallic fittings shall not be

permitted for PVC conduit connections.

- I. Crimp or set-screw type fittings are not acceptable.
- J. Minimum conduit size shall be 3/4 inch, except 1/2 inch flexible metallic conduit may be used as fixture whips.
- K. PVC coated rigid steel conduit shall be externally coated with a 40 mil PVC coating and internal phenolic coating over a galvanized surface.

## 2.5 WALL AND CEILING OUTLET BOXES

- A. Galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Minimum box size shall be 4" square by 2 1/8" deep except boxes for light fixtures may be octagonal, 4" and 1 1/2" deep.
- B. Outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.
- C. Provide multi-gang outlets of single box design. Sectional boxes are not acceptable. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NEC, and not less than 1 1/2 inch deep unless shallower boxes are required by structural conditions and are approved by the A/E.
- D. Provide deep type FD cast metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with 3/4" threaded conduit ends, cast aluminum face plate with spring-hinged waterproof cap for outdoor use.
- E. Outlet boxes in poured concrete shall be plenum type without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.
- F. Provide 4-inch octagonal ceiling outlet boxes.

## 2.6 PULL AND JUNCTION BOXES

- A. Boxes shall be galvanized sheet metal conforming to ANSI/NEMA OS 1 with screw-on cover and welded seams, stainless steel nuts, bolts, screws and washers.
- B. Boxes larger than 12 inches in any dimension shall be panelboard code gauze galvanized steel with hinged cover.
- C. Boxes shall be sized in accordance with NEC.

## PART 3 - EXECUTION

### 3.1 INSTALLATION - CONDUIT

- A. Install products as indicated, in accordance with the applicable requirements of NEC, NEMA and the National Electrical Contractors Association's "Standard of Installation".
- B. Cut conduit square using a saw or pipe cutter. De-burr cut ends. Joints in steel conduit must be painted with T&B Kopr shield and drawn up tight. Threads for rigid metal conduit and IMC shall be deep and clean. Running threads shall not be used. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement with brush to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum. Spray type of cement is not acceptable. Install raceway and conduit system from point of origin in outlets shown, complete with support assemblies including all necessary hangers, beam clamps, hanger rods, turnbuckles, bracing, rolls, clips angles, through bolts, brackets, saddles, nuts, bolts, washers, offsets, pull boxes, junction boxes and fittings to ensure a complete functional raceway system. Where vertical drops of conduit are made to equipment in open space, the vertical conduit shall be rigidly supported from racks supported on the floor.

- C. Install rigid wall hot-dipped galvanized steel conduit or hot-dipped galvanized intermediate metal conduit for service entrance; feeders; wall or floor penetrations; mechanical rooms electrical rooms and exposed locations where there is a high potential subject to physical damage; exposed outdoor locations; damp locations or any location as per design drawing. The following exceptions permitted:
1. EMT
    - a. In sizes up to and including 1-1/2 inch, may be used inside dry locations where not subject to mechanical damage. EMT may be used in air-conditioned spaces, such as accessible ceilings, dry wall partitions and exposed where 6 feet above the floor. EMT may not be used outside, in concrete, underground, in under floor spaces, in masonry walls, in locations likely to be damp, in electrical rooms subject to mechanical damage due to future installation, or exposed within 6 feet of the floor. EMT shall not be used for medium voltage circuits.
    - b. Where used for feeder circuits receptacle branch circuits and motor branch circuits EMT shall also contain a NEC grounding conductor.
    - c. All conduits shall be concealed in walls or ceilings unless otherwise noted.
  2. Liquid-tight
    - a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Install external ground wire on flexible conduit with grounding bushings. Maximum length shall be 6 feet minimum of 2 feet.
  3. Flexible Metal Conduit
    - a. Install standard flexible metal conduit (not liquid-tight), which shall be only used for lighting fixture whips or motor vibrations, with internal ground wire. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. Maximum length shall be 6 feet minimum of 3 feet; minimum size shall be 3/4; and minimum size shall be 1/2 inch for lay-in light fixture whips.
- D. Install conduits parallel and supported on Unistrut, or equal, trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. No raceways or boxes shall be supported using wire. Arrange conduit to maintain headroom and present a neat appearance. Conduit routes shall follow the contour of the surface it is routed on. Route exposed conduit and tray above accessible ceilings parallel and perpendicular to walls and adjacent piping. Maintain 12-inch clearance between conduit and heat sources, such as flues, steam pipes, and heating appliances. Wire ties or "wrap lock" are not permitted to support or secure conduit system. Fasten conduit with the following material:
1. Wood screws on wood
  2. Toggle bolts on hollow masonry
  3. Bolts and expansion anchors in concrete or brick
  4. Machine screws, threaded rods and clamps on steel
  5. Conduit clips on steel joists.
  6. 4 inch x 4 inch penta-treated pine installed in pitch pans on roof, spaced at intervals not to exceed 5 feet.
- E. Install conduits outside of building lines at a minimum depth of 30 inches below finished grade. Maintain twelve inches earth or two inches concrete separation between electrical conduits and other services or utilities underground. Encase all plastic service entrance conduits with concrete unless otherwise specifically detailed or noted on the drawings.
- F. Fittings shall be approved for grounding purposes or shall be jumpered with copper grounding conductors of appropriate ampacity. Leave termination of such jumpers exposed.

G. Install expansion fittings in metal and PVC conduit as follows:

1. Conduit Crossing Building Expansion Joints:

- a. EMT all sizes
- b. IMC all sizes
- c. RMC all sizes
- d. PVC all sizes

2. Conduits entering environmental rooms and other locations subject to thermal expansion and as required by NEC.

3. Unless expansion fitting has an integral bonding braid, as in Crouse-Hinds Type XC, a green insulated grounding conductor shall be pulled in the conduit. Both ends of this green grounding conductor shall be accessible for inspection.

H. Install conduit concealed in walls, partitions and above ceilings. Install conduit exposed in ceiling area (at structure) of boiler rooms, mechanical rooms and in other similar rooms where ceilings are not called for.

I. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

J. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture if cable or wire are not installed immediate after conduit run. Tape covering conduit ends is not acceptable.

K. Provide 200 lb. nylon cord full length in empty conduit.

L. Where conduit penetrates fire-rated walls and floors, provide pipe sleeve two sizes larger than conduit; pack void around conduit with oakum and fill ends of sleeve with fire-resistive compound or provide mechanical fire-stop fittings with UL listed fire-rating or seal opening around conduit with UL listed foamed silicone elastomer compound equal to fire-rating of floor or wall.

M. Install no more than the equivalent of three 90-degree bends between boxes. Where four 90 degree bends are required, prior approval by the Engineer is required. Use conduit bodies to make sharp changes in direction, as around beams. Conduit bodies shall be readily accessible and sized for the cables installed. Running or rolling offsets are not approved. Use factory long radius elbows for bends in conduit larger than 2-inch size. All parallel bends shall be concentric.

N. Nylon pull string shall be provided full length in conduit designated for future use.

3.2 INSTALLATION - SURFACE METAL RACEWAY AND MULTI-OUTLET

A. Use flathead screws to fasten channel to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings on multi-outlet assembly.

C. Maintain grounding continuity between raceway components to provide a continuous grounding path in accordance with the requirement of NEC.

3.3 INSTALLATION - WIREWAYS

A. Bolt wireways to steel channels fastened to the wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight wireway.

C. Mount rain tight wireway for exterior installation in horizontal position only.

3.4 INSTALLATION - BOXES

A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Provide outlet box accessories as required for each installation, including mounting brackets,

wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

- C. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in.
  - D. Locate and install boxes to allow access, minimum 12 inches above ceiling except where space dimensions do not allow.
  - E. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation. Provide minimum 24-inch separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the two and pack openings with fiberglass.
  - F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Do not support junction boxes from the raceway systems. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.
  - G. Provide knockout plugs for unused openings.
  - H. Use multiple-gang boxes where more than one device is mounted together. Do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
  - I. Install boxes in walls without damaging wall insulation.
  - J. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8 inch plaster covering back of box.
  - K. Outlet boxes for switch shall not be used as junction boxes.
  - L. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.
  - M. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
  - N. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Lighting fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.
  - O. Set floor boxes level and flush with finish flooring material.
  - P. Provide tamper resistance receptacles in child care areas, psychiatric, and medical facilities.
- 3.5 WALL AND FLOOR PENETRATIONS:
- A. Core drilling shall be approved in writing by the Structural Engineer prior to execution.
  - C. Provide a 4 inch curb around block outs through concrete floors. Fire-stop all openings per Architectural specification.
  - D. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket. Coordinate roof penetrations with the roofing contractor.

END OF SECTION

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SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Nameplates and tape labels
- B. Wire and cable markers
- C. Conduit color coding and labeling

1.2 REFERENCES

- A. NFPA 70 – National Electrical Code (latest edition)

1.3 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.
  - 1. Furnish nameplate identification schedules listing equipment type and nameplate data with letter sizes and nameplate material.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Equipment Nameplates:
  - 1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.
  - 2. For emergency equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.
  - 3. For UPS powered equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on an orange background.
  - 4. For fire alarm system provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.
- B. Underground Warning Tape
  - 1. Manufactured polyethylene material and unaffected by acids and alkalines.
  - 2. 3.5 mils thick and 6 inches wide.
  - 3. Tensile strength of 1,750 psi lengthwise.
  - 4. Printing on tape shall include an identification note BURIED ELECTRIC LINE, and a caution note CAUTION. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background.
- C. Conductor Color Tape and Heat Shrink:
  - 1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.
  - 2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or enclosure. Variations to the cable color coding due to standard types of wire or cables are not acceptable.
- D. Conduit Labels (5 kV and 15 kV Conduits Only): 2-inch black letters on yellow background reading "DANGER - 12,470 VOLTS" or "DANGER - 4,160 VOLTS". Labels shall have adhesive

backing, and shall be installed at intervals not exceeding 50 feet and on all pull boxes located to be visible from floor.

- E. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2" lettering.
- F. Tape Labels: Embossed adhesive tape, with minimum 1/4-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.
  - 1. White letters on black background for normal power.
  - 2. White letters on red background for emergency/standby power.
  - 3. White letters on orange background for UPS power.
- G. J-Box and Cover plate Voltage Labels: Black stenciled letters 1/4" high. Adhesive back tapes may be used if a clear tape is applied over the label for protection.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Degrease and clean surfaces to receive nameplates or tape labels.
- B. Install nameplates parallel to equipment lines.
- C. Secure plastic nameplates to equipment fronts using screws or rivets. Use of adhesives shall be per Owner's approval. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

**3.2 WIRE IDENTIFICATION**

- A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits. Label control wire with number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
- B. Conductors for power circuits to be identified per the following schedule.

Conductor	System Voltage		
	480/277V	208/120V	
Phase A	Brown	Black	
Phase B	Purple	Red	
Phase C	Yellow	Blue	
Neutral	Gray	White	
Grounding IG	Green N/A	Green Green w/Yellow	

**3.3 NAMEPLATE ENGRAVING SCHEDULE**

- A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.
- B. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4-inch; identify source to device and the load it serves, including location.
- C. Dry Type Transformers Not in Substations: 3/8-inch; identify equipment designation. 1/4-inch; identify primary and secondary voltages, primary source, and secondary load and location.
- D. Automatic Transfer Switches: 3/8-inch; white letters and red background; identify equipment designation 1/4-inch; identify voltage rating, normal source, standby source and load served including location.

- E. Panelboards: 3/8-inch; identify equipment designation. 1/4 -inch; identify source, voltage and bus rating.

3.4 ENCLOSURE COLOR CODING

- A. The following systems shall have each junction and pull box cover completely painted per the following:

System	Color of Box Cover
Telecommunications	Brown
DDC	Green
Emergency Power	Red
Security	White
Fire Alarm	Yellow
UPS	Orange

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES AND FLOOR BOXES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Wiring Devices:
  - 1. Wall switches.
  - 2. Receptacles.
  - 3. Device plates and box covers.
  - 4. Wall dimmers.
  - 5. Occupant sensors.
- B. Floor boxes.
- C. Wiring for HVAC in Division 23 shall meet the requirement of this specification.

1.2 REFERENCES

- A. Americans with Disabilities Act (ADA)
- B. ANSI/NEMA OS 1- Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- C. ANSI/UL 20 – General Use Snap Switches.
- D. ANSI/UL 498 – Attachment Plugs and Receptacles.
- E. ANSI/UL 943 – Ground Fault Circuit Interrupters.
- F. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts maximum).
- G. NEMA WD 1 – General-Purpose Wiring Devices.
- H. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.
- I. NEMA WD 5 - Specific-Purpose Wiring Devices.
- J. Texas Accessibility Standards. (TAS)

1.3 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver wiring devices individually wrapped in factory-fabricated containers.
- B. Handle wiring devices carefully to avoid damage, breaking and scoring.
- C. Store in a clean dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide factory fabricated wiring devices in the type and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection to correspond with branch circuit wiring and overcurrent protection. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.
- B. Device color:
  - 1. Switches, receptacles, and dimmers on normal power shall be white.

2. Switches, receptacles, and dimmers on emergency power shall be red.
3. Key operated switches shall be gray.
4. Provide receptacles in surface mounted raceways in colors the same as listed above.

## 2.2 WALL SWITCHES

### A. Acceptable manufacturers

1. Arrow-Hart
2. Hubbell
3. General Electric
4. Leviton
5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

### B. Material

1. Wall switches for lighting circuits and motor loads under 1/3 hp shall be AC general use snap switch with toggle handle, 20 amperes and 120/277 volt AC with number of poles as required.
2. Pilot light type shall be equipped with red toggle handle (glow when on), 20 amperes and 120/277 volt AC with number of poles as required.
3. Key operated switches shall be Gray, 20 amperes and 120/277 volt AC with number of poles as required key all locks alike. Furnish keys compatible with key switch, quantity as directed by Owner, minimum of ten copies.
4. Illuminated Emergency-Power-Off switch shall be provided with button guard equal to Allen-Bradley #800T-QA10R or approved substitutions.
5. A listed manual switch having a horsepower rating not less than the rating of the motor and marked "Suitable as Motor Disconnect" shall be permitted to serve as disconnect means for stationary motor of 2 horsepower or less.
6. Switch terminal screws or connectors shall be designed to accommodate No. 10 solid conductor.

## 2.3 RECEPTACLES

### A. Acceptable manufacturers

1. Arrow-Hart
2. Hubbell
3. General Electric
4. Leviton
5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

### B. Material

1. Hospital grade receptacles shall be installed in clinic, patient care and other areas required by NFPA. Tamper proof in areas serving children.
2. Dedicated circuit and convenience duplex receptacles shall be rated 20 amperes, 125 volt AC.
3. GFCI receptacles shall be rated 20 amperes, 125 volt with integral ground fault current interrupter
4. Specific-use receptacles shall have volts, amps, poles and NEMA configuration as noted on drawings.

5. Heavy-duty lock-blade receptacles shall be NEMA WD5 heavy-duty specification grade.
6. Emergency receptacles shall be red plastic face.
7. Weatherproof receptacles as specified shall be mounted in a cast steel box. All weatherproof cover plates shall be UL listed. Use weatherproof aluminum or stainless steel lift up covers over receptacles located outdoors and in other locations as shown on the plans. Use In-use type clear weatherproof cover over selected receptacles as noted on the drawings. Cover shall be a Leviton 5976-CL or equal.
8. Designations: The following designations are for brown devices; provide devices in the color specified in Article 2.1B.

<u>Type</u>	<u>Arrow-Hart</u>	<u>Hubble</u>	<u>GE</u>	<u>Leviton</u>
5-20R	8300	8300	8300	8300
5-20R(single)	8310	8310	8310	8310
6-20R	8500	8400	8400	8400
14-20R	5759	8410	1420	--
15-20R	5781	8420	1520	--
5-30R	5716N	9308	4138-3	5371
6-30R	5700N	9330	4139-3	5372
14-30R	5744N	9430A	1439-3	278
15-30R	8430N	8430A	1530	8430-A
5-50R	5711N	9360	4140-3	5375
6-50R	5709N	9367	4141-3	5374
14-50R	5754N	9450A	4181-3	279
15-50R	8450N	8450A	1550	8450-A
GFCI	GF8300	GF8300	GFR 8300-1	6898-HG
Twist Lock	5708	5235	--	5361-CH

## 2.4 DEVICE PLATES

### A. Acceptable manufacturers

1. Arrow-Hart
2. Hubbell
3. General Electric
4. Leviton
5. Crouse Hinds – Cast Metal Wall Plates
6. OZ Gedney – Cast Metal Wall Plates

### B. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement and:

### C. Material

1. Device plates in IT, mechanical and electrical rooms, loading dock, and other industrial areas shall be 302 stainless steel with cutouts as required for devices indicated on drawings, unless otherwise noted. Other wall plates shall be smooth plastic, 0.1 inch thick. Where switches or outlets are shown adjacent to each other, they shall be ganged with partitions between different type services and covered by a single custom wall plate.
2. Exposed boxes:
  - a. Dry interior spaces: Use cast metal plates with cast metal box. Use heavy cadmium-plated sheet steel plates with steel boxes and copper-free aluminum with aluminum boxes. All screws shall be stainless steel. Edges of plates must be flush with edges of boxes.

- b. Outdoor locations: Use weatherproof devices plates. Provide cast metal plates with gasketed spring door
3. Jumbo plates are not permitted.
4. Weatherproof cover plates shall be UL listed metal lift up type with sealing gaskets. Weatherproof plates shall be used in exterior locations as described above.

## 2.5 WALL DIMMERS

### A. Acceptable manufacturers

1. Lutron
2. Leviton
3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

### B. Material

1. Provide NEMA WD 2 solid-state wall-box dimmers, where indicated on drawings. Dimmers shall be complete, with linear slide-type solid-state dimming controls, and LED light level ON/OFF indicators. Dimmer shall produce IES square-law response from blackout to full brightness. Dimmer rise time shall be restricted to prevent interference with professional quality audio or video equipment. Dimmer shall be compatible with ballast per manufacturer's specification.
2. Device: White finish plastic with linear slide.
3. Voltage: As noted on drawings.
4. Power rating: Match load shown; 1000 watts minimum, larger size is required to accommodate connected loads greater than 1000 watts. Load to 80% of the dimmer capacity, maximum.

## 2.6 FLOOR MOUNTED SERVICE FITTINGS AND BOXES

### A. Acceptable manufacturers

1. Steel City
2. Walker
3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

### B. Material

1. Floor mounted service boxes shall be flush mounted brushed aluminum housing with poke-through assembly. Provide brass cover plate with two hinged lift lids where carpeting is installed.
2. Quantity of outlets for A/V and power per drawings.

## 2.7 OCCUPANT SENSORS

### A. Acceptable manufacturers

1. Wattstopper
2. Pass & Seymour
3. Leviton
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.



B. Material

1. See plans for specification.

2.8 TAPE LABELS

- A. Provide tape labels in accordance with Section 26 05 53, Electrical Identification, on all receptacles and switches indicating panelboard and circuit number. White tape with 3/16 inch black letters/numbers.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Installer must examine the areas and conditions under which wiring devices and floor boxes are to be installed and notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the work. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 DEVICE COORDINATION

- A. Where items of equipment are provided under other sections of this specification or by the Owner, provide a compatible receptacle and/or device plate for the cap or plug, and cord of the equipment.

3.3 INSTALLATION

A. General:

1. Install wiring devices and floor boxes as indicated, in accordance with the applicable requirements of the latest release of NEC, NEMA, and ANSI.
2. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the drawings. These drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building drawings and by actual measurements during construction of the building before rough-in, subject to the approval of the Constructor Inspector.
3. Where more than one device occurs in one outlet box, causing 300 volts or more voltage difference between them, a barrier must be provided for isolation to meet NEC Article 380.

B. Wall Switches and Dimmers:

1. Location:

- a. Install wall switches and dimmers in suitable outlet box centered at the height of 48 inches above finished floor, OFF position down.
- b. Where wainscot occurs at the 48" level, install device in the wall below the wainscot and as near the 48" level as possible to provide the most pleasing appearance, but in no case partially in the wainscot and partially in the wall.
- c. Where shown near doors, install switches and dimmers not less than 2" and not more than 12" from door trim.
- d. Verify all door swings before rough-in and locate switches and dimmers on strike side of door as finally installed.

2. Position:

- a. Wall switches: Install wall switches in a uniform position so the same direction of operation will open and close the circuits throughout the project, generally up or to the left for the ON position.
- b. Wall dimmers: Install dimmers in a uniform position so the same direction of operation will brighten and dim the lights throughout the project, generally up for brightest position.

3. Wall Box Dimmers:

- a. De-rate ganged dimmers as instructed by manufacturer. Do not use common neutral.
  - b. Compatibility: Where dimmers are connected to fluorescent lights, verify with ballast manufacturer and dimmer manufacturer the suitability of the ballast for dimming applications.
  - c. Test: Test dimmers per manufacturer's instructions. Demonstrate that unit's function as specified. Where remote dimmers are provided, demonstrate that unit's function properly as master and remote.
  - d. Burn-in: Where dimmers are connected to fluorescent fixtures, operate at full brightness for the full burn-in duration as specified or recommended by the lamp manufacturer.
- C. Receptacles:
1. Location:
    - a. Install convenience outlets, telephone, data and TV outlets in suitable steel outlet boxes centered at the height of 18 inches above the finished floor, 6 inches above countertop or at the backsplash level, or as indicated on the drawings. Coordinate with equipment and architectural drawings.
    - b. Install receptacles generally where indicated on drawings. The Owner's representative reserves the right to make any reasonable changes in receptacle locations without change in the contract sum.
    - c. Install specific-use receptacles at heights shown on Drawings.
  2. Position:
    - a. Install receptacles vertically with ground pole on bottom. Install receptacles horizontally, where field condition does not allow vertical installation, with ground pole on left.
  3. All receptacles with 6 feet of a water source such as sinks shall be GFCI type. Arrange circuit wiring for last receptacle on circuit to be GFCI. Feed through to non-GFCI receptacles is not permitted.
- D. Plates:
1. Where cover plates do not completely conceal the rough openings for the devices, it shall be the responsibility of the General Contractor to patch, paint, etc. around the opening to the satisfaction of the Owner's representative.
  2. All devices and cover plates shall be plumb and parallel to adjacent surfaces or trim. Devices must be flush with the finished trim cover plates and plates must be tight to surfaces over which they are installed.
  3. Where switches controlling devices that are out of sight, or where three or more switches are gang mounted, plates shall be labeled to identify items being controlled, or areas being lighted. Labeling shall be 3/16-inch Condensed Gothic and shall be filled with black enamel.
- E. Floor Boxes:
1. Verify locations of all floor boxes with the Owner's representative before installation. Increase slab thickness at boxes if required to obtain a minimum of 1 inch of concrete below bottom of box.
  2. Install floor boxes level and flush with finish flooring material. Completely envelope floor boxes in concrete except at the top.
  3. Adjust covers flush with finished floor.
- F. Occupant Sensors:
1. Flush mount occupant sensors through round hole cut in ceiling tile, positioning and placement per sensor manufacturer's recommendation.

2. It is the installer's responsibility to replace damaged ceiling tiles during his installation of sensor.
3. The low voltage control wiring installed above ceiling tiles shall be plenum rated or general building wiring installed in raceway system.

END OF SECTION

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SECTION 26 51 00

INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Interior lighting fixtures and accessories
- B. Emergency lighting units
- C. Emergency exit signs
- D. Emergency fluorescent lamp power supplies
- E. Lamps
- F. Ballasts
- G. Lighting controls

1.2 REFERENCES

- A. NEPA 101 - Code for Safety to Life from Fire in Buildings and Structures
- B. NEMA WD1 - General-Purpose Wiring Devices
- C. ANSI C82.1 - Specification for Fluorescent Lamp Ballasts
- D. ANSI C82.4 - Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type)
- E. NEMA LE - H-I-D Lighting System Noise Criterion (LS-NC) Ratings
- F. UL 844 - Electric Lighting Fixtures for Use in hazardous (classified) Locations
- G. UL 924 - Emergency Lighting and Power Equipment
- H. UL 935 - Fluorescent-Lamp Ballasts
- I. UL 1029 - High-Intensity-Discharge Lamp Ballasts
- J. UL 1572 - High Intensity Discharge Lighting Fixtures
- K. UL 1574 – Track Lighting Systems
- L. IESNA – Lighting Handbook
- M. NEMA WD 1 - General Color Requirements for Wiring devices
- N. NEMA LE 5B – Procedure for Determine Luminaire Efficacy Ratings for High-Intensity Discharge Industrial Luminaires
- O. NFPA 70 – National Electrical Code
- P. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- Q. Standards For State-Funded Outdoor Lighting Fixture – Texas House Bill 916 (1999)
- R. UT System OFPC – Security Planning and Design Guidelines (2002 release)

1.3 DESIGN CRITERIA

- A. Lighting level design shall be per IESNA (Illuminating Engineering Society of North America) recommendation.
- B. The power consumption for interior and exterior lighting shall not exceed power allowance as per ASHRAE 90.1 latest revision.

1.4 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Division 1 for submittal requirement.
- B. Submit manufacturer's data on interior and exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by luminaire "type" in alphabetical order, with the proposed fixture and accessories clearly labeled.
- C. Submit dimensioned drawings and performance data including complete photometric test data for each luminaire, candlepower distribution curves in two or more planes, candlepower chart zero to 90 degrees, lumen output zonal summary chart, average and maximum brightness data, and coefficients of utilization for zonal cavity calculations, spacing to mounting height ratio, efficiency and visual comfort probability. Also provide luminaire weights, mounting data, and accessory information for each luminaire type.
- D. Lamps: Catalog cuts showing voltages, colors, approximate hours life, approximate initial lumens, lumen maintenance curve, lamp type and base.
- E. Ballasts: Catalog cuts showing type, wiring diagram, nominal watts, input voltage, starting current, input watts, sound rating, power factor and low temperature characteristics.
- F. Controls: Catalog cuts and/or shop drawings showing dimensions, voltage capacity, contact ratings, wiring diagrams, operating levels, and temperature ratings.
- G. Lighting design shall be in compliance with power allowance for lighting, which is stipulated by ASHRAE 90.1. Compliance forms along with engineering data associated with it shall be submitted for Owner's review during design phase.

#### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver lighting fixtures individually wrapped in factory-fabricated fiberboard type containers. Parabolic louvers shall be shipped in thermally sealed polyethylene wrapper.
- B. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.
- C. Store lighting fixtures in a clean, dry space and protected from the weather.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Lighting fixtures and accessories shall comply with the design and function requirements of the project. Design characteristics shall be as noted in manufacturer's submittal data.
- B. Provide lighting fixtures of the size, type and rating as scheduled, complete with, but not limited to, lamps, lamp holders, reflectors, ballasts, poles and wiring.

#### 2.2 INTERIOR LIGHTING FIXTURES

- A. Fluorescent Fixtures
  1. See plans for light fixture schedule.
- B. Incandescent fixtures shall be pre-wired equipped with integral thermal protection. Use incandescent only where aesthetics outweighs economic considerations.
- C. Lighting track shall be surface mount or pendant mount per the requirement on drawings, by manufacturer of track mounted light fixtures.
- D. High Bay, Low Bay HID Fixtures
  1. Provide rugged, lightweight, cast aluminum ballast housing with a baked electro-coat paint finish.
  2. Optic reflector shall be fully fluted, anodized aluminum providing high efficiency. Where enclosed and gasketed type fixtures are specified, provide luminaires designed for continuous operation in an ambient temperature of 55° C.

E. Lamp Holders or Sockets

1. Incandescent lamp holders shall be screw base and have porcelain insulating shells and be rated for heavy duty, 660W.
2. Fluorescent Sockets: Fluorescent lamp holders shall be heat-resistant porcelain or plastic, designed and rated for the lamp type specified. Lamp holders shall be designed to maintain solid electrical contact at all times. The detent position for bi-pin lamp holders shall be a positive lock so that mechanical effort shall be required to rotate the lamps. Lamp holder shall be specifically compatible with lamping.
3. HID Medium and Mogul Base Sockets: Provide glazed porcelain pulse-rated heavy duty sockets with silicone leads hard soldered to nickel plated brass screw shell. Lamp holders shall also employ a positive spring locking means to maintain good electrical contact at the center terminal of the lamp.
4. Lamp holders and sockets shall be provided with minimum 18 AWG wiring leads.

F. Reflector Finishes

1. Painted Finishes: Provide electro-statically applied dry polyester white powder coat finish with minimum reflectance of 88 percent on all light reflecting surfaces.
2. Specular/Semispecular Finishes: Provide Alzak-type anodized finish on aluminum louvers and reflectors as specified in Luminaire Schedule as shown on the drawings. Minimum reflectivity shall be:
  - a. Specular: 80 percent
  - b. Semi-specular: 75 percent

G. UL Listing

1. All Luminaires and components shall be UL tested, listed, and labeled.
2. Luminaires installed under canopies, roofs, or similar damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.
3. Recessed luminaires installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall be approved for the installation in a fire-rated ceiling.

2.5 EXIT SIGNS

- A. See plans for light fixture schedule.

2.6 LAMPS

A. Acceptable Manufacturers

1. General Electric Company
2. Philip Lighting Company
3. Osram/Sylvania
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 1 for substitution requirement.

B. General Requirements

1. Lamps including linear fluorescent, compact fluorescent, and HID shall be low mercury type and shall pass all federal TCLP (Toxicity Characteristic Leaching Procedure) test requirements in effect at the time of manufacture. All lamps shall be energy saving and rapid start type.
2. General use incandescent lamps shall be inside frosted type, 120 volts, 750 hour minimum.

3. Linear fluorescent lamps shall be T8 lamps. Compact lamps shall be twin or double twin tubes. All lamps for one project shall be provided by the same manufacturer with color temperature as indicated on drawings. Operation voltage and wattage shall be as indicated on drawings.
4. Mercury vapor HID lamps shall not be used.
5. Metal halide HID lamps shall be phosphor coated, suitable for the burning position required.
6. High-pressure sodium HID lamps shall be clear or diffuse coated.
7. Maintenance Stock: Furnish a stock of replacement lamps in the original cartons or packing sleeves, amounting to 10% (but not less than two lamps in each case) of each type and size lamp used in each fixture type. Deliver replacement stock as directed to Owner's storage space.

## 2.7 BALLASTS

### A. Acceptable Manufacturers

1. Valmont
2. Advance
3. Magnetek
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 1 for substitution requirement.

### B. General Requirements

All ballasts shall be UL listed and have the UL symbol on the label.

#### 1. Ballasts for fluorescent lamps

- a. Provide 277V ballasts for all operations except as indicated otherwise on plans. Ballasts shall be electronic type, instant start, less than 10% THD, and power factor of 95 percent or greater, suitable to operate at 60 Hz input frequency.
- b. Electronic ballasts shall comply with all FCC and NEMA limits governing EMI and RFI, and shall have Total Harmonic Distortion (THD) of less than 10 percent.
- c. Ballasts shall be Class P thermally protected.
- d. Sound level criteria
  - 1) Nominal 430 mA Lamps: Class A sound rated.
  - 2) Nominal 800 mA Lamps: Class B sound rated.
  - 3) Nominal 1500 mA Lamps: Class D sound rated. Provide isolation mounting and insulation to reduce sound transmission and radiation.
- e. Electronic Dimming Ballasts: Compatible with lamp and dimming system, labeled for use and listed as compatible by dimmer manufacturer with a minimum full-to-5 percent dimming range.
- f. Exterior Fluorescent Ballasts: Provide zero degree starting rating.

#### 2. Ballasts for HID lamps

- a. HID ballast shall be multi-tap encased and potted thermally protected high power factor of 90 percent or greater, constant wattage regulating, and autotransformer type. Ballast ambient operating temperature range shall be -20 to +130 degrees F. Ballasts shall be compatible to the lamps chosen for specific burning position, and compensate for the loss in efficiency.



- b. Provide isolation mounting and insulation of HID ballasts to reduce sound transmission or radiation.
- c. Each HID ballast shall have a fast acting primary inline fuse built into the fixture assembly by the manufacturer.

## 2.8 LIGHTING CONTROL

- A. Refer to Section 26 27 26 Wiring Devices and Floor Boxes for lighting switch, dimming control, and occupancy sensor.
- B. Photocell shall be automatic dawn on, dusk off switching; moisture, temperature, and vibration-resistant die-cast aluminum housing; time delay feature to prevent false switching; field adjustable to control operating levels.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Prior to order lighting fixture, check the building electrical system requirements, architectural finishes, and the type of ceilings that lighting fixture will be installed. Any discrepancies of compatibility pertaining trim, frames, color, mounting, ballast, voltage and etc. shall be brought to the attention of A/E by written notice. Do not proceed with procurement until discrepancies are resolved in a satisfactory manner.
- B. Installer shall examine the areas and conditions that light fixtures are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF LIGHTING FIXTURES

- A. Install light fixtures in accordance with the manufacturer's written instructions, the applicable requirements of NEC and national and local code, standard, and regulations. Install lamps in accordance with manufacturer's instructions.
- B. Install luminaries at locations as shown on the Drawings; install aligned, aimed, and leveled. Install fixtures in accordance with manufacturer's installation instructions complete with mounting accessories, trim and support materials. Fasten fixtures securely to structural support members of the building; solid pendant fixtures shall be plumb.
- C. Coordinate with other crafts to avoid conflicts between luminaires, supports, fittings and mechanical equipment.
- D. Incandescent Fixtures
  - 1. Surface Mounted Incandescent Fixtures: Mount directly to outlet box equipped with fixture stud or mounting bar.
  - 2. Recessed Incandescent Fixtures: Mount with support rails attached to ceiling suspension support system.
- E. Surface Mounted Fluorescent Fixture:
  - 1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of fixtures.
  - 2. Where ceiling system has not been certified to support weight of fixtures, fixtures shall be supported at four points near each corner of fixtures.
  - 3. Provide a minimum 5/8" air space between the fixture and the ceiling.
- F. Recessed Fluorescent Fixtures:
  - 1. Handle specular/semi-specular louvers and down light cones using only new clean white cotton or silk gloves. Do not touch louvers or cones with bare hands. Leave luminaries clean and free of any visible dust, debris, or fingerprints with all lamps operational at time of acceptance of work.

2. All recessed fluorescent fixtures shall be supported from building structure above ceiling with galvanized steel wire at not less than 4 points near corners of fixture. Size of wire shall be capable of supporting weight of fixtures.
  3. Recessed luminaries trims shall fit snugly to the mounting surface and shall not exhibit light leaks or gaps. Provide feed-through junction boxes or provide separate junction boxes. All components shall be accessible through the ceiling opening.
  4. Connect recessed luminaries to junction box with flexible steel conduit and fixture wire.
- G. HID Fixtures
1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of fixtures.
- H. Lighting Fixtures Adjustment
1. Adjust to illuminate intended areas as directed.
  2. Adjust exterior fixtures during hours of darkness.
- I. Immediately before final observation, clean all fixtures, inside and out, including plastics and glassware, and adjust all trim to properly fit adjacent surface, replace broken or damaged parts, and lamp and test all fixtures for electrical as well as mechanical operation.
- J. Protect installed fixtures from damage during the remainder of the construction period.
- K. Upon completion of installation of interior lighting fixtures, and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- L. Incandescent lamps shall be new at time of final acceptance. Fluorescent lamps may be used in the final finishing of the building. Those that have exceeded more than 1/3 of their rated life (as established by Construction Inspector records), or that have blackened ends or inoperable shall be replaced with new lamps before final acceptance.
- M. Lamp Disposal
1. The procedure of disposal of lamps that are mercury containing shall follow the guideline set by EPA (definitions in Title 40 Code of Federal Regulations 261 Subpart C, January 2000).

END OF SECTION