EDINBURG CISD

PURCHASING DEPARTMENT
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CARMEN GONZÁLEZ, Vice President
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Dr. Mario H. Salinas, Superintendent

ADDENDUM 3
CSP 22-135
SOUTH MIDDLE SCHOOL HEATING & AIR CONDITION (HVAC) IMPROVEMENTS FUNDED THROUGH THE ELEMENTARY & SECONDARY RELIEF (ESSER) FUNDS
August 31, 2022

I. INSTRUCTIONS:

A. The following changes, omissions or alterations to the specification and drawings shall be made insofar as the specifications and drawings are inconsistent with following, this addendum shall govern.

B. Acknowledge receipt of this addendum by inserting its number and date of issue in the place provided for same in the proposal. This addendum forms a part of the Contract Documents.

C. It is imperative that this addendum be inserted INTO set of specifications.

II. SEE ADDENDUM BELOW:

PLEASE SEE ATTACHED.

PROPOSAL OPENING TO CHANGE

FROM: September 1, 2022 @ 3:00 P.M.

TO: September 16, 2022 @ 3:30 P.M.

Respectfully Submitted,

Amaro Tijerina

Amaro Tijerina
Director of Purchasing

_____
(Signature of authorized officer) Date

_____
Company Name

Nondiscrimination Statement
It is the policy of Edinburg CISD not to discriminate on the basis of gender, age, handicap, religion, race, color, or national origin in its educational programs.
Es poliza del Distrito Escolar de Edinburg el no discriminar por razones con base en genero, edad, religion, raza, color origen nacional, ni discapacidad dentro de sus programas educacionales.

HALFF

5000 West Military, Ste 100
McAllen, Texas 78503
(956) 664-0286
Fax (956) 664-0282

ADDENDUM 3 NARRATIVE

To:	Edinburg Consolidated School District Purchasing Department	**Date:**	August 24, 2022
From:	Kyle Hunter, PE.	**AVO:**	45215.20
Email:	khunter@halff.com	**Project:**	South Middle School Heating & Air Condition (HVAC) Improvements Funded through the Elementary Secondary Schools Emergency Relief (ESSER) Funds – Edinburg CISD
Subject:	Addendum No. 3		

MECHANICAL
The following are clarification notes made to the plans and specifications. The changes are outlined by item number, as well as plan sheet number.

ITEM 1: Response to contractor questions

- At the Owner's direction, the bid shall include belt-driven, constant air volume, and constant speed compressors air conditioning equipment if it meets the performance characteristics outlined in the signed-sealed construction documents and specifications. Alternate manufacturers other than those listed are acceptable provided equipment meets or exceeds the performance characteristics outlined in the signed-sealed construction documents and specifications.
- Service light in supply fan section is not required.
- Johnson Controls is added as approved manufacturer for HVAC equipment and controls.

ITEM 2: SHEET M-502
- Packaged DX Rooftop unit schedule updated

ITEM 3: SHEET M-401
- Solid separator connection added

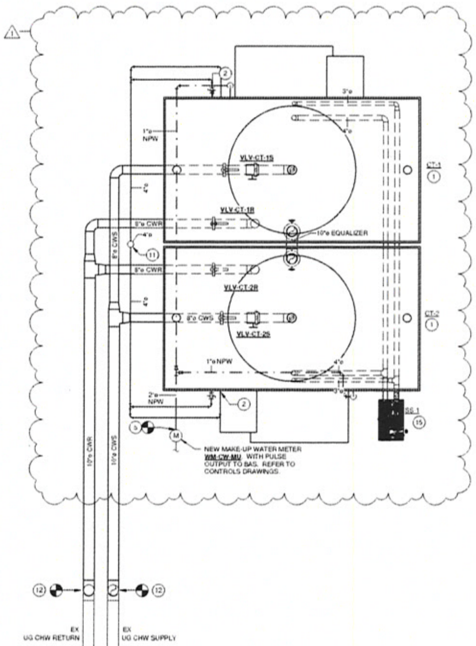
ITEM 4: SHEET M402
- Sheet updated

ITEM 5: SHEET MM-708
- Solid Separator sequence of operations added

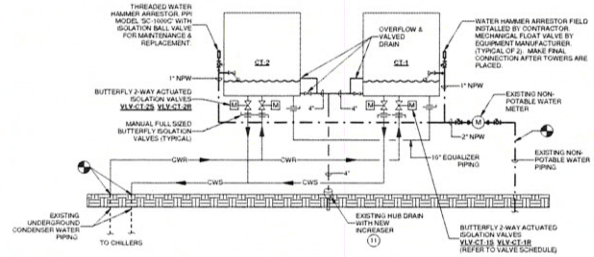
ITEM 6: Specification TOC updated

ITEM 7: Specification sections added / updated
- 230900 Instrumentation and Controls for HVAC
- 230993 Sequence of operations for HVAC controls
- 237413A Packaged, outdoor, air-handling units Roof tops
- 236500 Cooling Towers

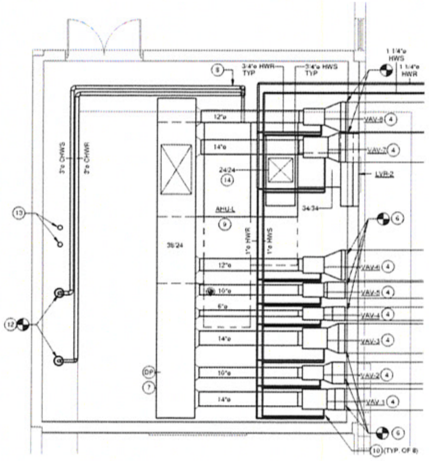
Halff Template Version: 2019.005



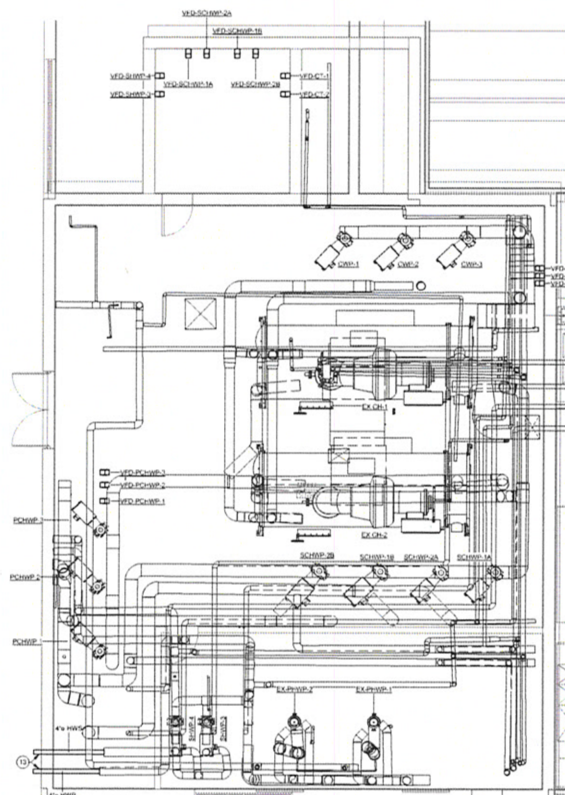
3 MECHANICAL HVAC ENLARGED PLAN - TOWER YARD
1/4" = 1'-0"



4 COOLING TOWER ONE-LINE DIAGRAM
N.T.S.



2 MECHANICAL HVAC ENLARGED PLAN - LIBRARY - MECH B136
1/4" = 1'-0"



1 MECHANICAL HVAC ENLARGED PLAN - CAFETERIA - MECH C123
1/4" = 1'-0"

GENERAL NOTES

A	REFER TO SHEET M-001 FOR GENERAL MECHANICAL NOTES.
B	THE MECHANICAL CONTRACTOR SHALL VERIFY THE OPERATION OF ALL EXISTING AIR HANDLING UNITS GREATER THAN 2,000 CFM SUPPLY AIR TO AUTOMATICALLY SHUTDOWN DURING SMOKE DETECTOR AND/OR FIRE ALARM SIGNAL.
C	CONTRACTOR SHALL PROVIDE IN A BID TO OWNER A PER UNIT PRICE TO REPAIR EXISTING MALFUNCTION EQUIPMENT INCLUDING: -SMOKE DETECTOR: UNIT PRICE $______ -COMMUNICATION CABLING: UNIT PRICE $______ -FA PROGRAMMING: UNIT PRICE $______

KEY NOTES

1	INSTALL NEW COOLING TOWER CELL ON NEW STRUCTURAL SUPPORTS. CONTRACTOR SHALL PROVIDE NEW STRUCTURAL DESIGN FOR THE TWO COOLING TOWERS SIGNED AND SEALED BY A PROFESSIONAL ENGINEER. COORDINATE STRUCTURAL SUPPORT DESIGN WITH TOWER MANUFACTURER FOR WEIGHT AND...
2	CONNECT OVERFLOW, AND DRAIN PIPING INTO ONE SINGLE PIPE AND ROUTE TO EXISTING HUB DRAIN AT GRADE LEVEL. PVC PIPE IS ACCEPTABLE FOR DRAIN PIPING. DRAIN PIPE SHALL HAVE A FULL SIZED BALL VALVE MOUNTED AT THE TOWER CONNECTION POINT.
3	RE-CONNECT NEW NON-POTABLE FILL WATER CONNECTION AT METER.
4	HYDRONIC REHEAT TERMINAL VAV UNIT INSTALLED WITH CONTROLLER ON BOTTOM SIDE OF UNIT. HOT WATER PIPING SHALL BE COORDINATED WITH VAV AND DUCTWORK INSTALLATION.
5	MECHANICAL CONTRACTOR TO MAKE FINAL CONNECTION TO 1-INCH NON-POTABLE SUPPLY PIPING SHALL BE INSULATED AND WRAPPED WITH ALUMINUM JACKETING. PROVIDE WATER HAMMER ARRESTORS AT EACH FILL VALVE, REFER TO ONE LINE DIAGRAM
6	EXISTING ZONE SUPPLY DUCTWORK STUBBED INTO MECHANICAL ROOM SHALL BE CONNECTED TO NEW VAV DUCTWORK. REINSULATE NEW DUCT TO MATCH EXISTING CONDITIONS AND SEAL NEW AND OLD INSULATION GAP TO MAINTAIN VAPOR BARRIER.
7	NEW STATIC PRESSURE SENSOR SHALL BE INSTALLED IN THE DUCT PLENUM WHERE SHOWN. REFER TO MECHANICAL CONTROLS DRAWINGS FOR ADDITIONAL INFORMATION.
8	CONNECT NEW 3-INCH CHILLED WATER SUPPLY AND RETURN PIPING TO NEW COIL CONNECTION FOR AIR HANDLER. REFER TO DETAIL 11/M-601 FOR COIL ACCESSORIES.
9	NEW AIR HANDLER SHALL BE MOUNTED ON MECHANICAL EQUIPMENT PAD. THE CONTRACTOR SHALL BE FIELD MEASURE EXISTING MECHANICAL PAD AND EXPAND THE PAD AS REQUIRED TO ACCOMODATE NEW EQUIPMENT. RECONNECT EXISTING CHILLED WATER SUPPLY AND RETURN PIPING TO INLET/OUTLET CONNECTIONS ON AIR HANDLER. REFER TO DETAIL 11/M-601 FOR ADDITIONAL INFORMATION ON PIPING CONNECTIONS TO AIR HANDLER.
10	MAKE FINAL CONNECTION TO HYDRONIC REHEAT COIL ON VAV TERMINAL UNIT. PROVIDE CONTROL VALVE, STRAINER AND OTHER ACCESSORIES AS ILLUSTRATED ON DETAIL 10/M-602.
11	CONTRACTOR SHALL ROUTE NEW 4-INCH DRAIN DOWN TO EXISTING HUB DRAIN. INSTALL A NEW PVC INCREASER TO THE EXISTING HUB DRAIN OPENING TO INCREASE THE SIZE OF DRAIN. ADD A 12-INCH STANDPIPE ON THE TOP OF THE HUB DRAIN.
12	CONTRACTOR SHALL FIELD VERY SIZE AND EXACT LOCATION OF UNDERGROUND CHILLED WATER PIPES. CONTRACTOR SHALL TRANSITION AS REQUIRED TO CONNECT NEW CHILLED WATER PIPES TO EXISTING.
13	CONTRACTOR TO PROVIDE SHOP DRAWINGS REGARDING NEW HYDRONIC HEATING PIPING PRIOR TO CONSTRUCTION. EXISTING HYDRONIC HEATING PIPING TO BE ABANDONED IN PLACE AND CAPPED AT FINISHED FLOOR. NEW HYDRONIC HEATING PIPING TO PENETRATE THROUGH WALL AS INDICATED ON PLANS.
14	RISE 24/24 OUTSIDE AIR DUCT UP TO EXISTING OUTSIDE AIR INTAKE HOOD ON ROOF. PROVIDE AND INSTALL MODULATING CONTROL DAMPER IN OUTSIDE AIR DUCT. DAMPER SHALL BE EQUAL TO RUSKIN "CD60", HIGH-PERFORMANCE, AIRFOIL, OPPOSED BLADE.
15	SIDE STREAM SEPERATOR SHALL BE SECURED TO CONCRETE PAD. PAD SHALL BE 4" HIGH AND EXTEND 4" BEYOND EVERY EDGE. PROVIDE 1" NEOPRENE ISOLATORS TO ABSORB VIBRATION AND PREVENT THE FRAME FROM TOUCHING THE CONCRETE. PIPE INLET AND OUTLET SHALL HAVE FLEXIBLE PIPE CONNECTORS. PROVIDE MANUAL ISOLATION VALVES AT BOTH INLET AND OUTLET OF SS-1.

LEGEND

(bold outline)	NEW MECHANICAL
(light outline)	EX MECHANICAL

SOUTH MIDDLE SCHOOL HEATING & AIR CONDITION (HVAC) IMPROVEMENTS FUNDED THROUGH THE ELEMENTARY SECONDARY SCHOOLS EMERGENCY RELIEF (ESSER) FUNDS

ECISD
601 W Freddy Gonzalez Dr, Edinburg, TX 78539

HALFF
5000 W MILITARY HWY #100
MCALLEN, TX 78503-7468
(956) 664-0286

Revision No.	Date	Description
1	8/24/22	ADD #3

STATE OF TEXAS
KYLE A. HUNTER
121984
LICENSED PROFESSIONAL ENGINEER
8/24/22

AVO:	45215.020
Issued:	06/05/2022
Drawn By:	LM,MH
Checked By:	KH
Scale:	As indicated

Sheet Title
MECHANICAL HVAC ENLARGED PLANS

M-401
Sheet Number

100% CONSTRUCTION DOCUMENTS

PACKAGED DX ROOFTOP UNIT SCHEDULE

	UNIT														FILTERS	COOLING										HEATING				
					ELECTRICAL			EFFICIENCY	SUPPLY FAN							EAT		LAT				AMBIENT	COMPRESSOR			EAT	LAT	CAPACITY		
MARK	MANUF	MODEL	LXWXH (IN)	WEIGHT (LB)	VOLTS/PH/HZ	MCA (A)	MOCP (A)	EER/IEER (SEER)	TYPE	TOTAL SUPPLY AIRFLOW (CFM)	OUTSIDE AIRFLOW (CFM)	ESP (INH2O)	BRAKE HORSE-POWER (BHP)	MOTOR SIZE (HP)	TYPE	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	TOTAL CAPACITY (MBH)	SENSIBLE CAPACITY (MBH)	DB (°F)	STAGES	QTY	REFRIGERANT	EDB (°F)	LDB (°F)	KW	STAGES	NOTES
RTU-1	TRANE	OAB036	115X52X65	1,428	460/3	19.0	20.0	11.1/-	DDP	760	230	0.5	0.3	1.0	MERV-13	81.5	67.1	50.9	50.2	38	26	105.0	INF	1	R-410A	59.4	101	10	2	ALL
RTU-2	TRANE	OAB036	115X52X65	1,428	460/3	19	20	11.8/-	DDP	700	300	0.5	0.3	1.0	MERV-13	84.0	70.0	52.8	52.0	39.5	24.2	105.0	INF	1	R-410A	56.0	101	10	2	ALL
RTU-3	TRANE	OAD010	146X95X68	3,112	460/3	40.9	45	12.7/-	DDP	1980	910	0.5	0.6	1.0	MERV-13	86.6	71.6	51.9	51.4	127	76	105.0	INF	2	R-410A	54.0	92	24	2	ALL

NOTES:
1. SINGLE POINT POWER. NON-FUSED DISCONNECT SWITCH. NON-POWERED 115V GFI OUTLET (OUTLET TO BE POWERED BY DIVISION 26)
2. PROVIDE ECO-COATED COILS. COMPLETE COAT COATED CONDENSER COIL, ASTMB-117-97, 6000+ HOURS.
3. STAINLESS STEEL DRAIN PAN, STAINLESS STEEL COOLING COIL CASING, STAINLESS STEEL INTERIOR, 2" R-13 DOUBLE WALL CONSTRUCTION, HINGED ACCESS DOORS.
4. PROVIDE ECM BACKWARD CURVED PLENUM FAN, VARIABLE SPEED SCROLL 1ST AND 2ND STAGE (WHERE APPLICABLE) AND SOUND ATTENUATION PACKAGE.
5. PROVIDE CONDENSING COILS W/ HAIL GUARDS AND LED SERVICE LIGHT IN SUPPLY FAN SECTION
6. PROVIDE UNIT CONTROL BOARD W/ BACNET INTEGRATION ABILITY AND TOUCHSCREEN DIGITAL DISPLAY. UNIT MANUFACTURER TO PROVIDE ROOM TEMPERATURE SENSOR
7. PROVIDE WITH NEW WIND RATED ROOF CURB, 18" TALL
8. PROVIDE FIN & TUBE MODULATING HOT GAS REHEAT
9. PROVIDE WITH FACTORY MOUNTED APR VALVE FOR CAPACITY MODULATION AND VARIABLE SPEED HEAD PRESSURE CONTROL
10. PROVIDE AIRFLOW MONITORING FOR OUTSIDE AIR.
11. PROVIDE MODULATING O/A AND R/A DAMPERS
12. CONTRACTOR SHALL CONFIRM IN FIELD EXISTING MECHANICAL EQUIPMENT VOLTAGES, ELECTRICAL EQUIPMENT SERVING IT, AND CIRCUIT OVERCURRENT PROTECTION PRIOR TO PREPARING A HVAC EQUIPMEN... UNIT CHARACTERISTICS, NO EXCEPTIONS.

HVAC PIPING MATERIALS SCHEDULE

						Insulation		
Service	Size	Pipe	Fittings	Joints	Hangers	Conditioned Spaces	Unconditioned Spaced	Outdoors
Chilled Water Above Grade	1/2-4"	Glas fiber reinforced PP-R/CT SDR7.4/11	Socket fusion	fusion	rubber-lined	as per pipe manufacturer	as per pipe manufacturer	as per pipe manufacturer
	4" & up	Glas fiber reinforced PP-R/CT SDR11/17.6	Butt fusion	fusion	rubber-lined	as per pipe manufacturer	as per pipe manufacturer	as per pipe manufacturer
Condenser Water (Interior)	1/2-4"	Glas fiber reinforced PP-R/CT SDR7.4/11	Socket fusion	fusion	rubber-lined	as per pipe manufacturer	as per pipe manufacturer	N/A
	4" & up	Glas fiber reinforced PP-R/CT SDR11/17.6	Butt fusion	fusion	rubber-lined	as per pipe manufacturer	as per pipe manufacturer	N/A
Condenser Water Above Grade (Exterior)	1/2-4"	Glas fiber reinforced PP-R/CT SDR7.4/11	Socket fusion	fusion	rubber-lined	N/A	N/A	UV wrap or elastomer paint
	4" & up	Glas fiber reinforced PP-R/CT SDR17.6	Butt fusion	fusion	rubber-lined	N/A	N/A	UV wrap or elastomer paint
Condensate	All	Type M Copper	Wrot copper	95-5 Solder	Copper Plated	3/4" Flexible Elastomeric - PVC Jacket	3/4" Flexible Elastomeric - PVC Jacket	3/4" Flexible Elastomeric - Aluminum Jacket
Refrigerant	0-4"	Type L Copper ACR	Wrot Copper Long Rad.	Silfos	Copper Plated	1" Flexible Elastomeric	1" Flexible Elastomeric	1" Flexible Elastomeric
	5" & up	Type L Copper ACR	Wrot Copper Long Rad.	Silfos	Copper Plated	1" Flexible Elastomeric	1" Flexible Elastomeric	1" Flexible Elastomeric
Chiller Air Vent	All	Type K Copper	Wrot Copper	95-5 Solder	Copper Plated	None	None	None

SWHP-3 & SWHP-4

EXISTING DOCUMENTION WAS NOT SUFFICIENT TO PROVIDE AN ACCURATE PUMP SELECTION. PUMP SCHEDULE FOR REFERENCE ONLY FOR SHWP-3 & 4. CONTRACTOR TO TAB HEAD PRESSURE AND HOT WATER FLOW RATES FOR EXISTING HWP-3 & HWP-4 AND TO COORDINATE WITH THE ENGINEER OF RECORD PRIOR TO EQUIPMENT SUBMITTAL.

PUMP SCHEDULE

									MOTOR DATA					
MARK	EXISTING TAG	SERVICE	TYPE	GPM	DYNAMIC HEAD-FT	RPM	MIN. EFF% HP	NPSH MIN. REQ.	HP	VOLT	PHASE	MANUFACTURER	MODEL	NOTES
PCHWP-1	CHP-1	CHILLED WATER	VERTICAL INLINE	733	40	1760	69.9	15.4	15	480	3	GRUNDFOS	VLS-6096A	ALL
PCHWP-2	CHP-2	CHILLED WATER	VERTICAL INLINE	733	40	1760	69.9	15.4	15	480	3	GRUNDFOS	VLS-6096A	ALL
PCHWP-3	CHP-3	CHILLED WATER	VERTICAL INLINE	733	40	1760	69.9	15.4	15	480	3	GRUNDFOS	VLS-6096A	ALL
SCHWP-1A	CHWP-4	CHILLED WATER	VERTICAL INLINE	1052	120	1780	78.2	16.9	50	480	3	GRUNDFOS	VLS-50129	ALL
SCHWP-2A	CHWP-5	CHILLED WATER	VERTICAL INLINE	1052	120	1780	78.2	16.9	50	480	3	GRUNDFOS	VLS-50129	ALL
SCHWP-1B	CHWP-6	CHILLED WATER	VERTICAL INLINE	415	75	1760	77.5	7.9	15	480	3	GRUNDFOS	VLS-40959	ALL
SCHWP-2B	CHWP-7	CHILLED WATER	VERTICAL INLINE	415	75	1760	77.5	7.9	15	480	3	GRUNDFOS	VLS-40959	ALL
CWP-1	CWP-1	COND. WATER	VERTICAL INLINE	1050	50	1780	71.4	11.8	25	460	3	GRUNDFOS	VLS-60957	ALL
CWP-2	CWP-2	COND. WATER	VERTICAL INLINE	1050	50	1780	71.4	11.8	25	460	3	GRUNDFOS	VLS-60957	ALL
CWP-3	CWP-3	COND. WATER	VERTICAL INLINE	1050	50	1780	71.4	11.8	25	460	3	GRUNDFOS	VLS-60957	ALL
SHWP-3	HWP-3	HOT WATER	END SUCTION	300	75	3516	73.68	13.27	10	460	3	GRUNDFOS	NBS 025-070-2P	ALL
SHWP-4	HWP-4	HOT WATER	END SUCTION	300	75	3516	73.68	13.27	10	460	3	GRUNDFOS	NBS 025-070-2P	ALL

NOTES:
1. PROVIDE END SUCTION PUMP WITH RIGID ALUMINUM COUPLING THAT REQUIRES NO FIELD ALIGNMENT. IF NOT AVAILABLE, LASER ALIGNMENT SHALL BE REQUIRED.
2. PROVIDE WITH TEFC MOTOR ENCLOSURE.
3. PROVIDE LIFETIME WARRANTY ON PUMP ALIGNMENT.
4. PROVIDE SHAFT GROUNDING RINGS.
5. PROVIDE SUCTION DIFFUSER AND INERTIA ISOLATION BASE FOR END SUCTION PUMPS.
6. VERTICAL IN-LINE PUMPS SHALL BE PROVIDED WITH SUCTION DIFFUSER, VIBRO ACOUSTICS 'SIPS' PUMP STAND AND 'NEOv' NEOPRENE ISOLATORS (OR FACTORY PROVIDED EQUIVALENT PUMP STAND).
7. CONTRACTOR SHALL CONFIRM IN FIELD EXISTING MECHANICAL EQUIPMENT VOLTAGES, ELECTRICAL EQUIPMENT SERVING IT, AND CIRCUIT OVERCURRENT PROTECTION PRIOR TO PREPARING A HVAC EQUIPMENT SUBMITTAL PACKAGE. CONTRACTOR SHALL FURNISH AND INSTALL HVAC EQUIPMENT THAT MATCHES EXISTING MECHANICAL UNIT ELECTRICAL CHARACTERISTICS. NO EXCEPTIONS.

COOLING TOWER SCHEDULES

DESCRIPTON			PERFORMANCE								ELECTRICAL			
MARK	MFGR	MODEL	WET BULB DESIGN (F)	WATER FLOW RATE (GPM)	CELL EWT (F)	BASIN LWT (F)	STATIC LIFT (FT)	ASHRAE 90.1 PERFORMANCE (GPM/HP)	AIRFLOW PER CELL (CFM)	FAN RPM	HP	BHP	V/PH/HZ	NOTES
CT-1	MARLEY	NC8407PAN2	80	1,050	95	85	12	112	118,300	273	15	15	460/3/60	ALL
CT-2	MARLEY	NC8407PAN2	80	1,050	95	85	12	112	118,300	273	15	15	460/3/60	ALL

NOTES:
1. EACH COOLING TOWER CELL SHALL BE BALANCED FOR 1,050GPM AT 95 EWT/ 85 LWT/ 80 WB. TOTAL TOWER FLOW SHALL BE 2,100 GPM
2. COOLING TOWER HOT WATER DISTRIBUTION SYSTEM SHALL BE CAPABLE OF OPERATING AT 840 GPM WHILE MAINTAINING AN UNIFORM AIR SIDE PRESSURE DROP THROUGH THE FILL TO MAXIMIZE COOLIN... EFFICIENCY AND MINIMIZE SCALE FORMATION IN THE FILL.
3. PROVIDE WITH INVERTER DUTY MOTORS WITH SHAFT GROUNDING RINGS.
4. PROVIDE WITH FAN VIBRATION SHUT-OFF SWITCH HARDWIRE TO DRY CONTACT AT VFD FOR SHUTDOWN.
5. PROVIDE VELOCITY RECOVERY STACK.
6. PROVIDE COMPLETE 300 SERIES (301L) STAINLESS STEEL CONSTRUCTION AND STAINLESS STEEL HARDWARE
7. PROVIDE WITH FAN MOTORS LOCATED OUTSIDE OF TOWER AIRSTREAM.
8. PROVIDE WITH GEAR DRIVEN FAN.
9. PROVIDE GRP BOTTOM SUMP OUTLET
10. PROVIDE EQUALIZER LINE CONNECTION
11. PROVIDE MANUAL FLOAT VALVE FOR BASIN FILL.
12. LEVEL CONTROLLER IS SCHEDULED ON THE MECHANICAL CONTROLS DRAWING.
13. PROVIDE 120V POWER FOR THE VIBRATION SAFETY SWITCH, LEVEL CONTROLLER, OIL LEVEL SWITCH, AND BAS CONTROLLER

VAV TERMINAL UNIT WITH HYDRONIC HEAT SCHEDULE

				COOLING CFM		ASHRAE 36 CO2...		HYDRONIC HEAT COIL								
MARK	MFGR	MODEL	INLET SIZE	MAX	MIN.	MIN.	MAX.	CFM	CAPACITY (MBH)	EAT (DEG F)	MIN LAT (DEG F)	FLUID FLOW (GPM)	PD (FT. W.G.)	ROWS	EWT / LWT (DEG F)	NOTES
VAV-1	PRICE	SDV	16	1980	595	220	520	990	38	55	90	1.5	0.33	2L	160/106	ALL
VAV-2	PRICE	SDV	10	950	285	115	260	475	18	55	90	1	0.19	2L	160/111	ALL
VAV-3	PRICE	SDV	16	1980	595	415	600	990	52	55	90	3.17	1.27	2L	160/126	ALL
VAV-4	PRICE	SDV	6	400	120	115	260	200	8	55	90	0.33	0.002	2L	160/110	ALL
VAV-5	PRICE	SDV	12	1260	378	56	110	630	24	55	90	1	0.36	2L	160/110	ALL
VAV-6	PRICE	SDV	14	1730	519	330	600	865	33	55	90	1.5	0.26	2L	160/108	ALL
VAV-7	PRICE	SDV	14	1940	582	220	520	970	38	55	90	1.4	0.32	2L	160/108	ALL
VAV-8	PRICE	SDV	14	1820	546	200	550	910	35	55	90	1.4	0.29	2L	160/108	ALL

NOTES:
1. UNIT SIZES ARE GIVEN IN INCHES, PRESSURE DROP IS IN FEET OF WATER.
2. GENERAL AND SUBCONTRACTORS SHALL VERIFY ALL SPACE REQUIRMENTS PRIOR TO INSTALLATION AND DUCT FABRICATION
3. BOX MANUFACTURER SHALL PROVIDE DDC CONTROLS TRANSFORMER.
4. CONTROL BOX LOCATION SHALL BE BOTTOM MOUNTED FOR ALL BOXES, OPTION 'CB-CONTROLS BOTTOM'
5. PROVIDE HYDRONIC KIT WITH ALL VAVS INCLUDING STRAINER, FLOW CONTROLLER, PETE'S PLUGS AND SHUT OFF VALVES.
6. 1/2-INCH - 1.5 PCF DENSITY FIBERGLASS INTERNAL INSULATION MEETING REQUIREMENTS OF NFPA 90A AND UL181.
6. PROVIDE UNIT WITH MOUNTING BRACKETS.

VFD SCHEDULE

MARK	SERVES	EQUIP	HP	INPUT VOLT	OUTPUT VOLT	MOUNTING	ENCLOSURE	MANUF	MODEL	NOTES
VFD-PCHWP-1	PCHWP-1	PUMP	15	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-PCHWP-2	PCHWP-2	PUMP	15	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-PCHWP-3	PCHWP-3	PUMP	15	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-CWP-1	CWP-1	PUMP	20	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-CWP-2	CWP-2	PUMP	20	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-CWP-3	CWP-3	PUMP	20	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
SCHWP-1A	SCHWP-1A	PUMP	50	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
SCHWP-2A	SCHWP-2A	PUMP	50	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
SCHWP-1B	SCHWP-1B	PUMP	15	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
SCHWP-2B	SCHWP-2B	PUMP	15	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-SHWP-3	SHWP-3	PUMP	10	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-SHWP-4	SHWP-4	PUMP	10	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-CT-1	CT-1	FAN	15	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL
VFD-CT-2	CT-2	FAN	15	460/3	460/3	WALL	NEMA 3R	DANFOSS	VLT-HVAC	ALL

NOTES:
1. VFD SHALL BE PROVIDED BY MECHANICAL CONTRACTOR AND WIRED BY ELECTRICAL CONTRACTOR
2. VFD SHALL BE PROVIDED WITH DISCONNECT.
3. PROVIDE BACNET DEVICE FOR INTERFACE WITH DDC SYSTEM.
4. CONTRACTOR SHALL CONFIRM IN FIELD EXISTING MECHANICAL EQUIPMENT VOLTAGES, ELECTRICAL EQUIPMENT SERVING IT, AND CIRCUIT OVERCURRENT PROTECTION PRIOR TO PREPARING A HVAC EQUIPMENT SUBMITTAL PACKAGE. CONTRACTOR SHALL FURNISH AND INSTALL HVAC EQUIPMENT THAT MATCHES EXISTING MECHANICAL UNIT ELECTRICAL CHARACTERISTICS. NO EXCEPTIONS
5. VFD MANUFACTURER'S REQUIREMENTS: THERMO SETTING TYPE CABLE IN COMPLIANCE WITH NFPA 79 FOR BOTH POWER AND GROUNDING.

ROOF PIPING CURB SCHEDULE

MARK	MANUFACTURER	SERIES	MODEL	SERVES	LENGTH (INCHES)	WIDTH (INCHES)	HEIGHT (INCHES)	OPTIONS
RPC-1	ROOF PENETRATION HOUSINGS, LLC	AWI MEDIUM VAULT	AWI201412	HOT WATER PIPING	20	14	12	1, 2, 3

NOTES:
A. ALL ALUMINUM PRE-INSULATED AND GASKETED CURB AND HOUSINGS W/VANDAL RESISTANT COVER AND STAINLESS STEEL SCREWS
B. EACH PIPE SHALL HAVE IT'S OWN EXIT SEAL WITH SILX14 GASKET SEAL

OPTIONS & ACCESSORIES:
1. PROVIDE VAULT 5000, 6000 OR 7000 EXIT SEALS MATCHED TO SIZE OF HOT WATER PIPING (CONTRACTOR TO DETERMINE QUANTITIES AND SIZES)
2. REVIEW EXISTING INSULATION THICKNESS AT EACH LOCATION ON ROOF AND PROVIDE CURB HEIGHT EXTENSION AS REQUIRED
3. 3RD PARTY TESTED BY THE NATIONAL WIND INSTITUTE TO MEET ICC-500 AND FEMA 320/361

GRAVITY INTAKE LOUVERED PENTHOUSE SCHEDULE

MARK	SERVES	MAX CFM	THROAT VELOCITY (FPM)	THROAT SIZE (IN x IN)	LOUVER HEIGHT	FREE AREA (FT2)	WEIGHT (LBS)	STATIC PRESS. (IN WG)	MANUFACTURER	MODEL	NOTES
IH-1	AHU-L	4,600	500	24" X 24"	18"	4	144	0.072	GREENHECK	EHH-601PD	1-4

NOTES:
1. 14" MINIMUM GALVANIZED DOUBLE WALL CONSTRUCTION CURB WITH BIRD SCREEN. TOP OF CURB SHALL BE MINIMUM 10" ABOVE FINISHED ROOF
2. LOW PROFILE
3. ALL ALUMINUM CONSTRUCTION
4. PENTHOUSE LOUVER ASSEMBLY SHALL COMPLY WITH TAS 203 (CYCLIC WIND-LOADING, AND SHALL INCORPORATE HIGH PERFORMANCE HORIZONTAL WIND-DRIVEN RAIN STYLE BLADES FOR MAXIMUM PROTECTION AGAINST WIND-DRIVEN RAIN.

SOUTH MIDDLE SCHOOL HEATING & AIR CONDITION (HVAC) IMPROVEMENTS FUNDED THROUGH THE ELEMENTARY SECONDARY SCHOOLS EMERGENCY RELIEF (ESSER) FUNDS

ECISD

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Revision No.	Date	Description
1	8-24-22	ADD #3

KYLE A. HUNTER
121984
LICENSED PROFESSIONAL ENGINEER
STATE OF TEXAS

AVO:	45215.020
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Sheet Title	MECHANICAL SCHEDULE II
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100% CONSTRUCTION DOCUMENTS

POINTS SCHEDULE

SYSTEM: SOLIDS SEPARATOR, SERVING COOLING TOWER BASINS FOR CT-1, CT-2, & CT-3

SYSTEM: SS-1

			HARDWARE																	SOFTWARE															
			OUTPUT FROM BAS						INPUT TO BAS																										
			DIGITAL			ANALOG			DIGITAL						ANALOG					OBJECT TYPES						CALCULATED				ALARMS	SCHEDULE	GRAPHICS & TRENDING			
POINT DESCRIPTION	POINT ID CODE	SOFTWARE POINT / BACNET MSTP	CONTROL RELAY FOR START/STOP	FLOATING CONTROL	ENABLE / DISABLE	CONTROL POINT ADJUSTMENT	4-20mA SIGNAL	0-10 VDC	DIFF. PRESSURE SWITCH	ALARM CONTACT	END SWITCH (DAMPER ACTUATOR)	CURRENT RELAY	MOMENTARY PUSHBUTTON	OEM DRY CONTACT	TEMPERATURE, DEG F	PSIG, PSIA, PSID	CURRENT SENSING TRANSDUCER	0-10 VDC OR 4-20mA	DIFF. PRESSURE TRANSDUCER	ANALOG INPUT OBJECT (AI)	ANALOG OUTPUT OBJECT (AO)	ANALOG VALUE OBJECT (AV)	BINARY VALUE OBJECT (BI)	BINARY VALUE OUTPUT (BO)	BINARY VALUE OBJECT (BV)	SETPOINT	LINKED TO OTHER POINTS	RUN TIME	FLOW RATE - CFM (FT^3/MIN)			DATA ARCHIVING	TREND REPORTING	DYNAMIC TREND GRAPH	DYNAMIC COLOR GRAPHICS
CHILLER RM. EMER. EXH FANS - HARD WIRED POINTS																																			
SS-1 OEM MOTOR COMMAND STATUS	DI-01													X														X				X			X
SS-1 BAS OVERRIDE - REMOTE START / STOP	DO-01		X																																X
SS-1 CURRENT STATUS (SPLIT CORE - ADJUSTABLE)	DI-02											X																		X					X
SS-1 MOTOR OVERLOAD TRIP STATUS (TRIPPED / OK)	DI-03													X																X					X

SS-1 SOLID SEPARATOR - SEQUENCE OF OPERATION

SOLIDS SEPARATOR:

SOLID SEPARATOR SHALL HAVE IT'S OWN STAND ALONE CONTROLS. THE ON BOARD SWITCH SHALL NORMALLY BE SET TO 'AUTO' AND SHALL BE CONTROLLED BY THE BAS

GRAPHICS DATA ARCHIVING, AND TRENDING:

- PROVIDE DYNAMIC COLOR GRAPHICS, DATA ARCHIVING, AND TRENDING FOR ALL POINTS INDICATED WITH AN 'X' ON THE POINTS SCHEDULE

PUMP OPERATION:

- A HARD WIRED DIGITAL OUTPUT FROM THE BAS SHALL BE SENT TO THE PUMP'S MOTOR STARTER TO START THE PUMP WHEN THE SYSTEM IS IN 'AUTO'
- THE PUMP SHALL BE COMMANDED TO OPERATE CONTINUOUSLY WHEN AT LEAST ONE (1) CONDENSER WATER PUMP IS RUNNING (CWP-1, CWP-2, OR CWP-3)

FREEZE SEQUENCE:

- WHEN EITHER THE OUTSIDE AIR TEMPERATURE DROPS BELOW 35F OR THE BASIN WATER TEMPERATURE DROPS BELOW 34F FOR AN ADJUSTABLE TIME PERIOD OF 30 MINUTES, SS-1 SHALL ENERGIZE THE PUMP MOTOR AND INDICATE **'FREEZE PROTECTION MODE'** ON THE GRAPHICS SCREEN AT THE OPERATOR WORKSTATION.
- ONCE IN **FREEZE** PROTECTION MODE, THE SYSTEM SHALL CONTINUOUSLY RUN UNTIL BASIN TEMPERATURE RISES ABOVE 35F OR OUTSIDE AIR TEMPERATURE RISES ABOVE 36F FOR 30 MINUTES (ADJUSTABLE).
- AFTER PUMP EXITS **'FREEZE PROTECTION MODE'** THE SYSTEM SHALL BE PUT IN NORMAL SEQUENCE OF OPERATION.

PUMP STATUS:

- PUMP COMMANDED 'ON' AND STATUS INDICATES NO POWER TO PUMP MOTOR
- PUMP COMMANDED 'OFF' AND STATUS INDICATES PUMP IS STILL RUNNING
- ALARM IF MOTOR OVERLOAD TRIPS

RUN TIME NOTIFICATIONS:

FRONT END GRAPHICS SCREEN SHALL PROVIDE THE FOLLOWING:

1. RUN TIME FOR THE PUMP WITH AN ADJUSTABLE MAINTENANCE SETPOINT WITH A MANUAL RESET BUTTON ON THE GRAPHICS SCREEN.
2. RUN TIME FOR THE FILTER WITH AN ADJUSTABLE MAINTENANCE SETPOINT WITH A MANUAL RESET BUTTON ON THE GRAPHICS SCREEN.

2 MC_SS-1 SOLIDS SEPARATOR
N.T.S.

POINTS SCHEDULE

SYSTEM: CONDENSER WATER

SUB-SYSTEM: CONDENSER WATER PUMPS

SYSTEM: CWP - 1,2,3

			HARDWARE																	SOFTWARE															
			OUTPUT FROM BAS						INPUT TO BAS																										
			DIGITAL			ANALOG			DIGITAL						ANALOG					OBJECT TYPES						CALCULATED				ALARMS	SCHEDULE	GRAPHICS & TRENDING			
POINT DESCRIPTION	POINT ID CODE	SOFTWARE POINT / BACNET MSTP	CONTROL RELAY FOR START/STOP	FLOATING CONTROL	ENABLE / DISABLE	CONTROL POINT ADJUSTMENT	4-20mA SIGNAL	0-10 VDC	DIFF. PRESSURE SWITCH	ALARM CONTACT	PULSE	CURRENT RELAY	MOMENTARY PUSHBUTTON	TEMPERATURE SWITCH	TEMPERATURE, DEG F	PSIG, PSIA, PSID	CURRENT SENSING TRANSDUCER	0-10 VDC OR 4-20mA	DIFF. PRESSURE TRANSDUCER	ANALOG INPUT OBJECT (AI)	ANALOG OUTPUT OBJECT (AO)	ANALOG VALUE OBJECT (AV)	BINARY VALUE OBJECT (BI)	BINARY VALUE OUTPUT (BO)	BINARY VALUE OBJECT (BV)	SETPOINT	LINKED TO OTHER POINTS	RUN TIME	FLOW RATE - CFM (FT^3/MIN)			DATA ARCHIVING	TREND REPORTING	DYNAMIC TREND GRAPH	DYNAMIC COLOR GRAPHICS
CONDENSER WATER PUMPS HARD WIRED POINTS																																			
VFD START/STOP	DO-01				X																							X							X
VFD SPEED COMMAND (0-10VDC)	AO-01							X																		X	X						X	X	X
CURRENT STATUS (SPLIT CORE - ADJUSTABLE)	DI-01											X																		X					X
VFD GENERAL ALARM (FAULT)	DI-02																													X					X
THE FOLLOWING POINTS SHALL BE INTEGRATED THROUGH BACnet MS/TP																																			
CHILLED WATER PUMPS CHWP-1,2,3 INTEGRATION POINTS																																			
REFER TO M-702 FOR TYPICAL VFD POINTS.	IP	X																																	

CWP-1,2,3 SEQUENCE OF OPERATION

CONDENSER WATER PUMPS:

GRAPHICS, DATA ARCHIVING AND TRENDING:

- PROVIDE DYNAMIC COLOR GRAPHICS, DATA ARCHIVING, AND TRENDING FOR ALL POINTS INDICATED WITH AN 'X' ON THE POINTS SCHEDULE

PUMP OPERATION:

- REFER TO THE CENTRAL PLANT SEQUENCE FOR OPERATIONAL SEQUENCES FOR THE CONDENSER WATER PUMPS

PUMP ROTATION (LEAD / LAG / STANDBY):

- THE PUMPS SHALL BE SET UP AS LEAD / LAG AND STANDBY. ALL THREE PUMPS SHALL BE INCLUDED IN A MINIMUM RUNTIME ROTATION WHERE THE PUMP WITH THE LOWEST TOTALIZED RUNTIME IS DESIGNATED AS LEAD PUMP FOLLOWED BY LAG AND STANDBY (LOWEST RUNTIME TO HIGHEST RUNTIME).

PUMP STATUS:

PROVIDE A SPLIT CORE CURRENT SENSOR FOR PUMP STATUS. PROVIDE A VISUAL DISPLAY OF PUMP OPERATION ON THE GRAPHICS SCEEN CONFIRMING RUN STATUS FOR EACH PUMP.

PUMP FAILURE SEQUENCE:

- IF A CONDENSER WATER PUMP IS COMMANDED BY THE BAS TO START AND DOES NOT START WITHIN 20 SECONDS (ADJUSTABLE) OF START COMMAND, OR IF OPERATING PUMP FAILS BASED ON CURRENT SENSOR RELAY THE FOLLOWING SHALL OCCUR:
  1. THE BAS SHALL SWITCH THE LEAD PUMP TO THE STANDBY PUMP OR LAG PUMP.
  2. THE BAS SHALL COMMAND THE NEW DESIGNATED 'LEAD' PUMP TO START.
  3. THE FAILED PUMP SHALL BE DE-ENERGIZED (COMMANDED TO STOP)
  4. THE FAILED PUMP SHALL BE LOCKED OUT FROM SERVICE UNTIL MANUALLY RESET THROUGH THE BAS.
  5. THE BAS SHALL GENERATE A CRITICAL ALARM AT THE OPERATOR WORKSTATION

PUMP OPERATION:

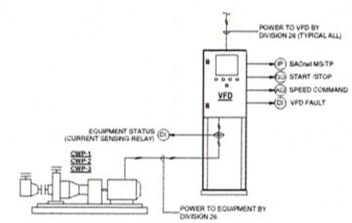
- A HARD WIRED DIGITAL OUTPUT FROM THE BAS SHALL BE SENT TO THE VFD TO START THE PUMP.
- INITIAL START SIGNAL TO VFD SHALL BE NO LOWER THAN 15Hz, THEN SLOWLY RAMP TO SPEED VALUE PRESET BY TEST AND BALANCE FIRM.
- THE PUMP IS A CONSTANT SPEED PUMP AND SHALL BE BALANCED TO THE FLOW RATE REQUIRED BY THE CHILLER'S CONDENSER SECTION.
- PUMP SPEED SETPOINT. (SET BY TEST & BALANCE CONTRACTOR).

ALARM SUMMARIES:

- PUMP COMMANDED 'ON' AND STATUS INDICATES NO POWER TO PUMP MOTOR.
- PUMP COMMANDED 'OFF' AND STATUS INDICATES PUMP STILL RUNNING (HAND)
- ANY INTEGRATED POINT ALARMS SHOWN IN THE VFD POINTS SCHEDULE SHALL BE ALARMED. REFER TO DRAWING M-702.
- MAINTENANCE TIME LIMIT EXCEEDED FOR ANY PUMP

RUN TIME NOTIFICATIONS:

- FRONT END GRAPHICS SCREEN SHALL PROVIDE A TOTALIZED RUN TIME FOR EACH PUMP NOTIFICATIONS SHALL BE SENT WHEN MAINTENANCE SETPOINTS ARE REACHED BASED ON QUANTITY OF HOURS IN OPERATION.
- PROVIDE MAINTENANCE SETPOINTS ON GRAPHICS SCREEN (ADJUSTABLE) SEPARATELY FOR EACH PUMP. INITIAL SETPOINT SHALL BE 1500 HOURS.



1 CONDENSER WATER PUMPS
N.T.S.

SOUTH MIDDLE SCHOOL HEATING & AIR CONDITION (HVAC) IMPROVEMENTS FUNDED THROUGH THE ELEMENTARY SECONDARY SCHOOLS EMERGENCY RELIEF (ESSER) FUNDS
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Revision No.	Date	Description
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EDINBURG CISD
South Middle School Heating & Air Condition (HVAC) Improvements Funded through the Elementary Secondary Schools Emergency Relief (ESSER) Funds
TABLE OF CONTENTS

Division	Section Title

EDINBURG CISD
South Middle School Heating & Air Condition (HVAC) Improvements Funded through the Elementary Secondary Schools Emergency Relief (ESSER) Funds
TABLE OF CONTENTS

END OF TABLE OF CONTENTS

SECTION 237413A - PACKAGED, OUTDOOR AIR-HANDLING (ROOF-TOP) UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, outdoor air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Electric-heating coils.
3. Integral, space temperature controls.
4. Roof curbs.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VAV: Variable-air volume.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design RTU supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Wind-Restraint Performance:

1. Basic Wind Speed: 130
2. Building Classification Category: III.
3. Minimum 10 lb/sq. ft (48.8 kg/sq. m) multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wind Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to 1/4" = 1'-0" scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which RTUs will be attached.
2. Roof openings
3. Roof curbs and flashing.

B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation.
2. Engineered Air.
3. Daiken.
4. Trane.
5. Johnson Controls

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.0626 inch thick.
2. Finished Surface shall withstand minimum 750 hour salt spray test in accordance with ASTM B117 standard.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.034 inch thick.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 2 inches thick, 1-1/2 pound density.
3. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

A. Direct Drive: ECM Plenum, single width.

B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

C. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor or cast aluminum microchannel.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Cathodic epoxy coating.

C. Electric-Resistance Heating:

1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.

3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:

    a. Magnetic contactors.
    b. Step Controller: Pilot lights and override toggle switch for each step.
    c. Time-delay relay.
    d. Airflow proving switch.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Two minimum.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-407C or R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

D. Units 20 tons and greater shall have a minimum of four stages of capacity.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: MERV 13.

2.7 DAMPERS

A. Outdoor- and Return and Exhaust-Air Mixing Dampers (Economizer): Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Outside and return air dampers shall be sized to accommodate 100 percent of supply air flow.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Barometric with or motorized control for positive shut off, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.8 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

A. Control equipment and sequence of operation are specified in HVAC Controls specification and shown on plans.

B. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
3. Provide BACnet or LonWorks compatible interface for central HVAC control workstation for the following:

    a. Adjusting set points.
    b. Monitoring supply fan start, stop, and operation.
    c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
    d. Monitoring occupied and unoccupied operations.
    e. Monitoring constant and variable motor loads.
    f. Monitoring variable-frequency drive operation.
    g. Monitoring cooling load.
    h. Monitoring economizer cycles.
    i. Monitoring air-distribution static pressure and ventilation air volume.

2.10 ACCESSORIES

A. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

B. Hail guards of galvanized steel, painted to match casing.

2.11 ROOF CURBS

A. Roof curbs with vibration isolators and wind restraints are specified in Section 230548 "Vibration Controls for HVAC Piping and Equipment."

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

    a. Materials: ASTM C 1071, Type I or II.
    b. Thickness: 1-1/2 inches.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

    a. Liner Adhesive: Comply with ASTM C 916, Type I.
    b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
    d. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: 14 inches.

D. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install RTUs on concrete base using elastomeric pads. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Minimum Deflection: 1/4 inch.

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to **NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts."** Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing with anchor bolts.

C. Install wind restraints according to manufacturer's written instructions.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified with concrete.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.

    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

27. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 15732A

SECTION 236500 - COOLING TOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Open-circuit, induced-draft, crossflow cooling towers.

1.3 DEFINITIONS

A. BMS: Building management system.

B. FRP: Fiber-reinforced polyester.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design cooling tower support structure and wind restraints where necessitated by windstorm requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.

   1. Maximum flow rate.
   2. Minimum flow rate.
   3. Drift loss as percent of design flow rate.
   4. Volume of water in suspension for purposes of sizing a remote storage tank.
   5. Sound power levels in eight octave bands for operation with fans off, fans at minimum, and design speed.
   6. Performance curves for the following:

      a. Varying entering-water temperatures from design to minimum.
      b. Varying ambient wet-bulb temperatures from design to minimum.
      c. Varying water flow rates from design to minimum.
      d. Varying fan operation (off, minimum, and design speed).

7. Fan airflow, brake horsepower, and drive losses.
8. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
9. Electrical power requirements for each cooling tower component requiring power.
10. Vibration switch
11. Automated Leveling Controller as specified on drawings.
12. Cooling Tower Materials of Basin, Structural Components and Fill.
13. Harmonic Testing on all tower cells and VFD lockout frequency programming. Provide documentation on the test procedure to test all three towers from 0-100% speed with vibration sensor equipment attached. Lock out VFD frequencies for each tower cell that correspond with harmonic vibrations out of spec (refer to controls drawings).

B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of support structure.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Design Calculations: Calculate requirements for selecting vibration isolators and wind restraints and for designing vibration isolation bases.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale 1/4" = 1'-0", on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
5. Include Plumbing connections – Fill Water, water hammer arrestors, and overflow drains.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Source quality-control reports.

D. Field quality-control reports.

E. Startup service reports.

F. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

E. FMG approval and listing in the latest edition of FMG's "Approval Guide."

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:
   1. All components of cooling tower.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings:

1. Amcot Cooling Tower Corp.
2. Marley Cooling Technologies; an SPX Corporation.
3. Evapco Cooling

B. Wind Loading:
1. Tower shall be designed and installed to resist wind loading as specified by local codes.

C. Casing and Frame:

1. Casing Material: Stainless Steel.
2. Frame Material: Stainless steel.
3. Fasteners: Stainless steel.
4. Joints and Seams: Sealed watertight.
5. Welded Connections: Continuous and watertight.

D. Collection Basin:

1. Material: Stainless Steel

2. Sump: GRP.
3. Removable stainless-steel strainer with openings smaller than nozzle orifices.
4. Overflow and drain connections.
5. Makeup water connection.
6. Outlet Connection: ASME B16.5, Class 150 flange.

E. Electric/Electronic, Collection Basin Water-Level Controller:

1. Manufacturer:
   a. Waterline Controls
   b. Marley
   c. Evapco Cooling

2. Enclosures: NEMA 250, Type 4X.
3. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve and low- and high-level alarms.
4. Electrode Probes: Stainless steel.
5. Water Stilling Chamber: FRP.
6. Solenoid Valve: Not used on this project.
7. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

F. Electric Basin Heater (ONLY WHERE SPECIFIED):

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.

3. Enclosure: NEMA 250, Type 4X.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a fused disconnect switch and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

G. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.

1. Material: Stainless Steel.
2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
3. Inlet Connection: ASME B16.5, Class 150 flange.
4. Joints and Seams: Sealed watertight.
5. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.
6. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable [corrosion-resistant] [stainless-steel] hardware.
7. Single-Inlet, Field Pipe Connection: Pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the bottom unless otherwise indicated.

H. Fill:

1. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E 84.
2. Minimum Thickness: 20 mils, before forming.
3. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

I. Drift Eliminator:

1. Material: PVC; with maximum flame-spread index of 5 according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
4. Location: Integral to fill.

J. Air-Intake Louvers:

1. Material: PVC.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
4. Location: Integral to fill.

K. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: Aluminum.
2. Hub Material: Aluminum.
3. Blade Pitch: Field adjustable.
4. Protective Enclosure: Removable, stainless steel, wire-mesh screens complying with OSHA regulations.

L. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned in the field after motor is mounted outside the air-stream.

1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
4. Operation: Able to operate both forward and in reverse.
5. Drive-to-Motor Connection: Connected to motor located outside of cooling tower casing by a full-floating drive shaft.
6. Drive Shaft Material: Stainless steel, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
7. Extend oil fill, drain, and vent to outside of cooling tower casing using stainless-steel piping. Provide installation with oil-level dip stick.

M. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed fan cooled (TEFC).
3. Energy Efficiency: NEMA Premium Efficient.
4. Service Factor: 1.15.
5. Insulation: Class F.
6. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
7. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
8. Severe-duty rating with the following features:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F.

9. Motor Base: Fixed for gear driven assembly.

N. Fan Discharge Stack: Material shall match casing, manufacturer's standard design.

O. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4X.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch with manual-reset button for hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration,shut down the fan.

P. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch.

1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm.

2. Provide a Digital Output for connection to the BAS.

Q. Controls: Comply with requirements in Section 230900 "Instrumentation and Control for HVAC."

R. Control Package: Shipped separately.
1. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" Paragraph.
2. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
3. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil-Level Switch" Paragraph.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Test and certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

B. Factory pressure test heat exchangers after fabrication and prove to be free of leaks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

2. Coordinate with mechanical piping shop drawings.

3. Coordinate with electrical rough in.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cooling towers on support structure indicated.

B. Equipment Mounting: Install cooling tower using elastomeric pads designed for the weight of the towers. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 1/2 inch.
2. Provide stainless-steel plate to equally distribute weight over elastomeric pad.

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to cooling towers to allow service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Provide drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

F. Domestic Water Piping: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Connect to mechanical float valve with shutoff valve and union, flange, or mechanical coupling at each connection.

G. Supply and Return Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping." Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a flange or mechanical coupling.

H. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.

I. All piping below cooling towers shall be supported by the cooling tower steel framing. No weight shall be supported from the pipe flanges.

J. Connect solids separator to the in and out pipe connections on the bottom of the cooling towers

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform field tests and inspections.

B. Tests and Inspections: Comply with CTI ATC 105, "Acceptance Test Code for Water Cooling Towers."

C. Cooling towers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

    a. Clean entire unit including basins.
    b. Verify that accessories are properly installed.
    c. Verify clearances for airflow and for cooling tower servicing.
    d. Check for vibration isolation and structural support.
    e. Lubricate bearings.
    f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
    g. Adjust belts to proper alignment and tension.
    h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
    i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
    j. Provide a full vibration analysis on all tower cells from 0-100% full speed and program lock-out frequencies to prevent prolonged operation of towers in the zones where vibrations exceed requirements (Refer to drawings).
    k. Check vibration switch setting. Verify operation.

l. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
m. Verify operation of basin heater and control (where applicable)
n. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
o. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.6 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION 236500

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:

1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

C. Mechanical controls drawings.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. VAV: Variable air volume.

1.4 AHU SINGLE ZONE (HW COIL & CW COIL)

A. Refer to mechanical controls drawing for points, controls diagram and sequence.

1.5 AHU-L

A. Refer to mechanical controls drawing for points, controls diagram and sequence.

1.6 VAV W/REHEAT COIL

A. Refer to mechanical controls drawing for points, controls diagram and sequence.

1.7 RTU-1, RTU-2, RTU-3

A. Refer to mechanical controls drawing for points, controls diagram and sequence.

1.8 AHU-1, AHU-2 (DX Split Systems)

A. Refer to mechanical controls drawing for points, controls diagram and sequence.

1.9 COOLING TOWERS, CT-1 & CT-2

A. Refer to mechanical controls drawing for points, controls diagram and sequence.

1.10 CONDENSER WATER PUMPS, CWP,1,2,3

A. Refer to mechanical controls drawing for points, controls diagram and sequence.

1.11 CHILLED WATER PUMPS, CHWP-1,2,3

A. Refer to mechanical controls drawing for points, controls diagram and sequence.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.

C. The work contained in this project includes new air handlers, new primary chilled water pumps, new secondary chilled water pumps, new condenser water pumps, and new secondary hot water pumps. The scope of this project also includes providing new controls for two (2) new outdoor cooling towers. The infrastructure for this system shall integrate into the existing front end system on the campus.

Currently, an existing Johnson Controls system is installed and operating to control the existing equipment in the building and central plant.

The contractor shall ensure that all infrastructure necessary is installed to support all of the equipment shown on the drawings.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. MS/TP: Master slave/token passing.

D. PC: Personal computer.

E. PID: Proportional plus integral plus derivative.

F. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

a. Water Temperature: Plus or minus 1 deg F.
b. Water Flow: Plus or minus 5 percent of full scale.
c. Water Pressure: Plus or minus 2 percent of full scale.
d. Space Temperature: Plus or minus 1 deg F.
e. Ducted Air Temperature: Plus or minus 1 deg F.
f. Outside Air Temperature: Plus or minus 2 deg F.
g. Dew Point Temperature: Plus or minus 3 deg F.
h. Temperature Differential: Plus or minus 0.25 deg F.
i. Relative Humidity: Plus or minus 5 percent.
j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
l. Airflow (Terminal): Plus or minus 10 percent of full scale.
m. Air Pressure (Space): Plus or minus 0.01-inch wg.
n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
o. Carbon Monoxide: Plus or minus 5 percent of reading.
p. Carbon Dioxide: Plus or minus 50 ppm.
q. Electrical: Plus or minus 5 percent of reading.

1.5 SEQUENCE OF OPERATION

A. Refer to HVAC plans.

1.6 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

5. Software license required by and installed for DDC workstations and control systems.

E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

F. Qualification Data: For Installer and manufacturer.

G. Field quality-control test reports as delineated in Part 3-Field Quality Control. THIS IS A SUBMITTAL THAT INCLUDES POINT BY POINT VERIFICATION OF THE ENTIRE DDC SYSTEM. IT IS REQUIRED.

H. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units where applicable.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.10 ELECTRICAL SERVICE

A. The HVAC Controls Contractor shall be responsible for the provision of line voltage electrical power to each individual HVAC control component that requires it. As each HVAC Control system has unique electrical requirements, it is unreasonable for the project documents to account for each scenario by designing for worst case. Rather, it is logical for the respective HVAC Controls Contractor to account for the specific power requirements of their individual system. As such, the HVAC Controls Contractor shall either self-perform this work using licensed electricians of their employ or contract with the project's electrical contractor to perform this work. In doing so, all electrical specifications from the project manual apply. All work shall be performed and completed to comply with and maintain all electrical warranties.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve actuator, controller, thermostat and positioning relay.
2. Maintenance Materials: Two thermostat adjusting key(s).

1.12 SCHEDULE OF VALUES

1. By the very nature of HVAC Control systems, much of the true value to the Owner occurs with the final programming to make the system operational and commissioning to ensure compliance with the design sequences and provide operation efficiency. Unfortunately, to often, the DDC Contractor focuses on the equipment and infrastructure installation and does not prioritize the latter phases of a successful DDC system implementation. To help mitigate this, the following allocation of fee for the work shall apply:
   - Approved submittals 5%
   - Delivery of equipment to site 25%
   - Installation of equipment to/Hardware 40%
   - Software and System programming 15%
   - System commissioning, verification, close-out 15%

   These allocations reference the DDC price only. Any applicable withholding of retainage are separate and above.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturer specified.

2.2 CONTROL SYSTEM

A. Manufacturers:
   1. Johnson Controls, Inc.; Controls Group.
   2. Climatec
   3. TRANE
   4. Schneider

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

C. Control system shall include the following:

   1. Building intrusion detection system specified in Division 26 Section "Intrusion Detection."
   2. Building clock control system specified in Division 26 Section "Clock Systems."
   3. Building lighting control system specified in Division 26 Section "Network Lighting Controls."
   4. Fire alarm system specified in Division 28 Section "Fire Detection and Alarm."

2.3 DDC EQUIPMENT

A. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

   1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
   2. Processor: Intel Core 2 Duo, 2.2GHz MHz.
   3. Random-Access Memory: 2GB.
   4. Graphics: Video adapter, minimum 1024 x 768 pixels, 256-MB video memory.
   5. Monitor: 15 inches, LCD color.
   6. Keyboard: QWERTY 105 keys in ergonomic shape.
   7. Hard-Disk Drive: 80 GB.
   8. CD-ROM Read/Write Drive: 48x24x48.

9. Pointing Device: Touch pad or other internal device.

B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
e. Remote communications.
f. Maintenance management.
g. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.

c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.5 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.

1. Alarm Condition: Indicating light flashes and horn sounds.
2. Acknowledge Switch: Horn is silent and indicating light is steady.
3. Second Alarm: Horn sounds and indicating light is steady.
4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.6 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.7 TIME CLOCKS

A. Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.8 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

1. Accuracy: Plus or minus 0.5 deg F at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: As required 36 inches or 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Concealed.
    d. Color: Manufacturer's standard.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

B. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
4. Averaging Elements in Ducts: 24 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Concealed.
    d. Color: Manufacturer's standard.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 2 percent full range with linear output.
2. Room Sensor Range: 20 to 80 percent relative humidity.
3. Room Sensor Cover Construction: Manufacturer's standard locking covers.

   a. Set-Point Adjustment: Exposed.
   b. Set-Point Indication: Exposed.
   c. Thermometer: Concealed.
   d. Color: manufacturer's standard.

4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg FDuct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

D. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

   a. Accuracy: 1 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0- to 0.25-inch wg.
   d. Duct Static-Pressure Range: 0- to 5-inch wg.

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

E. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

2.9 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (Unless indicated otherwise on plans).

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump (Unless indicated otherwise on plans).

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.10 FLOW MEASURING STATIONS

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.

1. Casing: Galvanized-steel frame.
2. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.
3. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

2.11 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.

1. Label switches "FAN ON-OFF".
2. Mount on single electric switch box.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

    a. Time of day.
    b. Actual room temperature.
    c. Programmed temperature.
    d. Programmed time.
    e. Duration of timed override.
    f. Day of week.
    g. System mode indications include "heating," "off," "fan auto," and "fan on."

C. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:

    1. Reset: Manual.

D. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

E. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

F. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

    1. Bulb Length: Minimum 20 feet.
    2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

G. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

    1. Bulb Length: Minimum 20 feet.
    2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.12 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

    a. Belimo Aircontrols (USA), Inc.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: 40 to 104 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
12. Run Time: 30 seconds;

2.13 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 5-psig maximum pressure drop at design flow rate or the following:

    a. Two Position: Line size.
    b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

C. Butterfly Valves: 200-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Lug.
2. Disc Type: Stainless steel.
3. Sizing: 1-psig maximum pressure drop at design flow rate.

D. Pressure Independent Characterized control Valves: Brass body, brass trim, two ports, replaceable plugs and seats, and union and threaded ends.

1. Rating: 600 psi at 212 of operating conditions.
2. Sizing: 5-50 psi operating range to close against 200 psi.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics.

2.14 DAMPERS

A. Dampers: AMCA-rated, parallel or opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Classrooms.
4. Where indicated on plans.

E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 23 Section "Mechanical Identification."

H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

I. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable:

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.

3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
7. Check temperature instruments and material and length of sensing elements.
8. Check control valves. Verify that they are in correct direction.
9. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.

e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

B. Allocate 8 hours to demonstrate proper operation of any and all control sequences to the design engineer. Should the system be at a level of performance that requires additional time for verification of proper operation by the design engineer, this time shall be compensated to the engineer by the contractor at a rate of $200/hour.

3.7 REMOTE USER ACCESS

A. Controls contractor shall provide read-only access to the project HVAC Control System. Access shall be available to the HVAC design engineer and to the Commissioning Agent, where applicable. It shall be either software housed on a computer located in the Engineer's (or Cx) office or internet accessible at industry standard speeds and shall be available for a minium of one year form Substantial Completion of the project.

END OF SECTION 230900