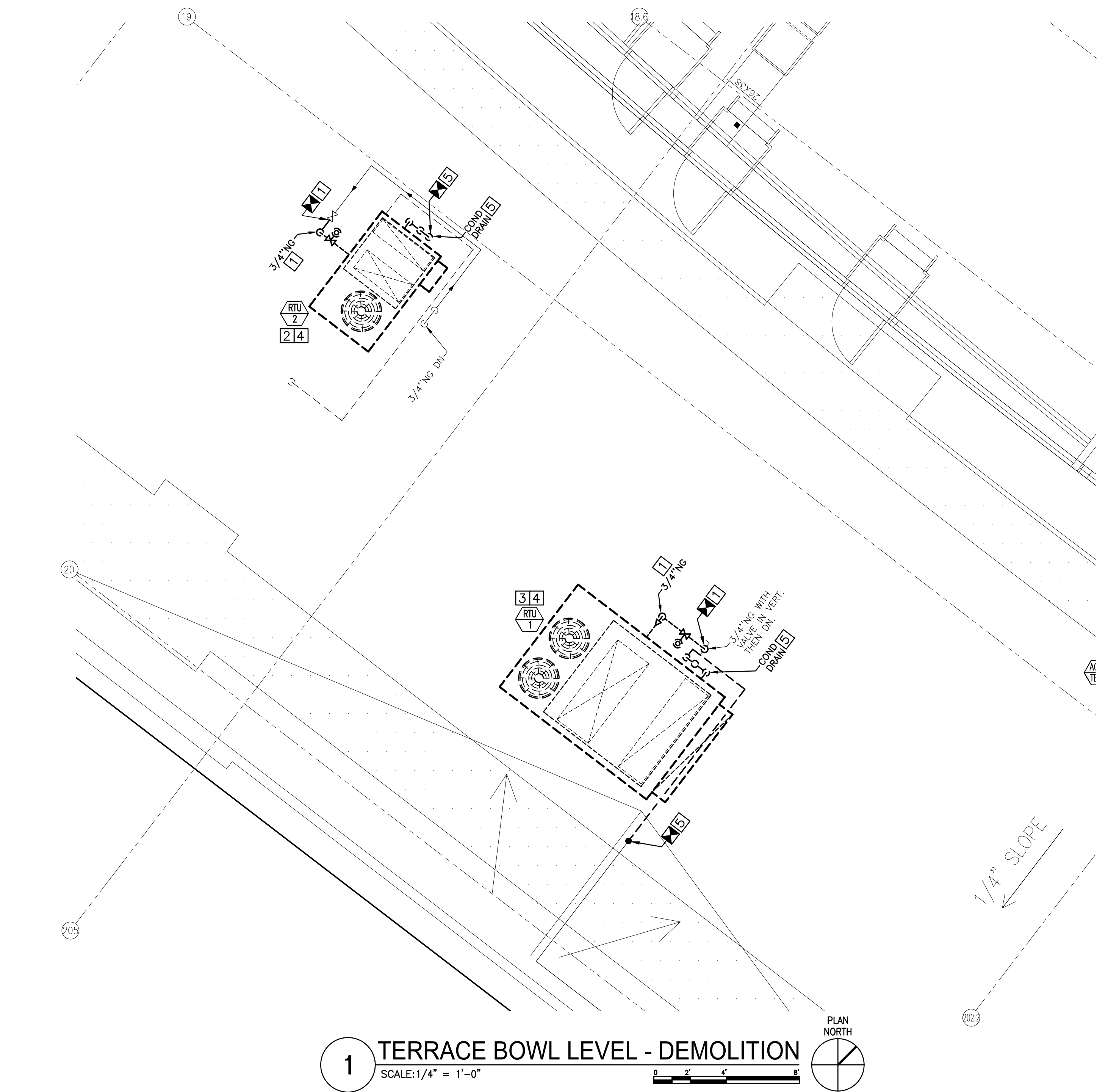
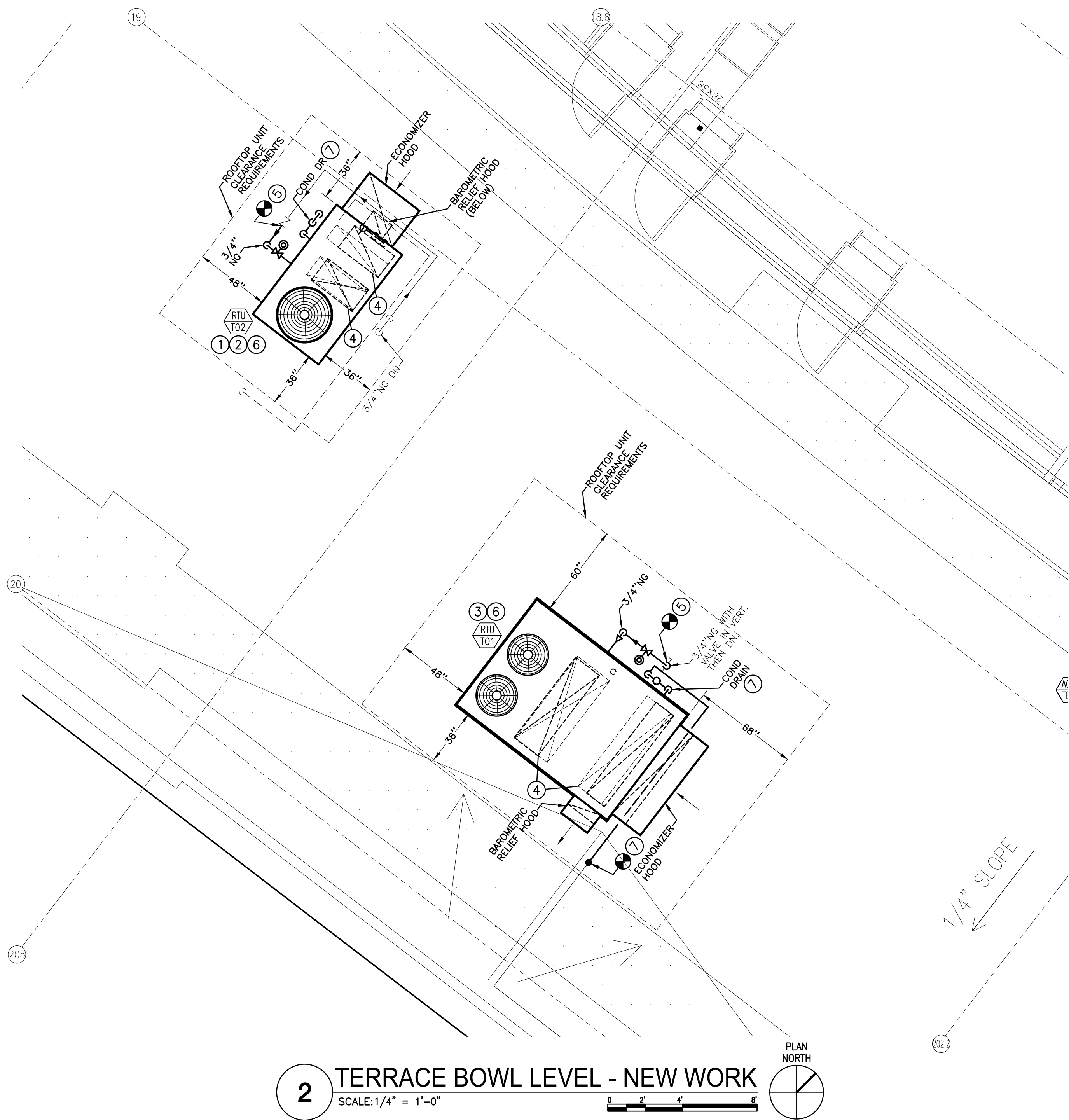




1 TERRACE BOWL LEVEL - DEMOLITION
SCALE:1/4" = 1'-0"

KEYED NOTES: DEMOLITION

- TURN GAS VALVE TO CLOSED POSITION. DISCONNECT GAS PIPING FROM ROOFTOP UNIT AND DEMOLISH GAS PIPING BACK TO GAS VALVE. FIELD VERIFY LOCATION. REMAINING GAS PIPING TO STAY AND TO BE UTILIZED FOR GAS TO NEW UNIT. REFER TO NEW WORK.
- DEMOLISH EXISTING ROOFTOP UNIT RTU-2. REMOVE EXISTING ROOF CURB. SUBCONTRACT FJA CHRISTIANSON FOR ANY ROOFING WORK REQUIRED. COORDINATE WITH ELECTRICAL CONTRACTOR (E.C.) TO DISCONNECT POWER PRIOR TO UNIT DEMOLITION/REMOVAL. SEE NEW WORK.
- DEMOLISH EXISTING ROOFTOP UNIT RTU-1 (ONE FOR ONE REPLACEMENT). EXISTING ROOF CURB TO REMAIN FOR REUSE. COORDINATE WITH E.C. TO DISCONNECT POWER PRIOR TO UNIT DEMOLITION/REMOVAL. SEE NEW WORK.
- MECHANICAL CONTRACTOR SHALL PROVIDE ALL MATERIALS AND LABOR FOR CRANE LIFT. COORDINATE LIFT LOCATION AND SCHEDULE WITH OWNER.
- DISCONNECT CONDENSATE DRAIN PIPING FROM UNIT AND DEMOLISH BACK TO POINT INDICATED. SEE NEW WORK.
- SUBCONTRACT JOHNSON CONTROLS TO REMOVE AND RECONNECT CONTROLS CABLING WITH NEW FLEX CONNECTION.



2 TERRACE BOWL LEVEL - NEW WORK
SCALE:1/4" = 1'-0"

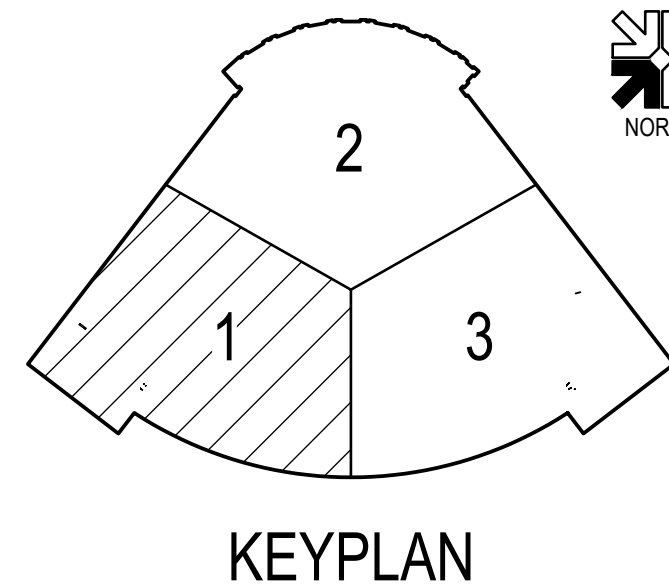
KEYED NOTES: NEW WORK

- NEW SPRING ISOLATED ROOF CURB IS PROVIDED BY MECHANICAL CONTRACTOR (M.C.). INSTALL CURB IN LOCATION WHERE EXISTING ROOFTOP UNIT/CURB WERE REMOVED FROM.
- NEW ROOFTOP UNIT IS PROVIDED BY M.C. INSTALL NEW UNIT ON TO NEW ROOF CURB. SUBCONTRACT FJA CHRISTIANSON FOR ANY ROOFING WORK REQUIRED TO FLASH NEW ROOF CURB TO ROOF. COORDINATE CONNECTION OF POWER TO NEW ROOFTOP UNIT WITH ELECTRICAL CONTRACTOR (E.C.).
- NEW ROOFTOP UNIT IS PROVIDED BY M.C. INSTALL NEW UNIT ON EXISTING ROOF CURB. SUBCONTRACT FJA CHRISTIANSON FOR ANY ROOFING WORK OR REPAIRS REQUIRED. COORDINATE CONNECTION OF POWER TO NEW ROOFTOP UNIT WITH E.C.
- MECHANICAL CONTRACTOR TO PROVIDE SHEET METAL TRANSITIONS FOR EXISTING SUPPLY AND RETURN DUCTWORK TO MATE WITH NEW CURB OR EXISTING OPENINGS.
- PROVIDE NEW 3/4" GAS LINE AND NEW GAS REGULATOR SIZED FOR NEW UNIT. MATCHING EXISTING MATERIALS, RUN NEW GAS LINE FROM GAS CONNECTION ON NEW UNIT AND CONNECT TO EXISTING GAS LINE AT POINT INDICATED. TURN GAS VALVE TO OPEN POSITION.
- MECHANICAL CONTRACTOR SHALL PROVIDE ALL MATERIALS AND LABOR FOR CRANE LIFT. COORDINATE LIFT LOCATION AND SCHEDULE WITH OWNER.
- M.C. TO PROVIDE NEW CONDENSATE TRAP AND PIPING FROM UNIT CONNECTION TO LOCATION SHOWN.
- SUBCONTRACT JOHNSON CONTROLS TO PROVIDE BACNET INTEGRATION FOR RTU-T01 AND RTU-T02 TO BUILDING AUTOMATION SYSTEM. BASED ON POINT LIST PROVIDED BY OWNER, TRANE TO ASSIST WITH IDENTIFICATION OF POINTS.

PACKAGED ROOFTOP AIR CONDITIONING UNIT SCHEDULE

PACKAGED ROOFTOP AIR CONDITIONING UNIT SCHEDULE																																						
TAG	SERVICE	LOCATION	UNIT SIZE	SUPPLY FAN					COOLING PERFORMANCE							GAS HEATING			CONDENSER DATA		CONDENSER FAN DATA		COMPRESSOR DATA		UNIT DATA							BASIS OF DESIGN		NOTES				
				TOTAL AIRFLOW (CFM)	EXTERNAL STATIC PRESSURE (IN. W.C.)	FAN RPM	BHP	MOTOR HP	V-φ/Hz	EAT DB ° F	EAT WB ° F	LAT DB ° F	NET TOTAL MBH	NET SENSIBLE MBH	REFRIGERANT	OUTPUT CAPACITY MINIMUM (MBH)	INPUT CAPACITY MAXIMUM (MBH)	STAGES	SSE (%)	EAT WB ° F	LAT DB ° F	TYPE	AMBIENT OAT (° F)	NUMBER OF FANS	DRIVE TYPE	NUMBER OF STAGES OF COOLING	TYPE	V-φ/Hz	MCA	MOP	EER	UNIT WEIGHT (LBS)	OVERALL DIMENSIONS (W x H x L)		MFR.	MODEL NUMBER		
RTU-T01	OFFICE	TERRACE BOWL - LOW ROOF	15 TONS	6000	1.5	1398	3.53	2 @ 3	460/3/60	80.0	67.0	57.5	57.0	175.5	136.1	R-454B	324.0	400.0	10.0	X	60.0	109.5	PROPELLER	95.0	2.0	DIRECT	X	VARIABLE SPEED WITH VFD	460/3/60	48 A	70 A	12.4	23.4	2499	87" W x 66" H x 123" L	TRANE PRECEDENT	YZK180A4SBH**P4C0A1A100A0010A	SEE NOTES
RTU-T02	OFFICE	TERRACE BOWL - LOW ROOF	5 TONS	2000	1	1005	0.66	3	460/3/60	80.0	67.0	57.0	56.9	58.9	46.4	R-454B	121.5	150.0	2.0	X	60.0	115.0	PROPELLER	95.0	1.0	DIRECT	X	VARIABLE SPEED WITH VFD	460/3/60	17 A	20 A	14.3	20.2	1081	53.3" W x 50.9" H x 88.1" L	TRANE PRECEDENT	YZK060A4SAH**P4C0A1B100A0010A	SEE NOTES
NOTES: ROOFTOP UNIT WILL BE FURNISHED AND INSTALLED BY MECHANICAL CONTRACTOR. UNIT SHALL BE ULTRA HIGH EFFICIENCY WITH DX COOLING/MODULATING GAS HEAT, MULTIPLE ZONE VAV, RETURN AIR SMOKE DETECTOR, LOW AMBIENT CONTROLS, CRANK CASE HEATER, ADVANCED CONTROLS AND BACNET BAS AND SHALL INCLUDE DOWNFLOW LOW LEAK ECONOMIZER, THROUGH-THE-BASE ELECTRICAL, NON-FUSED DISCONNECT SWITCH AND UNPOWERED GFCI 20A CONVENIENCE OUTLET, 2" MERV 9 FILTERS, LEAK DETECTION SYSTEM, ECONOMIZER HOOD, BAROMETRIC RELIEF DAMPER AND BAROMETRIC RELIEF HOOD. RTU-T02 SHALL COME WITH EVERYTHING SIMILAR TO RTU-T01 BUT WILL HAVE A POWERED GFCI, 15A CONVENIENCE OUTLET AND SPRING ISOLATED ROOF CURB. RTUS SHALL BE COMPLIANT WITH UL-60335-2-40.																																						

NOTES: ROOFTOP UNIT WILL BE FURNISHED AND INSTALLED BY MECHANICAL CONTRACTOR. UNIT SHALL BE ULTRA HIGH EFFICIENCY WITH DX COOLING/MODULATING GAS HEAT, MULTIPLE ZONE VAV, RETURN AIR SMOKE DETECTOR, LOW AMBIENT CONTROLS, CRANK CASE HEATER, ADVANCED CONTROLS AND BACNET BAS AND SHALL INCLUDE DOWNFLOW LOW LEAK ECONOMIZER, THROUGH-THE-BASE ELECTRICAL, NON-FUSED DISCONNECT SWITCH AND UNPOWERED GFCI 20A CONVENIENCE OUTLET, 2" MERV 8 FILTERS, LEAK DETECTION SYSTEM, ECONOMIZER HOOD, BAROMETRIC RELIEF DAMPER AND BAROMETRIC RELIEF HOOD. RTU-T02 SHALL COME WITH EVERYTHING SIMILAR TO RTU-T01 BUT WILL HAVE A POWERED GFCI, 15A CONVENIENCE OUTLET AND SPRING ISOLATED ROOF CURB. RTUS SHALL BE COMPLIANT WITH UL-60335-2-40.



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ISSUES & REVISIONS	DATE
1 ISSUED FOR CLIENT REVIEW	06/19/2026
2 ISSUED FOR BID	09/15/2026

TERRACE BOWL LEVEL - MECHANICAL PLANS - DEMOLITION AND NEW WORK

AMERICAN FAMILY FIELD - RTU-T01 AND RTU-T02 REPLACEMENT

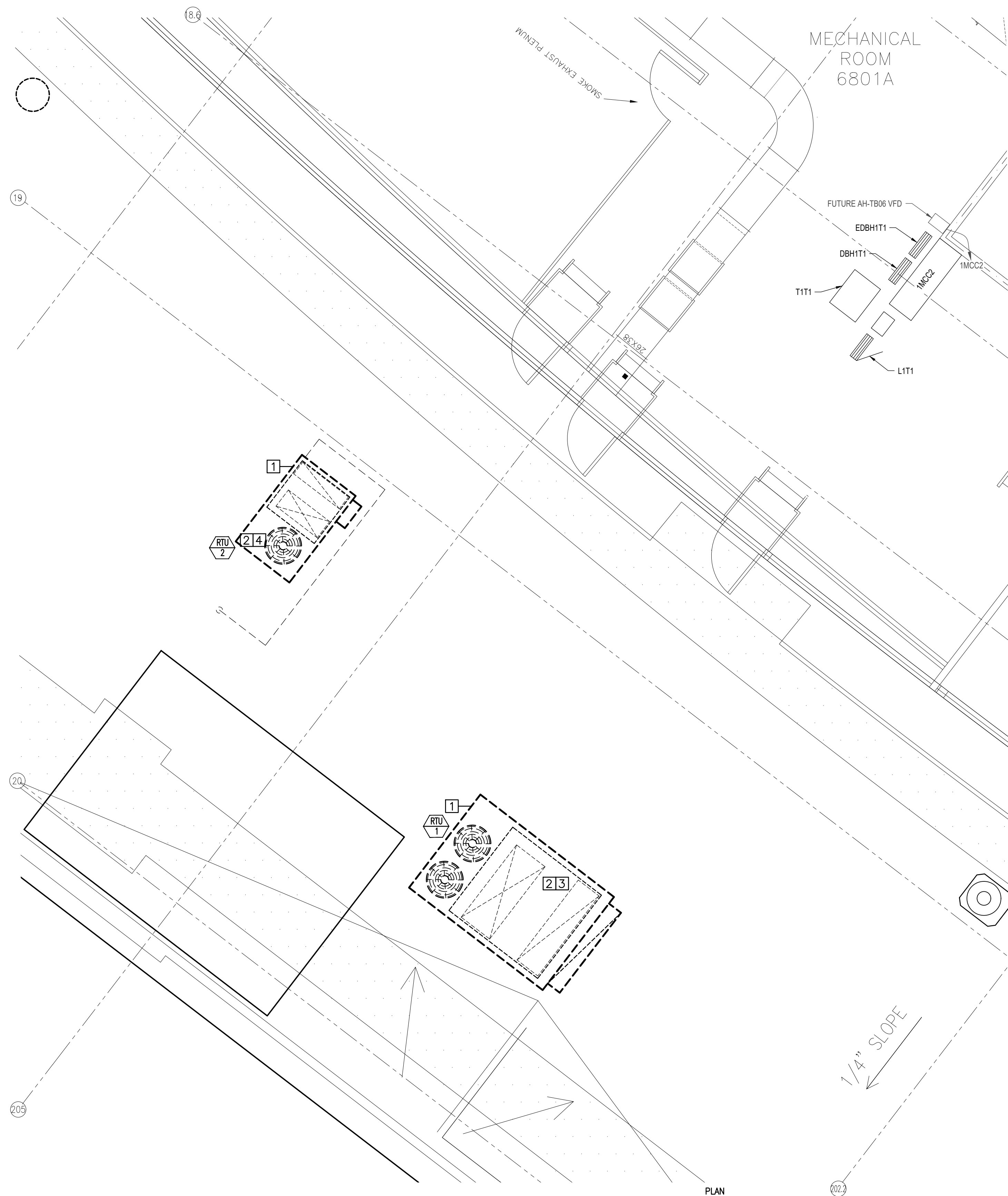
TERRACE BOWL LEVEL

WISCONSIN PROFESSIONAL BASEBALL PARK DISTRICT

ONE BREWERS WAY, MILWAUKEE, WI 53214

DATE	SCALE	DESIGNED	CHECKED	APPROVED	DATE
06/19/2026	1/4" = 1'-0"	JLV	RLE	RLE	06/19/2026

M1610

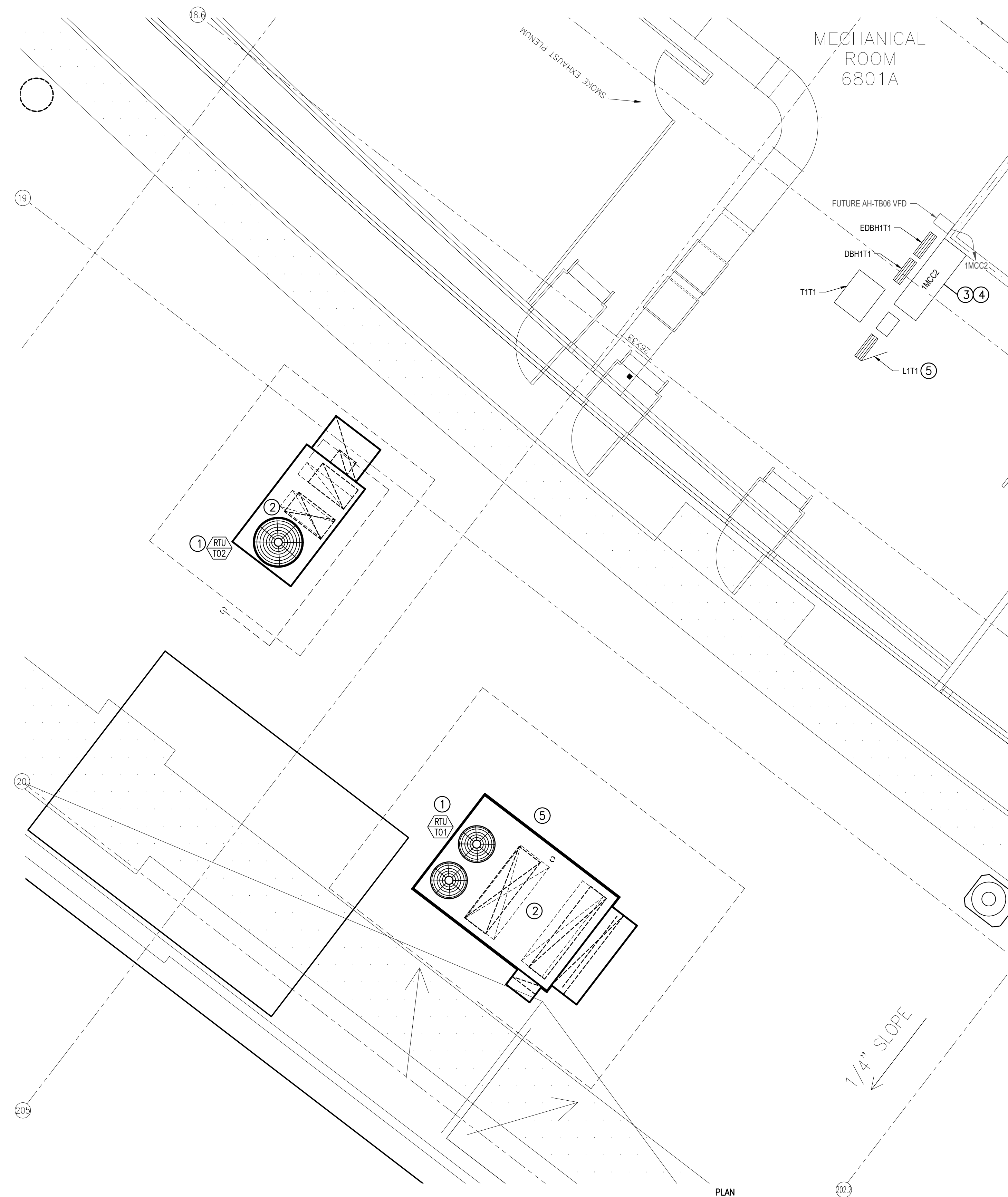


1 TERRACE BOWL LEVEL - DEMOLITION
SCALE: 1/4" = 1'-0"

KEYED NOTES: DEMOLITION

- 1 DISCONNECT RTU TO FACILITATE REPLACEMENT BY MECHANICAL CONTRACTOR. DEMOLISH LFMC FROM UNIT TO LB FITTING.
- 2 DISCONNECT DUCT DETECTION CONTROL WIRING AT THE RTU AND MAINTAIN TO EXTEND TO NEW RTU.
- 3 DEMOLISH EXISTING WIRING FOR EXISTING RTU-1 BACK TO 1MCC2.
- 4 DISCONNECT EXISTING WIRING FROM EXISTING RTU-2. MAINTAIN EXISTING LB, ROOF PENETRATION, AND CONDUIT BACK TO 1MCC2 FOR REUSE.

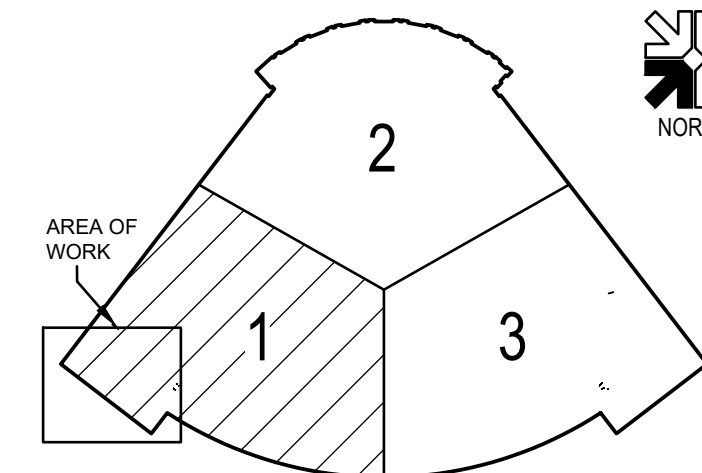
NEW HVAC EQUIPMENT SCHEDULE (SUPPLIED BY DIVISION 23 CONTRACTOR)															
TAG	EQUIPMENT	LOCATION	LOAD					SOURCE PANEL	CIRCUIT BREAKER (A)	FEEDER / CIRCUIT INFORMATION			DISCONNECT		REMARKS
			PHASE	VOLTS	FLA	MCA	MOCPP			PHASE CONDUCTOR(S)	GROUND CONDUCTOR	CONDUIT SIZE	SIZE	FUSE	
RTU-T01	ROOF TOP UNIT	TERRACE BOWL - LOW ROOF	3	460	-	48	70	1MCC2	70	(3) #4 AWG	(1) #8 AWG	1"		INTEGRAL	-
RTU-T02	ROOF TOP UNIT	TERRACE BOWL - LOW ROOF	3	460	-	17	20	1MCC2	20	(3) #12 AWG	(1) #12 AWG	3/4"		INTEGRAL	-



2 TERRACE BOWL LEVEL - NEW WORK
SCALE: 1/4" = 1'-0"

KEYED NOTES: NEW WORK

- 1 PROVIDE NEW FEEDER FOR NEW RTU-T01 AND RTU-T02. REUSE CONDUIT FROM SOURCE PANEL UP TO ROOF. PROVIDE NEW CONDUIT AND SUPPORTS FROM EXISTING LB/ROOF PENETRATION TO NEW UNIT. FINAL CONNECTION TO EQUIPMENT SHALL BE MADE WITH LFMC. COORDINATE INSTALLATION WITH MECHANICAL CONTRACTOR.
- 2 EXTEND DUCT DETECTOR CONTROL WIRING TO NEW RTU. CONFIRM RTU SHUT DOWN ON SMOKE DETECTION IS WORKING PROPERLY.
- 3 PROVIDE NEW 70A/3P BREAKER AND WIRING FOR NEW RTU-T01 IN 1MCC2. BREAKER KALC SHALL MATCH THE FULL RATING OF THE MCC.
- 4 PROVIDE NEW 20A/3P BREAKER AND WIRING FOR NEW RTU-T02 IN 1MCC2. BREAKER KALC SHALL MATCH THE FULL RATING OF THE MCC.
- 5 PROVIDE NEW 20A/1P BREAKER IN PANEL L1T1 AND POWER TO NEW RTU-T01 CONVENIENCE OUTLET.



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2	ISSUED FOR BID	09/15/2026	

TERRACE BOWL LEVEL - ELECTRICAL PLANS - DEMOLITION AND NEW WORK

AMERICAN FAMILY FIELD - RTU-T01 AND RTU-T02 REPLACEMENT

TERRACE BOWL LEVEL

WISCONSIN PROFESSIONAL BASEBALL PARK DISTRICT

ONE BREWERS WAY, MILWAUKEE, WI 53214

DATE	06/19/2026	SCALE	1/4"=1'-0"	MEP	KLL	KLL
DRAWN		CHECKED		APPROVED		
DESIGN		DATE		REV	NO.	225-1279

E1610

1MCC2 SQUARE D MODEL 6 MCC 600A HORIZONTAL 300A VERTICAL			
	SPACE	SPACE	SPACE
SPACE	EF-TB11	EF-TB23 15A/3P	ELEVATOR MACHINE ROOM HEATER
IDF/TB-01	HOA STARTER	HOA STARTER	HOA STARTER
	EF-TB13 (OFF)	PRV-TB6	
HEATER BLOWER (IGFH)	HOA STARTER	HOA STARTER	ELEVATOR MACHINE ROOM 16KW HEATER
	EF-TB32	RTU-1	HOA STARTER
HEATER BLOWER (IGFH)	HOA STARTER	HOA STARTER	SPACE
	RTU-2	PRV-TB6PRV-TB10 (OFF)	
AH-TB06 60A/3P	HOA STARTER	HOA STARTER	
	EF-TB22 (OFF)	SPARE	SPACE
	HOA STARTER	HOA STARTER	

MCC ELEVATION
1MCC2 - DEMOLITION WORK
SCALE: NONE

1MCC2 SQUARE D MODEL 6 MCC 600A HORIZONTAL 300A VERTICAL			
	SPACE	SPACE	SPACE
SPACE	EF-TB11	EF-TB23 15A/3P	ELEVATOR MACHINE ROOM HEATER
IDF/TB-01	HOA STARTER	HOA STARTER	HOA STARTER
	EF-TB13 (OFF)	PRV-TB6	
HEATER BLOWER (IGFH)	HOA STARTER	HOA STARTER	ELEVATOR MACHINE ROOM 16KW HEATER
	EF-TB32	RTU-T01	HOA STARTER
HEATER BLOWER (IGFH)	HOA STARTER	70A, 3P BREAKER	SPACE
	RTU-T02	PRV-TB6PRV-TB10 (OFF)	
AH-TB06 60A/3P	20A, 3P BREAKER	HOA STARTER	
	EF-TB22 (OFF)	SPARE	SPACE
	HOA STARTER	HOA STARTER	

MCC ELEVATION
1MCC2 - NEW WORK
SCALE: NONE

Existing Panel L1T1													
CKT	PH	CIRCUIT DESCRIPTION	BREAKER		LOAD DISTRIBUTION							CONN LOAD KVA	BUILDING LOCATION: MECHANICAL RM 6801A
			AMPS	POLE	REC	LTG 125%	EQ 100%	EQ 125%	MTR 100%	HTG 100%	CLG 125%		
1	A	SO #T14	20	1									FED FROM:
3	B	SO #T16	20	1									
5	C	SO #T44	20	2									AMPERES: 225A
7	A												VOLTS: 208Y/120V
9	B	FIRE ALARM	20	1									PHASE: 3
11	C	UNKNOWN LOAD (ON)	20	1									WIRE: 4
13	A												BUS TYPE: CU
5	B	SO #T17	20	3									A.I.C.: 10k
17	C												
19	A	SO #T18	20	3									PANEL MFR: SQUARE D
21	B												PANEL TYPE: NQDD
23	C												M.L.O: YES
25	A	SO #T19	20	3									MCB: YES
27	B												MOUNTING: RECESSED
29	C												
31	A	OPERABLE LOUVERS	20	1									GND BUS: YES
33	B	OPERABLE LOUVERS	20	1									ISOLATED GND: NO
35	C	OPERABLE LOUVERS	20	1									200% NEUTRAL: NO
37	A	RTU-T01 CONVENIENCE OUTLET	20	1									
39	B	SPACE											
41	C	SPACE											
PANEL TOTAL CONN LOAD:													
2	A	SO #T45 (OFF)	40	2									RECEPTACLES:
4	B												LIGHTING:
6	C	MTR #T14 (AC-TB05)	40	2									EQUIP 100%
8	A												EQUIP 125%
10	B												MOTORS
12	C	SO #T20	20	3									HEATING
14	A												COOLING
16	B												TOTAL:
18	C	SO #T21	20	3									FEEDER TOTAL CONN LOAD:
20	A												RECEPTACLES:
22	B	LIGHTS	20	1									LIGHTING:
24	C	RECEPTACLE	20	1									EQUIP 100%
26	A	RECEPTACLE	20	1									EQUIP 125%
28	B	RECEPTACLE OUTLET CATWALK	20	1									MOTORS
30	C	SPARE (SC 6802 (M.B. CAMERA)	20	1									HEATING
32	A	EXHAUST FAN EF-TB36	20	1									COOLING
34	B	UNKNOWN LOAD (ON)	20	1									TOTAL:
36	C	SPACE											FEEDER DEMAND LOAD
38	A	SPACE											
40	B	SPACE											
42	C	SPACE											

GENERAL NOTES

- FIELD VERIFY ALL EXISTING CONDITIONS NECESSARY TO PERFORM THE WORK INCLUDED IN THIS PROJECT.
- REWORK ALL TERMINATIONS, ELECTRICAL CONNECTORS, CONDUCTORS, CONDUITS, ETC. TO FACILITATE NEW WORK.
- PROTECT ALL EXISTING SYSTEMS AND THEIR COMPONENTS DURING CONSTRUCTION.
- COORDINATE WORK WITH ALL OTHER DISCIPLINES.
- COORDINATE ANY OUTAGES WITH OWNER AT LEAST 1 MONTH PRIOR TO BEGINNING WORK.
- REFER TO E1000 SERIES SHEETS FOR EQUIPMENT LOCATIONS.

KEY NOTES - DEMOLITION WORK

- DEMOLISH ENTIRE FEEDER BUCKET AND STARTER. PREPARE SPACE FOR NEW CIRCUIT BREAKER FEEDER BUCKET.
- FUTURE DEMOLITION WORK.

KEY NOTES - NEW WORK

- PROVIDE NEW CIRCUIT BREAKER FEEDER BUCKET, SIZED AS SHOWN. MATCH MANUFACTURER, TYPE, AND INTERRUPTING RATING OF EXISTING MCC.
- FUTURE NEW WORK.
- PROVIDE NEW 20A/1P CIRCUIT BREAKER IN PANEL L1T1 FOR NEW RTU-T01 CONVENIENCE OUTLET LOAD.



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ELECTRICAL DETAILS AND SCHEDULES

AMERICAN FAMILY FIELD – RTU–T01 AND RTU–T02 REPLACEMENT
TERRACE BOWL LEVEL

WISCONSIN PROFESSIONAL BASEBALL PARK DISTRICT
ONE BREWERS WAY, MILWAUKEE, WI 53214

DATE
06/19/2026

SCALE
NONE

DRAWN
MEP

CHECKED
K.L.

APPROVED
K.L.

DESIGN NO.
225-1279

E4001

SPECIFICATIONS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 1100	SUMMARY OF WORK
SECTION 01 2300	ALTERNATES
SECTION 01 3103	STARTING OF SYSTEMS
SECTION 01 3300	SUBMITTALS
SECTION 01 4000	QUALITY CONTROL SERVICES
SECTION 01 6000	MATERIAL AND EQUIPMENT
SECTION 01 7329	CUTTING AND PATCHING
SECTION 01 7700	PROJECT CLOSEOUT
SECTION 01 7823	OPERATION AND MAINTENANCE DATA
SECTION 01 9113	GENERAL COMMISSIONING REQUIREMENTS

**SECTION 01 1100
SUMMARY OF WORK**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Scope of work
- B. Owner-furnished products
- C. Contractor use of site and premises
- D. Work sequence

1.2 OWNER-FURNISHED PRODUCTS

- A. Products furnished to the site and paid for by Owner:
 - 1. None (CONFIRM WITH OWNER BEFORE BIDDING)
- B. Owner's responsibilities:
 - 1. Arrange for and deliver Owner-reviewed shop drawings, product data and samples, to Contractor.
 - 2. Pay for product delivery to site.
 - 3. On delivery, inspect products jointly with Contractor.
- C. Contractor's responsibilities:
 - 1. Review Owner-reviewed shop drawings, product data and samples.
 - 2. Receive and unload products at site; inspect for completeness or damage, jointly with Owner.
 - 3. Handle, store, install and finish products.
 - 4. Repair or replace items damaged after receipt.
 - 5. Arrange for product delivery to site.
 - 6. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 - 7. Arrange for manufacturers' warranties, inspections and service.

1.3 CONTRACTOR USE OF SITE AND PREMISES

- A. Limit use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Use of premises by Owner to conduct normal activities.
- B. Tie-ins to existing systems must be done in a manner so as to minimize interference with Owner's operations (i.e., during premium time).
- C. Normal Site Business Hours: 7 AM – 5 PM, Weekdays. Work by contractor may be done at any time.
- D. Access to site: Limited to area of work indicated on Drawings.
- E. Construction operations: Limited to area of work indicated on Drawings.

- F. Time restrictions for performing work: Work shall be completed during the baseball off season with Completion prior to March 6, 2027.
- G. Utility outages and shutdown: Coordinate with Owner.

1.4 WORK SEQUENCE

- A. Install work to accommodate Owner's occupancy requirements during the construction period. Coordinate mechanical or electrical schedule and operations with Owner/Engineer.
 - 1. Work shall commence November 2026 and be complete by March 2027.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

**SECTION 01 2300
ALTERNATES**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Submission procedures
- B. Documentation of changes to contract sum/price and contract time
- C. Requirements
- D. Selection and award of Alternates
- E. Schedule of Alternates

1.2 REQUIREMENTS

- A. Submit Alternates with full description of the proposed Alternate and the effect on adjacent or related components.
- B. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner Contractor Agreement.
- C. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

1.3 SELECTION AND AWARD OF ALTERNATIVES

- A. Indicate variation of Bid Price for Alternates described below and list in Bid Form Document or any supplement to it, which requests a 'difference' in Bid Price by adding to or deducting from the base bid price.
- B. Bid may be evaluated on base bid price. After determination of preferred bidder, consideration will be given to Alternates and Bid Price adjustments.

1.4 SCHEDULE OF ALTERNATES

- A. Alternate Bid: Provide new Secondary Chilled Water and Hot Water Pumps.

PART 2 - PART 2 - PRODUCTS

Not Applicable

PART 3 - PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 01 3103
STARTING OF SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Starting systems
- B. Demonstration and instructions
- C. Testing, adjusting, and balancing

1.2 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Owner seven calendar days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
- D. Verify that tests, meter readings and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Verify utilities, connections and controls are complete and equipment is in operable condition.
- G. Observe start-up and adjustments: Record time and date of start-up and results.
- H. Observe equipment demonstrations to Owner: Record times and additional information required for Operation and Maintenance Manuals.
- I. Execute start up under supervision of responsible manufacturer's representative and Contractors' personnel in accordance with manufacturers' instructions.
- J. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start up and to supervise placing equipment or system in operation.
- K. Submit a written report in accordance with Division 01 Section 01 4000, "Quality Control Services," that equipment or system has been properly installed and is functioning correctly.

1.3 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Demonstration and instructions shall be provided by a qualified manufacturers' representative who is knowledgeable about the Project.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start up, operation, control, adjustment, trouble shooting, servicing, maintenance and shutdown of each item of equipment at agreed upon times, at equipment location.

- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

1.4 INSPECTION AND ACCEPTANCE OF EQUIPMENT

- A. Prior to inspection, verify that equipment is tested, operational and clean.
- B. Assist Engineer with inspection. Prepare list of items to be completed and corrected.

1.5 TESTING, ADJUSTING AND BALANCING

- A. Contractor will appoint, employ and pay for services of an independent firm to perform testing, adjusting and balancing.
- B. The independent firm will perform services specified in Division 23 Section 23 0593, "Testing, Adjusting, and Balancing for HVAC," except for factory tests.
- C. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or noncompliance with specified requirements and with the requirements of the Contract Documents.

1.6 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 01 3300
SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Submittal procedures
- B. Contractor-prepared shop drawings
- C. Preventive maintenance (PM) tasks/schedule
- D. Product data
- E. Manufacturers' instructions
- F. Manufacturers' certificates

1.2 SUBMITTAL PROCEDURES

- A. Refer also to provisions of the General Conditions.
- B. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet, equipment tag, system designation number(s) and specification Section number, as appropriate.
- C. Where possible, submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in a single submittal so long as this does not delay individual items whose review is time-critical.
- D. If only part of required drawings in one group are submitted, action will be withheld on them until remaining drawings are submitted.
- E. Catalog cuts showing more than one model of a product shall be clearly marked indicating which model is being proposed.
- F. Capacity and performance data shall be given in same form, units and completeness presented in Contract Documents.
- G. Identifying symbols and tags used on drawings shall be clearly cross-referenced on shop drawings.
- H. Identify room names and numbers in which various products will be used.
- I. Schedule submittals to expedite the Project and deliver to Engineer electronically.
- J. Mark in units to match those specified.
- K. Provide space for Contractor and Engineer review stamps.
- L. Apply Contractor's stamp, signed or initialed, certifying that review, verification of Products required, field dimensions, adjacent construction Work and coordination of information is in accordance with the requirements of the Work and Contract Documents.
- M. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work.
- N. Revise and resubmit submittals as required, identifying all changes made since previous submittal.
- O. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.3 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit estimated progress schedule in duplicate within 7 business days after date of Owner-Contractor Agreement established in Notice to Proceed for Engineer review.
- B. Revise and resubmit as required.
- C. Revise and resubmit work schedule affected by accepted alternates.

1.4 CONTRACTOR-PREPARED SHOP DRAWINGS

- A. Submit the number of hard copies as established at the preconstruction conference. Alternatively, shop drawings may be submitted electronically in .pdf format.
- B. Submit ¼" scale floor plans indicating proposed routing of new piping and duct systems, new and relocated equipment locations and connection points to existing services including sections through equipment and piping diagrams of all connections.
- C. Identify equipment, pipe risers, duct risers, column lines, etc., with designations shown on Contract Documents.
- D. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described in Division 01 Section 01 7700, "Project Closeout."

1.5 PREVENTIVE MAINTENANCE (PM) TASKS/SCHEDULE

- A. Submit complete listing of PM tasks within 10 business days after date of Notice to Proceed.

1.6 PRODUCT DATA

- A. Submit the number of hard copies as established at the preconstruction conference. Alternatively, shop drawings may be submitted electronically in .pdf format.
- B. Mark each copy to identify applicable products, models, systems, equipment tags and other data. Supplement manufacturers' standard data to provide information unique to this Project.
- C. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described in Division 01 Section 01 7700, "Project Closeout."

1.7 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification Sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start up, adjusting, and testing in quantities specified for Product Data.
- B. Identify conflicts between manufacturers' instructions and Contract Documents.

1.8 MANUFACTURER'S CERTIFICATES

- A. When specified in individual specification Sections, submit manufacturer's certificate to Engineer for review in quantities specified for Product Data.
- B. Indicate that material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits and certifications as appropriate.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 01 4000
QUALITY CONTROL SERVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Quality assurance and control of installation
- B. References
- C. Manufacturers' field services and reports

1.2 QUALITY ASSURANCE/CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions and workmanship to produce Work of specified quality.
- B. Comply fully with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes or specified requirements indicate higher standards or more precise workmanship.
- E. Work to be performed by persons qualified to produce workmanship of specified quality.
- F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.3 REFERENCES

- A. Conform to reference standard by date of Contract Documents when there are no Bids date specified in product Sections.
- B. Obtain copies of standards when required by Contract Documents.
- C. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.4 MANUFACTURERS' FIELD SERVICES, FIELD TESTS AND REPORTS

- A. When specified in individual specification Sections, Contractor shall require material or Product suppliers, Subcontractors, or manufacturers to provide qualified staff personnel to observe site conditions; testing; conditions of installation; quality of workmanship; start-up of equipment; testing, adjusting and balancing of equipment and materials; and troubleshooting as applicable B and to initiate instructions when necessary. Submit report per paragraph C below, this section.
- B. Report observations and site decisions or instructions given to Owner, applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- C. Submit written report in duplicate within 10 days of observation, start-up, testing, etc. to Engineer for review.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

**SECTION 01 6000
MATERIAL AND EQUIPMENT**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Products
- B. Transportation and handling
- C. Storage and protection
- D. Product options
- E. Substitutions

1.2 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures and systems forming the work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- C. Provide interchangeable components of the same manufacturer for similar components.

1.3 TRANSPORTATION AND HANDLING

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement or damage.

1.4 STORAGE AND PROTECTION

- A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather tight, climate-controlled enclosures.
- B. For exterior storage of fabricated products, place on sloped supports above ground.
- C. Provide off site storage and protection when site does not permit on site storage or protection.
- D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.
- E. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement or damage.
- G. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

1.5 PRODUCT OPTIONS

- A. Products specified by Reference Standards or by description only: Any product meeting those standards or description.
- B. Products specified by naming one or more manufacturers: Products of manufacturers named and meeting specifications; no options or substitutions allowed.
- C. Product specified by naming one manufacturer as a base and naming others as acceptable: Obligations listed in the following "Substitutions" paragraph apply when an "Acceptable Other" is used. Manufacturer named on the drawings and in equipment scheduling are to be considered as a Base; with respect to the particular product described, other manufacturers named in those documents are acceptable others.
- D. When an "Acceptable Other" manufacturer is used in lieu of Specified, Contractor shall coordinate mechanical, plumbing and electrical requirements and will bear any additional costs required by other subcontractors as a result of the proposed product.

1.6 SUBSTITUTIONS

- A. Engineer will consider requests for substitutions only within 10 days after date established in Notice to Proceed. See Division 01 Section 01 3300, "Submittals."
- B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.
- C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- D. A request constitutes a representation that the Contractor:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 - 2. Will provide the same warranty for the substitution as for the specified product.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - 4. Has investigated that the proposed product can be installed in the space available with access for servicing and maintenance.
 - 5. Has coordinated mechanical, plumbing and electrical requirements and will bear any additional costs required by other subcontractors as a result of the proposed product.
 - 6. Waives claims for additional costs or time extension which may subsequently become apparent.
 - 7. Will reimburse Owner for review or redesign services associated with re approval by authorities.
- E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, or when acceptance will require revision to the Contract Documents.
- F. Substitution submittal procedure:
 - 1. Submit two copies of request for substitution for consideration. Limit each request to one proposed substitution.
 - 2. Submit shop drawings, product data and certified test results attesting to the proposed product equivalence.

3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements and limitations for cutting and patching of work.

1.2 SUBMITTALS

- A. Submit written request in advance of cutting or alteration which affects:
 - 1. Structural integrity of any element of project
 - 2. Integrity of weather exposed or moisture resistant element
 - 3. Efficiency, maintenance, or safety of any operational element
 - 4. Visual qualities of sight exposed elements
 - 5. Work of Owner or separate contractor
- B. Include in request:
 - 1. Effect on work of Owner or separate contractor
 - 2. Written permission of affected separate contractor
 - 3. Identification of project
 - 4. Location and description of affected work
 - 5. Necessity for cutting or alteration
 - 6. Description of proposed work and products to be used
 - 7. Alternatives to cutting and patching
 - 8. Effect on work of Owner or separate contractor
 - 9. Written permission of affected separate contractor
 - 10. Date and time work will be executed

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Primary products: Those required for original installation.
- B. Product substitution: For any proposed change in materials, submit request for substitution under provisions of Division 01 Section 01 6000, "Material and Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.
- B. After uncovering existing work, inspect conditions affecting performance of work.

- C. Beginning of cutting or patching means acceptance of existing conditions.

3.2 PREPARATION

- A. Provide temporary supports to ensure structural integrity of the work. Provide devices and methods to protect other portions of project from damage.
- B. Provide protection from elements for areas which may be exposed by uncovering work.
- C. Maintain excavations free of water.

3.3 CUTTING AND PATCHING

- A. Execute cutting, fitting and patching to complete work.
- B. Fit products together, to integrate with other work.
- C. Uncover work to install ill-timed work.
- D. Remove and replace defective or non-conforming work.
- E. Remove samples of installed work for testing.
- F. Provide openings in the work for penetration of mechanical and electrical work.

3.4 PERFORMANCE

- A. Execute work by methods to avoid damage to other work and which will provide appropriate surfaces to receive patching and finishing.
- B. Employ original installer to perform cutting and patching for weather exposed and moisture resistant elements and sight exposed surfaces.
- C. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- D. Restore work with new products in accordance with requirements of Contract Documents.
- E. Fit work air tight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
- F. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material [in accordance with Division 20 Section 20 0517, "Penetrations for Mechanical to full thickness of the penetrated element.
- G. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

END OF SECTION

**SECTION 01 7700
PROJECT CLOSEOUT**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Closeout procedures
- B. Final cleaning
- C. Adjusting
- D. Project record documents
- E. Operation and maintenance data
- F. Warranties
- G. Spare parts and maintenance materials

1.2 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected and that Work is complete in accordance with Contract Documents and ready for inspection by Engineer.
- B. Provide submittals to Engineer that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- D. Owner will occupy all portions of the building as specified in Division 01 Section 01 1100, "Summary of Work."

1.3 FINAL CLEANING

- A. Execute final cleaning prior to final inspection.
- B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces; vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to a sanitary condition.
- D. Replace strainers and replace filters of operating equipment affected by new installation.
- E. Clean debris from roofs, gutters, downspouts, and drainage systems.
- F. Clean site; sweep paved areas, rake clean landscaped surfaces affected by installation.
- G. Remove waste and surplus materials, rubbish and any construction facilities and equipment from the site.

1.4 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.5 PROJECT RECORD DOCUMENTS

- A. Maintain on site, one set of the following record documents; record actual revisions to the Work:

1. Contract drawings
 2. Specifications
 3. Addenda
 4. Change Orders and other modifications to the Contract
 5. Reviewed shop drawings, product data, and samples
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress.
- D. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
1. Manufacturer's name and product model and number
 2. Product substitutions or alternates utilized
 3. Changes made by Addenda and Modifications
- E. Record documents and shop drawings: Legibly mark each item to record actual construction including:
1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements
 2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work
 3. Field changes of dimension and detail
 4. Details not on original Contract drawings
- F. Submit changes to Record Documents in AutoCAD format.
- G. Delete Engineer title block and seal from all documents.
- H. Submit documents to Engineer with claim for final Application for Payment.

1.6 OPERATION AND MAINTENANCE DATA

- A. Quality assurance
1. Instructions and data are to be prepared by personnel experienced in maintenance and operation of described products.
- B. Binders: Commercial quality, 8½" x 11" 3-D side ring binders with hardback, cleanable, plastic covers; 3" maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- C. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" and title of project. Include subject matter of binder when multiple binders are required.
- D. Internally subdivide the binder contents with permanent page dividers, logically organized as described below with tab titling clearly printed under reinforced laminated plastic tabs.
- E. Contents: Prepare a printed Table of Contents for each volume, with each Product or System description identified.

- F. Part 1: Directory listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors and major equipment suppliers.
- G. Part 2: Operation and maintenance instructions, arranged by system and subdivided by component. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - 1. Significant design criteria.
 - 2. List of equipment.
 - 3. Parts list for each component.
 - 4. Operating instructions.
 - 5. Maintenance instructions for equipment and systems.
 - 6. Maintenance instructions for finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
- H. Part 3: Project documents and certificates, including the following:
 - 1. Shop drawings and product data.
 - 2. Air and water balance reports.
 - 3. Certificates.
 - 4. Photocopies of warranties.
- I. Submit one copy of completed volumes in final form 15 days prior to final inspection. This copy will be returned after final inspection with Engineer comments. Revise content of documents as required prior to final submittal.
- J. Submit final volumes revised within 10 days after final inspection.

1.7 WARRANTIES

- A. Provide notarized copies.
- B. Execute and assemble documents from Subcontractors, suppliers and manufacturers.
- C. Provide Table of Contents and assemble in 3-D side ring binder with durable cover.
- D. Submit prior to final Application for Payment.
- E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing date of acceptance as start of warranty period.

1.8 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.
- B. Deliver to Project site and place in location as directed; obtain receipt from Owner prior to final payment.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 01 7823
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Format and content of manuals
- B. Instruction of Owner's personnel
- C. Schedule of submittals

1.2 QUALITY ASSURANCE

- A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

1.3 FORMAT

- A. Prepare data in the form of an instructional manual.
- B. Binders: Commercial quality, 8½" x 11" 3-D side ring binders with hardback, cleanable, plastic covers; 3" maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- C. Cover: Identify each binder with typed or printed title "OPERATION AND MAINTENANCE INSTRUCTIONS;" list title of Project; identify subject matter of contents.
- D. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.
- E. Provide tabbed fly leaf for each separate product and system with typed description of product and major component parts of equipment.
- F. Text: Manufacturer's printed data or typewritten data on 24 pound paper.
- G. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.4 CONTENTS, EACH VOLUME

- A. Table of Contents: Provide title of Project; names, addresses and telephone numbers of Engineer, subconsultants and Contractor with name of responsible parties; schedule of products and systems indexed to content of the volume.
- B. For each product or system: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- C. Product data: Mark each sheet to clearly identify specific products and component parts and data applicable to installation. Delete inapplicable information.
- D. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

- E. Type text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Division 01 Section 01 4000, "Quality Control Services."
- F. Warranties and bonds: Bind in copy of each.

1.5 MANUAL FOR MATERIALS AND FINISHES

- A. Building products, applied materials and finishes: Include product data, with catalog number, size, composition and color and texture designations.
- B. Instructions for care and maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance.
- C. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition and details of installation. Provide recommendations for inspections, maintenance and repair.
- D. Additional requirements: As specified in individual product specification Sections.

1.6 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Each item of equipment and each system: Include description of unit or system and component parts. Identify function, normal operating characteristics and limiting conditions. Include performance curves, with engineering data and tests and complete nomenclature and commercial number of replaceable parts.
- B. Panelboard circuit directories: Provide electrical service characteristics, controls and communications.
- C. Include color-coded wiring diagrams as installed.
- D. Operating procedures: Include start up, break in and routine normal operating instructions and sequences. Include regulation, control, stopping, shut down and emergency instructions. Include summer, winter and any special operating instructions.
- E. Maintenance requirements: Include routine procedures and guide for trouble shooting; disassembly, repair and reassembly instructions; and alignment, adjusting, balancing and checking instructions.
- F. Provide servicing and lubrication schedule and list of lubricants required.
- G. Include manufacturer's printed operation and maintenance instructions.
- H. Include sequence of operation by controls manufacturer.
- I. Provide original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
- J. Provide control diagrams by controls manufacturer as installed.
- K. Provide Contractor's coordination drawings with color-coded piping diagrams as installed.
- L. Provide charts of valve tag numbers, with location and function of each valve keyed to flow and control diagrams.
- M. Provide list of original manufacturer's spare parts and recommended quantities to be maintained in storage.

- N. Include test and balancing reports as specified in Division 01 Section 01 4000, "Quality Control Services and Division 23 Section 23 0593, "Testing, Adjusting, and Balancing for HVAC."
- O. Additional requirements: As specified in individual product specification Sections.

1.7 DEMONSTRATIONS AND INSTRUCTIONS OF OWNER PERSONNEL

- A. Before final observation, instruct Owner's designated personnel in operation, adjustment and maintenance of products, equipment and systems at agreed upon times.
- B. Project equipment demonstrations are to be by qualified manufacturers' representatives who are knowledgeable about the Project.
- C. For equipment requiring seasonal operation, perform instructions for other seasons within six months.
- D. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance and shutdown of each item of equipment at agreed-upon times at equipment location.
- F. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.8 SUBMITTALS

- A. For equipment or component parts of equipment put into service during construction and operated by Owner, submit documents within 10 days after acceptance.
- B. Submit one copy of completed volumes in final form 15 days prior to final observation. Copy will be returned after final observation, with Engineer comments. Revise content of documents as required prior to final submittal.
- C. Submit two copies of revised volumes of data in final form within 10 days after final observation.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 01 9113
GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Commissioning is a requirement of this project and required as per the 2015 IECC code, Chapter 4 Commercial Energy Efficiency, Section C408 System Commissioning.
- B. The Owner shall retain a Commissioning Provider (CxP) to coordinate commissioning activities for this project. The objective of the commissioning process is to verify and document that the performance of facilities, systems, and assemblies installed as part of this project meet defined objectives and criteria.
- C. The Commissioning Provider (CxP) shall be Grumman|Butkus.
- D. The Commissioning Provider must hold a current commissioning certification from the Building Commissioning Association (BCA), University of Wisconsin, AABC Commissioning Group (ACG).
- E. The Commissioning Provider must hold current member, AND, be able to demonstrate continuous member to either BCA or ACG for the past 5 years.
- F. This section outlines the general roles and responsibilities of the CxP, Owner, Design Team, and Contractor. Division 23 section defines roles and responsibilities which are applicable to Division 23 work.
- G. Commissioning requires support from the Contractor and sub-contractors.
- H. The Contractor is responsible for coordinating all commissioning activities.

1.2 RELATED SECTIONS

- A. Division 23 Section 23 0995 - Commissioning of Integrated Automation

1.3 DEFINITIONS

- A. *Checklists*: Project and element-specific checklists that are developed and used during all phases of the Commissioning Process to verify that the owner's project requirements and design intent are being achieved. Checklists are used for general evaluation, testing, training, and other design and construction requirements.
- B. *Commissioning Process or Commissioning (Cx)*: A quality focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the project design intent.
- C. *Commissioning Provider (CxP)*: An entity approved by the registered design professional and hired by the Contractor who plans, schedules, and coordinates the commissioning team to implement the Commissioning Process.
- D. *Commissioning Field Report*: A written document that identifies the commissioning activities completed during a visit to the project site. The report identifies significant findings, results, comments and questions that resulted from the visit. This is typically produced by the CxP per site visit.

- E. *Commissioning Plan*: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Commissioning Process.
- F. *Commissioning Team (Cx Team)*: The individuals and agencies who, through coordinated actions, are responsible for implementing the Commissioning Process.
- G. *Construction Team*: The Contractor, related sub-contractors, and other contractors working for the Owner during the Construction Phase.
- H. *Final Commissioning Report (Final Cx Report)*: A document that records the activities and results of the Commissioning Process and is developed from the final Commissioning Plan with all of its attached appendices. The final report shall at a minimum meet all requirements as outlined in IECC 2015, Section C408.2.5.4.
- I. *Functional Performance Test (FPT)*: A written protocol that defines methods, personnel, and expectations, for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.
- J. *Issues Log*: A formal document and ongoing record of problems or concerns identified through the construction phase which deviate from the project's construction documents, applicable codes and/or normal construction industry practices and their resolution. Items on this issues log should be reviewed by the Contractor and corrected in a timely manner by the applicable trades and contractors.
- K. *Preliminary Commissioning Report (Preliminary Cx Report)*: A preliminary report of commissioning test procedures and results that is made available to the Owner, registered design professional (design engineer), Contractor and authority having jurisdiction (code official) PRIOR to the final mechanical inspection. The preliminary commissioning report shall at a minimum meet all requirements as outlined in IECC 2015, Section C408.2.4.
- L. *Training Plan*: A written document that details the expectations, schedule, duration and deliverables of Commissioning Process Activities related to training of project operating and maintenance personnel, users, and occupants.

1.4 ROLES AND RESPONSIBILITIES

- A. Commissioning Provider (CxP)
 - 1. The primary role of the CxP is to oversee the commissioning process. This includes: site observations of installation of commissioned systems and equipment; coordination of the execution of equipment startups, and testing/adjusting and balancing; development of FPT procedures; observation and documentation of the FPTs and performance that systems are functioning in accordance with the design intent and in accordance with the Contract Documents.
 - 2. Develop a Commissioning Plan.
 - 3. Coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications with the Cx team, and frequently update timelines and schedules for Cx activities.
 - 4. The CxP may assist with problem solving, non-conformance or deficiencies, but ultimately that responsibility resides with the Contractor (Contractor) and the Engineer.

5. Coordinate the commissioning schedule and work with the Contractor to incorporate commissioning activities into the master project schedule maintained by the Contractor.
6. Update and revise the Commissioning Plan as required.
7. Plan and conduct a commissioning kickoff meeting and other commissioning meetings with the Cx team. The CxP will record meeting minutes for Cx meetings facilitated by the CxP.
8. Request and review additional information required to perform commissioning tasks, including: equipment submittals, installation, operations and maintenance (IOM) manuals and materials, contractor start-up and checkout procedures.
9. Conduct periodic construction observations to verify that systems and equipment are installed consistently with the contract documents. Document deficiencies in the issues logs and distribute it to the Commissioning Team (Note: the Commissioning Provider is responsible for identifying deficiencies but is not responsible for ensuring that deficiencies are corrected).
10. Attend selected job-site meetings to obtain information on construction progress.
11. Collect and review contractor installation tests, such as duct leakage and hydronic system pressure tests, for inclusion in the commissioning report.
12. Collect and selectively witness contractor and/or manufacturer startup procedures and testing of the equipment to be commissioned. Include copies of these reports in the commissioning report.
13. Write and distribute, for the design team and contractor review, the functional performance test procedures
14. Review start-up and TAB reports to confirm included systems are ready for functional performance testing.
15. Coordinate, witness and document functional performance testing by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved per design specifications. See section 3, "Cost of Re-Evaluation" within this specification, for extent of retesting included in the commissioning scope.
16. Provide a preliminary commissioning report.
17. Coordinate, witness and document required seasonal or deferred functional performance testing and any deficiency corrections required.
18. Oversee and review the training of the Owner's operating personnel.
19. Review O&M manuals submitted by the Contractor for completeness and conformance to contract documents.
20. Provide a final commissioning report for review and acceptance by the registered design professional.

B. Contractor and Sub-Contractors

1. Include the cost to support the commissioning process and activities in the contract price.
2. The Contractor is responsible for coordinating all commissioning activities of the sub-contractors. Commissioning activities may be completed by the Mechanical Contractor (MC), Electrical Contractor (EC), Controls Contractor (CC), or Test and Balance (TAB) contractor, but the Contractor is ultimately responsible for completion of all of these tasks.

3. Facilitate the coordination of the commissioning work by the CxP and incorporate commissioning activities into the master schedule.
4. Furnish a copy of all construction documents, addenda, change orders, Requests for Information (RFIs), approved submittals, shop drawings, and IOMs, related to commissioned systems and equipment to the CxP.
5. In each purchase order or subcontract written, include requirements for commissioning.
6. Ensure that all sub-contractor's execute their commissioning responsibilities according to the Contract Documents and schedule.
7. The Contractor shall designate a staff member who will be knowledgeable and responsible for the construction of the commissioned systems (typically the MEP superintendent) to be their active representative on the commissioning team. This person shall attend the commissioning kickoff meeting and other necessary meetings scheduled by the CxP to facilitate the commissioning process.
8. The sub-contractors shall designate a staff member who will be knowledgeable and responsible for the construction of the commissioned systems (typically the trade superintendent) to be their active representative on the commissioning team. This person shall attend the commissioning kickoff meeting and other necessary meetings scheduled by the CxP to facilitate the commissioning process.
9. Coordinate and share the issues identified on the Issues Log with the appropriate trade sub-contractors. Respond in writing to the CxP with the contractor's response, appropriate trade responsible for the corrective action and anticipated completion date for the corrective action.
10. Follow up with the subcontractors as to the status of the corrective actions to the items on the Issues Log, and update the CxP.
11. The Contractor's designated Cx team staff member shall personally examine, witness, and verify that all issues are corrected and complete when the sub-contractor states they have "corrected" an item on the Issues Log.
12. After the Contractor has verified issues are resolved, they shall notify the CxP accordingly.
13. Notify the CxP one week in advance of all equipment start-ups and tests required by the Contract Documents.
14. Submit test results for tests required by the Contract Documents, including (but not limited to) duct leakage tests, hydronic system pressure tests, plumbing system disinfection certification, generator tests, smoke evacuation system tests, fire pump tests, fire alarm tests, etc. as applicable to the commissioning scope.
15. Notify the CxP when contractor testing, startups and TAB activities will be taking place and have been completed.
16. Provide CxP copies of all submitted reports.
17. Coordinate with subcontractors to review that all pre-functional activities including contractor testing, equipment startups and TAB work have been completed for systems to be functionally tested.
18. Coordinate with subcontractors to ensure qualified technicians are available for the functional performance test procedures as directed by the CxP.
19. Coordinate the training of Owner personnel.

20. Verify that subcontractors prepare and submit O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
21. Ensure that subcontractors execute seasonal or deferred functional performance testing, witnessed by the CxP, according to the specifications.
22. Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
23. Gather and submit all project closeout documentation, including submittals, O&M manuals, as-built drawings, warranties, etc. to CxP for approval.

C. Owner

1. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions according to the Commissioning (Cx) Plan.
2. Provide input and direction on commissioning-related recommendations that arise from the commissioning process which may enhance the operation of the building but are not included in the project documents and may be an additional project cost. If the Owner is in agreement with commissioning recommendations, they are to direct the Design Team to review and issue the appropriate directive to add that scope and maintain the Design Team's responsibility for all construction documents.

D. Design Team (Engineer)

1. As per IECC 2015, Section C408, the registered design professional (design engineer) shall review and approve the following:
 - a. Selection of the CxP with the Contractor.
 - b. Cx Plan
 - c. Test procedures including the functional performance test procedures
 - d. Air and Hydronic balancing
 - e. Preliminary Cx report
 - f. Final Cx report
2. If submittal comments are provided by the CxP, incorporate into submittal response back to contractors.
3. Assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
4. Participate in the resolution of deficiencies identified during commissioning.
5. Notify the CxP of substantive changes to the Contract Documents.
6. Provide clarifications to Contract Documents as required.

1.5 SCOPE OF WORK

- A. Refer to specification sections 23-0995 for listing of systems and equipment to be commissioned and requirements.

1.6 COMMISSIONING DOCUMENTATION

A. General

1. CxP shall prepare and submit a commissioning plan.
2. CxP shall prepare and distribute Cx meeting minutes.
3. CxP shall prepare and distribute field observation reports after each site visits.
4. CxP shall distribute a issues log after each site visit.
5. Contractor and contractors to respond to the issues log.
6. CxP shall prepare and distribute for review the functional performance test procedures.
7. Contractor and contractors shall provide copies of all contractor testing, startup reports and TAB reports.
8. The functional performance test documents will be filled in by the CxP as they witness the test conducted by the contractors.
9. Contractor and contractors shall provide copies of training attendance sign in sheets.
10. CxP shall provide a seasonal or deferred testing plan to test systems under appropriate climatic conditions.
11. CxP shall submit a final report.

1.7 SCHEDULE

- A. Commissioning of systems shall proceed per the criteria established in the specific sections that follow, with activities to be performed on a timely basis. The CxP shall be available to respond promptly to avoid construction delays.
- B. Contractor field testing, manufacturer startup, TAB and other checkout activities that are the primary responsibility of the contractor / vendor must be in advance of functional performance testing.
- C. Problems observed shall be addressed immediately, responsible parties notified, and actions to correct deficiencies coordinated in a timely manner.
- D. Contractor schedules and scheduling is the responsibility of the Contractor. The CxP shall provide commissioning scheduling information to the Contractor for review and planning activities.

1.8 REFERENCE STANDARDS

- A. Industry standards and guidelines are a guide to the commissioning process and are hereby incorporated and will be applied as appropriate. Reference standards and guidelines include, but are not limited, to the following:
- B. References:
 1. ASHRAE Standard 202-2013: Commissioning Process for Buildings and Systems
 2. ASHRAE Guideline 0-2013: The Commissioning Process
 3. ASHRAE Guideline 1.1-2007: HVAC&R Technical Requirements for The Commissioning Process
 4. IECC 2015: Section C408: System Commissioning

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All industry standard test equipment required for performing the specified tests shall be provided by the applicable contractor (as specified) and shall be approved by the CxP. Any proprietary vendor specific test equipment shall be provided by that vendor or manufacturer.
- B. Any portable or hand-held setup / calibration devices required to initialize the control system shall be made available by the control vendor (at no cost) to the CxP.
- C. The instrumentation used in the commissioning process shall meet the following standards:
 - 1. Be of sufficient quality and accuracy to test and/or measure system performance within the tolerances required.
 - 2. Be calibrated at the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument
 - 3. Be maintained in good repair and operating condition throughout the duration of use on this project.
 - 4. Be immediately re-calibrated or repaired if dropped and/or damaged in any way during use on this project.

2.2 BAS HARDWARE AND SOFTWARE

- A. BAS Access
 - 1. The BAS Contractor shall provide the CxP with access to connect to, communicate with and command the BAS at no additional charge to the CxP.
 - 2. Access level shall allow the CxP to fully execute all commissioning procedures and will include the ability to:
 - a. View system operation
 - b. Override setpoints
 - c. Command digital and analog output points
 - d. View BAS programming source code (read-only)
 - e. View and print graphics
 - f. Create, view, modify, print and download trend logs, histories and reports
- B. Technical Support
 - 1. The BAS Contractor shall also provide technical support to the CxP as reasonably requested by the CxP regarding setting up and operating BAS hardware and software to support successful execution of the Cx Process.

PART 3 - EXECUTION

3.1 COMMISSIONING PLAN AND SCHEDULE

- A. The CxP shall generate a commissioning plan which shows the relative scheduling and extent of resources required from the Commissioning Team and, especially, the Contractor and Sub-Contractors for construction and post-construction commissioning activities. Per 2015 IECC, Section C408.2.1 the Commissioning Plan shall include at a minimum:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including personnel intended to accomplish each of the activities.
 2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
 3. Functions to be tested, including, but not limited to calibration and economizer controls.
 4. Conditions under which the test will be performed. At a minimum, testing shall include winter and summer modes of operation and full outside air conditions.
- B. The CxP will submit a Cx schedule for the commissioning process which shall be integrated into the construction schedule by the Contractor.

3.2 PROJECT INFORMATION: SUBMITTALS, RFIS, IOMS, SHOP DRAWINGS, COORDINATION DRAWINGS, BIM MODEL

- A. The Contractor shall provide to the CxP access and copies of all project information requested.
- B. The CxP shall review all project information as it pertains to the systems and equipment to be commissioned.
- C. The CxP shall develop project specific FPTs based on the project information provided and submitted by sub-contractors.

3.3 MEETINGS AND CONSTRUCTION OBSERVATIONS

- A. The CxP shall plan and conduct an initial commissioning kickoff meeting with the Owner, design team, Contractor and sub-contractors to review the Cx plan and discuss the commissioning requirements for the project.
- B. The CxP shall coordinate a special controls integration meeting after submission of the controls submittal. The CxP shall coordinate the meeting which is usually held on the job-site with the design team, Contractor, mechanical contractor, BAS contractor, TAB contractor and other contractors/vendors that will interface with the BAS such as boilers, chillers, fire, electrical, etc. to review the following:
 1. Interoperability and communication needed for the BAS to communicate with other systems that the BAS is connected to.
 2. Review of all system controlling devices and sensors and setpoint that are needed by the controls contractor and TAB contractor.
 3. Review of special controls or safeties that are specific to manufacturer's equipment such as boilers or chillers.
- C. The CxP shall make site visits to attend construction meetings, participate and conduct Cx meetings and observations of work-in-progress to verify conformance with design documents. Site visits are above and beyond the kick off meeting and controls integration meetings listed above.
- D. Each site visits shall be documented with the following:
 1. Field Inspection Report
 2. Issues Log
 3. Photos and other supporting information

- E. The CxP shall conduct additional construction observations to witness contractor pre-start testing, manufacturer startups and TAB work in progress as specified in the specific discipline specific commissioning specifications.
- F. Document deficiencies via Issues Logs and Commissioning Reports and distribute to the design and construction team (NOTE: The construction team is responsible for ensuring that identified items are completed).

3.4 COMMISSIONING ISSUES LOGS

- A. As part of the commissioning process the Issues Log shall be maintained by the CxP as follows.
 - 1. Issues Log
 - a. This log is a formal and ongoing record of problems or concerns pertaining to the installation of the commissioned systems and equipment which identifies where the contractors have deviated from the design intent, contract documents, applicable codes or normal industry construction practices. It is the Contractor's responsibility to receive this log from the CxP, follow up and review each item on the list with the appropriate trades, and respond to the CxP with feedback within 5 business days from the issuance of the log from the CxP.
 - b. There is a contractor section identified on log which is where the Contractor should provide feedback which includes the following sections:
 - (1) Response/Action: This is the contractor's response to the issue identified by the CxP.
 - (2) Trade: This identifies the specific contractor responsible for the correction of the issue.
 - (3) Expected Completion Date: This is the date which the Contractor and subcontractor agree the issue will be resolved by. This provides information back to the CxP as to when items should be corrected by for spot checking the correction of issues.
 - c. The Contractor shall provide feedback and updates to the issues log to the CxP within 5 business days from its issuance from the CxP.
 - d. The CxP will maintain them master issues log.
 - e. A sample of the issues log is included in Appendix B.

3.5 CONTRACTOR INSTALLATION TESTS AND MANUFACTURER STARTUP TESTING

- A. The contractors shall conduct all startup testing as required by the specifications, equipment manufacturer, the manufacturer's installation, operations and maintenance manual or as necessary to verify all equipment is properly installed.
- B. Startup testing shall be documented. Appropriate documentation shall be by the contractor and/or the manufacturer's representative or entity specified in the construction documents.
- C. The startup testing shall be documented using the manufacturer's standard forms or contractor generated forms if no manufacturer forms are available.
- D. The Contractor and/or contractors shall submit a copy of test forms to the CxP.
- E. The CxP shall include copies of all contractor testing within the preliminary and final Cx reports.

3.6 TESTING AND BALANCING

- A. Testing, Adjusting, and Balance Contractor (TAB) Requirements

1. Prior to the start of TAB activities, the TAB contractor shall submit a proposed TAB plan, procedures and documentation to the CxP and A/E for review. TAB procedures shall be submitted to allow sufficient time for CxP review and approval prior to the start of TAB activities.
2. After this review, and prior to start of field work, the TAB contractor will attend one or more planning meetings as required with the Commissioning Team to review and discuss outstanding issues relating to TAB procedures and forms, discuss resolution of issues identified during the TAB contractor's plan review and field inspections, and to coordinate field work.
3. The TAB contractor shall coordinate with the controls contractor to ensure that all system setpoints and changes made to the control system during TAB (flow coefficients, duct areas, etc.) are archived and become the default or initial values for these parameters.
4. The TAB contractor shall provide daily lists of issues and/or problems identified during TAB work to the Contractor, CxP and A/E for follow-up & resolution with the appropriate contractors.
5. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB report where required by the CxP for verification or diagnostic purposes.
6. Test and balance contractor to provide a copy of the final balancing report to CxP.
7. The CxP shall include a copy of the final balancing report within the preliminary and final Cx reports.

3.7 BAS CONTROLS & INSTRUMENTATION TESTING

- A. Prior to start of control system Functional Performance Procedures, the Building Automation System (BAS) Contractor shall verify and document that all control systems are installed and operating properly including the following:
 1. **Control Panels & Hardware Installation** shall be fully verified and the BAS contractors internal checklists completed prior to proceeding to subsequent installation/checkout steps.
 - a. The BAS contractor shall provide a copy of the control panel and hardware installation checklists and documentation to the CxP and design engineer.
 2. **Point-to-Point Checkout** shall be completed and documented per the requirements of Integrated Automation and Controls section of Division 23 and item 3 below; OR; per BAS contractors internal point to point checklists that have been approved by the design engineer.
 - a. The BAS contractor shall provide a copy of all point to point checkout documentation to the CxP and design engineer.
 3. **Control Sequence Checkout.** Contractor shall verify that operation of control system programming matches the specified sequences of operation. For these checkouts, the Contractor shall, as much as possible, simulate actual operating conditions for the various operating modes being tested (heating, cooling, etc.) by false-loading systems, adjusting setpoints and similar techniques. The CxP will make the control sequence functional performance test procedures available to the BAS Contractor for use in these checkouts.
 - a. The BAS contractor shall provide a copy of the control sequence checkout documentation to the CxP and design engineer
 4. **Tune all Control Loops** to obtain timely and stable response, per the controls specifications, without unreasonable hunting, offset or overshoot. Record tuning parameters and response test results for each control loop and provide trend reports to document results. Trend logs shall show both steady-state operation and response to setpoint changes.

5. **Test All Alarms and Safeties** Record all alarm parameters and alarm messages. Document all alarms and safeties have been tested and are functioning properly.
- B. The BAS Contractor shall work with the TAB Contractor(s) to make sure that all systems are balanced and system setpoints determined and programmed into the BAS.
- C. The CxP shall include a copy of all controls checkout forms and test documents within the preliminary and final Cx reports.

3.8 FUNCTIONAL PERFORMANCE TEST PROCEDURES

- A. Scope
 1. Functional Performance Test (FPT) procedures are executed after commissioned equipment and systems have been installed, started-up and balanced. The goal of these procedures is to conclusively verify that commissioned equipment, sub-systems and major systems operate and perform per the design intent, the project specifications.
 2. Equipment-level FPTs will be used to verify operation and capacity of selected equipment such as boilers, chillers cooling towers, pumps, exhaust fans, air handling units, etc.
 3. System-level FPTs will verify the following aspects of system operation
 - a. System operation under both normal and alternate operating conditions and modes
 - b. Interactions between equipment and sub-systems
 - c. Operation of safeties and interlocks
 - d. Control system operation, response time, stability and tuning
 - e. System response to abnormal and/or emergency conditions such as fire, equipment failure and power outages
 - f. All control sequence of operation strategies, alarm generation and reporting shall also be reviewed and proper operation verified by the CxP.
 - g. The central work station graphics, point assignments, alarm messages, and logging functions shall be verified.
- B. Functional Performance Test Forms
 1. The CxP shall develop FPT procedures and forms.
- C. Contractor Requirements
 1. The Cx team will, in a joint effort, coordinate and schedule FPT activities.
 2. Scheduling of FPTs shall be contingent on notification from the affected contractor(s) to the Contractor and CxP that equipment and systems are ready for checkout.
 3. Other prerequisites for execution of FPTs shall include the following:
 - a. All pre-functional activities and contractor startup procedures have been completed and documented.
 - b. TAB has been completed.
 - c. All Cx issues identified affecting equipment or system performance or operations have been resolved.
 4. Prior to claiming readiness for FPT, the controls contractor shall ensure that the following items are completed and documented:
 - a. Point-to-point checkouts

- b. Verify that network communication between all devices and systems is established
- c. Sequence of Operation checkouts
- d. Printed and annotated trend logs and alarm histories establishing acceptable operation including
 - (1) Stable control
 - (2) Recovery from upset/changes (e.g., from setback)
 - (3) Special and/or seasonal modes
 - (4) Emergency and alarm modes including loss/restoration of power
- 5. Execution of the FPTs will be conducted by the contractors providing and installing the equipment and systems being commissioned and the BAS contractors and witnessed by the CxP.
- 6. Typical activities during FPT execution will include the following:
 - a. Starting/stopping equipment
 - b. Energizing/de-energizing electrical distribution gear
 - c. Opening/closing valves and dampers
 - d. Manipulating BAS inputs, outputs and setpoints
 - e. Setup, collection and downloading of BAS trend data
 - f. Test all modes of operation (normal, failure, backup, emergency, etc.)
 - g. Confirmation of required alarms sent to BAS
- 7. The Contractor(s) shall maintain full responsibility for the facility, equipment and systems operated during the FPTs, maintain all guarantees and warranties, and shall repair any damage to the facility caused during the FPTs.
- 8. Contractors shall conduct seasonal FPTs as necessary. This includes performing FPTs on equipment during the season it is intended to operate (i.e. test cooling equipment during the peak cooling season and test heating equipment during the peak heating season, etc.).
- 9. The CxP shall assist and witness all seasonal FPT's.
- 10. Tools, test equipment and instrumentation required for completion of the FPTs shall be provided by the CxP except for special-purpose or proprietary tools, test equipment and instrumentation which will be provided by the contractors. All instruments shall meet the requirements of Part 2 of this specification.
- 11. FPT acceptance shall confirm the performance of systems to the extent of the design intent. When a system is accepted, the Owner, design team and Contractor shall be assured that the system is complete, works as intended, is correctly documented, and operator training has been performed.

3.9 COST OF RE-EVALUATION

- A. The cost for Contractors to re-evaluate any Commissioning Procedure due to open issues shall be borne by the contractors.
- B. The CxP shall include and be available for two attempts of the Functional Performance Tests (one initial and one re-try) with minimal follow-up where necessary (due to deficiencies, systems not ready, incomplete work, etc.) to try to accomplish each test as part of the contract. When additional work is required because systems are not ready or because they do not successfully pass the FPT

after they have been indicated as ready, the contractor will be charged for the CxP's additional retesting costs. Additional fees will be paid to the CxP by the Contractor. The Contractor has the authority to back change or request a credit by the sub-contractor that causes multiple re-tests.

- C. Any required re-testing by any contractor shall not be allowed as a justified reason for a claim of delay or for a time extension by the contractor.

3.10 PRELIMINARY CX REPORT

- A. The CxP shall prepare and submit a preliminary commissioning report upon completion of FPTs and prior to the final mechanical inspection. Per 2015 IECC, Section C408.2.4 the Preliminary commissioning report shall will include **at a minimum**:
 - 1. Itemization of deficiencies found during testing that have not been corrected at the time of report preparation.
 - 2. Deferred tests that cannot be performed at the time of report preparation because of climatic conditions.
 - 3. Climatic conditions required for performance of the deferred tests.

3.11 OPERATING AND MAINTENANCE (O&M) MANUALS

- A. The CxP shall review and comment on the contractor submitted O&M manuals for equipment and systems commissioned.
- B. The CxP shall review that the contractor submitted operating and maintenance manuals comply with the project's technical specific specifications and at a minimum the IECC code requirements as per, Section C408.2.5.5 Manuals, which states O&M's shall include all of the following:
 - 1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
 - 2. Manufacturer's operation manuals and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
 - 3. Name and address of at least one service agency.
 - 4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.
 - 5. A narrative of how each system is intended to operate, including recommended setpoints.
- C. The CxP shall prepare and provide a supplement to the O&M that documents the system setpoints for each system and piece of equipment commissioned upon completion of the functional performance testing and any seasonal or deferred testing.

3.12 TRAINING

- A. General
 - 1. The Contractor shall train the Owner's personnel in the operation and maintenance of systems and equipment listed in this Section and as mentioned in other sections.
 - 2. The CxP review and comment on the training plans submitted by the contractors.

3. The CxP shall participate in, witness and verify training by the contractors.
4. The CxP shall verify training is conducted by obtaining sign in attendance sheets.
5. The required training and demonstration specified within this section is supplemental to the requirements of the training and demonstration as outlined in the discipline specific technical sections of the specifications. See the technical specification sections for the systems and equipment that require training and the quantity of hours to be provided.

B. Scope of Training

1. Training must be conducted in two parts and include both classroom and on-the-job (hands-on) instruction by qualified manufacturer's representatives, vendors, installation/service technicians and operation personnel having the necessary knowledge, experience, and teaching skills.
2. The training shall provide comprehensive instruction on the operation and maintenance of building components, equipment, controls, and systems including procedures for startup, shutdown, normal operation, abnormal operation, preventive maintenance, troubleshooting, and corrective maintenance.
3. The classroom portion of each training session, shall be based on the information contained in the approved O&M Manuals and will use copies of these manuals for reference. This shall include the following items as applicable:
 - a. Content and organization of appropriate O&M Manual materials
 - b. Overall equipment / system layout and configuration
 - c. Locations and tag numbers of major components
 - d. Theory of Operation / Design Intent
 - (1) Startup and Shutdown Procedures
 - (2) Normal Operating Procedures
 - (3) Non-normal Operating Procedures (unoccupied, seasonal operation, etc.)
 - (4) Emergency procedures
 - e. Health and Safety issues (both to O&M personnel and building occupants)
 - f. Energy Efficiency Issues
 - g. Occupant Comfort and IAQ Issues
 - h. Control System Sequence of Operation
 - i. Preventive Maintenance Procedures
 - j. Diagnostic & Troubleshooting Procedures
 - k. Corrective Maintenance & Repair Procedures
 - l. Review of the BAS front end operators work station. A temporary work station and/or laptop shall be set up to review and train O&M staff on the actual BAS controls for this project.
4. The field portion of each training session shall at a minimum cover the following items as applicable:
 - a. Walk-down of covered equipment and systems
 - b. Demonstration of startup, shutdown and operating procedures
 - c. Demonstration of diagnostic, service, maintenance and repair procedures
 - d. Emergency shutdown procedures

- e. Locations of critical isolation valves
- 5. Follow-up or post-occupancy training, where specified, shall be planned, scheduled and conducted per the requirements of this specification. This training will focus on seasonal issues that could not be addressed during the initial training and on addressing operational and maintenance issues identified by the Owner since turnover.
- C. Coordination & Scheduling
 - 1. Training shall not begin until the following items have been completed:
 - a. Building systems and equipment are complete and operational.
 - b. Functional Performance Testing for the equipment and systems being trained on have been successfully completed.
 - c. The design team, Contractor and CxP have received and approved the final submittal copies of the Operation and Maintenance Manuals
 - d. The contractor's proposed training plan and schedule have been approved by the owner.
 - e. The Building Automation System (BAS) has been completed and tested.
 - 2. The contractor shall work closely with the Owner's personnel and the CxP in the development and implementation of the training program. This may include preliminary meetings to map out the direction the training will take and development, with Owner approval, of the written training materials.
 - 3. The minimum specific hours of training time provided for equipment and systems shall be in accordance with the requirements in the individual equipment spec sections.
 - 4. All training shall include two identical training sessions. The first training session shall occur in the morning and shall cover the early morning and day shift staff and the second session shall occur in the late afternoon and cover the evening and night shift staff. Exact training plan and schedule shall be submitted to Contractor and owner for approval prior to any training session.
 - 5. The Contractor and owner retains the option of redistributing training time, subject to the total time specified. This may include repetition of selected training sessions or provision for follow-up training sessions after occupancy.
 - 6. Specific schedules for all training sessions must be coordinated in advance with Owner.
- D. Training Program and Materials
 - 1. The contractor will submit a written training program outlining the proposed scope of training, training materials and instruction schedule for review and approval by the Contractor, design engineer and CxP approximately 30 days before the scheduled completion of the work for which training is to occur.
 - 2. Copies of training materials furnished by the Contractor as part of their training program shall become the property of the Owner. This includes but is not limited to:
 - a. All lesson plans, teachers' guides or training aids used to instruct the students. One complete set shall be given to the Owner.
 - b. All written materials. e.g. workbooks, manufacturers' instructions, brochures, student tests, charts or other printed or photographed visual aids. Three (3) sets with one complete reproducible master shall be given to the Owner.

- c. All audio-visual materials e.g. DVD's, CD's, video tapes, film and audio cassettes, overhead projector transparencies, software files of presentations, or other audio visual medium. Three sets shall be given to the Owner.
- 3. The Contractor shall provide all equipment related to the conveyance of the training program e.g. DVD's, CD's projectors, TV monitors, overhead projector, or other related equipment. Non-permanent mounted white boards, cork board and projector screens. Equipment of this nature provided by the contractors for use during training sessions does NOT become the property of the Owner. Contractors shall promptly remove said equipment at the end of the training session(s).
- E. Instructor Qualifications
 - 1. Credentials of training instructors are subject to review and approval by the design engineer, Contractor and CxP.
 - 2. Instructors must have knowledge and experience with the equipment on which they are providing training
 - 3. Instructors must be familiar with the organization and content of Operation and Maintenance Manuals for the equipment on which they are providing training.
 - 4. Instructors for controls must be knowledgeable and familiar with the specific controls equipment, project applications, and specific sequences of operation for this project.
- F. Classroom Training Facilities
 - 1. Locations for classroom training sessions shall be coordinated with the Owner. All training shall be conducted on-site except by prior arrangement and approval by the Contractor and Owner.

3.13 CX FINAL REPORT

- A. The CxP shall prepare and submit a final commissioning report within 90 days of the date of receipt of the certificate of occupancy to the contractor and building contractor, which will include an executive summary, list of participants and roles, brief building description, the commissioning plan, a list of all open and closed deficiencies found, copies of all commissioning site observation field reports, copied of all completed and/or uncompleted FPTs. Per 2015 IECC, Section C408.2.5.4 the Final commissioning report shall will include at a minimum:
 - 1. Results of functional performance tests.
 - 2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
 - 3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.
 - 4. (Exception: Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.)

3.14 SEASONAL / DEFERRED TESTING

- A. Seasonal and Deferred testing is required by these specifications and IECC code whenever full load or part load performance testing cannot be done at the time of initial functional performance testing because of inappropriate climatic conditions.
- B. The CxP and contractors shall assume seasonal testing will be required based on the preliminary project schedule available at the time these specifications were prepared.

3.15 RECORD DRAWINGS

- A. The CxP shall review the as-built contract documents to verify incorporation of both design changes and as-built construction details. Discrepancies noted shall be corrected by the appropriate party.

3.16 EXCLUSIONS

- A. Responsibility for construction means and methods: The CxP is not responsible for construction means, methods, job safety, or any construction management or Contractor functions on the job site.
- B. Hands-on work by the CxP: The contractors shall provide all services requiring tools or the use of tools to start-up, test, adjust, or otherwise bring equipment and systems into a fully operational state. The CxP shall coordinate and observe these procedures (and may make minor adjustments), but shall not perform construction or technician services other than verification of testing, adjusting, balancing, and control functions.

END OF SECTION