Addendum No.: 2 **Date Of Addendum: August 8, 2018**

CT DAS | Construction Services | Office of Legal Affairs, Policy, and Procurement

Renovations to Physical Plant
Naugatuck Valley Community College
750 Chase Parkway
Waterbury, CT
BI-CTC-500

Original Bid Due Date / Time:	**August 15, 2018**	**1:00 PM**
Previous Addendums:	**Addendum No. 1 dated 7/25/2018**	
Revised Bid Due Date / Time:	**August 22, 2018**	**1:00 PM**

TO: **Prospective Bid Proposers:**
This Addendum forms part of the "Contract Documents" and modifies or clarifies the original "Contract Documents" for this Project dated March 23, 2018. Prospective Bid Proposers **shall** acknowledge receipt of the total number the Addenda issued for this Project on the space provided on Section 00 41 00 Bid Proposal Form.

Failure to acknowledge receipt of the total number the Addenda issued for this Project on the space provided on Section 00 41 00 Bid Proposal Form shall subject Bid Proposers to disqualification.

The following clarifications are applicable to drawings and specifications for the project referenced above.

Item 1:

The bid opening date will be changed from 8/15/2018 at 1:00 PM to 8/22/2018 at 1:00 PM.

Item 2:

In Section 23 0900 – Instrumentation and Control for HVAC, Paragraph 3.03.

DELETE: Paragraph C.

SUBSTITUTE the following**:**

C. Occupancy and Seasonal Adjustments: Within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied, unoccupied and seasonal conditions. Provide six 8 hour visits to Project for this purpose. Submit report for each visit.

Item 3:

In Section 23 1123 – Facility Natural Gas Piping, Paragraph 2.5.B.

DELETE: Paragraph 12.

SUBSTITUTE: 12. Maximum Inlet Pressure: 10 psig.

Item 4:

Section 23 5100 – Breeching, Chimneys and Stacks.

REPLACE the entire section with the attached.

Item 5:

Section 23 5216 – Condensing Boilers.

REPLACE the entire section with the attached.

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Item 6:

Section 23 6416 – Centrifugal Water Chillers.

REPLACE the entire section with the attached.

Item 7:

Drawing S-200 – New Stack Enclosure – Plans & Details.

On Plan detail A/S-200, ADD the following note #4:

MECHANICAL CONTRACTOR TO DESIGN MECHANICAL HVAC STACK SUPPORT TO MAXIMIZE GRAVITY SUPPORT LOAD AT THE BOILER PLANT FLOOR, AND MINIMIZE THE GRAVITY SUPPORT AT THE PLAZA LEVEL. MAXIMUM ALLOWABLE GRAVITY LOAD WHICH MAY BE APPLIED AT THE PLAZA LEVEL TO BE 750 LB PER EACH STACK OR LESS. CONTRACTOR TO DESIGN FLOOR MOUNTED STACK SUPPORT AND SUBMIT TO BVH FOR REVIEW AND APPROVAL.

Item 8:

Drawing G-101.C2 – Core Level 1 Plumbing Plan - New.

CHANGE the note referring to the new housekeeping pad for the six (6) new boilers to: NEW HOUSEKEEPING PADS. SEE DETAIL 5/S-202 ON STRUCTURAL DRAWINGS FOR MORE INFORMATION. HEIGHT TO BE MINIMUM 8” HIGH AND SIZE MINIMUM 6” GREATER THAN UNIT DIMENSION ON ALL SIDES. COORDINATE WITH MECHANICAL AND PLUMBING CONTRACTOR. The housekeeping pad for the two (2) gas water heaters and three (3) expansion tanks may remain at a minimum of 4” high.

Item 9:

Drawing P-020 – Plumbing Schedules – Domestic Water and Natural Gas Piping Specialties Schedule.

ADD the following sentences to Gas Pressure Regulator GPR-1: COORDINATE SPRING AND ORIFICE SIZE WITH SPECIFIED EQUIP MFR. REVISE AS REQUIRED FOR SUBSTITUTE MFR.

CHANGE Gas Pressure Regulator GPR-2 description to: ACTARIS GAS B38 SERIES SPRING LOADED PRESSURE REGULATOR RATED FOR INLET PRESSURES UP TO 10 PSIG AND OUTLET PRESSURE OF 5"WC TO 5 PSIG. ORIFICE SIZE AND SPRING SELECTION SHALL BE BASED ON AN INLET GAS PRESSURE OF 10 PSI, AN OUTLET PRESSURE OF 2 PSI, AND A FLOW RATE OF 36,000 CFH. COORDINATE SPRING AND ORIFICE SIZE WITH SPECIFIED EQUIP MFR. REVISE AS REQUIRED FOR SUBSTITUTE MFR.

ADD the following sentences to Gas Pressure Regulator GPR-3: COORDINATE SPRING AND ORIFICE SIZE WITH SPECIFIED EQUIP MFR. REVISE AS REQUIRED FOR SUBSTITUTE MFR.

Item 10:

REPLACE drawing P-101.C2 – Core Level 1 Plumbing Plan - New with the attached revised drawing. The revisions include revised gas piping sizing and connection to boilers and water heaters.

Item 11:

Drawing P-105.T – Technology Hall Level 5 Plumbing Plans - Demolition and New

CHANGE Plumbing Drawing Note #1 to: PROVIDE GAS FIRED WATER HEATERS. PROVIDE 2" H&CW, 1" HWR, 1 1/2" GAS CONNECTIONS. REFER TO DETAIL ON DWG# P-400 FOR ADDITIONAL INFORMATION.

ADD that the common gas line from the outlet of GPR-3 to the two domestic water heaters shall be 2” diameter.

Item 12:

REPLACE drawing P-400 – Plumbing Details with the attached revised drawing. The revisions include changes to the details for gas piping to boilers and water heaters.

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Item 13:

Drawing H-010 – HVAC General Notes, Abbreviations and Symbols List

CHANGE HVAC General Note #14 to: INSTALL FLOOR-MOUNTED EQUIPMENT ON A CONCRETE HOUSEKEEPING PAD. PADS SHALL BE MINIMUM 4" HIGH (BOILER/WATER HEATER PADS MINIMUM 8" HIGH) AND MINIMUM 6" GREATER THAN UNIT DEMINSIONS ON ALL SIDES.

Item 14:

REPLACE drawing H-020 – HVAC Schedules with the attached revised drawing. The revisions include clarifications related to boiler and chiller requirements for manufacturers other than the basis of design.

Item 15:

REPLACE drawing H-102.C1 – Core Level 2 HVAC Plan - Demolition with the attached revised drawing. The revisions include clarifications to the existing intake and relief plenums, and associated ductwork.

Item 16:

REPLACE drawing H-102.C2 – Core Level 2 HVAC Plan - New with the attached revised drawing. The revisions include changes to the ductwork connections to existing intake and relief plenums, and separation of sealed combustion air ducts for each appliance into a dedicated duct. There are also clarifications related to differences required for boilers manufacturers other than the basis of design.

Item 17:

REPLACE drawing H-102.A1 – Fine Arts Level 2 HVAC Pipe Tunnel Plans – Demolition and New with the attached revised drawing. The revisions include clarifications on modification to support racks for piping.

Item 18:

Drawing H-102.A2 – Fine Arts Level 2 HVAC Pipe Tunnel Plans – Demolition and New

The revisions made to details 3, 4, 5 and 6 on drawing H-102.A1 are also applicable to this sheet (drawing not re-issued with this addendum).

Item 19:

Drawing H-102.K – Kinney Hall/Fine Arts Level 2 HVAC Pipe Tunnel Plans – Demolition and New

The revisions made to details 3, 4, 5 and 6 on drawing H-102.A1 are also applicable to this sheet (drawing not re-issued with this addendum).

Item 20:

Drawing H-102.L1 – Learning Resource Center Level 2 HVAC Pipe Tunnel Plans – Demolition and New

The revisions made to details 3, 4, 5 and 6 on drawing H-102.A1 are also applicable to this sheet (drawing not re-issued with this addendum).

Item 21:

Drawing H-102.L2 – Learning Resource Center Level 2 HVAC Pipe Tunnel Plans – Demolition and New

The revisions made to details 3, 4, 5 and 6 on drawing H-102.A1 are also applicable to this sheet (drawing not re-issued with this addendum).

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Item 22:

Drawing H-500 – Boiler Plant Hot Water Flow Diagram

CLARIFY that the DP (differential pressure) sensors indicated in light line weight on the overall flow diagram are new devices (not existing as would be implied by the light line weight).

CHANGE the note pointing to the typical boiler safety relief valve to: MULTIPLE RELIEF VALVE(S) @ BOILER; SET AT 75 PSIG. DISCHARGE TO FLOOR DRAIN THROUGH FIXED AIR GAP (TYP).

CLARIFY that the TWO-WAY ON/OFF AUTOMATIC CHANGEOVER VALVES (TYP EACH BOILER) are furnished by the Boiler Manufacturer; field installed.

Item 23:

Drawing H-504 – Central Chiller Plant Flow Diagram

ADD DP (differential pressure) sensors across the supply and return mains adjacent to each of the new bypass control valves indicated on the overall flow diagram. **CHANGE** the note pointing to each of the new bypass control valves to: NEW 2-WAY PICV DP BYPASS VALVE SIZED FOR 375 GPM, AND DP SENSOR INTERLOCKED WITIH CHILLER AND PUMP MINIMUM FLOW REQUIREMENTS.

Item 24:

REPLACE drawing H-601 – HVAC Controls with the attached revised drawing. The revisions include clarifications related to coordination of integral boiler controls with field installed DDC controls.

Item 25:

Drawing H-701 – HVAC Details

On the Condensing Boiler Piping Detail, **CLARIFY** that the gas train indicated is factory-piped, and **ADD** a DEDICATED GAS REGULATOR BY BOILER MANUFACTURER, INSTALLED BY PLUMBING CONTRACTOR. CLARIFY that the line to the packaged condensate neutralization system is FOR EACH BOILER.

On the Chiller Piping Detail, **ADD** a STRAINER WITH BLOWDOWN VALVE (TYP) on the chilled water return line at the inlet of the motorized butterfly valve.

Item 26:

REPLACE drawing H-702 – HVAC Building Sections with the attached revised drawing. The revisions include clarifications related to configuration of supports for boiler and water heater vents.

Item 27:

Drawing E-020 – Electrical Schedules

On the Mechanical Equipment Circuiting Schedule, **ADD** note #4: PROVIDE WITH SHUNT TRIP CIRCUIT BREAKER; Apply this note to Boilers B-1 through B-6, and Gas Water Heaters GWH-1 & 2.

On the Mechanical Equipment Circuiting Schedule, **ADD** note #5: WIRE TOGGLE SWITCH IN SERIES WITH GAS-FIRED WATER HEATER TO ACT AS EMERGENCY DISCONNECTING MEANS; Apply this note to Gas Water Heaters GWH-3 & 4.

On Branch Panel Schedule LPP-1, in branch pole position 3, **ADD** shunt trip device for C/B #1; in branch pole position 4, **ADD** shunt trip device for C/B #2; in branch pole position 5, **ADD** 20A/1-P spare circuit breaker.

Item 28:

Drawing E-105.T – Technology Hall Level 5 Electrical Plans – New

In Water Service Room T520, ADD two (2) Emergency switches next to the door, with note: PROVIDE EMERGENCY SHUTOFF SWITCH TO DISCONNECT POWER TO NEW GAS-FIRED WATER HEATERS. REFER TO EMERGENCY POWER OFF DETAIL FOR ADDITIONAL INFORMATION.

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Item 29:

Drawing E-302 – Electrical One-Line Diagram - New

CHANGE the feeder between ATS-Emergency and switchboard SWBD-ESWBD to: (2) SETS OF (4) #600 KCMIL & (1) 1/0 GND IN 4" C.

CHANGE the feeder between ATS-Standby and switchboard SWBD-SSSWBD to: (2) SETS OF (4) #600 KCMIL & (1) 1/0 GND IN 4" C.

CHANGE the feeder between switchboard SWBD-SSSWBD and MCC2A to: (2) SETS OF (4) #600 KCMIL & (1) 1/0 GND IN 4" C.

Attachments: Specification sections 23 5100, 23 5216 and 23 6416; Drawings P-101.C2, P-400, H-020, H-102.C1, H-102.C2, H-102.A1, H-601 and H-702.

All questions must be **written** (not **verbal** or by **phone**) and must be forwarded to the consulting Engineer (Jerry Alverson, Email: JerryA@bvhis.com) with copies sent to the DAS/CS Project Manager (Joel Baranowski, Email: Joel.Baranowski@ct.gov) and Construction Administrator (Steve Buccheri, Email: SteveBuccheri@newfieldconstruction.com)

End of Addendum Number 2

Mellanee Walton

Mellanee Walton, Associate Fiscal Administrative Officer
State of Connecticut
Department of Administrative Services, Construction Services
Office of Legal Affairs, Policy, and Procurement

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Listed double-wall special gas vents.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Special gas vents**, including fittings, accessories, and connectors**.
~~2. Guy wires and connectors.~~

B. Shop Drawings: For **special** vents, ~~breechings, chimneys,~~ and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers, expansion compensation and ~~seismic~~ **wind** restraints, and location and size of each field connection.
2. For all vent, breeching, chimney and grease ducts installed products, include calculations required for **wind** ~~seismic~~ restraints, ~~guying~~ and bracing material components and connections to adjacent structures and structural analysis data signed and sealed by the qualified professional engineer. **Include anchor locations and loads (gravity and lateral) to be supported from existing structure. See HVAC and structural drawings for additional information.** ~~Guying and bracing material components and connections to adjacent structures.~~
3. Include vent, breeching, chimney and stack manufacturer draft and sizing calculations for system based on vented equipment being provided and actual fabrication layout, assuring proper venting of all supplied equipment.
~~4. Include vent, breeching, chimney and stack manufacturer's expansion calculations for system based on vented equipment being provided and actual fabrication layout, assuring proper expansion compensation of system.~~
~~5.~~**4.** Include details of required clearances to construction specific to the project and installation. Indicate required openings and chase sizes required. ~~Indicate maximum ceiling height to maintain clearances required.~~ Note any conflicts to plans for Architect/Engineer review.
~~6.~~**5.** Include UL listing with rating criteria, including temperature and pressures.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated ~~breeching~~ **special vents**, ~~chimneys,~~ and stacks; accessories; and components will withstand ~~seismic and~~ wind forces defined in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of anchorage devices on which the certification is based and their installation requirements.

B. Boiler/Water Heater Manufacturer Acceptance Certification: Submit with delegated design submittal, written certification and acceptance of vent sizing and layout from the boiler manufacturer being supplied.

~~B.~~**C.** Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Certified Sizing and Expansion Calculations: Manufacturer shall certify venting system sizing and expansion calculations for specific equipment being supplied.

~~B.~~**1. Include boiler/water heater manufacturer acceptance certification.**

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENTS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Heat-Fab, Inc.
2. Metal-Fab, Inc.
3. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
4. Jeremias Venting.

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211 and suitable for condensing-gas applications.

C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

E. Outer Jacket: Aluminized steel for interior applications; Type 316 stainless steel for exterior applications.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, ~~barometric dampers,~~ **drain sections,** expansion compensation, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Exit cone with drain section incorporated into riser.

G. System shall be capable of being self-supporting for a minimum of 5 feet above the roof/attachment point without the use of guy wires or other additional bracing.

~~2.2 GUYING AND BRACING MATERIALS~~

~~A. Cable: Three stainless steel, stranded wires of the following thickness:~~

~~1. Minimum Size: 1/4 inch in diameter.~~
~~2. For ID Sizes 4 to 15 Inches: 5/16 inch.~~
~~3. For ID Sizes 18 to 24 Inches: 3/8 inch.~~
~~4. For ID Sizes 27 to 30 Inches: 7/16 inch.~~
~~5. For ID Sizes 33 to 36 Inches: 1/2 inch.~~
~~6. For ID Sizes 39 to 48 Inches: 9/16 inch.~~
~~7. For ID Sizes 51 to 60 Inches: 5/8 inch.~~

~~B. Guy Tensioners: Spring-loaded type. Provide when expansion is 1-1/2 inches or greater~~

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Special Gas Vent: Condensing gas appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Install in strict accordance with manufacturer's instructions.

B. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

1. Maintain required clearances to construction as required by product listing, manufacturer's instructions and code. Coordinate size of all chases and openings. Confirm ceiling heights. Notify Architect/Engineer of any conflicts prior to fabrication and installation.

C. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

E. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

F. Lap joints in direction of flow.

G. Utilize 45-degree tees for all vent connectors to breeching and breeching to chimney fittings of listed building heating appliance chimney and engine exhaust chimney vent systems.

H. Provide drain tee section at the chimney base of listed building heating appliance chimney vent systems. Pipe drain to nearest indirect waste through neutralizer system.

I. Provide expansion compensation per manufacturer's instructions.

J. Pipe all open type stack outlet drain sections through neutralizer system to indirect waste at appliance location.

K. Provide firestops at all penetrations of rated construction.

L. Provide ventilated thimbles with storm collars suitable for roof type and slope at all roof penetrations and at all exterior wall applications suitable for wall type.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

3.5 APPLICATION SCHEDULE

A. Boilers and Domestic Water Heaters:

1. Fuel: Gas.
2. Interior Pressure: Positive.
3. Vent Temperature: Condensing.
4. Venting System:

    a. Vents: Special gas vent.
    b. Vent Connectors: Listed special gas vent.

END OF SECTION 235100
~~03/23/2018~~**Addendum No. 2 – 8/8/2018**

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For each boiler.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators ~~and seismic restraints~~ and for designing vibration isolation bases.
b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. ~~Include adjustable motor bases, rails, and frames for equipment mounting.~~

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports**, including seasonal and occupancy adjustments schedule and reports for each visit**.

C. Sample Warranty: For special warranty.

D. Product Certificates:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.5 CLOSEOUT SUBMITTALS

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

1.6 WARRANTY

A. Manufacturer's **Special** Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. Leakage and Materials: 10 years from date of Substantial Completion.
b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

C. ANSI/ASHRAE/IESNA Standard 90.1 Compliance: Boilers shall have minimum efficiency required by standard. Each boiler shall bear a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE Standard 90.1.

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.

E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. AHRI Certification: For boilers with input ratings greater than or equal to 300 MBH, and less than or equal to 2,500 MBH. Boilers to be certified by AHRI to be rated in accordance with DOE boiler test procedures as published in the latest edition of the Code of Federal Regulations, 10 CFR Part 431, and subject to verification of rating accuracy by AHRI - sponsored, independent, third party testing.

G. Mounting Base: For securing boiler to concrete base.

2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings **(AERCO; Benchmark)** or comparable product **(see schedule on drawings for performance)** by one of the following:

1. AERCO; Benchmark.
2. Cleaver-Brooks; Clear Fire.
3. Lochinvar; Crest.

B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only. Boiler shall have no minimum return water temperature requirement and a minimum flow rate requirement no greater than 20 percent of the design flow rate. Piping to boilers shall be primary only and no dedicated primary boiler pump shall be required.

1. Low nox operation **(<20 ppm)**.
2. Sealed combustion air.

C. Heat Exchanger: 304/316L or 439 stainless steel with downfire arrangement and nonferrous, corrosion-resistant combustion chamber. Any metal that is designed to come into contact with flue condensation is to be stainless steel.

D. Pressure Vessel: Carbon or stainless steel with welded heads and tube connections.

E. Burner: Natural gas, forced draft, with capability of a minimum of 3 to 1 turndown.

F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Gas Train: Combination gas valve with manual shutoff ~~and pressure regulator~~, FM approved.

H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:

1. Jacket: Manufacturer standard, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Manufacturer standard protective finish.
4. Insulation: Minimum 2-inch- thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

2.3 TRIM

A. Include devices sized to comply with ASME B31.1.

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated. See plans for relief pressure setting requirements. **Provide multiple valves per manufacturer's requirements.**

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

G. Provide condensate neutralization system for each boiler/water heater and additional neutralization systems for boiler/domestic water heater special gas vent drain sections.

H. Boiler **manufacturer supplied, field-installed** two-way, two-position motorized **butterfly lug body** isolation valve.

1. 50 psi bubble-tight shutoff.
2. 125/150 ANSI Class flanges.
3. 90-degree rotation.
4. Ductile-iron body with epoxy powder coat.
5. 304 stainless steel disc with EPDM seat, 416 stainless steel shaft.
6. 24V electronic actuator, 180 in-IDS of torque, power closed, failsafe open with manual override button, reversible CW/CCW switch, proof of open end switch.
7. Field-wired and controlled from boiler control system.
8. See boiler control section for sequence requirements.

~~H.~~**I. Gas Regulator: Lock up style vent-less regulators suitable for 2 psi inlet pressure, ANSI and UL listed.**

2.4 CONTROLS

A. Refer to Division 23 Section "Direct Digital Control (DDC) System for HVAC" HVAC control drawing diagrams and Sequence of Operations.

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature.

a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

~~a.~~**4. Isolation Valve Control: Boiler controls to assure selected lead boiler valve remains open at all times and staging off time delay for heat dissipation of sequenced lag boilers.**

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.

3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

1. A BACnet communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

a. Provide BACnet **MSTP** gateway. Coordinate with Division 23 "Instrumentation and Control for HVAC."

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to wire terminal strip.
5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

2.6 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.

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

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section "Vibration and Seismic Controls for HVAC."

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

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

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

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 "Hydronic Piping Specialties."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

I. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections.

J. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

~~B.~~**1. Engage a factory-authorized service representative to provide seasonal and occupancy adjustments described herein.**

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. **Seasonal and** Occupancy Adjustments: ~~When requested within~~**Within** 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied**, unoccupied,** and seasonal conditions. Provide ~~up to~~ six **8-hour** visits to Project ~~during other than normal occupancy hours~~ for this purpose. **Submit report for each visit. Submit proposed schedule to Engineer prior to substantial completion. Notify Engineer 14 days in advance of each visit.**

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain ~~chillers~~ **boilers**. Video record the training sessions and provide electronic copy to Owner. Refer to Division 01 for additional requirements.

1. Instructor shall be factory trained and certified.
2. Provide not less than eight hours of training over a two day period.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Provide a minimum of 8 hours training over a 2 day period. .

END OF SECTION 235216
~~03/23/2018~~**Addendum No. 2 – 8/8/2018**

SECTION 236416 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.

1.3 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input, using consistent units for any given set of rating conditions.

B. DDC: Direct digital control.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated according to the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

E. kVAR: Kilovolt-ampere reactive.

F. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

G. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated according to the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

H. SCCR: Short-circuit current rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. **Full load kW/ton and IPLV p**erformance at AHRI standard conditions ~~and at conditions indicated~~**, including part load performance**.

3. **Full load kW/ton and NPLV p**erformance at **non-**AHRI standard ~~unloading~~ conditions**, including part load performance and certification of ASHRAE 90.1 2010 compliance for non-standard conditions (see schedule on drawings)**.
4. Minimum evaporator flow rate.
5. Minimum condenser flow rate.
6. Refrigerant capacity of chiller.
~~7. Oil capacity of chiller.~~
~~8.~~**7.** Fluid capacity of evaporator, condenser.
~~9.~~**8.** Characteristics of safety relief valves.
~~10.~~**9.** Minimum entering condenser-fluid temperature.
~~11.~~**10.** Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.
~~12.~~**11.** Force and moment capacity of each piping connection.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   a. Structural supports.
   b. Piping roughing-in requirements.
   c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
   d. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

2. Coordination drawings showing plan, section, and elevation views, drawn to 1/4" = 1'-0".
3. Each view to show screened background with the following:

   a. Column grids, beams, columns, and concrete housekeeping pads.
   b. Room layout with walls, floors, and roofs, including each room name and number.
   c. Equipment and products of other trades that are located in vicinity of chillers and part of final installation, such as lighting, fire-suppression, and plumbing systems.

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

C. Source quality-control reports.

D. Field Quality-Control Reports: Startup service reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

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

B. Instructional Videos: Including those that are pre-recorded and those that are recorded during training.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Touch-up Paint: 32-oz. container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.8 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller according to AHRI 550**/590** certification program.

~~A.~~**B. ASHRAE 90.1 Compliance: Certify chiller performance at non-AHRI 550/590 standard condition complies with ASHRAE 90.1 2010 for non-standard design condition.**

~~B.~~**C.** Manufacturer must have at least 3 years' experience in manufacturing current generation model chillers in order to be considered.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Package chiller for export shipping in totally enclosed bagging.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller, including refrigerant and oil charge (if applicable).
b. Complete compressor and drive assembly, including refrigerant and oil charge (if applicable).
c. Refrigerant and oil charge (if applicable).

1) Loss of refrigerant charge for any reason due to manufacturer product defect and product installation.

d. Parts and labor.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 50 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 60 deg F.
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

B. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

C. Performance Tolerance: Comply with AHRI 550/590.

D. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1 **for non-standard design conditions**.

F. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.

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

H. Comply with requirements of Underwriters Laboratories Inc., and include label by a qualified testing agency showing compliance.

I. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement, even if not explicitly indicated.

2.2 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings (Daikin Applied Model WME) or comparable product **(see schedule on drawings for performance)** by one of the following:

1. Carrier Corporation; a unit of United Technologies Corp., Model 19DV.
2. ~~Trane Model CVHF~~

~~3.~~ **2.** YORK; a Johnson Controls company, Model YMC^2.

2.3 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system, evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.

1. Multi-Piece Assembly: Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

B. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

2.4 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Single-stage or multistage, variable- or dynamic-displacement, centrifugal-type compressor driven by an electric motor.

B. Oil-Free Technology:

1. Compressors shall have oil-free technology using a permanent magnet synchronous motor, magnetic bearings, integral variable-frequency controller, and digital electronic controls.

a. Magnetic Bearings, Ceramic Bearings or Roller Element Bearings:

1) Levitated shaft position shall be actively controlled and monitored by an X-, Y-, and Z-axis digital position sensor.
2) Compressor assembly shall be capable of coming to a controlled, safe stop without damage during a power failure by diverting stored power to the magnetic bearing control system.

b. Compressor assembly shall be capable of coming to a controlled, safe stop without damage during a power failure by diverting stored power to the magnetic bearing control system.

c. Integrate monitoring and controls associated with magnetic bearings into chiller controls, including following:

1) Operating Information: Positions, currents, temperatures, rotor elongation, and speed.
2) Warning Messages: Vibration.
3) Safety Shutdown: Internal fault, high bearing temperature or current, startup failure, speed signal fault, overspeed fault, communication error, rotor elongation, oscillator fault, rotor contraction, unauthorized rotation, and high and low voltage.
4) Cycling Shutdown: Position, low-frequency displacement, vibration, speed signal fault, startup failure, serial communications fault.

C. Compressor:

1. Casing: Cast iron or cast aluminum, precision ground.
2. Impeller: High-strength cast-aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.

D. Drive: Direct- or gear-drive, hermetic design, using an electric motor as the driver.

1. Gear Drives:

    a. For chillers with oil-lubricated gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating.
    b. For chillers with oil-free technology, gear drives shall be of single- or double-helical gear design without the need for oil while chiller is operating, starting, and stopping.
    c. Gears shall comply with American Gear Manufacturer Association standards.

2. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
3. Seals: Seal drive assembly to prevent refrigerant leakage.

E. Compressor Motor:

1. The motor shall be of the semi-hermetic type, of sufficient size to efficiently fulfil compressor horsepower requirements. It shall be liquid refrigerant cooled with internal thermal sensing devices in the stator windings.
2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. Provide motor with thermistor or RTD in each of three-phase motor windings to monitor temperature and report information to chiller control panel.
5. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.

F. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.

1. Vibration Limits: Velocities not to exceed 0.18 inches/s and 0.8 mils peak to peak on all axes.

G. Service: Easily accessible for inspection and service.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

H. Economizers: For multistage chillers, provide interstage economizers.

I. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 15 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature of 2.5 deg F for each 10 percent in capacity reduction.
4. Chillers with variable-frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
5. Avoid use of hot-gas bypass if other options are available to achieve performance indicated. Apply hot-gas bypass according to ASHRAE/IES 90.1 and governing codes.

~~J. Oil Lubrication System: Consisting of pump, filtration, cooler, factory-wired power connection, and controls.~~

~~1. Bearings, gears, and other rotating surfaces shall be lubricated at all operating, startup, coast down, and standby conditions, including power failure.~~
~~2. Manufacturer's standard method to remove refrigerant from oil.~~

~~3. Oil filter shall be the easily replaceable cartridge type, minimum 0.5 micron efficiency, with means of positive isolation while servicing.~~
~~4. Refrigerant or water cooled oil cooler.~~
~~5. Factory-installed and pressure-tested piping with isolation valves and accessories.~~
~~6. Oil compatible with refrigerant and chiller components.~~
~~7. Positive visual indication of oil level.~~

2.5 REFRIGERATION

A. Refrigerant:

1. Type: R-1233zde (Class A1) or R-514A; ASHRAE 34, Class B1 or R-134a; ASHRAE 34, Class A1. Manufacturer shall provide a centrifugal chiller which offers refrigerants which have zero ODP and no phase out date.
2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. The entire chiller system, including all pressure vessels, shall remain above atmospheric pressure during all operating conditions and during shut down to ensure that non-condensables and moisture do not contaminate the refrigerant and chiller system. If any portion of the chiller system is below atmospheric pressure during either operation or shut down, the manufacturer shall include, at no charge:

    a. A complete purge system capable of removing non- condensables and moisture during operation and shut-down.
    b. The manufacturer shall include a factory-installed and wired system that will enable service personnel to readily elevate the vessel pressure during shutdown to facilitate leak testing.

B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

C. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
3. Where dual pressure relief devices are installed in series, provide a sensor with indicator between devices to indicate refrigerant release past first device.
4. For Chillers Using R-1233zde or R-514A: Manufacturer's standard offering complying with ASHRAE 15 and ASHRAE 147.
5. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.

E. Refrigerant Isolation for Chillers Using R-134a:

1. Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell.
2. Suction side of compressor from evaporator shall have an isolation valve to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

3. A separate pump-out system and storage tank sufficient to hold the charge of the largest unit being furnished shall be provided if the chiller does not have valves and capacity to hold entire refrigerant charge in the evaporator or condenser.

F. Purge System:

1. For chillers operating at subatmospheric pressures (using R-1233zde of R514A refrigerant), factory install an automatic purge system for collection and return of refrigerant ~~and lubricating oil~~ and for removal of noncondensables, including, but not limited to, water, water vapor, and noncondensable gases.
2. System shall be of thermal purge design, refrigerant or air cooled, and equipped with a carbon filter that includes an automatic regeneration cycle.
3. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
4. Construct components of noncorrodible materials.
5. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
6. Efficiency of not more than 0.02 lb of refrigerant per pound of air when rated according to AHRI 580.
7. Operation independent of chiller according to ASHRAE 147.

G. Positive-Pressure System:

1. For chillers operating at subatmospheric pressures (using R-1233zde ~~of~~ **or** R-514A refrigerant), factory install an automatic positive-pressure system.
2. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant-pressure vessel of not less than 0.5 psig adjustable up to a pressure that remains within the vessel design pressure limits.
3. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

2.6 EVAPORATOR

A. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Shell is separate from condenser.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Evaporator shall have sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: Manufacturer's choice 3/4 or 1 inch.
5. Minimum Wall Thickness: 0.025 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear, but not more than 4 feet apart.

H. Water Box:

1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections.
3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
4. Hinged or davited marine water-box covers.
5. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange, welded, ASME B16.5, raised-face flange, or grooved for mechanical-joint coupling.
6. Thermistor or RTD temperature sensor factory installed in each nozzle.
7. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Flow Sensor: Thermal dispersion type, factory calibrated for project-specific application.

2.7 CONDENSER

A. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Shell is separate from evaporator.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

D. Condenser shall have sight glass or other form of positive visual verification of refrigerant charge and condition.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: 3/4 or 1 inch.
5. Minimum Wall Thickness: 0.025 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear, but not more than 4 feet apart.

H. Water Box:

1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections.
3. Water boxes and marine water-box covers shall have lifting lugs or eyebolts.
4. Hinged or davited marine water-box covers.

5. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange, welded, ASME B16.5, raised-face flange, or grooved for mechanical-joint coupling.
6. Thermistor or RTD temperature sensor factory installed in each nozzle.
7. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Flow Sensor: Thermal dispersion type, factory calibrated for project-specific application.

2.8 INSULATION

A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Thickness: Minimum 3/4 inch.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Manufacturer has option to factory or field insulate chiller components installed in multiple pieces to reduce potential for damage during installation.
6. Manufacturer has option to factory or field insulate water boxes and nozzles to reduce potential for damage during installation.

D. Field-Applied Insulation:

1. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
2. Manufacturer shall be responsible for chiller insulation whether factory or field installed, to ensure manufacturer is the single point of responsibility for chillers.
3. Manufacturer factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
4. After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.9 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to fused disconnect switch or circuit breaker. Minimum short circuit current rating (SCCR) according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.

1. Branch power circuit to each motor, electric heater, dedicated electrical load, and control, with circuit breaker or disconnect switch having SCCR to match main disconnecting means.

a. NEMA KS 1, heavy-duty fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller for each variable-speed motor furnished.
3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring located outside of enclosures shall be installed in metal raceway, and terminal connections shall be made with not more than a 24-inch length of liquidtight or flexible metallic conduit.

E. Factory install and wire capacitor bank for the purpose of power factor correction to 0.93 at all operating conditions.

1. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as that for motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
2. Capacitors shall be of non-PCB dielectric fluid, metallized electrode design, with low loss with low-temperature rise. The kVAR ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
3. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
4. Provide a ground terminal and a terminal block or individual connectors for phase connection.

~~2.10 MOTOR CONTROLLER~~

~~A. Enclosure: Factory installed, unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key or padlock and key.~~

~~B. Control Circuit: Obtained from integral control power transformer with a control power transformer of enough capacity to operate connected control devices.~~

~~C. Overload Relay shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.~~

~~D. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.~~

~~1. Externally Operated, Door-Interlocked Disconnect: Fused disconnect switch or circuit breaker. Short circuit current rating (SCCR) according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.~~
~~2. Control Relays: Time-delay relays.~~
~~3. Elapsed Time Meters: Numerical readout in hours on face of enclosure.~~
~~4. Number of Starts Counter: Numerical readout on face of enclosure.~~
~~5. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:~~

~~a. Selectable, digital display of the following:~~

~~1) Phase Currents, Each Phase: Plus or minus 1 percent.~~
~~2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.~~
~~3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.~~
~~4) Three-Phase Real Power: Plus or minus 2 percent.~~
~~5) Three-Phase Reactive Power: Plus or minus 2 percent.~~
~~6) Power Factor: Plus or minus 2 percent.~~

~~7) Frequency: Plus or minus 0.5 percent.~~
~~8) Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.~~
~~9) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.~~

~~b. Mounting: Display and control unit flush or semirecessed in instrument compartment door.~~

~~6. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.~~
~~7. Power Protection: Chiller shall shut down within six cycles of power interruption.~~

~~2.11~~2.10 VARIABLE-FREQUENCY CONTROLLER

A. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

B. Description: NEMA ICS 2; listed and labeled according to ETL or UL 508 as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

C. Enclosure: Unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key.

D. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum short circuit current rating (SCCR) according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.

E. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors; suitable for variable torque loads.

F. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.
2. Regulator shall provide full digital control of frequency and voltage.
3. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage for application to a squirrel-cage motor. Inverter shall produce a sine-coded, PWM output waveform and shall conduct no RFI back to the input power supply.

G. Output Rating: Three phase, with voltage proportional to frequency throughout voltage range.

H. Operating Requirements:

1. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum.
2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
3. Capable of driving full load, without derating, under the following conditions:

   a. Ambient Temperature: Zero to 40 deg C.
   b. Relative Humidity: Up to 95 percent (noncondensing).
   c. Altitude: Up to 3300 feet.

4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter; 98 percent with harmonic filter.
6. Overload Capability: 1.05 times the full-load current for seven seconds.

7. Starting Torque: As required by compressor-drive assembly.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

I. Internal Adjustability Capabilities: Integral to controller or through chiller control panel.

1. Minimum Output Frequency: 6 Hz.
2. Maximum Output Frequency: 60 Hz.
3. Acceleration: Two seconds to a minimum of 60 seconds.
4. Deceleration: Two seconds to a minimum of 60 seconds.
5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

J. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

1. Overtemperature.
2. Short circuit at controller output.
3. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
4. Open circuit at controller output.
5. Input undervoltage.
6. Input overvoltage.
7. Loss of input phase.
8. Reverse phase.
9. AC line switching transients.
10. Instantaneous overload, line to line or line to ground.
11. Sustained overload exceeding 100 percent of controller-rated current.
12. Starting a rotating motor.

K. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

L. Automatic Reset and Restart:

1. Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
2. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

M. Visual Indication: On face of controller enclosure, chiller control enclosure or separate power meter. indicating the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. Motor speed (percent).
8. Fault or alarm status (code).
9. DC-link voltage.
10. Motor output voltage.
11. Input kilovolt amperes.
12. Total power factor.

13. Input kilowatts.
14. Input kilowatt-hours.
15. Three-phase input voltage.
16. Three-phase output voltage.
17. Three-phase input current.
18. Three-phase output current.
19. Three-phase input voltage THD.
20. Three-phase input current THD.
21. Output frequency (Hertz).
22. Elapsed operating time (hours).
23. Diagnostic and service parameters.

N. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

O. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
2. Manufacturer has option to incorporate control signal interface into chiller control panel.

P. Passive Harmonic Distortion Filter **(factory furnished remote, field-installed)** to meet IEEE 519 latest standard requirement:

Q. Cooling: Air or refrigerant cooled.

R. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

1. Control Relays: Auxiliary and adjustable time-delay relays.

S. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

~~2.12~~**2.11** CONTROLS

A. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory, so that reprogramming is not required on loss of electrical power.

B. Enclosure: Unit mounted, NEMA 250, Type 1, hinged or lockable, factory wired with a single-point, with field-power connection and a separate control circuit.

C. Factory-installed wiring outside of enclosures shall be in a NFPA 70-approved raceway. Make terminal connections with liquidtight or flexible metallic conduit.

D. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:

1. Date and time.
2. Operating or alarm status.
3. Fault history with not less than last 10 faults displayed.
4. Set points of controllable parameters.
5. Trend data.
6. Operating hours.
7. Number of chiller starts.

8. Outdoor-air temperature or space temperature if required for chilled-water reset.
9. Entering- and leaving-fluid temperatures of evaporator and condenser.
10. Difference in fluid temperatures of evaporator and condenser.
11. Refrigerant pressures in evaporator and condenser.
12. Refrigerant saturation temperature in evaporator and condenser shell.
13. Compressor refrigerant suction and discharge temperature.
14. Compressor bearing temperature.
15. Motor bearing temperature.
16. Motor winding temperature.
17. Phase current.
18. Percentage of motor-rated load amperage.
19. Phase voltage.
20. Demand power (kilowatts).
21. Energy use (kilowatt-hours).
22. Power factor.
23. For chillers equipped with variable-frequency controllers and harmonic filters, include the following:

    a. Output voltage and frequency.
    b. Voltage THD for each phase.
    c. Supply current TDD for each phase.
    d. Inlet vane position.
    e. Controller internal ambient temperature.
    f. Heatsink temperature.

24. Purge suction temperature if purge system is provided.
25. Purge elapsed time if purge system is provided.

E. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator-fluid temperature shall be reset based on [**return-water**] [**outdoor-air**] [**space**] temperature.
3. Current limit and demand limit.
4. Condenser-fluid temperature.
5. External chiller emergency stop.
6. Variable evaporator flow.

F. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

1. Low evaporator pressure or temperature; high condenser pressure.
2. Low evaporator-fluid temperature.
~~3. Low oil differential pressure (if applicable).~~
~~4. High or low oil pressure (if applicable).~~
~~5. High oil temperature (if applicable).~~
~~6.~~**3.** High compressor-discharge temperature.
~~7.~~**4.** Loss of condenser-fluid flow.
~~8.~~**5.** Loss of evaporator-fluid flow.
~~9.~~**6.** Motor overcurrent.
~~10.~~**7.** Motor overvoltage.
~~11.~~**8.** Motor undervoltage.
~~12.~~**9.** Motor phase reversal.
~~13.~~**10.** Motor phase failure.
~~14.~~**11.** Sensor- or detection-circuit fault.
~~15.~~**12.** Processor communication loss.
~~16.~~**13.** Motor controller fault.
~~17.~~**14.** Extended compressor surge.
~~18.~~**15.** Excessive air-leakage detection for chillers using R-1233zde or R-514a refrigerant.

G. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

H. Security Access: Provide electronic security access to controls through identification and password, with at least three levels of access: view only; view and operate; and view, operate, and service.

I. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

J. Communication Port: RS-232 port, USB 2.0 port or higher, or equivalent connection capable of connecting a printer and a notebook computer.

K. DDC System Interface: Factory install hardware and software to enable system to monitor, control, and display chiller status and alarms.

1. Hardwired I/O Points:

a. Monitoring: On-off status, common trouble alarm, electrical power demand (kilowatts), electrical power consumption (kilowatt-hours).
b. Control: On-off operation, chilled-water, discharge temperature set-point adjustment, electrical power demand limit.

2. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the chiller from an operator workstation.

a. Control features and monitoring points displayed locally at chiller control panel shall be available through the control system, including, as a minimum, the following:

1) Start-stop command from remote source.
2) Unit control source, local, analog, digital or modem.
3) Chiller control panel start-stop.
4) Accumulated operating hours.
5) Accumulated starts.
6) Compressor motor status.
7) Unit operation code.
8) Unit safety fault code.
9) Unit cycling fault code.
10) Chilled-water pump status.
11) Chilled-water flow proof.
12) Chilled-water entering temperature.
13) Chilled-water leaving temperature.
14) Chilled-water leaving temperature set-point adjustment from remote source.
15) Condenser(s) water entering temperature.
16) Condenser(s) water leaving temperature.
17) Evaporator refrigerant pressure.
18) Condenser(s) refrigerant pressure.
19) Evaporator refrigerant saturation temperature.
20) Condenser(s) refrigerant saturation temperature.
21) Refrigerant discharge temperature.
22) Refrigerant level.
23) Refrigerant liquid level set point.
24) High-speed thrust bearing proximity position.
25) High-speed thrust bearing proximity reference.
26) Motor current percent of full-load amps.
27) Motor current phase A.
28) Motor current phase B.
29) Motor current phase C.
30) Motor current set-point adjustment from remote source.

31) Motor average winding temperature.
32) Variable-frequency controller selection, auto or fixed.
33) Variable-frequency controller output voltage.
34) Variable-frequency controller input power, rate.
35) Variable-frequency controller input power, consumption.
36) Variable-frequency controller DC bus voltage.
37) Variable-frequency controller inverter link current.
38) Variable-frequency controller output frequency.
39) Variable-frequency controller internal ambient temperature.
40) Variable-frequency controller converter heatsink temperature.
41) Variable-frequency controller harmonic filter installed, true or false.
42) Harmonic Filter THD at maximum voltage, percent.
43) Harmonic filter total demand distortion at maximum current, percent.
44) Harmonic filter total supply kVA.
45) Anti-recycle time remaining.
46) Liquid line solenoid.
47) Pre-rotation vanes position.
48) Adaptive capacity control valve surge map installed, true or false.
49) Adaptive capacity control new surge point, true or false.
50) Adaptive capacity control surge type, pressure differential or current.
51) Adaptive capacity control surge count.
52) Adaptive capacity control PRV position.
53) Adaptive capacity control output frequency.

L. Ride-Through and Rapid-Restore:

1. The chiller shall be able to maintain operation during a momentary power loss event lasting up to 5 seconds when operated at standard AHRI load and lift conditions. The chiller shall be able to ride through this momentary power loss event without shutting down. Chillers not able to maintain operation during momentary power loss events lasting up to 5 seconds shall include a properly sized thermal storage tank to maintain temperature stability in the system.
2. In the event that the power loss is in excess of 5 seconds, the chiller shall automatically restore chiller operation up to 80 percent capacity within 75 seconds after a 30-second power interruption.
3. Quick-start feature shall ensure guide vanes remain open following a power interruption event and quick ramp-up speed logic is employed to facilitate shortest time to deliver chilled water at set-point temperature.
4. Chiller manufacturer shall provide integral UPS unit(s) with chiller controls if required to keep chiller integral controls operational to comply with requirement.
5. Chiller manufacturer shall demonstrate chiller Ride-Through and Rapid-Restore capabilities through simulating power fault, power service return, restart time, and capacity control, to produce desired chilled-water temperature at load indicated.

~~2.13~~**2.12** FINISH

A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

1. Provide at least one coat of primer with a total dry film thickness of at least 1.5 mils.
2. Provide at least two coats of alkyd-modified, vinyl enamel or epoxy finish with a total dry film thickness of at least 3 mils.
3. Paint surfaces that are to be insulated before applying the insulation.
4. Paint installed insulation to match adjacent uninsulated surfaces.
5. Color of finish coat shall be manufacturer's standard.

~~2.14~~**2.13** ACCESSORIES

A. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.
2. Thermal-Dispersion Water Flow Switches: Provide factory-mounted and wired, thermal-dispersion water flow switches on each vessel to prevent unit operation with no or low water flow. Paddle and pressure differential type switches are not acceptable due to high rates of failure and false indications from these types of flow indicators.

B. Vibration Isolation:

1. Chiller manufacturer shall furnish vibration isolation for each chiller.
2. Neoprene Pad:

    a. 0.375-inch- thick, ribbed- or waffle-pattern neoprene pads.
    b. Fabricate pads from 40- to 60-durometer neoprene.
    c. Provide steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

~~2.15~~**2.14** SOURCE QUALITY CONTROL

A. Perform functional run tests of chillers before shipping.

1. Each chiller shall be factory run-tested under load conditions for a minimum of one hour on an AHRI certified test stand with evaporator and condenser waterflow at job conditions (excluding glycol applications). Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Any deviation in performance or operation shall be remedied prior to shipment and the unit retested if necessary to confirm repairs or adjustments. Manufacturer shall supply a certificate of completion of a successful run-test upon request.

B. Factory Performance Testing:

1. Factory performance test chillers, before shipping, according to AHRI 550/590. Tolerances shall be in accordance with specification section 2.1.C.
2. Test the following conditions:

    a. 100% @ 85F entering condenser water temperature.
    b. 75% @ 75F entering condenser water temperature.
    c. 50% @ 65F entering condenser water temperature.
    d. 25% @ 65F entering condenser water temperature.

3. Allow Owner access to place where chillers are being tested. Notify Owner in writing at least 30 days in advance of testing.
4. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory Sound Testing:

1. For chillers located indoors, rate sound power level according to AHRI 575.
2. Factory sound test chillers, before shipping, according to AHRI 575.
3. Test the same conditions as 2.15.B.
4. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

D. Factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test fluid side of heat exchangers, including water boxes, to 1.3 times the rated pressure. Pressure proof test refrigerant side of heat exchangers to a minimum of 45 psig. Vacuum and pressure test for leaks.

E. Owner Travel Expenses:

1. Include cost associated with Owner travel expenses to witness factory testing. Total value attributed to travel expenses shall be clearly indicated.
2. Expenses shall include roundtrip coach airfare, out-of-town hotel accommodations, out-of-town meals (breakfast, lunch, dinner), out-of-town ground transportation, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for two Owner representatives with origin of Hartford, Connecticut.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, control and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

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

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

3.2 CHILLER INSTALLATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

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

~~C. Install chillers on support structure indicated.~~

~~D.~~**C.** Equipment Mounting:

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

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

~~F.~~**E.** Maintain clearances required by governing code.

~~G.~~**F.** Chiller manufacturer's factory-trained service personnel shall charge chiller with refrigerant and fill with oil if not factory installed.

~~H.~~**G.** Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," and Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to chillers, allow space for service and maintenance.

C. Evaporator-Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve.
3. Make connections to chiller with a flange or mechanical coupling.

D. Condenser-Fluid Connections:

1. Connect to condenser inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve.
3. Make connections to chiller with a flange or mechanical coupling.

E. Refrigerant-Pressure Relief Device Connections:

1. For chillers installed indoors, extend separate vent piping for each chiller to the outdoors without valves or restrictions.
2. Comply with ASHRAE 15-2013.
3. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

F. For chillers equipped with a purge system, extend separate purge vent piping for each chiller to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.

G. Connect each chiller drain connection with a drain valve, which is full size of drain connection. Connect drain pipe to drain valve with union, and extend drain pipe to terminate over floor drain.

H. Connect each chiller water box vent connection with an automatic or manual vent, which is full size of vent connection.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC control system for remote monitoring and control of chillers. Comply with requirements in Section 230900 "Instrumentation and Control for HVAC".

D. Install nameplate on face of chiller control panel indicating the control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 0.5 inches high.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant relief piping, and safety devices from test pressure if they are not rated above the test pressure.
3. Test piping of each system at not less than 225 psig.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, piping, controls and electrical connections for proper assembly, installation, and connection.

C. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

D. Prepare test and inspection startup reports.

3.8 WARRANTY PERIOD TESTING

A. Within one month of warranty period expiration, perform testing, analysis, and reporting indicated for each chiller.

~~B. Oil Analysis (if applicable):~~

~~1. Take oil sample and solicit services of a third-party testing agency, specializing in such analysis, to perform oil analysis.~~
~~2. Submit analysis results and recommendations to Owner.~~

~~C.~~**B.** Refrigerant Analysis:

1. Take refrigerant sample and solicit services of a third-party testing agency, specializing in such analysis, to perform refrigerant analysis.
2. Submit analysis results and recommendations to Owner.

~~D.~~**C.** Site Access and Scheduling:

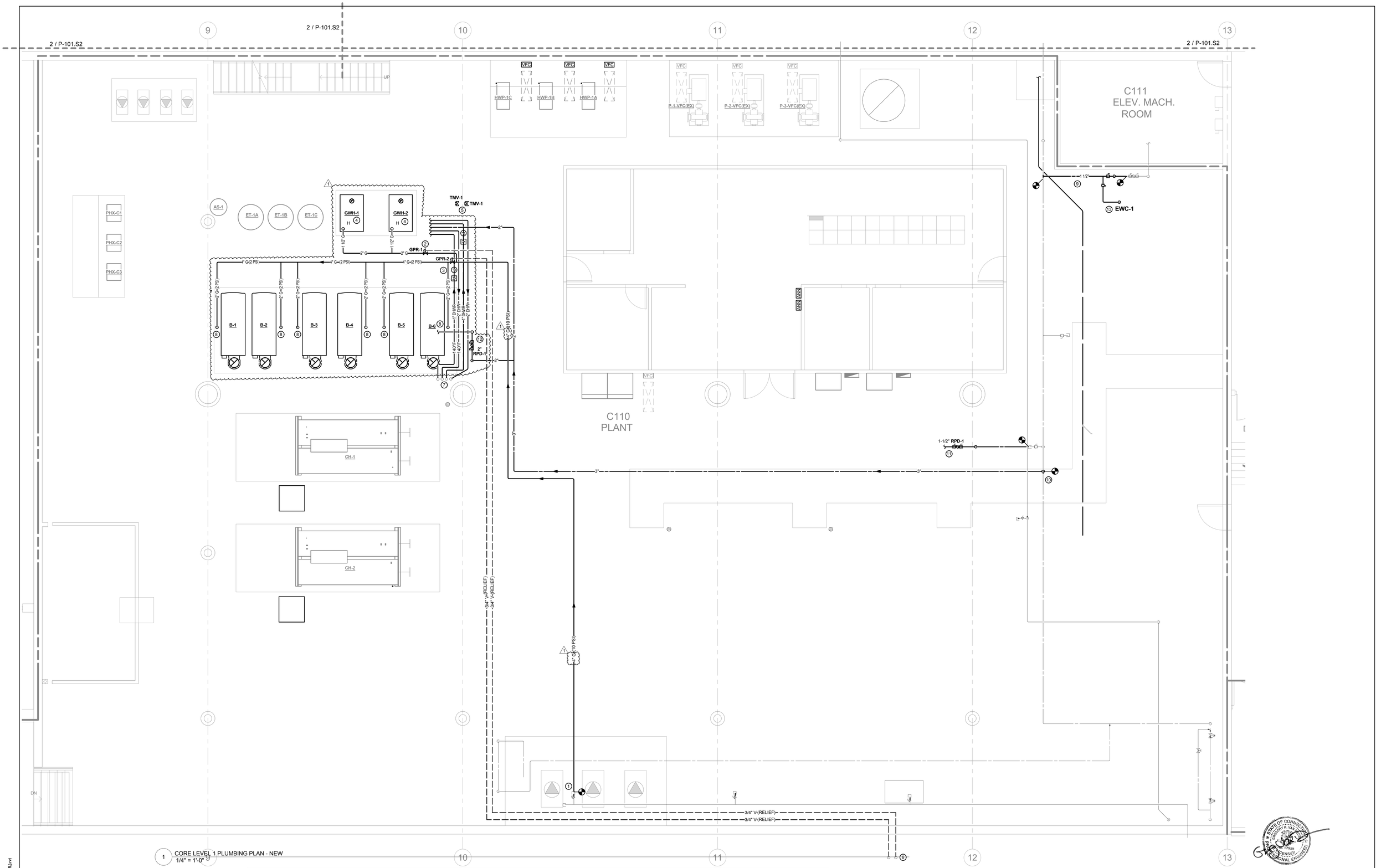
1. Contact Owner to schedule testing at least 30 days in advance of testing.
2. Make mutually agreeable schedule adjustments to accommodate Owner's request for testing.
3. Review, with Owner, requirements for visitors in advance of testing.
4. Comply with Owner requirements for visitors while on-site.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions and provide electronic copy to Owner. Refer to Division 01 for additional requirements.

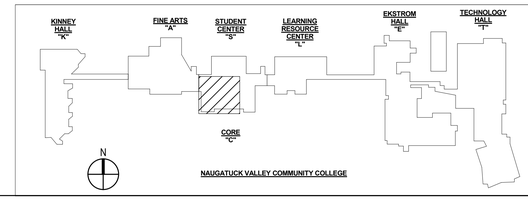
1. Instructor shall be factory trained and certified.
2. Provide not less than twelve hours of training over a two day period.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION 236416



PLUMBING DRAWING NOTES

1. PROVIDE 1" GAS (10 PSI) CONNECTION FROM EXISTING PIPING.
2. GAS PRESSURE REGULATOR FOR WATER HEATERS. SET AT 14" W.C. OUTLET PRESSURE. PROVIDE 3/4" VENT THROUGH WALL. TERMINATE WITH INSECT SCREEN.
3. GAS PRESSURE REGULATOR FOR BOILERS. SET AT 2 PSI OUTLET PRESSURE. PROVIDE 3/4" VENT THROUGH WALL. TERMINATE WITH INSECT SCREEN.
4. GAS FIRED WATER HEATERS. PROVIDE 2" H&CW, 1 1/2" GAS CONNECTIONS. SEE DETAIL FOR PIPING INFORMATION.
5. MASTER THERMOSTATIC MIXING VALVE. SEE DETAIL FOR PIPING INFORMATION.
6. (2) 1-1/2" GAS RELIEF VENT UP THRU WALL. EXTEND PIPING THRU WALL AND TERMINATE WITH INSECT SCREEN.
7. 2"HW (140°F), 1"HWR (140°F), 1-1/2"HW, 3/4"HWR UP.
8. 2" GAS (2 PSI) DROP TO BOILERS SEE DETAIL FOR ADDITIONAL INFORMATION.
9. PROVIDE 1-1/4"CW CONNECTION TO EXISTING RPZ BACKFLOW FROM EXISTING CW SUPPLY. PIPE RELIEF TO NEAREST F.D. THRU AIR GAP.
10. PROVIDE 3"CW CONNECTION FROM EXISTING.
11. PROVIDE 1-1/2"CW CONNECTION TO HVAC BLOWDOWN EQUIPMENT THRU RPZ BACKFLOW. PIPE RELIEF TO F.D. THRU AIR GAP. (MOUNT ASSEMBLY ON STEEL CHANNEL FRAMING)
12. PROVIDE 2"CW CONNECTION TO HVAC EQUIPMENT THRU 2" RPZ BACKFLOW ASSEMBLY (MOUNTED ON STEEL CHANNEL FRAMING)
13. PROVIDE ELECTRIC WATER COOLER. EXTEND 1/2"CW CONNECTION TO EWC-1 FROM CW MAIN. PROVIDE 1-1/2"W CONNECTION FROM EXISTING WASTE STUB.



drawing title: CORE LEVEL 1 PLUMBING PLAN - NEW

REVISIONS

mark	date	description
1	08/08/2018	ADDENDUM # 02

STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES

drawing prepared by
BVH INTEGRATED SERVICES
206 WEST NEWBERRY ROAD
BLOOMFIELD CT, 06002

date: 03/23/2018
scale: 1/4" = 1'-0"
drawn by: JJM
approved by: JBA
drawing no.: P-101.C2

project
RENOVATIONS TO PHYSICAL PLANT
Naugatuck Valley Community College
750 Chase Parkway, Waterbury, CT 06708

CAD no.: 21-16-043
project no.: BI-CTC-500

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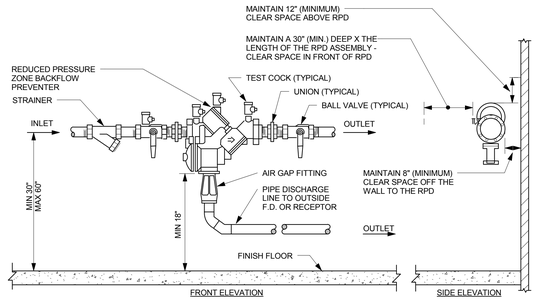
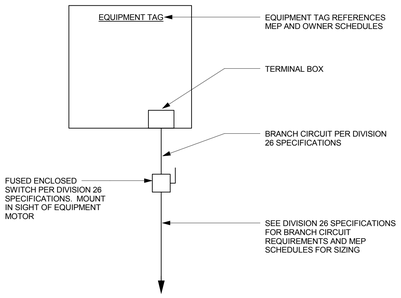


NOTE:
ALL ASSEMBLIES SHALL BE ADEQUATELY SUPPORTED AND/OR RESTRAINED TO PREVENT LATERAL MOVEMENT. PIPE HANGERS, BRACES, SADDLES, STANCHIONS, PIERS, ETC., SHOULD BE USED TO SUPPORT THE DEVICE AND SHOULD BE PLACED IN A MANNER THAT WILL NOT OBSTRUCT THE FUNCTION OF OR ACCESS TO THE RELIEFT VALVE, TEST PORTS OR VALVES.

NOTES:

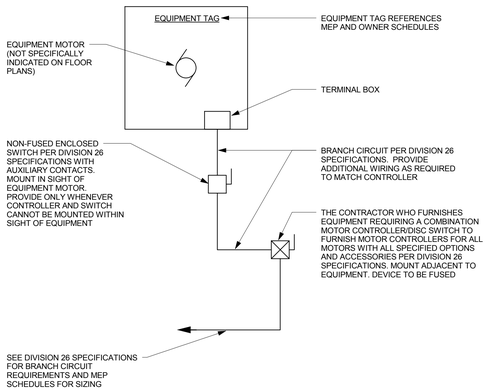
1. REFER TO DRAWINGS FOR UNIT SIZE(S).
2. THE RPD MOUNTING HEIGHT AND CLEARANCES INDICATED ABOVE SHALL BE MAINTAINED FOR PROPER ACCESS TO UNIT FOR MAINTENANCE, TESTING AND INSPECTION PURPOSES.
3. THE LOCATION AND MOUNTING HEIGHT OF THE RPD SHALL BE APPROVED BY THE WATER COMPANY PRIOR TO INSTALLATION.
4. ACCESS TO THIS UNIT SHALL NOT REQUIRE THE USE OF A LADDER OR REMOVAL OF CEILING TILES OR OTHER PERMANENT OR SEMI-PERMANENT CONSTRUCTION.
5. DO NOT INSTALL UNIT ABOVE A CEILING.
6. THE AREA WHERE THE RPD IS TO BE INSTALLED SHALL BE WELL LIT, PROVIDED WITH ADEQUATE DRAINAGE AND SHALL NOT BE SUBJECT TO FLOODING.

TYPICAL REDUCED PRESSURE ZONE BACKFLOW PREVENTER INSTALLATION DETAIL
NOT TO SCALE



NOTE:
THIS DETAIL IS FOR ALL EQUIPMENT WHERE EQUIPMENT REQUIRES POWER AND WHERE THERE ARE NO MOTORS INVOLVED OR WHERE SPECIFICATIONS OR SCHEDULES FOR MULTIPLE MOTOR EQUIPMENT SPECIFICALLY INDICATE ONE POINT POWER CONNECTION. CONTRACTOR TO PROVIDE WIRING BETWEEN REMOTE DISCONNECTS, STARTERS AND MOTORS. SEE EQUIPMENT SCHEDULES AND SPECIFICATIONS.

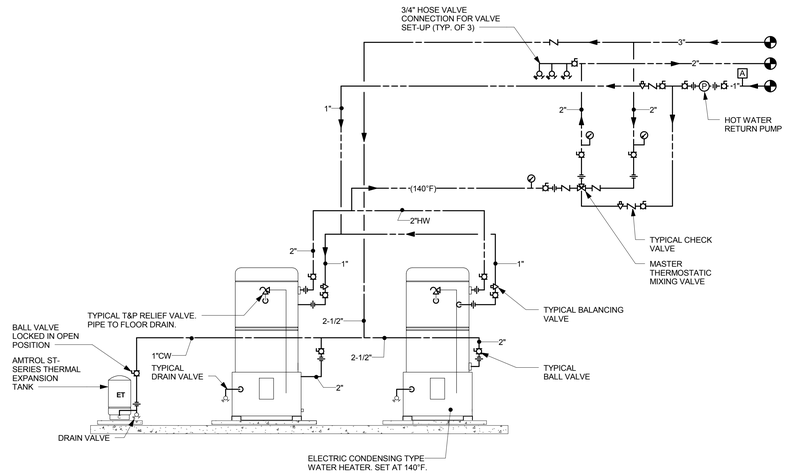
TYPICAL EQUIPMENT CONNECTION DETAIL
NOT TO SCALE



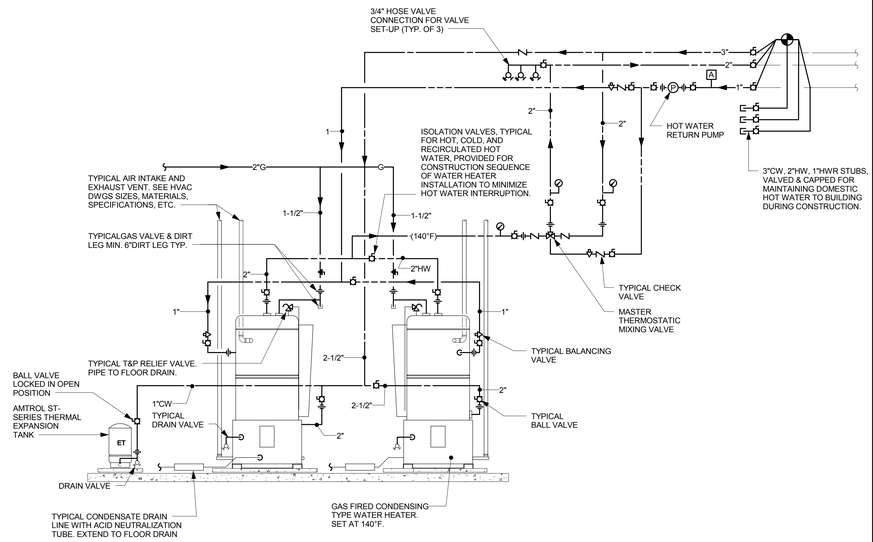
NOTE:

THIS DETAIL IS FOR ALL EQUIPMENT MOTORS. CONTRACTOR TO PROVIDE WIRING BETWEEN REMOTE COMBINATION MOTOR CONTROLLER/ DISC SWITCH AND MOTORS. SEE EQUIPMENT SCHEDULES AND SPECIFICATIONS. IF NOT NOTED OTHERWISE IN EQUIPMENT SCHEDULES, CONTRACTOR SHALL PROVIDE A COMBINATION MOTER CONTROLLER/DISC. SWITCH.

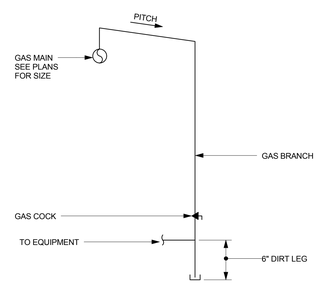
TYPICAL COMBINATION MOTOR CONTROLLER/DISC SWITCH DETAIL
NOT TO SCALE



ELECTRIC DOMESTIC WATER HEATER PIPING DETAIL
NOT TO SCALE



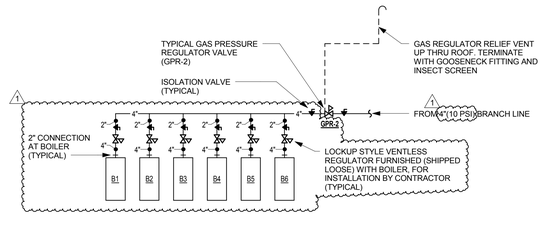
TECH HALL BUILDING - GAS-FIRED CONDENSING -TYPE STORAGE DOMESTIC WATER HEATER PIPING DETAIL
NOT TO SCALE



TYPICAL GAS DROP DETAIL
NOT TO SCALE

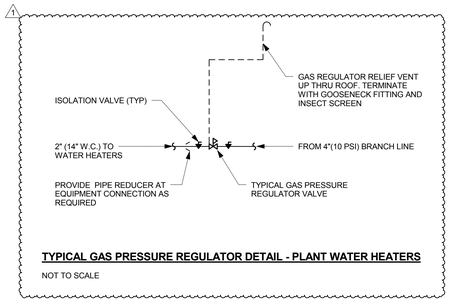
NOTE:
THIS DETAIL IS FOR ALL EQUIPMENT MOTORS. CONTRACTOR TO PROVIDE WIRING BETWEEN REMOTE DISCONNECTS, STARTERS AND MOTORS. SEE EQUIPMENT SCHEDULES AND SPECIFICATIONS. IF NOT NOTED OTHERWISE IN EQUIPMENT SCHEDULES, CONTRACTOR SHALL PROVIDE A COMBINATION MOTOR CONTROLLER/DISC. SWITCH.

TYPICAL MOTOR, SWITCH AND CONTROLLER DETAIL
NOT TO SCALE

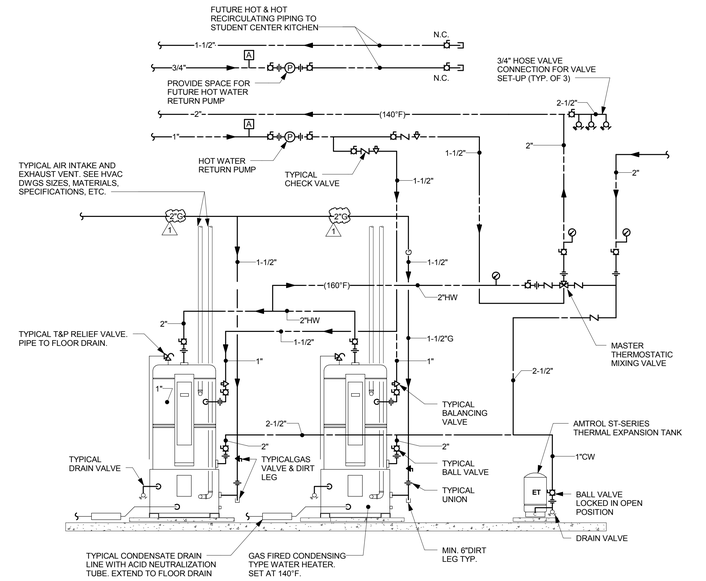


TYPICAL GAS PRESSURE REGULATOR DETAIL - BOILERS
NOT TO SCALE

TYPICAL GAS PRESSURE REGULATOR DETAIL - TECH HALL WATER HEATERS
NOT TO SCALE



TYPICAL GAS PRESSURE REGULATOR DETAIL - PLANT WATER HEATERS
NOT TO SCALE



STUDENT CENTER (LOCATED IN PHYSICAL PLANT) GAS-FIRED CONDENSING -TYPE STORAGE DOMESTIC WATER HEATER PIPING DETAIL
NOT TO SCALE

drawing title: PLUMBING DETAILS

REVISIONS

mark	date	description
1	08/08/2018	ADDENDUM # 02

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DEPARTMENT OF ADMINISTRATIVE SERVICES

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project no.	BI-CTC-500

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GENERAL NOTES	SCHEDULE NOTES
1. MANUFACTURER MODEL BASED UPON, UNLESS NOTED OTHERWISE: TITUS 2. ALL DRG ARE STEEL UNLESS NOTED OTHERWISE. 3. PROVIDE FRAME/MOUNTING TYPE SUITABLE FOR CEILING/WALL CONSTRUCTION REFLECTED CEILING PLANS AND GENERAL SERIES DRAWINGS. 4. PROVIDE CUSTOM COLOR AND FINISH PER DIRECTION OF ARCHITECT. 5. WHERE TYPE "B" DIFFUSERS ARE WALL MOUNTED, GRILLE TO BE RECTANGULAR PER DIRECTION OF ENGINEER AND EQUIVALENT NECK SIZE AREA TO SQUARE PER SIZING TABLE, UNLESS SIZE NOTED ON PLANS.	[1] NOT USED.

GRILLE AND DIFFUSER SCHEDULE

TYPE	MODEL	DESCRIPTION:
B	350RL	LOUVER TYPE CEILING/WALL RETURN OR EXHAUST GRILLE, 35° DEGREE FIXED DEFLECTION, 3/4" SPACING WITH BLADES PARALLEL TO THE LONG DIMENSION.
E	300 FS	WALL SUPPLY GRILLE, DOUBLE DEFLECTION WITH ADJUSTABLE VERTICAL FRONT BLADES, 3/4 BLADE SPACING

GRILLE AND DIFFUSER SCHEDULE

CEILING SUPPLY DIFFUSER			DUCTED CEILING RETURN/EXHAUST GRILLE		NON-DUCTED CEILING RETURN/EXHAUST GRILLE		FLEXIBLE DUCT SIZES TO SUPPLY DIFFUSERS	
CFM	SQUARE NECK SIZE	ROUND NECK SIZE	CFM	NECK SIZE	CFM	NECK SIZE	CFM	SIZE
0-100	6 x 6	6"Ø	0-350	12 x 12	0-350	12 x 12	0-100	6"Ø
101-250	9 x 9	8"Ø	351-1000	22 x 22	351-1200	22 x 22	101-250	8"Ø
251-400	12 x 12	10"Ø					251-400	10"Ø
401-600	15 x 15	12"Ø					401-600	12"Ø
601-800	18 x 18	14"Ø					601-800	14"Ø

FAN SCHEDULE

GENERAL NOTES	SCHEDULE NOTES
1. BASIS OF DESIGN MANUFACTURER UNLESS INDICATED OTHERWISE: COOK 2. MOTORS TO BE 1725 RPM.	[1] EXHAUST FAN CONTROL TYPE REFERENCED. SEE HVAC CONTROL DRAWINGS. [2] IN-LINE MIXED FLOW TYPE, EXTENDED LUBE LINES [3] WALL MOUNTED PROPELLER TYPE WITH WALL SLEEVE, SCREENED INLET, ALUMINUM PROPELLER, CORROSION COATED.

TAG ID	APPLICATION	MODEL NUMBER	TYPE	DRIVE	CFM	ESP (IN WC)	FAN RPM	BHP	HP	VOLTAGE	PHASE	VFC	UNIT CONTROL
EF-CP1	CHILLER/REFRIGERANT LEAK	270QMXD08	[2]	DIRECT	10000 CFM	0.75			3	480 V	3	YES	[1]
EF-CP2	ELECT RM EXHAUST	24EW414D17	[3]	DIRECT	4000 CFM	0.50	1528	0.7	1 1/2	480 V	3	YES	[1]

CONDENSING BOILER SCHEDULE

GENERAL NOTES	SCHEDULE NOTES
1. BASIS OF DESIGN MANUFACTURER: AERCO BENCHMARK PLATINUM. 2. PROVIDE INDIVIDUAL BOILER CONDENSATE NEUTRALIZATION KIT AND TRAP CAPABLE OF TREATING CONDENSATE FROM EACH BOILER AT FULL OUTPUT. 3. PROVIDE INDIVIDUAL GAS REGULATOR FOR EACH BOILER SIZE FOR 2 PSI INLET TO INDICATED GAS PRESSURE PER MANUFACTURER RECOMMENDATIONS.	[1] BASIS OF DESIGN LISTED MANUFACTURER [2] OTHER LISTED MANUFACTURER COMPARABLE PRODUCT SELECTION/PERFORMANCE FOR EACH BASIS OF DESIGN UNIT [3] DESIGN OPERATING FLOWS [4] AT DESIGN MAX OPERATING FLOW [5] PROVIDE LARGER CONCRETE PAD SIZE TO ACCOMODATE MANUFACTURER REQUIRMENT FOR MIN 24" CLEARANCE ON BOTH SIDES OF EACH BOILER. DIFFERENT THAN BOD MANUFACTURER REQUIRMENTS. [6] PROVIDE ADDITIONAL SPECIAL VENT OFFSETS TO ACCOMODATE MANUFACTURER REQUIRMENT FOR MIN 24" CLEARANCE ON BOTH SIDES OF EACH BOILER. DIFFERENT THAN BOD MANUFACTURER REQUIRMENTS. [7] PROVIDE LARGER COMBUSTION AIR DUCT SIZE AS INDICATED DIFFERENT THAN BOD MANUFACTURER REQUIRMENTS. [8] PROVIDE LARGER SPECIAL VENT SIZE AS INDICATED DIFFERENT THAN BOD MANUFACTURER REQURIMENTS.

TAG ID	MODEL	NATURAL GAS MBH INPUT	MBH OUTPUT (@120° F EWT)	GAS PRESSURE MIN	GAS PRESSURE MAX	BOILER DESIGN PRESSURE (PSIG)	RELIEF VALVE SETTING (PSIG)	REMARKS
B-1	BMK6000	6000	5670	14"	2 PSI	150	75	[1]
B-2	BMK6000	6000	5670	14"	2 PSI	150	75	[1]
B-3	BMK6000	6000	5670	14"	2 PSI	150	75	[1]
B-4	BMK6000	6000	5670	14"	2 PSI	150	75	[1]
B-5	BMK6000	6000	5670	14"	2 PSI	150	75	[1]
B-6	BMK6000	6000	5670	14"	2 PSI	150	75	[1]
B-(CLEAVER BROOKS CLEARFIRE)	CFLC-6000	6000	5280	28"	2 PSI	150	75	[2] [5] [6] [7] [8]
B-(LOCHINVAR CREST)	FB6000	6000	5520	4"	14"	150	75	[2] [5] [6] [7]

WC	MIN/MAX GPM [3]	EWT (°F)	LWT (°F)	MAX FT WPD [4]	COMB AIR (IN)	FLUE SIZE (IN)	POWER SUPPLY AMP	PHASE	VOLTAGE
B-1	75/600	160	180	12.0	14	14"	20	3	460 V
B-2	75/600	160	180	12.0	14	14"	20	3	460 V
B-3	75/600	160	180	12.0	14	14"	20	3	460 V
B-4	75/600	160	180	12.0	14	14"	20	3	460 V
B-5	75/600	160	180	12.0	14	14"	20	3	460 V
B-6	75/600	160	180	12.0	14	14"	20	3	460 V
B-(CLEAVER BROOKS CLEARFIRE)	140/600	160	180	12.0	16" [7]	16" [8]	20	3	460 V
B-(LOCHINVAR CREST)	144/600	160	180	12.0	16" [7]	14"	20	3	460 V

WATER COOLED CHILLER SCHEDULE

GENERAL NOTES	SCHEDULE NOTES
1. BASIS OF DESIGN MANUFACTURER: DAIKIN APPLIED 2. PROVIDE QUICK SHIP/EXPEDITED DELIVERY TO MEET OWNERS SCHEDULE. SEE DIV 1. 3. UNIT TO BE RIGGED THROUGH EXISTING OVERHEAD DOOR/PATHWAY COORDINATE ASSEMBLY/DISASSEMBLY OF COMPONENTS TO FIT THROUGHT DOOR AND INTO ROOM. PROVIDE MANUFACTURER SUPERVISION OF DISASSEMBLY/ASSEMBLY. 4. PERFORMANCE INDICATED IS NPLV DESIGN OPERATINGCONDITION (UNLESS NOTED OTHERWISE) AT 42/52 CHW, 85/95 CW WITH AHRI CONDENSER RELIEF. 5. PROVIDE A REMOTE HARMONIC FILTER WITH EACH CHILLER, FIELD INSTALLED AND WIRED. SEE DETAIL DWG. H-700. 6. ELECTRIC CENTRIFUGAL, VARIABLE SPEED, OIL-FREE TECHNOLOGY	[1] BASIS OF DESIGN LISTED MANUFACTURER [2] OTHER LISTED MANUFACTURER COMPARABLE PRODUCT SELECTION / PERFORMANCE FOR EACH BASIS OF DESIGN UNIT [3] AT AHRI 550/590 WITH AHRI CONDENSER RELIEF CONDITIONS, 44/54 CHW, 85 ENT CW, 3 GPM/TON [4] DESIGN GPM/ MIN GPM

TAG ID	MODEL	COMPRESSOR TYPE	TONS	REFRIG. TYPE	FULL LOAD (KW/TON)	IPLV (KW/TON) [3]	OPERATING WEIGHT (LBS)	MCA	REMARKS
CH-1	WME-0701S	OIL-FREE	750	R-134A	0.557	0.3094	21,800	771	[1]
CH-2	WME-0701S	OIL-FREE	750	R-134A	0.586	0.3094	21,800	771	[1]
CH-(YORK)	YMC2-S2638A	OIL-FREE	750	R-134A	0.568	0.3057	32,735	737	[2]
CH-CARRIER)	19DV-G44G44	OIL-FREE CENTRIFUGAL	750	R-1233zd	0.555	0.3019	39,200	670	[2]

	EVAPORATOR						CONDENSER					
TAG ID	ETW (ºF)	LWT (ºF)	GPM @10°ΔT [4]	WPD (FT)	PASSES	FOULING FACTOR	EWT (°F)	LWT (°F)	GPM	WPD (FT)	PASSES	FOULING FACTOR
CH-1	52	42	1800/496	19.2	2	0.0001	85	94.44	2250	7.0	2	0.00025
CH-2	52	42	1800/496	19.2	2	0.0001	85	94.44	2250	7.0	2	0.00025
CH-(YORK)	52	42	1800/836	24.0	2	0.0001	85	94.3	2250	25.4	2	0.00025
CH-CARRIER)	52	42	1793/855	27.3	3	0.0001	85	94.3	2268	10.7	2	0.00025

HYDRONIC PUMP

GENERAL NOTES	SCHEDULE NOTES
1. BASIS OF DESIGN MANUFACTURER BELL AND GOSSETT ; DIVISION OF XYLEM INC. 2. ALL PUMPS SELECTED AT 1750 RPM UNLESS OTHERWISE NOTED. 3. PROVIDE MAXIMUM IMPELLER DIAMETER NON-OVERLOADING PERFORMANCE FOR SPECIFIED HORSEPOWER.	[1]. VERTICAL SPLIT COUPLED IN-LINE. [2]. PUMP PERFORMANCE CAPACITY BASED ON 2 PUMPS RUN IN PARALLEL, 1 STANDBY, PUMP SHALL ALSO BE ABLE TO OPERATE ON CURVE IN A 1 RUN CONDITION. SUBMIT CURVES FOR BOTH CONDITIONS. [3]. EACH PUMP AT DUTY POINT WHEN 2 PUMPS OPERATION [4]. MOTOR SPEED / RPM @ DUTY POINT [5] DUTY POINT PUMP EFFICIENCY BASE MOUNTED END SUCTION

TAG ID	SERVES	TYPE	MODEL/SIZE	GPM	FT OF HEAD	EFF [5]	MOTOR RPM [4]	MOTOR BHP [3]	MOTOR HP	MOTOR VOLTAGE	MOTOR PHASE	VFC	REMARKS
HWP-1A	CENTRAL HW	[1]	E-1510-6G	1500	145	84.2%	1800/1770	65.9	100	460 V	3	YES	[2]
HWP-1B	CENTRAL HW	[1]	E-1510-6G	1500	145	84.2%	1800/1770	65.9	100	460 V	3	YES	[2]
HWP-1C	CENTRAL HW	[1]	E-1510-6G	1500	145	84.2%	1800/1770	65.9	100	460 V	3	YES	[2]

PLATE HEAT EXCHANGER SCHEDULE

GENERAL NOTES	SCHEDULE NOTES
1. BASIS OF DESIGN MANUFACTURER: SWEP INTERNATIONAL. 2. ALL PLATE HEAT EXCHANGERS TO BE AHRI RATED (FOR NON-GLYCOL APPLICATIONS ONLY), UNLESS NOTED OTHERWISE. 3. UNIT TO BE COUNTERFLOW DESIGN CONFIGURATION. 4. UNIT TO BE BRAZED PLATE TYPE. 5. UNIT WORKING PRESSURE RATING: 150 PSIG. 6. SIZING / CAPACITY BASED ON 0.000 FOULING FACTOR	[1]. HOT WATER TO 30% GLYCOL HOT WATER (NON AHRI RATED). [2]. SUPPLEMENTAL BID #3. [3]. EXISTING CLEARANCE CONDITIONS ARE LIMITED, ALTERNATIVE MANUFACTURER DIMENSIONS SHOULD BE SIMILAR, CONTRACTOR RESPONSIBLE FOR ANY DIFFERENCES.

TAG ID	SERVES	MODEL	MBH	NO OF PLATES	SIZE (LxWxH) [3]	REMARKS
PHX-A1	FINE ARTS	AB	2440		24"x17"x48.5"	RUN
PHX-A2	FINE ARTS	AB	2440		24"x17"x48.5"	STANDBY [2]
PHX-C1	CENTRAL PLANT	AB	3750		24"x20"x48.5"	RUN
PHX-C2	CENTRAL PLANT	AB	3750		24"x20"x48.5"	RUN
PHX-C3	CENTRAL PLANT	AB	3750		24"x20"x48.5"	STANDBY [2]
PHX-E1	EKSTROM HALL	AB	6500		24"x40"x48.5"	RUN
PHX-E2	EKSTROM HALL	AB	6500		24"x40"x48.5"	STANDBY [2]
PHX-K1	KINNEY HALL	B	5000		24"x40"x48.5"	RUN [1]
PHX-K2	KINNEY HALL	B	5000		24"x40"x48.5"	STANDBY [1] [2]
PHX-L1	LEARNING RESOURCE	AB	1600		24"x12"x48.5"	RUN
PHX-L2	LEARNING RESOURCE	AB	1600		24"x12"x48.5"	STANDBY [2]
PHX-S1	STUDENT CENTER	AB	2400		24"x17"x48.5"	RUN
PHX-S2	STUDENT CENTER	AB	2400		24"x17"x48.5"	STANDBY [2]
PHX-T1	TECH HALL	AB	5400		24"x36"x48.5"	RUN
PHX-T2	TECH HALL	AB	5400		24"x36"x48.5"	STANDBY [2]

	HOT SIDE					COLD SIDE				
TAG ID	GPM	EWT (°F)	LWT (°F)	MAX WPD (FT)	PIPE RUNOUT SIZE (IN)	GPM	EWT (°F)	LWT (°F)	MAX WPD (FT)	PIPE RUNOUT SIZE (IN)
PHX-A1	244	180	160	16.7		244	158	178	16.7	
PHX-A2	244	180	160	16.7		244	158	178	16.7	
PHX-C1	375	180	160	16.7		375	158	178	16.7	
PHX-C2	375	180	160	16.7		375	158	178	16.7	
PHX-C3	375	180	160	16.7		375	158	178	16.7	
PHX-E1	650	180	160	16.7		650	158	178	16.7	
PHX-E2	650	180	160	16.7		650	158	178	16.7	
PHX-K1	500	180	160	16.2		500	158	178	16.2	
PHX-K2	500	180	160	16.2		500	158	178	16.2	
PHX-L1	160	180	160	16.7		160	158	178	16.7	
PHX-L2	160	180	160	16.7		160	158	178	16.7	
PHX-S1	240	180	160	16.7		240	158	178	16.7	
PHX-S2	240	180	160	16.7		240	158	178	16.7	
PHX-T1	540	180	160	16.7		540	158	178	16.7	
PHX-T2	540	180	160	16.7		540	158	178	16.7	

EXPANSION TANK SCHEDULE

GENERAL NOTES	DRAWING NOTES
1. BASIS OF DESIGN MANUFACTURER: BELL AND GOSSETT	[1] NOT USED

TAG ID	SYSTEM	TYPE	MODEL	ACCEPTANCE VOLUME	VOLUME	REMARKS
ET-1A	CENTRAL HW	BLADDER	B-1600	422	422	
ET-1B	CENTRAL HW	BLADDER	B-1600	422	422	
ET-1C	CENTRAL HW	BLADDER	B-1600	422	422	

AIR SEPARATOR SCHEDULE

GENERAL NOTES	SCHEDULE NOTES
1. BASIS OF DESIGN MANUFACTURER: BELL AND GOSSETT; DIVISION OF XYLEM INC. 2. MINIMUM 85% AIR ELIMINATION EFFICIENCY. 3. MAXIMUM 2 FT. PRESSURE DROP. 4. SUBMIT AIR ELIMINATION EFFICIENCY AND PRESSURE DROP FOR DESIGN LOW RATE. 5. FURNISH MODEL WITHOUT STRAINER.	[1] NOT USED

TAG ID	SERVES	MODEL	MAXIMUM FLOW RATE (GPM)	REMARKS
AS-1	CENTRAL HW	RL-12	2800	

STATE OF CONNECTICUT · GREGORY H. VAN DEUSEN · No. 17928 · LICENSED · PROFESSIONAL ENGINEER

drawing title	STATE OF CONNECTICUT
HVAC SCHEDULES	DEPARTMENT OF ADMINISTRATIVE SERVICES

REVISIONS

mark	date	description
1	08/08/2018	ADDENDUM # 02

drawing prepared by: BVH INTEGRATED SERVICES, 206 WEST NEWBERRY ROAD, BLOOMFIELD CT, 06002

date: 03/23/2018

scale:

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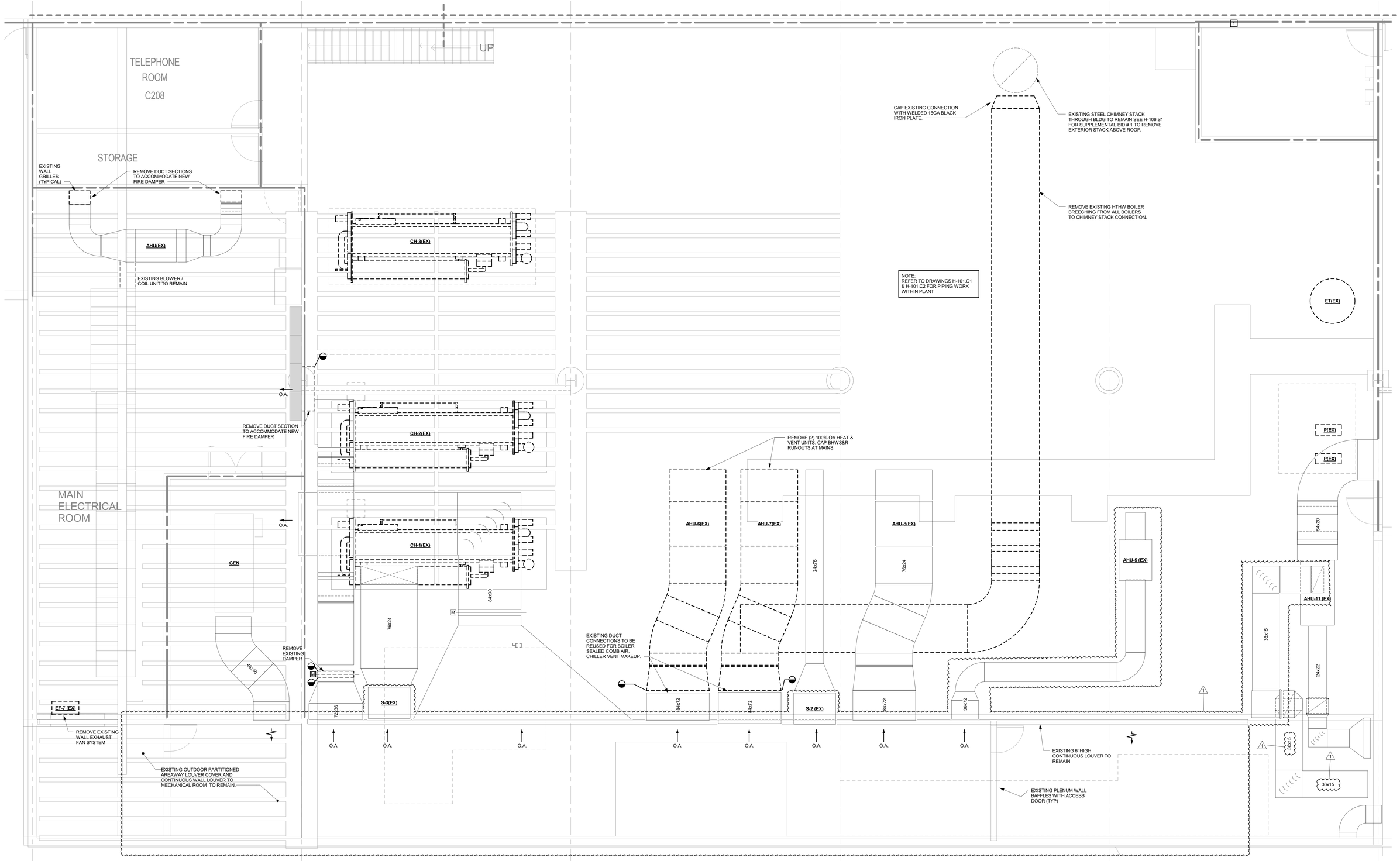


1 CORE LEVEL 2 HVAC PLAN - DEMOLITION
1/4" = 1'-0"

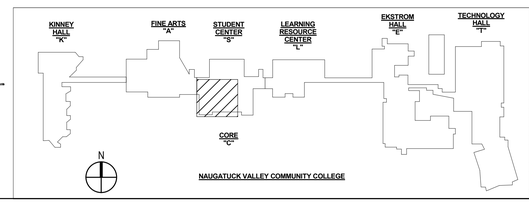
HVAC GENERAL DEMOLITION NOTES

1. REFER TO H-010 FOR PROJECT HVAC GENERAL DEMOLITION NOTES.
2. REFER TO RISER AND FLOW DIAGRAM DRAWINGS FOR ADDITIONAL INFORMATION.

DEMOLITION DRAWING NOTES

(NOTE: TYPICAL NOTES. NOT ALL NOTES APPLIED TO EACH DRAWING)

1. REMOVE EXISTING HIGH TEMPERATURE HOT WATER PIPING SYSTEM.
2. REMOVE EXISTING HIGH TEMPERATURE HOT WATER TO HOT WATER HEAT EXCHANGER SYSTEM.
3. REMOVE EXISTING PUMP SYSTEM.
4. REMOVE EXISTING SPECIALTIES SYSTEM.
5. REMOVE EXISTING ATC SYSTEM.
6. REMOVE EXISTING BUILDING HOT WATER PIPING SYSTEM.
7. TO EXISTING BUILDING HOT WATER SUPPLY AND RETURN DISTRIBUTION.
8. REMOVE EXISTING CONCRETE PAD. SEE GENERAL AND STRUCTURAL DRAWINGS FOR ADDITIONAL INFORMATION AND DETAIL.



drawing title: CORE LEVEL 2 HVAC PLAN - DEMOLITION

REVISIONS

mark	date	description
1	08/08/2018	ADDENDUM # 02

STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES

drawing prepared by
BVH INTEGRATED SERVICES
206 WEST NEWBERRY ROAD
BLOOMFIELD CT, 06002

project
RENOVATIONS TO PHYSICAL PLANT
Naugatuck Valley Community College
750 Chase Parkway, Waterbury, CT 06708

CAD no. 21-16-043
project no. BI-CTC-500

date 03/23/2018
scale 1/4" = 1'-0"
drawn by KLB
approved by JBA
drawing no. H-102.C1

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8 9 10 11 12 13

TELEPHONE ROOM C208

STORAGE

AHU(EX)

GEN

S-3(EX)

S-2 (EX)

AHU-8(EX)

AHU-5 (EX)

AHU-11 (EX)

AS-1

ET-1A ET-1B ET-1C

GWH-1 GWH-2

B-1 B-2 B-3 B-4 B-5 B-6

CH-1 CH-2

EF-CP1 EF-CP2 EF-CP2-VFC

BOILER LAYOUT BASED ON AERCO THAT ALLOWS REDUCED CLEARANCE BETWEEN (2) BOILERS. PROVIDE INCREASED PAD SIZE AND ADDITIONAL SPECIAL VENT OFFSETS TO STACK LOCATIONS WHEN PROVIDING BOILERS FROM LISTED COMPARABLE MANUFACTURERS LOCHINVAR AND CLEAVER BROOKS. CONTRACTOR TO PROVIDE ALL COORDINATION

10"Ø SEALED COMBUSTION AIR OA DUCT TO EACH WATER HEATER

SEALED COMBUSTION AIR DUCT DN TO EACH BOILER

6" WATER HEATER SPECIAL VENT UP (TYP)

BOILER SPECIAL VENT UP (TYP), SIZED PER MANUFACTURER REQUIRMENTS FOR BOILER SUPPLIED, SEE BOILER SCHEDULE AND TYPICAL SPECIAL VENT SECTION DETAIL, DWG H-702 MINIMUM SIZE REQUIRED BY MANUFACTURER AS FOLLOWS:
-AERCO: 14"
-LOCHINVAR: 14"
-CLEAVER BROOKS: 16"

OA

B-5000 36x24

E-5000 36x24

24x12 EXHAUST WITH MOTORIZED DAMPER DN TO 12" AFF (TYP OF 3)

32x32

76x24

48x30

PROVIDE NEW 2-HR FIRE WRAP ON EXISTING GENERATOR ROOM INTAKE VENTILATION AIR DUCT

INTERLOCK WITH NEW EXHAUST FAN

NEW CHILLER ROOM VENTILATION AND REFRIGERANT LEAK EXHAUST SYSTEM.

INTERLOCK WITH NEW EXHAUST FAN

EXISTING OUTDOOR PARTITIONED AREAWAY LOUVER COVER AND CONTINUOUS WALL LOUVER TO MECHANICAL ROOM TO REMAIN.

NEW ELECTRICAL ROOM EXHAUST FAN WITH SCREENED INLET. PROVIDE INDEPENDENT SUPPORT OF FAN TO STRUCTURE ABOVE.

O.A.

84x72

PROVIDE NEW CAP WITH NEW SEAL COMBUSTION AIR DUCT CONNECTIONS ON EXISTING OA PLENUM CONNECTED TO EXISTING LOUVER

STACK OA DUCTS, PROVIDE COMMON TRAPEZE SUPPORTS 8' O.C. WITH INDIVIDUAL DUCT STRAP HANGER FROM TRAPEZE

OA DUCT FOR BOILER/GWH SEALED COMBUSTION AIR, SIZED PER MANUFACTURER REQUIRMENTS FOR BOLIER SUPPLIED, SEE BOILER SCHEDULE. MINIMUM SIZE REQUIRED BY MANUFACTURER AS FOLLOWS:
-AERCO: 14"
-LOCHINVAR: 16"
-CLEAVER BROOKS: 16"

NOTE:
REFER TO DRAWINGS H-101.C1 & H-101.C2 FOR PIPING WORK WITHIN PLANT

60"x 60"x 3' LONG INSULATED EXHAUST PLENUM CONNECTED TO EXISTING EXHAUST LOUVER.

60x60

EXISTING 6' HIGH CONTINUOUS LOUVER

EXISTING OUTDOOR AREAWAY WITH LOUVER COVER

PROVIDE NEW SHEET METAL WALL WITH ACCESS DOOR IN OUTDOOR AREAWAY TO SEGREGATE REFRIGERANT EXHAUST. CONSTRUCTION TO BE SIMMILAR TO EXISTING

DIVIDING PANELS/AD BETWEEN EXH/OA SERVICE APPLICATIONS (TYP)

1 CORE LEVEL 2 HVAC PLAN - NEW
1/4" = 1'-0"

HVAC GENERAL NOTES

1. REFER TO H-010 FOR PROJECT HVAC GENERAL NOTES.
2. REFER TO RISERS AND FLOW DIAGRAMS FOR ADDITIONAL INFORMATION.
3. SEE DWG GI-100 FOR LEGEND OF RATED WALL TYPES. PROVIDE FIRE STOPPING FOR ALL NEW PIPE PENETRATIONS OF RATED WALLS IN ADDITION, PROVIDE FIRESTOPPING OF EXISTING PENETRATIONS INDICATED ON GENERAL DRAWINGS AND FIRE DAMPERS FOR ALL NEW PENETRATING 2 HR RATED WALLS.

STATE OF CONNECTICUT DEPARTMENT OF ADMINISTRATIVE SERVICES REGISTERED PROFESSIONAL ENGINEER

KINNEY HALL "K" | FINE ARTS "A" | STUDENT CENTER "S" | LEARNING RESOURCE CENTER "L" | EKSTROM HALL "E" | TECHNOLOGY HALL "T" | CORE "C"

N

NAUGATUCK VALLEY COMMUNITY COLLEGE

drawing title: CORE LEVEL 1 HVAC PLAN - NEW

REVISIONS

mark	date	description
1	08/08/2018	ADDENDUM # 02

STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES

drawing prepared by: BVH INTEGRATED SERVICES, 206 WEST NEWBERRY ROAD, BLOOMFIELD CT, 06002

date: 03/23/2018
scale: 1/4" = 1'-0"
drawn by: KLB
approved by: JBA
drawing no.: H-102.C2

project: RENOVATIONS TO PHYSICAL PLANT
Naugatuck Valley Community College
750 Chase Parkway, Waterbury, CT 06708

CAD no.: 21-16-043
project no.: BI-CTC-500

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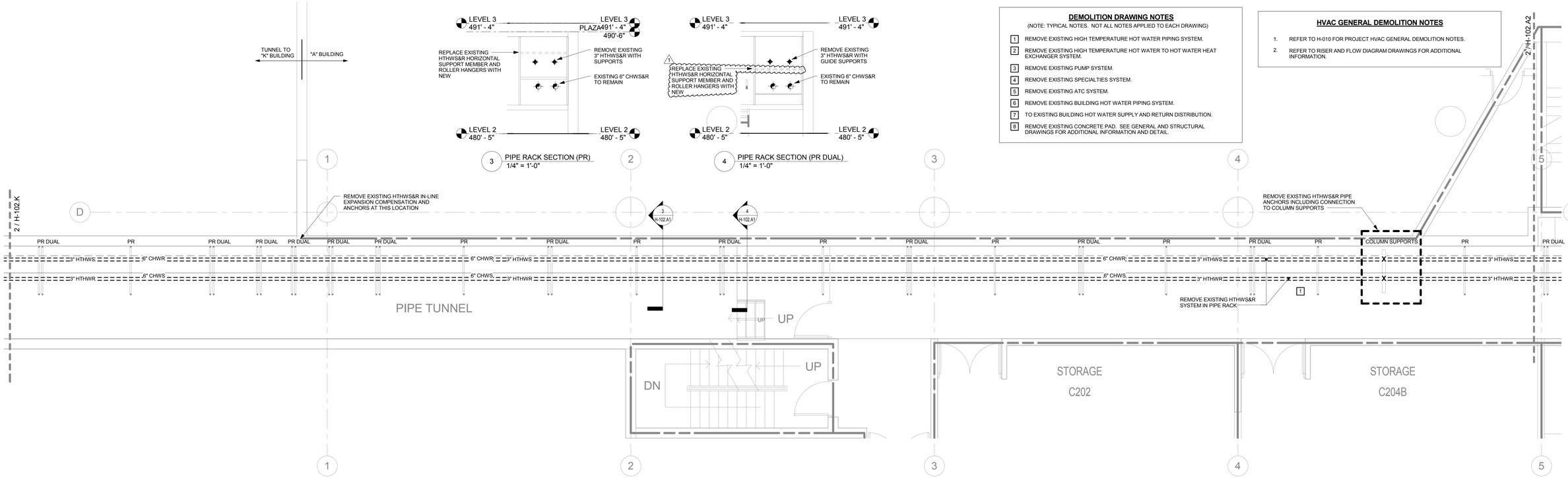
TUNNEL TO "K" BUILDING
"A" BUILDING
LEVEL 3 491' - 4"
LEVEL 3 PLAZA491' - 4" 490'-6"
REPLACE EXISTING HTHWS&R HORIZONTAL SUPPORT MEMBER AND ROLLER HANGERS WITH NEW
REMOVE EXISTING 3" HTHWS&R WITH SUPPORTS
EXISTING 6" CHWS&R TO REMAIN
LEVEL 2 480' - 5"
3 PIPE RACK SECTION (PR) 1/4" = 1'-0"
REPLACE EXISTING HTHWS&R HORIZONTAL SUPPORT MEMBER AND ROLLER HANGERS WITH NEW.
REMOVE EXISTING 3" HTHWS&R WITH GUIDE SUPPORTS
4 PIPE RACK SECTION (PR DUAL) 1/4" = 1'-0"
DEMOLITION DRAWING NOTES
(NOTE: TYPICAL NOTES. NOT ALL NOTES APPLIED TO EACH DRAWING)
1 REMOVE EXISTING HIGH TEMPERATURE HOT WATER PIPING SYSTEM.
2 REMOVE EXISTING HIGH TEMPERATURE HOT WATER TO HOT WATER HEAT EXCHANGER SYSTEM.
3 REMOVE EXISTING PUMP SYSTEM.
4 REMOVE EXISTING SPECIALTIES SYSTEM.
5 REMOVE EXISTING ATC SYSTEM.
6 REMOVE EXISTING BUILDING HOT WATER PIPING SYSTEM.
7 TO EXISTING BUILDING HOT WATER SUPPLY AND RETURN DISTRIBUTION.
8 REMOVE EXISTING CONCRETE PAD. SEE GENERAL AND STRUCTURAL DRAWINGS FOR ADDITIONAL INFORMATION AND DETAIL.
HVAC GENERAL DEMOLITION NOTES
1. REFER TO H-010 FOR PROJECT HVAC GENERAL DEMOLITION NOTES.
2. REFER TO RISER AND FLOW DIAGRAM DRAWINGS FOR ADDITIONAL INFORMATION.
2 / H-102.A2
2 / H-102.K
REMOVE EXISTING HTHWS&R IN-LINE EXPANSION COMPENSATION AND ANCHORS AT THIS LOCATION
REMOVE EXISTING HTHWS&R PIPE ANCHORS INCLUDING CONNECTION TO COLUMN SUPPORTS
PR DUAL
PR
3" HTHWS
6" CHWR
3" HTHWR
6" CHWS
6" HWS
6" HWR
COLUMN SUPPORTS
REMOVE EXISTING HTHWS&R SYSTEM IN PIPE RACK
PIPE TUNNEL
UP
DN
STORAGE
C202
STORAGE
C204B
2 FINE ART LEVEL 2 PIPE TUNNEL PART PLAN - DEMOLITION 1/4" = 1'-0"
NEW DRAWING NOTES
(NOTES: TYPICAL NOTES. NOT ALL NOTES APPLIED TO EACH DRAWING)
1 PROVIDE NEW SHUTOFF INCLUDING NEW WELDED FLANGE AT EACH NEW TO EXISTING PIPE CONNECTION FULL SIZE OF EXISTING PIPE SIZE TO ALLOW FOR ISOLATION BETWEEN NEW & EXISTING DISTRIBUTION AND PRESSURE TESTING OF NEW PIPING SYSTEMS.
2 TO EXISTING BUILDING HOT WATER SUPPLY AND RETURN DISTRIBUTION.
3 SUPPLEMENTAL BID # 3 SCOPE - PROVIDE REDUNDANT PHX. SEE PIPING DETAIL FOR ADDITIONAL INFORMATION.
4 INSTALL NEW EQUIPMENT ON MINIMUM 4" CONCRETE HOUSEKEEPING PAD MINIMUM 6" GREATER THAN UNIT DIMENSIONS ON ALL SIDES. SEE GENERAL AND STRUCTURAL DRAWINGS FOR ADDITIONAL INFORMATION AND DETAIL.
HVAC GENERAL NOTES
1. REFER TO H-010 FOR PROJECT HVAC GENERAL NOTES.
2. REFER TO RISERS AND FLOW DIAGRAMS FOR ADDITIONAL INFORMATION.
3. SEE DWG GI-100 FOR LEGEND OF RATED WALL TYPES. PROVIDE FIRE STOPPING FOR ALL NEW PIPE PENETRATIONS OF RATED WALLS IN ADDITION, PROVIDE FIRESTOPPING OF EXISTING PENETRATIONS INDICATED ON GENERAL DRAWINGS AND FIRE DAMPERS FOR ALL NEW PENETRATING 2 HR RATED WALLS.
LEVEL 3 491' - 4"
LEVEL 3 491' - 4"
NEW HORIZONTAL SUPPORT MEMBER AND CONNECTIONS TO EXISTING PIPE RACK WITH NEW ROLLER HANGERS FOR HWS&R PIPING. COORDINATE/ADJUST HORIZONTAL MEMBER MOUNTING HEIGHT WITH PR DUAL RACK. SUBMIT ENGINEERED SUBMITTAL
NEW 6"HWS&R WITH NEW SUPPORTS
EXISTING 6" CHWS&R TO REMAIN
LEVEL 2 480' - 5"
5 PIPE RACK SECTION (PR) 1/4" = 1'-0"
NEW HORIZONTAL SUPPORT MEMBER AND CONNECTIONS TO EXISTING PIPE RACK WITH NEW ROLLER HANGERS FOR HWS&R PIPING. COORDINATE/ADJUST HORIZONTAL MEMBER MOUNTING HEIGHT WITH PR DUAL RACK. SUBMIT ENGINEERED SUBMITTAL
NEW 3" HWS&R WITH NEW HORIZONTAL SUPPORT MEMBER AND CONNECTIONS TO EXISTING PIPE RACK WITH NEW ROLLER OR GUIDE SUPPORTS AS REQUIRED PER ENGINEERED SUBMITTALS REQUIRED PER SPECIFICATIONS "HANGERS AND SUPPORTS" FOR "HVAC PIPING AND EQUIPMENT" AND "EXPANSION LOOPS AND FITTINGS FOR HVAC PIPING".
EXISTING 6" CHWS&R TO REMAIN
6 PIPE RACK SECTION (PR DUAL) 1/4" = 1'-0"
1 / H-102.K
1 / H-102.A2
PROVIDE NEW IN-LINE EXPANSION COMPENSATORS IN HWS&R PIPING AT THIS LOCATION. PROVIDE NEW ANCHORS, REUSE AND REINFORCE EXISTING PIPE RACK SUPPORTS
PROVIDE NEW HWS&R ANCHORS TO EXISTING COLUMN SUPPORT AT THIS LOCATION.
NEW HWS&R SYSTEM IN PIPE RACK
PIPE TUNNEL
UP
DN
STORAGE
C202
STORAGE
C204B
1 FINE ART LEVEL 2 PIPE TUNNEL PART PLAN - NEW 1/4" = 1'-0"
TUNNEL DRAWINGS GENERAL NOTE
1. SEE NOTES AND PIPE RACK SECTIONS ON DEMO AND NEW PLANS FOR SCOPE REQUIREMENTS RELATED TO REMOVAL OF HTHW SYSTEM AND INSTALLATION OF NEW HW SYSTEM, INCLUDING MODIFICATION TO PIPE RACK SYSTEMS.
LEGEND
PR EXISTING SINGLE UNISTRUT FRAME PIPE RACK SUPPORT SYSTEM WITH ROLLER SUPPORT HANGER FOR EACH PIPE.
PR DUAL EXISTING DUAL UNISTRUT FRAME PIPE RACK SUPPORT SYSTEM WITH PIPE GUIDE SUPPORT FOR EACH PIPE
PH EXISTING MULTIPLE PIPE HANGER SUPPORT SYSTEM WITH THREADED ROD HUNG FROM STRUCTURE ABOVE AND ROLER PIPE SUPPORT
KINNEY HALL "K"
FINE ARTS "A"
STUDENT CENTER "S"
LEARNING RESOURCE CENTER "L"
EKSTROM HALL "E"
TECHNOLOGY HALL "T"
CORE "C"
N
NAUGATUCK VALLEY COMMUNITY COLLEGE
STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES
drawing title: FINE ARTS LEVEL 2 HVAC PIPE TUNNEL PLANS - DEMOLITION AND NEW
REVISIONS
mark 1 | date 08/08/2018 | description ADDENDUM # 02
drawing prepared by: BVH INTEGRATED SERVICES, 206 WEST NEWBERRY ROAD, BLOOMFIELD CT, 06002
date 03/23/2018
scale 1/4" = 1'-0"
project: RENOVATIONS TO PHYSICAL PLANT, Naugatuck Valley Community College, 750 Chase Parkway, Waterbury, CT 06708
drawn by KLB
approved by JBA
drawing no. H-102.A1
CAD no. 21-16-043
project no. BI-CTC-500
STATE OF CONNECTICUT TIMOTHY P. VAN DYKE No. 17926 LICENSED PROFESSIONAL ENGINEER
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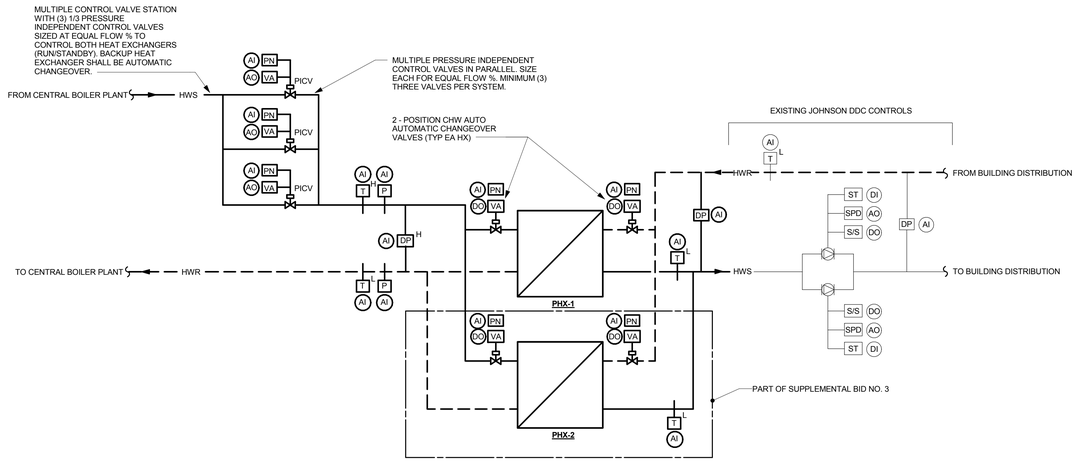
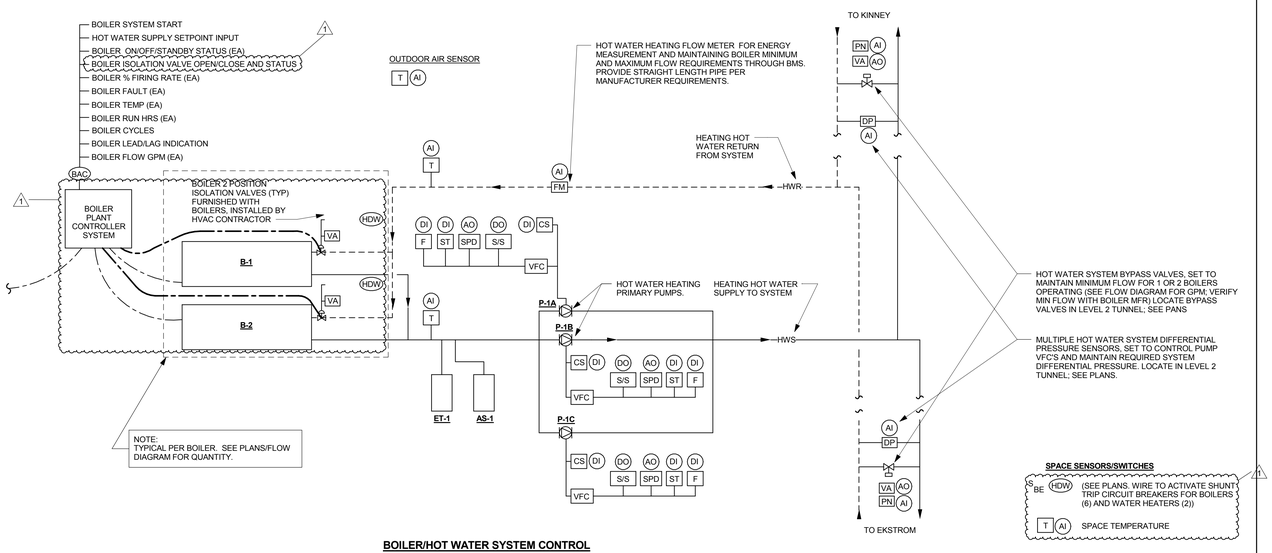


HOT WATER PLATE HEAT EXCHANGER CONTROL (KINNEY, FINE ARTS, STUDENT CENTER, LEARNING RESOURCE CENTER, EKSTROM & TECH HALL)

NOT TO SCALE

1. SEQUENCE OF OPERATION
   a. THE SEQUENCE SHALL BE ENABLED WHENEVER ITS ASSOCIATED EXISTING BUILDING HW SYSTEM PUMPS ARE ENABLED
   b. PRESSURE INDEPENDENT CONTROL VALVES SHALL MODULATE IN STAGED SEQUENCE TO MAINTAIN BUILDING DISTRIBUTION HOT WATER SUPPLY SETPOINT. MAINTAIN BLDG SUPPLY TEMPERATURE SETPOINT ACCORDING TO THE FOLLOWING SCHEDULE.
      1. 178°F WHEN OUTDOOR AIR TEMPERATURE IS 0°F. (ADJ)
      2. 115°F WHEN OUTDOOR AIR TEMPERATURE IS 50°F. (ADJ)
   c. MONITOR HOT WATER SUPPLY AND RETURN TEMPERATURES ON BOTH SIDE OF HEAT EXCHANGER. ALARM WHEN HWR TEMP BELOW 54ºF (ADJ). ALARM WHEN SUPPLY/RETURN DELTA TEMP IS 12ºF (ADJ) AND BELOW.
2. ALARMS
   a. HIGH PLANT HOT WATER SUPPLY TEMPERATURE
   b. LOW PLANT HOT WATER RETURN TEMPERATURE
   c. LOW PLANT BUILDING HOT WATER SUPPLY/RETURN DELTA TEMP.
   d. HIGH PLANT HOT WATER DP
   e. HIGH BUILDING HOT WATER SUPPLY TEMPERATURE
   f. LOW BUILDING HOT WATER RETURN TEMPERATURE
   g. LOW BUILDING HOT WATER SUPPLY/RETURN DELTA TEMP.
   h. HIGH BUILDING HOT WATER DP
3. GRAPHICS
   a. ALARM CONDITIONS
   b. LEAD PICV VALVE INDICATION
   c. PICV VALVE COMMAND PERCENTAGE (EA)
   d. PICV VALVE POSITION PERCENTAGE (EA)
   e. PLATE HEAT EXCHANGER STATUS (ENABLED / DISABLED)
   f. PLATE HEAT EXCHANGER CHANGEOVER VALVE COMMAND (EA)
   g. PLATE HEAT EXCHANGER CHANGEOVER VALVE POSITION (EA)
   h. BUILDING HOT WATER SUPPLY TEMPERATURE AND PRESSURE
   i. BUILDING HOT WATER RETURN TEMPERATURE AND PRESSURE
   j. PLANT HOT WATER SUPPLY TEMPERATURE AND PRESSURE
   k. PLANT HOT WATER RETURN TEMPERATURE AND PRESSURE
   l. PHX PLANT HOT WATER SUPPLY/RETURN DP
   m. PHX BUILDING HOT WATER SUPPLY/RETURN DP



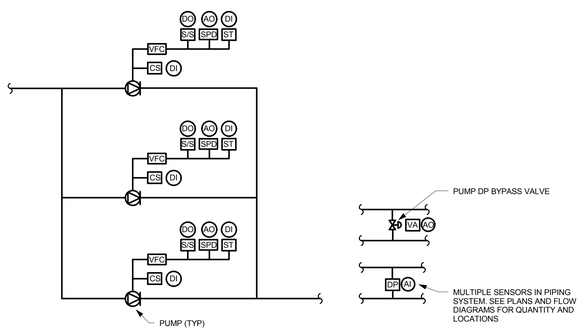
BOILER/HOT WATER SYSTEM CONTROL

NOT TO SCALE

SEQUENCE OF OPERATIONS:

1. GENERAL
   A. GAS FIRED CONDENSING BOILERS OPERATING IN-PARALLEL, EACH SIZED FOR 20% LOAD (N+1), VARIABLE VOLUME PRIMARY PUMPING. THE SYSTEM IS DESIGNED FOR 2 PUMPS RUNNING (LEAD/LAG), AND ONE STANDBY.
   B. SYSTEM TO BE AUTOMATICALLY ENABLED ON THROUGH BMS CENTRAL HEAD AND OPERATE 24/7 WHENEVER OUTDOOR AIR TEMPERATURE IS BELOW 60°F (ADJ).
   C. AUTOMATICALLY SEQUENCE SYSTEM TO MAINTAIN HOT WATER SUPPLY RESET TEMPERATURE AND SYSTEM FLOW.
   D. WHEN SYSTEM ENABLED ON, FACTORY BOILER PLANT CONTROLLER SYSTEM CYCLES BOILERS TO MAINTAIN HOT WATER SUPPLY SETPOINT.
   E. BMS SHALL INTERFACE WITH EACH BOILER THROUGH BACNET MSTP PROTOCOL.
   F. EMERGENCY SHUTDOWN: UPON ACTIVATION OF EMERGENCY SWITCH AND ROOM ENTRANCES, DISABLE BOILER AND DOMESTIC WATER HEATER SYSTEMS. MANUAL RESTART SYSTEM.
2. BOILER AND MAIN HOT WATER SYSTEM PUMPS
   A. BOILERS SHALL BE ENABLED WHENEVER AT LEAST ONE HEATING VALVE IS COMMANDED TO ANY OPEN PERCENTAGE AND BOILERS, SUBJECT TO PROOF OF HOT WATER FLOW, SHALL BE STAGED AND CYCLED BY BOILER PACKAGED CONTROLS. MAINTAIN HEATING-WATER SUPPLY TEMPERATURE SETPOINT ACCORDING TO THE FOLLOWING SCHEDULE:
      1) 180°F WHEN OUTDOOR AIR TEMPERATURE IS 0°F (ADJ)
      2) 120°F WHEN OUTDOOR AIR TEMPERATURE IS 50°F (ADJ)
   B. THE BMS SHALL:
      1) ENABLE SYSTEM ON AND OFF. WHEN SYSTEM ENABLED ON, ENABLE PRIMARY PUMP CONTROL AND COMMAND BOILER PLANT CONTROLLER EACH BOILER CONTROL PANEL WILL COMMAND OPEN ITS RESPECTIVE BOILER ISOLATION VALVE. PROVIDE FIELD WIRING BETWEEN EACH BOILER CONTROL PANEL AND RESPECTIVE ISOLATION VALVE PER MANUFACTURERS INSTRUCTIONS.
      2) BMS SHALL MONITOR BOILER STATUS, AND ADJUST PUMP SPEED TO MAINTAIN MINIMUM FLOW REQUIREMENTS, AS MEASURED BY COMMON RETURN MAIN FLOW METER, BASED ON NUMBER OF BOILERS OPERATING.
      3) BMS SHALL PROVIDE HWS TEMP SETPOINT TO BOILER PLANT CONTROLLER PER RESET SCHEDULE.
      4) BMS TO MONITOR BOILER PLANT CONTROLER THROUGH BACNET INTERFACE.
      5) BMS SHALL MONITOR BOILER COMMAND/STATUS.
      6) WHEN THE LAST BOILER IS SEQUENCED OFF, THE RESPECTIVE ISOLATION VALVE SHALL REMAIN OPEN UNTIL THE MAIN HOT WATER SYSTEM PUMPS ARE ALL COMMANDED OFF.
   C. BOILER PLANT CONTROL PACKAGE SHALL:
      1) DUTY CYCLE LEAD / LAG BOILERS ON RUN TIME
      2) START LAG BOILER UPON FAILURE OF LEAD BOILER AND SIGNAL ALARM
      3) EACH BOILER SHALL HAVE AN INTERNAL HIGH LIMIT, AS WELL AS A SECONDARY HIGH LIMIT ALARM THAT WILL SHUTDOWN ITS RESPECTIVE BURNER AND ANNUNCIATE TO THE BMS.
      4) PROVE BOILER FLOW PRIOR TO BURNER IGNITION.
      5) PROVE BOILER COMBUSTION AIR DAMPER OPEN PRIOR TO BURNER IGNITION.
      6) OPEN/CLOSE BOILER ISOLATION VALVES AND ASSURE THAT LEAD BOILER ISOLATION VALVE IS OPEN TO PREVENT DEAD HEADING OF THE PUMP
      7) DELAY CLOSURE OF BOILER ISOLATION VALVE ON BURNER SHUTDOWN TO ALLOW DISSIPATION OF HEAT.
   D. BOILER AND DOMESTIC WATER HEATER BURNER EMERGENCY SHUTDOWN CONTROL: INTERRUPT EACH BURNER SAFETY CIRCUIT THROUGH A RELAY PANEL, TO TURN OFF THE FUEL FIRED UNITS BY A MANUALLY OPERATED REMOTE SHUTDOWN SWITCH LOCATED AT EACH BOILER ROOM DOOR, MINIMUM 60" AFF. SWITCH SHALL BE LOCATED JUST OUTSIDE THE BOILER/WATER HEATER ROOM DOOR, EXCEPT WHERE THE DOOR IS LOCATED ON AN EXTERIOR WALL. THE SWITCH SHALL BE LOCATED JUST INSIDE THE DOOR. WHERE THE SWITCH WOULD BE ACCESSIBLE TO THE PUBLIC AND SUBJECT TO AHJ APPROVAL, LOCATE THE SWITCH JUST INSIDE OF THE DOOR. SWITCHES SHALL HAVE RED FACE PLATE WITH WHITE LETTERING INDICATING "BURNER EMERGENCY SHUTOFF" AND BE PROPERLY RATED FOR VOLTAGE. SWITCHES SHALL BE HARDWIRED TO BURNER SAFETY CONTROLS.
   E. HW SYSTEM PRIMARY PUMPS (P-1A,1B, 1C): SHALL BE ENABLED WHENEVER AT LEAST ONE HEATING VALVE IS COMMANDED TO ANY OPEN PERCENTAGE. WHEN ALL BUILDING HEATING VALVES ARE COMMANDED CLOSED THE SYSTEM SHALL BE DISABLED.
      1) THE LEAD PUMP SHALL BE SELECTED SWITCHING QUARTERLY.
      2) UPON FAILURE OF THE LEAD OR LAG PUMP AS SENSED BY THE CURRENT TRANSFORMERS OR FAILURE OF THE DRIVE IT SHALL SHUT DOWN AND THE STANDBY PUMP SHALL START AUTOMATICALLY.
      3) PUMP SPEED SHALL BE VARIED AS REQUIRED TO MAINTAIN SYSTEM DIFFERENTIAL PRESSURE. WHERE MULTIPLE DIFFERENTIAL PRESSURE TRANSMITTERS ARE USED IN THE SYSTEM, THE LOWEST CONSTANTLY POLLED PRESSURE SHALL BE USED. WHEN THE LEAD PUMP IS OPERATING ABOVE 90% SPEED AND THE SYSTEM DIFFERENTIAL PRESSURE IS BELOW SETPOINT FOR MORE THAN 5 MINUTES, THE LAG PUMP SHALL BE COMMANDED TO OPERATE. WHEN BOTH PUMPS ARE OPERATING BELOW 45% SPEED FOR MORE THAN 10 MINUTES, THE LAG PUMP SHALL BE DISABLED.
      4) WHENEVER THE VFC IS AT MINIMUM SPEED AND ALL DIFFERENTIAL PRESSURE SENSORS ARE ABOVE SET POINT THE BY-PASS VALVES SHALL MODULATE OPEN TO MAINTAIN SET POINT AT THE LOWEST SENSOR.
      5) BYPASS VALVES SHALL ALSO BE MODULATED OPEN AS REQUIRED TO MAINTAIN THE REQUIRED MINIMUM FLOW FOR THE ACTIVE BOILERS.

1. ALARMS
   A. GENERAL BOILER PLANT ALARM
   B. BOILER HIGH LIMIT
   C. PUMP FAILURES
   D. VFC FAILURES
   E. PUMP SYSTEM FAILURE (BOTH PUMPS NOT RUNNING)
   F. EMERGENCY BOILER SHUTDOWN SWITCH ACTIVATED.
2. GRAPHICS
   A. ALARMS
   B. OUTSIDE AIR (GLOBAL)
   C. PRIMARY PUMP START/STOP COMMAND (EA)
   D. PRIMARY PUMP START/STOP STATUS (EA)
   E. PRIMARY PUMP SPEED. (EA)
   F. SUPPLY WATER TEMERATURE SET POINT
   G. SUPPLY WATER TEMPERATURE
   H. RETURN WATER TEMPERATURE
   I. BOILER PLANT COMMAND
   J. BOILER PLANT STATUS
   K. BOILER ON/OFF/STANDBY STATUS (EA)
   L. BOILER % FIRING RATE (EA)
   M. BOILER TEMPERATURE/EACH
   N. BOILER FAULT (EA)
   O. BOILER RUN HOURS
   P. BOILER CYCLES
   Q. BOILER LEAD/LAG INDICATION
   R. [illegible]
   S. [illegible]
   T. PLANT HOT WATER FLOW GPM
   U. PRIMARY HW FLOW MINIMUM SETPOINT (1 BOILER OPERATING)
   V. PRIMARY HW FLOW MINIMUM SETPOINT (2 BOILERS OPERATING).
   W. MANUAL LEAD/LAG PUMP SELECTION (EA)
   X. MANUAL PUMP ENABLE/DISABLE (EA)
   Y. BYPASS VALVE COMMAND (EA)
   Z. BYPASS VALVE POSITION (EA)
   AA. SYSTEM DIFFERENTIAL PRESSURE (EA)
   BB. BOILER BACNET INTERFACE POINTS INDICATED ON DIAGRAM ABOVE
   CC. OTHER AVAILABLE BOILER POINTS THROUGH BACNET INTERFACE AT DIRECTION OF OWNER



VARIABLE SPEED LEAD/LAG PUMP CONTROL (HW/CHW/CDW)

NOT TO SCALE

1. SEQUENCE OF OPERATION
   a. CONTROL HOT WATER HEATING PUMPS FOR 2 RUN, STAGED OPERATION. HEATING PUMPS SHALL BE ENABLED YEAR ROUND WHENEVER AT LEAST ONE HEATING VALVE IS COMMANDED TO ANY OPEN PERCENTAGE. WHEN ALL BUILDING HEATING VALVES ARE COMMANDED CLOSED, THE SYSTEM SHALL BE DISABLED
   b. CONTROL CHILLED WATER COOLING PUMPS FOR 2 RUN, STAGED OPERATION. COOLING PUMPS SHALL BE ENABLED YEAR ROUND WHENEVER AT LEAST ONE COOLING VALVE IS COMMANDED TO ANY OPEN PERCENTAGE. WHEN ALL BUILDING COOLING VALVES ARE COMMANDED CLOSED, THE SYSTEM SHALL BE DISABLED.
   c. THE LEAD PUMP SHALL BE ROTATED BASED ON RUN TIME.
   d. UPON FAILURE OF A LEAD PUMP AS SENSED BY THE CURRENT TRANSFORMERS OR FAILURE OF THE DRIVE IT SHALL SHUT DOWN AND THE LAG PUMP SHALL START AUTOMATICALLY AND CONTROL IN A IDENTICAL MANNER.
   e. PUMPS SHALL BE STAGED AND PUMP SPEED SHALL BE VARIED AS REQUIRED TO MAINTAIN SYSTEM DIFFERENTIAL PRESSURE. IF MULTIPLE DIFFERENTIAL PRESSURE TRANSMITTERS ARE USED IN THE SYSTEM THE LOWEST CONSTANTLY POLLED PRESSURE SHALL BE USED. OPERATE PUMP AT SAME SPEED WHEN TWO PUMPS OPERATING.
   f. WHENEVER BOTH PUMPS VFCS ARE AT MINIMUM SPEED AND ALL DIFFERENTIAL PRESSURE SENSORS ARE ABOVE SET POINT ONE PUMP SHALL DISABLE FOR SINGLE PUMP OPERATION. WHEN THE SINGLE PUMP VFC IS AT MINIMUM SPEED, THE BY-PASS VALVE SHALL MODULATE OPEN TO MAINTAIN SET POINT AT THE LOWEST SENSOR
2. ALARMS
   a. PUMP FAILURE
   b. DRIVE FAILURE
   c. SYSTEM FAILURE (TWO PUMPS NOT RUNNING)
3. GRAPHICS
   a. ALARM CONDITIONS
   b. SPEED COMMAND PERCENTAGE
   c. PUMP STATUSES
   d. SYSTEM DIFFERENTIAL PRESSURE(S)
   e. MANUAL LEAD/LAG SELECTION
   f. MANUAL SYSTEM ENABLE/DISABLE
   g. BYPASS VALVE COMMAND PERCENTAGE

NOTE: CHW AND CDW PUMPS AND CONTROL ARE EXISTING JOHNSON DDC OPERATING ON METASYS VERSION 4.0.4 SOFTWARE. INTERFACE NEW CHILLER CONTROLS WITH EXISTING.

drawing title			STATE OF CONNECTICUT		
HVAC CONTROLS			DEPARTMENT OF ADMINISTRATIVE SERVICES		
REVISIONS					
mark	date	description	drawing prepared by		date
1	08/08/2018	ADDENDUM # 02	BVH INTEGRATED SERVICES 206 WEST NEWBERRY ROAD BLOOMFIELD CT, 06002		03/23/2018
					scale NOT TO SCALE
			project		drawn by KLB
			RENOVATIONS TO PHYSICAL PLANT Naugatuck Valley Community College 750 Chase Parkway, Waterbury, CT 06708		approved by JBA
			CAD no. 21-16-043	project no. BI-CTC-500	drawing no. H-601

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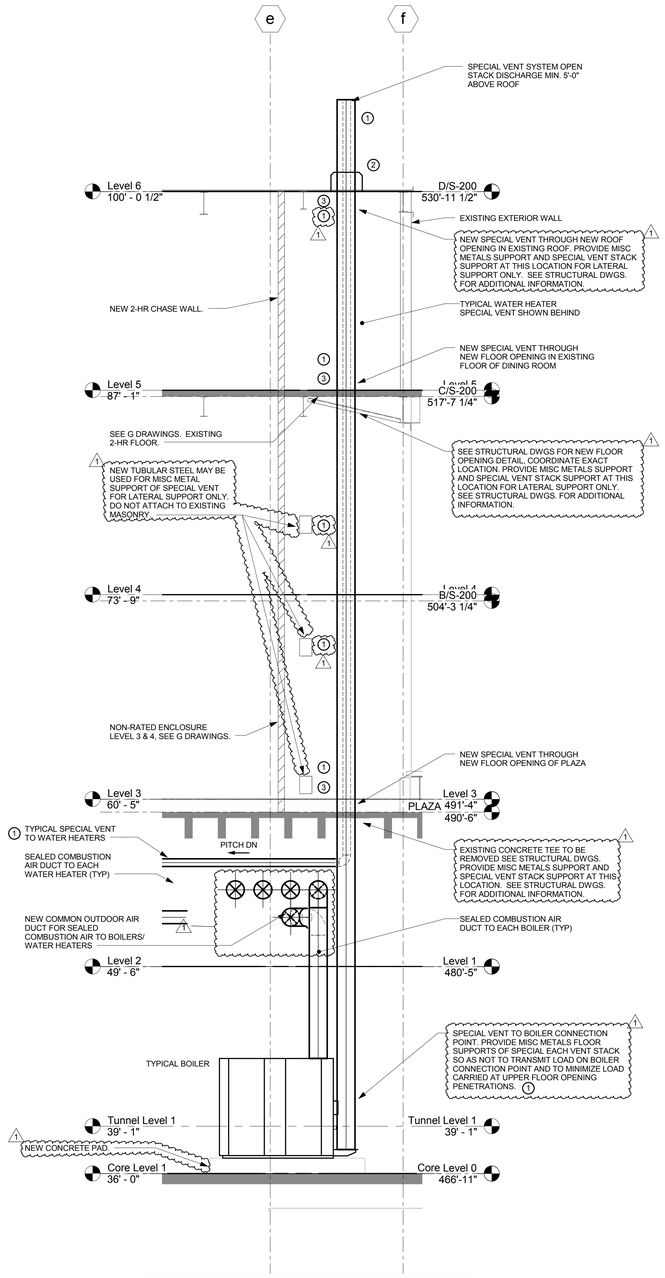
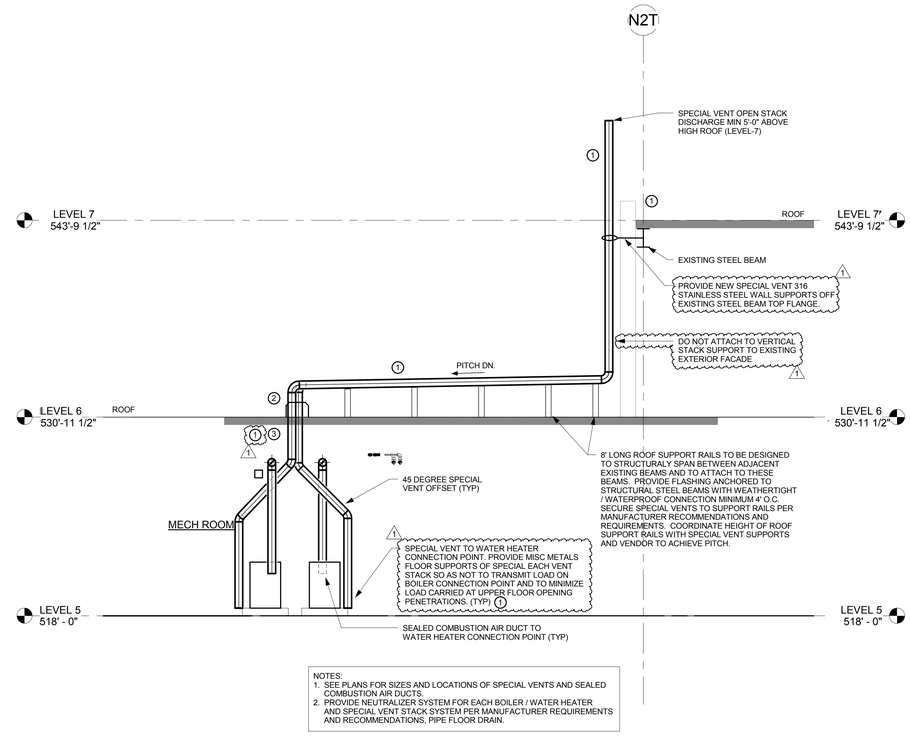


NOTES:
1. SEE PLANS FOR SIZES AND LOCATIONS OF SPECIAL VENTS AND SEALED COMBUSTION AIR DUCTS.
2. PROVIDE NEUTRALIZER SYSTEM FOR EACH BOILER / WATER HEATER AND SPECIAL VENT STACK SYSTEM PER MANUFACTURER REQUIREMENTS AND RECOMMENDATIONS, PIPE FLOOR DRAIN.
3. TYPICAL BOILER SPECIAL VENT AND SEALED COMBUSTION AIR SHOWN. WATER HEATER TYPICALLY SIMILIAR

1 CENTRAL PLANT TYPICAL BOILER / DOMESTIC WATER HEATER SPECIAL VENT SECTION (TYPICAL)
1/4" = 1'-0"

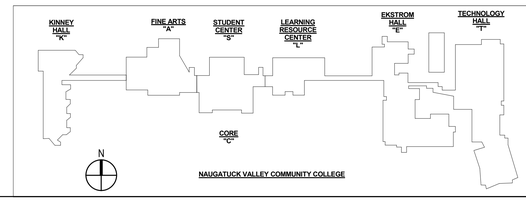


NOTES:
1. SEE PLANS FOR SIZES AND LOCATIONS OF SPECIAL VENTS AND SEALED COMBUSTION AIR DUCTS.
2. PROVIDE NEUTRALIZER SYSTEM FOR EACH BOILER / WATER HEATER AND SPECIAL VENT STACK SYSTEM PER MANUFACTURER REQUIREMENTS AND RECOMMENDATIONS, PIPE FLOOR DRAIN.

2 DOMESTIC WATER HEATER SPECIAL VENT- TECH BUILDING (TYP)
1/4" = 1'-0"

BOILER/WATER HEATER SPECIAL VENT SECTION DRAWING NOTES

1. PROVIDE DELEGATED DESIGN ENGINEERED SUPPORT SYSTEM PER SPECIFICATIONS AND COORDINATED WITH SPECIAL VENT SYSTEM MANUFACTURER. REQUIREMENTS FOR EACH BOILER/WATER HEATER. ANCHOR TO EXISTING STRUCTURE, SEE GENERAL (G) AND STRUCTURAL(S) DRAWINGS FOR ADDITIONAL INFORMATION. SUBMIT SPECIAL VENT ENGINEERS SUPPORT SUBMITTAL TO STRUCTURAL ENGINEER FOR REVIEW AND APPROVAL. SUBMITTAL TO INCLUDE ANCHOR LOCATION & LOADS (GRAVITY & LATERAL) TO BE SUPPORTED FROM THE EXISTING STRUCTURE.
2. SPECIAL VENT SYSTEM ROOF FLASHING AND, STORM COLLAR, FLASHING PER MANUFACTURER RECOMMENDATIONS AND REQUIREMENTS FOR EACH BOILER/WATER HEATER SPECIAL VENT.
3. COORDINATE EXACT LOCATION OF NEW FLOOR/ROOF OPENINGS WITH STRUCTURAL FOR STRAIGHT VERTICAL SPECIAL VENT STACK UP FROM EACH BOILER/WATER HEATER.



drawing title: HVAC BUILDING SECTIONS

REVISIONS

mark	date	description
1	08/08/2018	ADDENDUM # 02

STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES

drawing prepared by
BVH INTEGRATED SERVICES
206 WEST NEWBERRY ROAD
BLOOMFIELD CT, 06002

date: 03/23/2018
scale: 1/4" = 1'-0"
drawn by: KLB
approved by: JBA
drawing no.: H-702

project
RENOVATIONS TO PHYSICAL PLANT
Naugatuck Valley Community College
750 Chase Parkway, Waterbury, CT 06708

CAD no.: 21-16-043
project no.: BI-CTC-500

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SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Listed double-wall special gas vents.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Special gas vents**, including fittings, accessories, and connectors**.
~~2. Guy wires and connectors.~~

B. Shop Drawings: For **special** vents, ~~breechings, chimneys,~~ and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers, expansion compensation and ~~seismic~~ **wind** restraints, and location and size of each field connection.
2. For all vent, breeching, chimney and grease ducts installed products, include calculations required for **wind** ~~seismic~~ restraints, ~~guying~~ and bracing material components and connections to adjacent structures and structural analysis data signed and sealed by the qualified professional engineer. **Include anchor locations and loads (gravity and lateral) to be supported from existing structure. See HVAC and structural drawings for additional information.** ~~Guying and bracing material components and connections to adjacent structures.~~
3. Include vent, breeching, chimney and stack manufacturer draft and sizing calculations for system based on vented equipment being provided and actual fabrication layout, assuring proper venting of all supplied equipment.
~~4. Include vent, breeching, chimney and stack manufacturer's expansion calculations for system based on vented equipment being provided and actual fabrication layout, assuring proper expansion compensation of system.~~
~~5.~~**4.** Include details of required clearances to construction specific to the project and installation. Indicate required openings and chase sizes required. ~~Indicate maximum ceiling height to maintain clearances required.~~ Note any conflicts to plans for Architect/Engineer review.
~~6.~~**5.** Include UL listing with rating criteria, including temperature and pressures.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated ~~breeching~~ **special vents**, ~~chimneys,~~ and stacks; accessories; and components will withstand ~~seismic and~~ wind forces defined in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of anchorage devices on which the certification is based and their installation requirements.

B. Boiler/Water Heater Manufacturer Acceptance Certification: Submit with delegated design submittal, written certification and acceptance of vent sizing and layout from the boiler manufacturer being supplied.

~~B.~~**C.** Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Certified Sizing and Expansion Calculations: Manufacturer shall certify venting system sizing and expansion calculations for specific equipment being supplied.

~~B.~~**1. Include boiler/water heater manufacturer acceptance certification.**

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENTS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Heat-Fab, Inc.
2. Metal-Fab, Inc.
3. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
4. Jeremias Venting.

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211 and suitable for condensing-gas applications.

C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

E. Outer Jacket: Aluminized steel for interior applications; Type 316 stainless steel for exterior applications.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, ~~barometric dampers,~~ **drain sections,** expansion compensation, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Exit cone with drain section incorporated into riser.

G. System shall be capable of being self-supporting for a minimum of 5 feet above the roof/attachment point without the use of guy wires or other additional bracing.

~~2.2 GUYING AND BRACING MATERIALS~~

~~A. Cable: Three stainless steel, stranded wires of the following thickness:~~

~~1. Minimum Size: 1/4 inch in diameter.~~
~~2. For ID Sizes 4 to 15 Inches: 5/16 inch.~~
~~3. For ID Sizes 18 to 24 Inches: 3/8 inch.~~
~~4. For ID Sizes 27 to 30 Inches: 7/16 inch.~~
~~5. For ID Sizes 33 to 36 Inches: 1/2 inch.~~
~~6. For ID Sizes 39 to 48 Inches: 9/16 inch.~~
~~7. For ID Sizes 51 to 60 Inches: 5/8 inch.~~

~~B. Guy Tensioners: Spring-loaded type. Provide when expansion is 1-1/2 inches or greater~~

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Special Gas Vent: Condensing gas appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Install in strict accordance with manufacturer's instructions.

B. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

1. Maintain required clearances to construction as required by product listing, manufacturer's instructions and code. Coordinate size of all chases and openings. Confirm ceiling heights. Notify Architect/Engineer of any conflicts prior to fabrication and installation.

C. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

E. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

F. Lap joints in direction of flow.

G. Utilize 45-degree tees for all vent connectors to breeching and breeching to chimney fittings of listed building heating appliance chimney and engine exhaust chimney vent systems.

H. Provide drain tee section at the chimney base of listed building heating appliance chimney vent systems. Pipe drain to nearest indirect waste through neutralizer system.

I. Provide expansion compensation per manufacturer's instructions.

J. Pipe all open type stack outlet drain sections through neutralizer system to indirect waste at appliance location.

K. Provide firestops at all penetrations of rated construction.

L. Provide ventilated thimbles with storm collars suitable for roof type and slope at all roof penetrations and at all exterior wall applications suitable for wall type.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

3.5 APPLICATION SCHEDULE

A. Boilers and Domestic Water Heaters:

1. Fuel: Gas.
2. Interior Pressure: Positive.
3. Vent Temperature: Condensing.
4. Venting System:

    a. Vents: Special gas vent.
    b. Vent Connectors: Listed special gas vent.

END OF SECTION 235100

~~03/23/2018~~**Addendum No. 2 – 8/6/2018**

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For each boiler.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators ~~and seismic restraints~~ and for designing vibration isolation bases.
b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. ~~Include adjustable motor bases, rails, and frames for equipment mounting.~~

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports**, including seasonal and occupancy adjustments schedule and reports for each visit**.

C. Sample Warranty: For special warranty.

D. Product Certificates:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.5 CLOSEOUT SUBMITTALS

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

1.6 WARRANTY

A. Manufacturer's **Special** Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. Leakage and Materials: 10 years from date of Substantial Completion.
b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

C. ANSI/ASHRAE/IESNA Standard 90.1 Compliance: Boilers shall have minimum efficiency required by standard. Each boiler shall bear a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE Standard 90.1.

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.

E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. AHRI Certification: For boilers with input ratings greater than or equal to 300 MBH, and less than or equal to 2,500 MBH. Boilers to be certified by AHRI to be rated in accordance with DOE boiler test procedures as published in the latest edition of the Code of Federal Regulations, 10 CFR Part 431, and subject to verification of rating accuracy by AHRI - sponsored, independent, third party testing.

G. Mounting Base: For securing boiler to concrete base.

2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings **(AERCO; Benchmark)** or comparable product **(see schedule on drawings for performance)** by one of the following:

1. AERCO; Benchmark.
2. Cleaver-Brooks; Clear Fire.
3. Lochinvar; Crest.

B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only. Boiler shall have no minimum return water temperature requirement and a minimum flow rate requirement no greater than 20 percent of the design flow rate. Piping to boilers shall be primary only and no dedicated primary boiler pump shall be required.

1. Low nox operation **(<20 ppm)**.
2. Sealed combustion air.

C. Heat Exchanger: 304/316L or 439 stainless steel with downfire arrangement and nonferrous, corrosion-resistant combustion chamber. Any metal that is designed to come into contact with flue condensation is to be stainless steel.

D. Pressure Vessel: Carbon or stainless steel with welded heads and tube connections.

E. Burner: Natural gas, forced draft, with capability of a minimum of 3 to 1 turndown.

F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Gas Train: Combination gas valve with manual shutoff ~~and pressure regulator~~, FM approved.

H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:

1. Jacket: Manufacturer standard, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Manufacturer standard protective finish.
4. Insulation: Minimum 2-inch- thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

2.3 TRIM

A. Include devices sized to comply with ASME B31.1.

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated. See plans for relief pressure setting requirements. **Provide multiple valves per manufacturer's requirements.**

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

G. Provide condensate neutralization system for each boiler/water heater and additional neutralization systems for boiler/domestic water heater special gas vent drain sections.

H. Boiler **manufacturer supplied, field-installed** two-way, two-position motorized **butterfly lug body** isolation valve.

1. 50 psi bubble-tight shutoff.
2. 125/150 ANSI Class flanges.
3. 90-degree rotation.
4. Ductile-iron body with epoxy powder coat.
5. 304 stainless steel disc with EPDM seat, 416 stainless steel shaft.
6. 24V electronic actuator, 180 in-lDS of torque, power closed, failsafe open with manual override button, reversible CW/CCW switch, proof of open end switch.
7. Field-wired and controlled from boiler control system.
8. See boiler control section for sequence requirements.

~~H.~~**I. Gas Regulator: Lock up style vent-less regulators suitable for 2 psi inlet pressure, ANSI and UL listed.**

2.4 CONTROLS

A. Refer to Division 23 Section "Direct Digital Control (DDC) System for HVAC" HVAC control drawing diagrams and Sequence of Operations.

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature.

a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

~~a.~~**4. Isolation Valve Control: Boiler controls to assure selected lead boiler valve remains open at all times and staging off time delay for heat dissipation of sequenced lag boilers.**

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.

3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

1. A BACnet communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

a. Provide BACnet **MSTP** gateway. Coordinate with Division 23 "Instrumentation and Control for HVAC."

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to wire terminal strip.
5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

2.6 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.

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

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section "Vibration and Seismic Controls for HVAC."

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

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

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

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 "Hydronic Piping Specialties."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

I. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections.

J. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

~~B.~~**1. Engage a factory-authorized service representative to provide seasonal and occupancy adjustments described herein.**

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. **Seasonal and** Occupancy Adjustments: ~~When requested within~~**Within** 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied**, unoccupied,** and seasonal conditions. Provide ~~up to~~ six **8-hour** visits to Project ~~during other than normal occupancy hours~~ for this purpose. **Submit report for each visit. Submit proposed schedule to Engineer prior to substantial completion. Notify Engineer 14 days in advance of each visit.**

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain ~~chillers~~ **boilers**. Video record the training sessions and provide electronic copy to Owner. Refer to Division 01 for additional requirements.

1. Instructor shall be factory trained and certified.
2. Provide not less than eight hours of training over a two day period.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Provide a minimum of 8 hours training over a 2 day period. .

END OF SECTION 235216
~~03/23/2018~~**Addendum No. 2 – 8/6/2018**

SECTION 236416 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.

1.3 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input, using consistent units for any given set of rating conditions.

B. DDC: Direct digital control.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated according to the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

E. kVAR: Kilovolt-ampere reactive.

F. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

G. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated according to the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

H. SCCR: Short-circuit current rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. **Full load kW/ton and IPLV p**erformance at AHRI standard conditions ~~and at conditions indicated~~**, including part load performance**.

3. **Full load kW/ton and NPLV p**erformance at **non-**AHRI standard ~~unloading~~ conditions**, including part load performance and certification of ASHRAE 90.1 2010 compliance for non-standard conditions (see schedule on drawings)**.
4. Minimum evaporator flow rate.
5. Minimum condenser flow rate.
6. Refrigerant capacity of chiller.
~~7. Oil capacity of chiller.~~
~~8.~~**7.** Fluid capacity of evaporator, condenser.
~~9.~~**8.** Characteristics of safety relief valves.
~~10.~~**9.** Minimum entering condenser-fluid temperature.
~~11.~~**10.** Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.
~~12.~~**11.** Force and moment capacity of each piping connection.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   a. Structural supports.
   b. Piping roughing-in requirements.
   c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
   d. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

2. Coordination drawings showing plan, section, and elevation views, drawn to 1/4" = 1'-0".
3. Each view to show screened background with the following:

   a. Column grids, beams, columns, and concrete housekeeping pads.
   b. Room layout with walls, floors, and roofs, including each room name and number.
   c. Equipment and products of other trades that are located in vicinity of chillers and part of final installation, such as lighting, fire-suppression, and plumbing systems.

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

C. Source quality-control reports.

D. Field Quality-Control Reports: Startup service reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

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

B. Instructional Videos: Including those that are pre-recorded and those that are recorded during training.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Touch-up Paint: 32-oz. container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.8 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller according to AHRI 550**/590** certification program.

~~A.~~**B. ASHRAE 90.1 Compliance: Certify chiller performance at non-AHRI 550/590 standard condition complies with ASHRAE 90.1 2010 for non-standard design condition.**

~~B.~~**C.** Manufacturer must have at least 3 years' experience in manufacturing current generation model chillers in order to be considered.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Package chiller for export shipping in totally enclosed bagging.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller, including refrigerant and oil charge (if applicable).
b. Complete compressor and drive assembly, including refrigerant and oil charge (if applicable).
c. Refrigerant and oil charge (if applicable).

1) Loss of refrigerant charge for any reason due to manufacturer product defect and product installation.

d. Parts and labor.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 50 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 60 deg F.
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

B. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

C. Performance Tolerance: Comply with AHRI 550/590.

D. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1 **for non-standard design conditions**.

F. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.

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

H. Comply with requirements of Underwriters Laboratories Inc., and include label by a qualified testing agency showing compliance.

I. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement, even if not explicitly indicated.

2.2 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings (Daikin Applied Model WME) or comparable product **(see schedule on drawings for performance)** by one of the following:

1. Carrier Corporation; a unit of United Technologies Corp., Model 19DV.
2. ~~Trane Model CVHF~~

~~3.~~ **2.** YORK; a Johnson Controls company, Model YMC^2.

2.3 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system, evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.

1. Multi-Piece Assembly: Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

B. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

2.4 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Single-stage or multistage, variable- or dynamic-displacement, centrifugal-type compressor driven by an electric motor.

B. Oil-Free Technology:

1. Compressors shall have oil-free technology using a permanent magnet synchronous motor, magnetic bearings, integral variable-frequency controller, and digital electronic controls.

a. Magnetic Bearings, Ceramic Bearings or Roller Element Bearings:

1) Levitated shaft position shall be actively controlled and monitored by an X-, Y-, and Z-axis digital position sensor.
2) Compressor assembly shall be capable of coming to a controlled, safe stop without damage during a power failure by diverting stored power to the magnetic bearing control system.

b. Compressor assembly shall be capable of coming to a controlled, safe stop without damage during a power failure by diverting stored power to the magnetic bearing control system.

c. Integrate monitoring and controls associated with magnetic bearings into chiller controls, including following:

1) Operating Information: Positions, currents, temperatures, rotor elongation, and speed.
2) Warning Messages: Vibration.
3) Safety Shutdown: Internal fault, high bearing temperature or current, startup failure, speed signal fault, overspeed fault, communication error, rotor elongation, oscillator fault, rotor contraction, unauthorized rotation, and high and low voltage.
4) Cycling Shutdown: Position, low-frequency displacement, vibration, speed signal fault, startup failure, serial communications fault.

C. Compressor:

1. Casing: Cast iron or cast aluminum, precision ground.
2. Impeller: High-strength cast-aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.

D. Drive: Direct- or gear-drive, hermetic design, using an electric motor as the driver.

1. Gear Drives:

   a. For chillers with oil-lubricated gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating.
   b. For chillers with oil-free technology, gear drives shall be of single- or double-helical gear design without the need for oil while chiller is operating, starting, and stopping.
   c. Gears shall comply with American Gear Manufacturer Association standards.

2. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
3. Seals: Seal drive assembly to prevent refrigerant leakage.

E. Compressor Motor:

1. The motor shall be of the semi-hermetic type, of sufficient size to efficiently fulfil compressor horsepower requirements. It shall be liquid refrigerant cooled with internal thermal sensing devices in the stator windings.
2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. Provide motor with thermistor or RTD in each of three-phase motor windings to monitor temperature and report information to chiller control panel.
5. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.

F. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.

1. Vibration Limits: Velocities not to exceed 0.18 inches/s and 0.8 mils peak to peak on all axes.

G. Service: Easily accessible for inspection and service.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

H. Economizers: For multistage chillers, provide interstage economizers.

I. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 15 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature of 2.5 deg F for each 10 percent in capacity reduction.
4. Chillers with variable-frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
5. Avoid use of hot-gas bypass if other options are available to achieve performance indicated. Apply hot-gas bypass according to ASHRAE/IES 90.1 and governing codes.

~~J. Oil Lubrication System: Consisting of pump, filtration, cooler, factory-wired power connection, and controls.~~

~~1. Bearings, gears, and other rotating surfaces shall be lubricated at all operating, startup, coast down, and standby conditions, including power failure.~~
~~2. Manufacturer's standard method to remove refrigerant from oil.~~

~~3. Oil filter shall be the easily replaceable cartridge type, minimum 0.5 micron efficiency, with means of positive isolation while servicing.~~
~~4. Refrigerant or water cooled oil cooler.~~
~~5. Factory-installed and pressure-tested piping with isolation valves and accessories.~~
~~6. Oil compatible with refrigerant and chiller components.~~
~~7. Positive visual indication of oil level.~~

2.5 REFRIGERATION

A. Refrigerant:

1. Type: R-1233zde (Class A1) or R-514A; ASHRAE 34, Class B1 or R-134a; ASHRAE 34, Class A1. Manufacturer shall provide a centrifugal chiller which offers refrigerants which have zero ODP and no phase out date.
2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. The entire chiller system, including all pressure vessels, shall remain above atmospheric pressure during all operating conditions and during shut down to ensure that non-condensables and moisture do not contaminate the refrigerant and chiller system. If any portion of the chiller system is below atmospheric pressure during either operation or shut down, the manufacturer shall include, at no charge:

    a. A complete purge system capable of removing non- condensables and moisture during operation and shut-down.
    b. The manufacturer shall include a factory-installed and wired system that will enable service personnel to readily elevate the vessel pressure during shutdown to facilitate leak testing.

B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

C. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
3. Where dual pressure relief devices are installed in series, provide a sensor with indicator between devices to indicate refrigerant release past first device.
4. For Chillers Using R-1233zde or R-514A: Manufacturer's standard offering complying with ASHRAE 15 and ASHRAE 147.
5. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.

E. Refrigerant Isolation for Chillers Using R-134a:

1. Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell.
2. Suction side of compressor from evaporator shall have an isolation valve to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

3. A separate pump-out system and storage tank sufficient to hold the charge of the largest unit being furnished shall be provided if the chiller does not have valves and capacity to hold entire refrigerant charge in the evaporator or condenser.

F. Purge System:

1. For chillers operating at subatmospheric pressures (using R-1233zde of R514A refrigerant), factory install an automatic purge system for collection and return of refrigerant ~~and lubricating oil~~ and for removal of noncondensables, including, but not limited to, water, water vapor, and noncondensable gases.
2. System shall be of thermal purge design, refrigerant or air cooled, and equipped with a carbon filter that includes an automatic regeneration cycle.
3. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
4. Construct components of noncorrodible materials.
5. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
6. Efficiency of not more than 0.02 lb of refrigerant per pound of air when rated according to AHRI 580.
7. Operation independent of chiller according to ASHRAE 147.

G. Positive-Pressure System:

1. For chillers operating at subatmospheric pressures (using R-1233zde ~~of~~ **or** R-514A refrigerant), factory install an automatic positive-pressure system.
2. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant-pressure vessel of not less than 0.5 psig adjustable up to a pressure that remains within the vessel design pressure limits.
3. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

2.6 EVAPORATOR

A. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Shell is separate from condenser.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Evaporator shall have sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: Manufacturer's choice 3/4 or 1 inch.
5. Minimum Wall Thickness: 0.025 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear, but not more than 4 feet apart.

H. Water Box:

1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections.
3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
4. Hinged or davited marine water-box covers.
5. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange, welded, ASME B16.5, raised-face flange, or grooved for mechanical-joint coupling.
6. Thermistor or RTD temperature sensor factory installed in each nozzle.
7. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Flow Sensor: Thermal dispersion type, factory calibrated for project-specific application.

2.7 CONDENSER

A. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Shell is separate from evaporator.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

D. Condenser shall have sight glass or other form of positive visual verification of refrigerant charge and condition.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: 3/4 or 1 inch.
5. Minimum Wall Thickness: 0.025 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear, but not more than 4 feet apart.

H. Water Box:

1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections.
3. Water boxes and marine water-box covers shall have lifting lugs or eyebolts.
4. Hinged or davited marine water-box covers.

5. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange, welded, ASME B16.5, raised-face flange, or grooved for mechanical-joint coupling.
6. Thermistor or RTD temperature sensor factory installed in each nozzle.
7. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Flow Sensor: Thermal dispersion type, factory calibrated for project-specific application.

2.8 INSULATION

A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Thickness: Minimum 3/4 inch.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Manufacturer has option to factory or field insulate chiller components installed in multiple pieces to reduce potential for damage during installation.
6. Manufacturer has option to factory or field insulate water boxes and nozzles to reduce potential for damage during installation.

D. Field-Applied Insulation:

1. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
2. Manufacturer shall be responsible for chiller insulation whether factory or field installed, to ensure manufacturer is the single point of responsibility for chillers.
3. Manufacturer factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
4. After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.9 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to fused disconnect switch or circuit breaker. Minimum short circuit current rating (SCCR) according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.

1. Branch power circuit to each motor, electric heater, dedicated electrical load, and control, with circuit breaker or disconnect switch having SCCR to match main disconnecting means.

a. NEMA KS 1, heavy-duty fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller for each variable-speed motor furnished.
3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring located outside of enclosures shall be installed in metal raceway, and terminal connections shall be made with not more than a 24-inch length of liquidtight or flexible metallic conduit.

E. Factory install and wire capacitor bank for the purpose of power factor correction to 0.93 at all operating conditions.

1. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as that for motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
2. Capacitors shall be of non-PCB dielectric fluid, metallized electrode design, with low loss with low-temperature rise. The kVAR ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
3. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
4. Provide a ground terminal and a terminal block or individual connectors for phase connection.

~~2.10 MOTOR CONTROLLER~~

~~A. Enclosure: Factory installed, unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key or padlock and key.~~

~~B. Control Circuit: Obtained from integral control power transformer with a control power transformer of enough capacity to operate connected control devices.~~

~~C. Overload Relay shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.~~

~~D. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.~~

~~1. Externally Operated, Door-Interlocked Disconnect: Fused disconnect switch or circuit breaker. Short circuit current rating (SCCR) according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.~~
~~2. Control Relays: Time-delay relays.~~
~~3. Elapsed Time Meters: Numerical readout in hours on face of enclosure.~~
~~4. Number of Starts Counter: Numerical readout on face of enclosure.~~
~~5. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:~~

~~a. Selectable, digital display of the following:~~

~~1) Phase Currents, Each Phase: Plus or minus 1 percent.~~
~~2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.~~
~~3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.~~
~~4) Three-Phase Real Power: Plus or minus 2 percent.~~
~~5) Three-Phase Reactive Power: Plus or minus 2 percent.~~
~~6) Power Factor: Plus or minus 2 percent.~~

~~7) Frequency: Plus or minus 0.5 percent.~~
~~8) Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.~~
~~9) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.~~

~~b. Mounting: Display and control unit flush or semirecessed in instrument compartment door.~~

~~6. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.~~
~~7. Power Protection: Chiller shall shut down within six cycles of power interruption.~~

~~2.11~~2.10 VARIABLE-FREQUENCY CONTROLLER

A. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

B. Description: NEMA ICS 2; listed and labeled according to ETL or UL 508 as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

C. Enclosure: Unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key.

D. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum short circuit current rating (SCCR) according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.

E. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors; suitable for variable torque loads.

F. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.
2. Regulator shall provide full digital control of frequency and voltage.
3. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage for application to a squirrel-cage motor. Inverter shall produce a sine-coded, PWM output waveform and shall conduct no RFI back to the input power supply.

G. Output Rating: Three phase, with voltage proportional to frequency throughout voltage range.

H. Operating Requirements:

1. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum.
2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
3. Capable of driving full load, without derating, under the following conditions:

   a. Ambient Temperature: Zero to 40 deg C.
   b. Relative Humidity: Up to 95 percent (noncondensing).
   c. Altitude: Up to 3300 feet.

4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter; 98 percent with harmonic filter.
6. Overload Capability: 1.05 times the full-load current for seven seconds.

7. Starting Torque: As required by compressor-drive assembly.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

I. Internal Adjustability Capabilities: Integral to controller or through chiller control panel.

1. Minimum Output Frequency: 6 Hz.
2. Maximum Output Frequency: 60 Hz.
3. Acceleration: Two seconds to a minimum of 60 seconds.
4. Deceleration: Two seconds to a minimum of 60 seconds.
5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

J. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

1. Overtemperature.
2. Short circuit at controller output.
3. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
4. Open circuit at controller output.
5. Input undervoltage.
6. Input overvoltage.
7. Loss of input phase.
8. Reverse phase.
9. AC line switching transients.
10. Instantaneous overload, line to line or line to ground.
11. Sustained overload exceeding 100 percent of controller-rated current.
12. Starting a rotating motor.

K. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

L. Automatic Reset and Restart:

1. Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
2. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

M. Visual Indication: On face of controller enclosure, chiller control enclosure or separate power meter. indicating the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. Motor speed (percent).
8. Fault or alarm status (code).
9. DC-link voltage.
10. Motor output voltage.
11. Input kilovolt amperes.
12. Total power factor.

13. Input kilowatts.
14. Input kilowatt-hours.
15. Three-phase input voltage.
16. Three-phase output voltage.
17. Three-phase input current.
18. Three-phase output current.
19. Three-phase input voltage THD.
20. Three-phase input current THD.
21. Output frequency (Hertz).
22. Elapsed operating time (hours).
23. Diagnostic and service parameters.

N. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

O. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
2. Manufacturer has option to incorporate control signal interface into chiller control panel.

P. Passive Harmonic Distortion Filter **(factory furnished remote, field-installed)** to meet IEEE 519 latest standard requirement:

Q. Cooling: Air or refrigerant cooled.

R. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

1. Control Relays: Auxiliary and adjustable time-delay relays.

S. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

~~2.12~~**2.11** CONTROLS

A. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory, so that reprogramming is not required on loss of electrical power.

B. Enclosure: Unit mounted, NEMA 250, Type 1, hinged or lockable, factory wired with a single-point, with field-power connection and a separate control circuit.

C. Factory-installed wiring outside of enclosures shall be in a NFPA 70-approved raceway. Make terminal connections with liquidtight or flexible metallic conduit.

D. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:

1. Date and time.
2. Operating or alarm status.
3. Fault history with not less than last 10 faults displayed.
4. Set points of controllable parameters.
5. Trend data.
6. Operating hours.
7. Number of chiller starts.

8. Outdoor-air temperature or space temperature if required for chilled-water reset.
9. Entering- and leaving-fluid temperatures of evaporator and condenser.
10. Difference in fluid temperatures of evaporator and condenser.
11. Refrigerant pressures in evaporator and condenser.
12. Refrigerant saturation temperature in evaporator and condenser shell.
13. Compressor refrigerant suction and discharge temperature.
14. Compressor bearing temperature.
15. Motor bearing temperature.
16. Motor winding temperature.
17. Phase current.
18. Percentage of motor-rated load amperage.
19. Phase voltage.
20. Demand power (kilowatts).
21. Energy use (kilowatt-hours).
22. Power factor.
23. For chillers equipped with variable-frequency controllers and harmonic filters, include the following:

    a. Output voltage and frequency.
    b. Voltage THD for each phase.
    c. Supply current TDD for each phase.
    d. Inlet vane position.
    e. Controller internal ambient temperature.
    f. Heatsink temperature.

24. Purge suction temperature if purge system is provided.
25. Purge elapsed time if purge system is provided.

E. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator-fluid temperature shall be reset based on [**return-water**] [**outdoor-air**] [**space**] temperature.
3. Current limit and demand limit.
4. Condenser-fluid temperature.
5. External chiller emergency stop.
6. Variable evaporator flow.

F. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

1. Low evaporator pressure or temperature; high condenser pressure.
2. Low evaporator-fluid temperature.
~~3. Low oil differential pressure (if applicable).~~
~~4. High or low oil pressure (if applicable).~~
~~5. High oil temperature (if applicable).~~
~~6.~~**3.** High compressor-discharge temperature.
~~7.~~**4.** Loss of condenser-fluid flow.
~~8.~~**5.** Loss of evaporator-fluid flow.
~~9.~~**6.** Motor overcurrent.
~~10.~~**7.** Motor overvoltage.
~~11.~~**8.** Motor undervoltage.
~~12.~~**9.** Motor phase reversal.
~~13.~~**10.** Motor phase failure.
~~14.~~**11.** Sensor- or detection-circuit fault.
~~15.~~**12.** Processor communication loss.
~~16.~~**13.** Motor controller fault.
~~17.~~**14.** Extended compressor surge.
~~18.~~**15.** Excessive air-leakage detection for chillers using R-1233zde or R-514a refrigerant.

G. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

H. Security Access: Provide electronic security access to controls through identification and password, with at least three levels of access: view only; view and operate; and view, operate, and service.

I. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

J. Communication Port: RS-232 port, USB 2.0 port or higher, or equivalent connection capable of connecting a printer and a notebook computer.

K. DDC System Interface: Factory install hardware and software to enable system to monitor, control, and display chiller status and alarms.

1. Hardwired I/O Points:

a. Monitoring: On-off status, common trouble alarm, electrical power demand (kilowatts), electrical power consumption (kilowatt-hours).
b. Control: On-off operation, chilled-water, discharge temperature set-point adjustment, electrical power demand limit.

2. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the chiller from an operator workstation.

a. Control features and monitoring points displayed locally at chiller control panel shall be available through the control system, including, as a minimum, the following:

1) Start-stop command from remote source.
2) Unit control source, local, analog, digital or modem.
3) Chiller control panel start-stop.
4) Accumulated operating hours.
5) Accumulated starts.
6) Compressor motor status.
7) Unit operation code.
8) Unit safety fault code.
9) Unit cycling fault code.
10) Chilled-water pump status.
11) Chilled-water flow proof.
12) Chilled-water entering temperature.
13) Chilled-water leaving temperature.
14) Chilled-water leaving temperature set-point adjustment from remote source.
15) Condenser(s) water entering temperature.
16) Condenser(s) water leaving temperature.
17) Evaporator refrigerant pressure.
18) Condenser(s) refrigerant pressure.
19) Evaporator refrigerant saturation temperature.
20) Condenser(s) refrigerant saturation temperature.
21) Refrigerant discharge temperature.
22) Refrigerant level.
23) Refrigerant liquid level set point.
24) High-speed thrust bearing proximity position.
25) High-speed thrust bearing proximity reference.
26) Motor current percent of full-load amps.
27) Motor current phase A.
28) Motor current phase B.
29) Motor current phase C.
30) Motor current set-point adjustment from remote source.

31) Motor average winding temperature.
32) Variable-frequency controller selection, auto or fixed.
33) Variable-frequency controller output voltage.
34) Variable-frequency controller input power, rate.
35) Variable-frequency controller input power, consumption.
36) Variable-frequency controller DC bus voltage.
37) Variable-frequency controller inverter link current.
38) Variable-frequency controller output frequency.
39) Variable-frequency controller internal ambient temperature.
40) Variable-frequency controller converter heatsink temperature.
41) Variable-frequency controller harmonic filter installed, true or false.
42) Harmonic Filter THD at maximum voltage, percent.
43) Harmonic filter total demand distortion at maximum current, percent.
44) Harmonic filter total supply kVA.
45) Anti-recycle time remaining.
46) Liquid line solenoid.
47) Pre-rotation vanes position.
48) Adaptive capacity control valve surge map installed, true or false.
49) Adaptive capacity control new surge point, true or false.
50) Adaptive capacity control surge type, pressure differential or current.
51) Adaptive capacity control surge count.
52) Adaptive capacity control PRV position.
53) Adaptive capacity control output frequency.

L. Ride-Through and Rapid-Restore:

1. The chiller shall be able to maintain operation during a momentary power loss event lasting up to 5 seconds when operated at standard AHRI load and lift conditions. The chiller shall be able to ride through this momentary power loss event without shutting down. Chillers not able to maintain operation during momentary power loss events lasting up to 5 seconds shall include a properly sized thermal storage tank to maintain temperature stability in the system.
2. In the event that the power loss is in excess of 5 seconds, the chiller shall automatically restore chiller operation up to 80 percent capacity within 75 seconds after a 30-second power interruption.
3. Quick-start feature shall ensure guide vanes remain open following a power interruption event and quick ramp-up speed logic is employed to facilitate shortest time to deliver chilled water at set-point temperature.
4. Chiller manufacturer shall provide integral UPS unit(s) with chiller controls if required to keep chiller integral controls operational to comply with requirement.
5. Chiller manufacturer shall demonstrate chiller Ride-Through and Rapid-Restore capabilities through simulating power fault, power service return, restart time, and capacity control, to produce desired chilled-water temperature at load indicated.

~~2.13~~**2.12** FINISH

A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

1. Provide at least one coat of primer with a total dry film thickness of at least 1.5 mils.
2. Provide at least two coats of alkyd-modified, vinyl enamel or epoxy finish with a total dry film thickness of at least 3 mils.
3. Paint surfaces that are to be insulated before applying the insulation.
4. Paint installed insulation to match adjacent uninsulated surfaces.
5. Color of finish coat shall be manufacturer's standard.

~~2.14~~**2.13** ACCESSORIES

A. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.
2. Thermal-Dispersion Water Flow Switches: Provide factory-mounted and wired, thermal-dispersion water flow switches on each vessel to prevent unit operation with no or low water flow. Paddle and pressure differential type switches are not acceptable due to high rates of failure and false indications from these types of flow indicators.

B. Vibration Isolation:

1. Chiller manufacturer shall furnish vibration isolation for each chiller.
2. Neoprene Pad:

    a. 0.375-inch- thick, ribbed- or waffle-pattern neoprene pads.
    b. Fabricate pads from 40- to 60-durometer neoprene.
    c. Provide steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

~~2.15~~**2.14** SOURCE QUALITY CONTROL

A. Perform functional run tests of chillers before shipping.

1. Each chiller shall be factory run-tested under load conditions for a minimum of one hour on an AHRI certified test stand with evaporator and condenser waterflow at job conditions (excluding glycol applications). Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Any deviation in performance or operation shall be remedied prior to shipment and the unit retested if necessary to confirm repairs or adjustments. Manufacturer shall supply a certificate of completion of a successful run-test upon request.

B. Factory Performance Testing:

1. Factory performance test chillers, before shipping, according to AHRI 550/590. Tolerances shall be in accordance with specification section 2.1.C.
2. Test the following conditions:

    a. 100% @ 85F entering condenser water temperature.
    b. 75% @ 75F entering condenser water temperature.
    c. 50% @ 65F entering condenser water temperature.
    d. 25% @ 65F entering condenser water temperature.

3. Allow Owner access to place where chillers are being tested. Notify Owner in writing at least 30 days in advance of testing.
4. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory Sound Testing:

1. For chillers located indoors, rate sound power level according to AHRI 575.
2. Factory sound test chillers, before shipping, according to AHRI 575.
3. Test the same conditions as 2.15.B.
4. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

D. Factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test fluid side of heat exchangers, including water boxes, to 1.3 times the rated pressure. Pressure proof test refrigerant side of heat exchangers to a minimum of 45 psig. Vacuum and pressure test for leaks.

E. Owner Travel Expenses:

1. Include cost associated with Owner travel expenses to witness factory testing. Total value attributed to travel expenses shall be clearly indicated.
2. Expenses shall include roundtrip coach airfare, out-of-town hotel accommodations, out-of-town meals (breakfast, lunch, dinner), out-of-town ground transportation, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for two Owner representatives with origin of Hartford, Connecticut.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, control and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

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

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

3.2 CHILLER INSTALLATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

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

~~C. Install chillers on support structure indicated.~~

~~D.~~**C.** Equipment Mounting:

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

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

~~F.~~**E.** Maintain clearances required by governing code.

~~G.~~**F.** Chiller manufacturer's factory-trained service personnel shall charge chiller with refrigerant and fill with oil if not factory installed.

~~H.~~**G.** Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," and Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to chillers, allow space for service and maintenance.

C. Evaporator-Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve.
3. Make connections to chiller with a flange or mechanical coupling.

D. Condenser-Fluid Connections:

1. Connect to condenser inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve.
3. Make connections to chiller with a flange or mechanical coupling.

E. Refrigerant-Pressure Relief Device Connections:

1. For chillers installed indoors, extend separate vent piping for each chiller to the outdoors without valves or restrictions.
2. Comply with ASHRAE 15-2013.
3. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

F. For chillers equipped with a purge system, extend separate purge vent piping for each chiller to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.

G. Connect each chiller drain connection with a drain valve, which is full size of drain connection. Connect drain pipe to drain valve with union, and extend drain pipe to terminate over floor drain.

H. Connect each chiller water box vent connection with an automatic or manual vent, which is full size of vent connection.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC control system for remote monitoring and control of chillers. Comply with requirements in Section 230900 "Instrumentation and Control for HVAC".

D. Install nameplate on face of chiller control panel indicating the control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 0.5 inches high.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant relief piping, and safety devices from test pressure if they are not rated above the test pressure.
3. Test piping of each system at not less than 225 psig.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, piping, controls and electrical connections for proper assembly, installation, and connection.

C. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

D. Prepare test and inspection startup reports.

3.8 WARRANTY PERIOD TESTING

A. Within one month of warranty period expiration, perform testing, analysis, and reporting indicated for each chiller.

~~B. Oil Analysis (if applicable):~~

~~1. Take oil sample and solicit services of a third-party testing agency, specializing in such analysis, to perform oil analysis.~~
~~2. Submit analysis results and recommendations to Owner.~~

~~C.~~**B.** Refrigerant Analysis:

1. Take refrigerant sample and solicit services of a third-party testing agency, specializing in such analysis, to perform refrigerant analysis.
2. Submit analysis results and recommendations to Owner.

~~D.~~**C.** Site Access and Scheduling:

1. Contact Owner to schedule testing at least 30 days in advance of testing.
2. Make mutually agreeable schedule adjustments to accommodate Owner's request for testing.
3. Review, with Owner, requirements for visitors in advance of testing.
4. Comply with Owner requirements for visitors while on-site.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions and provide electronic copy to Owner. Refer to Division 01 for additional requirements.

1. Instructor shall be factory trained and certified.
2. Provide not less than twelve hours of training over a two day period.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION 236416
~~03/23/2018~~**Addendum No. 2 – 8/6/2018**