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addendum

addendum no.	01
date:	01/9/2019
bid date:	01/16/2019
project name:	MPS Central Middle School – Chiller Replacement
project no:	18353

This addendum is hereby made a part of the contract documents to the same extent as if it were originally included therein. Contract documents shall be considered modified or revised as hereinafter described.

general items

1. Pre-Bid Conference sign-in sheet is attached.

2. According to District Staff, the chilled water system currently contains no propylene glycol.

3. The District has first rights of salvage of all equipment. The District will salvage the existing chiller refrigerant. The District will provide containers, but it will be the responsibility of the Contractor to purge / recover the refrigerant from the chiller.

4. Plans call for all existing housekeeping pads to be removed and replaced. Contractor option to reuse existing pads provided they are in the correct location and of the correct size for new equipment. Enlarge existing pads as required.

mechanical items

1. The following manufacturers have been approved for the listed items. All items shall meet the requirements of the construction documents, specifications and are subject to review during the shop drawing process:

Specification Section	Item	Manufacturer
a. 232113	Strainers	Nexus
b. 236416	Centrifugal Chillers	Trane

2. Specification Section 236416 Centrifugal Water Chillers – numerous revisions. Entire section has been re-issued with changes shown in red text.

3. Sheet me1 – Demolition Plan – Modify deduct alternate limits to include existing condenser pump VFD and existing cooling tower VFD. See Sketch Sheet me1a.

4. Sheet me1 – New Work Plan – Modify deduct alternate limits to include new condenser water pump VFD and new cooling tower VFD. See Sketch Sheet me1a.

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5. Sheet me1 – New Work Plan – Modify location of new condenser water pump VFD. See Sketch Sheet me1a.

6. Sheet me1 – Add flag note E8: “Provide unistrut mounting frame for VFD as required to accommodate new equipment. Maintain NEC clearance requirements.”

7. Sheet me1 – Revise flag note MD9 to read “Deduct Alternate: Remove existing cooling tower VFD”.

8. Sheet me1 – New Work Plan – Change flag note pointing to the metal railing from MD10 to M9.

end of addendum

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attendance roster

project name: MPS Central Middle School – Chiller Replacement

project no: 18353

meeting location: Central Middle School

meeting date: January 08, 201 at 1:30 p.m.

subject: Pre-Bid Meeting

name	organization	phone	email
DAN BARNES	MECH. SYSTEMS	402-339-7277	dan@mechsystemsomaha.com
DAVID Ommen	Hayes Mechanical	402-718-2611	dommen@hayesmechanical.com
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Tyler Young	Data Power Mechanical	402-917-8117	tyoung@dptgroup.com
Adam Nielsen	MMC Contractors	402-215-2202	anielsen@mmccontractors.com
Adam Buzbee	Prairie Mechanical	402-510-9755	abuzbee@prairiemech.com
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name	organization	phone	email
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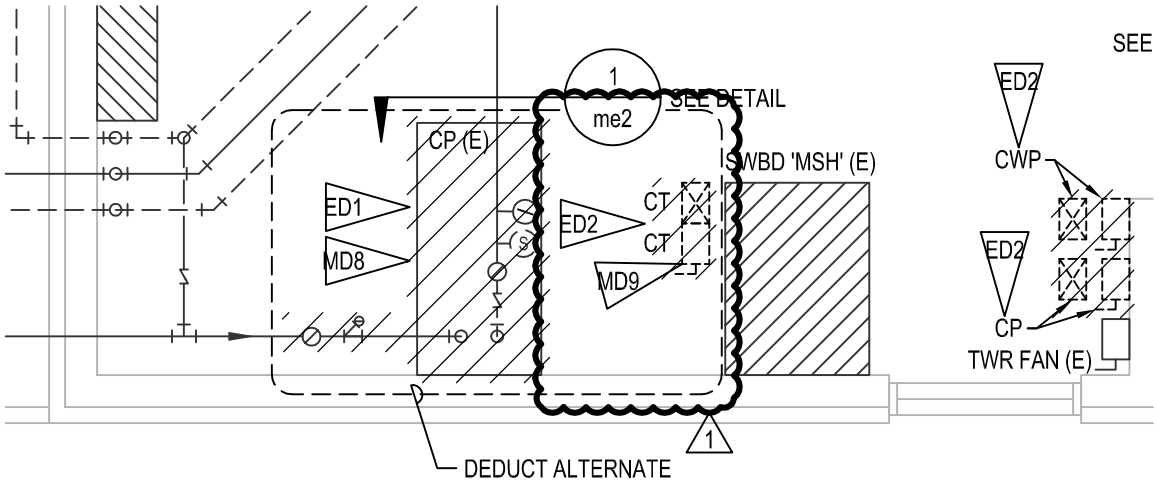

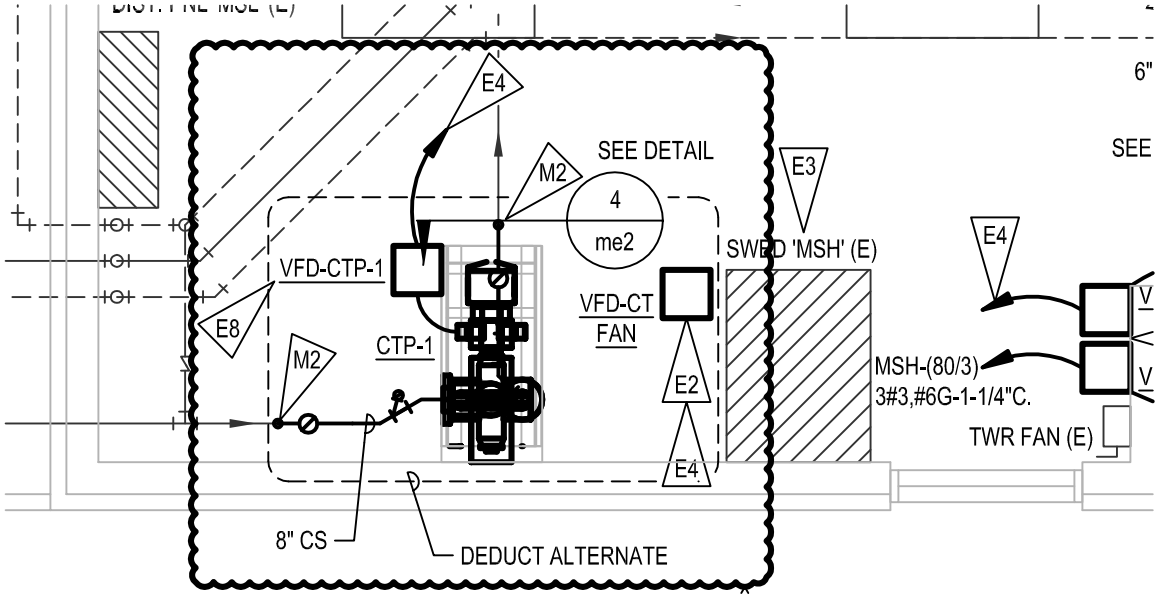

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Millard Central Middle School
Chiller Replacement
Omaha, NE

project no.:	18353	drawing referenced:	me1
date:	01/09/19	addendum no.:	1

sketch me1a

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.

B. The Owner has contracted directly with the Commissioning Authority (CxA) for this project. All Contractors shall cooperate with the CxA to complete all required commissioning. Specification Section 019113 defines the Contractor's responsibilities with respect to the process. The Contractor shall review this section and shall include in their bids the work associated with the commissioning effort described.

1.2 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, electric-motor-driven centrifugal chillers utilizing magnetic-bearing, lubrication-free technology.

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 SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. Performance at AHRI standard conditions and at conditions indicated.
3. Performance at AHRI standard unloading conditions.
4. Minimum evaporator flow rate.
5. Minimum condenser flow rate.
6. Refrigerant capacity of chiller.
7. Fluid capacity of evaporator, condenser.
8. Characteristics of safety relief valves.
9. Minimum entering condenser-fluid temperature.
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.
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.

C. 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 scale.
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.

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

E. Source quality-control reports.

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

G. Sample Warranty: For special warranty.

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

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

J. Tool kit to include the following:

1. A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.
2. Special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size shall be at least 1 inch high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 1/2 inch high.

K. 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.

1.5 QUALITY ASSURANCE

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

B. Chiller manufacturer's plant shall be ISO Registered.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 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 charge.
b. Complete compressor and drive assembly, including refrigerant charge.
c. Refrigerant charge.

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

d. Parts and labor.

2. Warranty Period: Two 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 40 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 55 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 the following in lieu of AHRI 550/590:

1. Allowable Capacity Tolerance: Zero percent.
2. Allowable Full-Load Energy Efficiency Tolerance: Zero percent.
3. Allowable Part-Load Energy Efficiency Tolerance: Zero percent.

D. Sound Performance:

1. Sounds pressure for the unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound pressure data shall be measured according to ARI Standard 575-08 and shall be in dB.

% Load	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	dBA
100	66.5	66.5	71.5	71.0	69.5	71.0	68.5	63.0	77.0
75	66.0	66.0	70.0	69.0	68.0	70.5	65.5	59.5	75.0
50	65.0	65.5	68.5	65.5	65.5	68.5	60.5	55.5	73.0
25	65.0	67.0	69.5	66.0	63.5	67.0	57.5	55.0	71.0

E. ASHRAE Compliance:

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

F. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

G. 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.

H. 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.

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

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin Applied.
2. Trane
3. YORK; a Johnson Controls company.

2.3 MANUFACTURED UNIT

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

2.4 COMPRESSOR-DRIVE ASSEMBLY

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

B. Lubrication-Free Technology:

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

a. Magnetic 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. 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, precision ground.
2. Impeller: High-strength cast-aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.
3. Compressor castings shall be designed for 235 psig working pressure and hydrostatically pressure tested at 355 psig.

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

1. Seals: Seal drive assembly to prevent refrigerant leakage.
2. During a power failure event, the magnetic bearings shall remain active throughout the compressor coast down.
3. Rolling element bearings shall be provided as a backup to the magnetic bearings, and designed for emergency touch down situations. Touch down bearings shall be designed for a minimum of 100 touch downs over the life of the chiller. If touch down bearings are not designed for a minimum of 100 touch downs, provide at no cost to the owner, replacement of touch down bearings for the life of the chiller, with the chiller bid.

E. Compressor Motor:

1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
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. Capacitor Banks:

1. Capacitor bank shall be designed for the 30-year life of the chiller. If capacitor bank is recommended to be replaced prior to the 30-year life of the chiller, provide at no cost to the owner, replacement of capacitor bank for the life of the chiller with the chiller bid.

G. 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. Overspeed Test: At least 25 percent above design operating speed.
2. Vibration Limits: Velocities not to exceed 0.15 inches/s and 0.8 mils peak to peak on all axes.

H. 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.

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 10 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design of entering condenser-fluid temperature.
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.

2.5 REFRIGERATION

A. Refrigerant:

1. Type: R-134a; ASHRAE 34, Class A1.
2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

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-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 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 a manual isolation valve to allow for isolation and storage of full refrigerant charge in the chiller condenser shell, or provide a separate pumpout system and storage tank sufficient to hold the charge of the largest unit being furnished. Check valves are not acceptable due to unreliable operation and premature failure.

2.6 EVAPORATOR

A. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell. 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: 3/4 or 1 inch.
5. Minimum Wall Thickness: 0.035 inch at the plain lands contacting the intermediate tube supports and end sheets..
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. Standard type for water box with piping connections; standard type for water box without piping connections.
3. Provide water boxes with lifting lugs or eyebolts.
4. Nozzle Pipe Connections: Grooved for mechanical-joint coupling.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. 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. 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: 0.035 inch at the plain lands contacting the intermediate tube supports and end sheets.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Smooth.

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. Standard type for water box with piping connections. Standard type for water box without piping connections.
3. Water boxes shall have lifting lugs or eyebolts.
4. Nozzle Pipe Connections: Grooved for mechanical-joint coupling.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. 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 C534, Type I for tubular materials and Type II for sheet materials.

1. Thickness: 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 nonfused disconnect switch. Minimum short circuit current rating (SCCR) according to UL 508 shall be as required by electrical power distribution system, but not less than 42,000 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.

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 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 42,000 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 90 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 or chiller control enclosure. 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. Active Harmonic Distortion Filter per IEEE Std. 519:

1. Factory mounted and wired to limit total voltage and current distortion to 5 percent.

Q. Cooling: Condenser water 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.

2.11 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. Factory provided control transformer integral to control enclosure suitable for all control power requirements.

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. Fluid flow of evaporator and condenser.
12. Fluid-pressure drop of evaporator and condenser.
13. Refrigerant pressures in evaporator and condenser.
14. Refrigerant saturation temperature in evaporator and condenser shell.
15. Compressor refrigerant suction and discharge temperature.
16. Compressor bearing temperature.

17. Motor bearing temperature.
18. Motor winding temperature.
19. Phase current.
20. Percentage of motor-rated load amperage.
21. Phase voltage.
22. Demand power (kilowatts).
23. Energy use (kilowatt-hours).
24. Power factor.
25. 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.

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. Current limit and demand limit.
3. Condenser-fluid temperature.
4. External chiller emergency stop.

F. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
1. Low evaporator-fluid temperature.
2. High compressor-discharge temperature.
3. Loss of condenser-fluid flow.
4. Loss of evaporator-fluid flow.
5. Motor overcurrent.
6. Motor overvoltage.
7. Motor undervoltage.
8. Motor phase reversal.
9. Motor phase failure.
10. Sensor- or detection-circuit fault.
11. Processor communication loss.
12. Motor controller fault.
13. Extended compressor surge.

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

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 one coat of alkyd-modified, vinyl enamel finish with a total dry film thickness of at least 2 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.

2.13 ACCESSORIES

A. Thermal-type flow sensor integral to chiller controls.

B. Vibration Isolation:

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

a. Two layers of 0.375-inch-thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
b. Fabricate pads from 40- to 50-durometer neoprene.
c. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

2.14 SOURCE QUALITY CONTROL

A. Perform functional run tests of chillers before shipping.

B. Factory Performance and Sound Testing:

1. Factory performance test chillers, before shipping, according to AHRI 550/590.
2. Test the following conditions:

a. Design conditions indicated.
b. Additional test points:
   1) 75% Load with 75 deg. F ECWT
   2) 50% Load with 65 deg. F ECWT
   3) 25% Load with 50 deg. F ECWT
c. Reduction in capacity from design to minimum load in steps of 25 with condenser fluid at design conditions.

3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Eddy Current Testing:

1. Perform factory testing of evaporator and condenser tubes of each chiller to ensure tube quality and longevity.
2. Submit test report, including, as a minimum:

a. List of equipment used and equipment settings.
b. Test data reports and accompanying strip charts of calibrations.
c. Identify tubes with significant defects and typical indications.
d. Statistical summary of defect indications.
e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

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. Equipment Mounting:

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in other Division 23 sections.

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

D. Maintain clearances required by governing code.

E. Chiller manufacturer's factory-trained service personnel shall charge chiller with refrigerant if not factory installed.

F. 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." 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, 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, 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, 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 vent piping to the outdoors without valves or restrictions.
2. Comply with ASHRAE 15.
3. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

F. 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.

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

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Division 26.

B. Ground equipment according to Division 26.

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 "HVAC Instrumentation and Controls".

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 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. Verify proper motor rotation.
7. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
8. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
9. Verify and record performance of chiller protection devices.
10. 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.

3.7 WARRANTY PERIOD TESTING

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

B. Eddy Current Testing:

1. Solicit services of a third-party testing agency, specializing in such analysis, to perform testing of evaporator and condenser tubes, to ensure tube quality and longevity.
2. Submit test report to Owner, including, as a minimum:

a. List of equipment used and equipment settings.
b. Test data reports and accompanying strip charts of calibrations.
c. Identify tubes with significant defects and typical indications.
d. Statistical summary of defect indications.
e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.

f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

C. 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. 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.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.

1. Instructor shall be factory trained and certified.
2. Provide not less than four hours of training.
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