THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Chilled Water Infrastructure Expansion East Chiller Plant

SCO ID 22-25588-02G, Code: 42123-355 / 42323-305
UNC Bldg. No. 505

Prepurchased Equipment Electric Centrifugal Chillers Bid Set

Submitted by:

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AEI Project No. 23480-02

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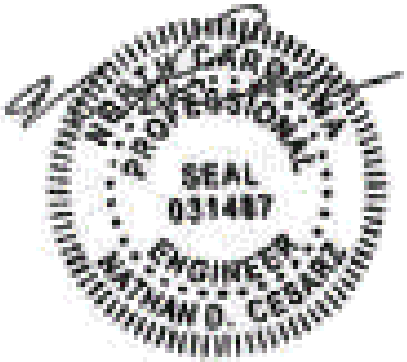

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SECTION 23 6000
PRIMARY COOLING EQUIPMENT

PART 1 – GENERAL

1.1 OWNER PRE-PURCHASED EQUIPMENT

A. This equipment will be prepurchased by the Owner and furnished to the successful Contractor after award for expediting delivery and installation as if the Contractor purchased the equipment directly.

B. Owner will make available manufacturer provided shop drawings of Owner prepurchased equipment for review by the Contractor. Contractor shall review shop drawings to ascertain that Contractor has included necessary labor and materials to install equipment and complete system it serves.

C. Contractor shall be responsible for arranging/coordinating delivery of Owner prepurchased equipment and all other related logistics and activities. This includes directing the delivery truck to the jobsite, coordinating the date and time of delivery, and receipt of the equipment at the jobsite. Manufacturer is responsible for equipment until it is unloaded by the Contractor and set/reassembled at the jobsite.

D. Contractor shall install Owner prepurchased equipment and all appurtenances. This shall include, but not be limited to; unloading, rigging and setting equipment in place, making connections, starting, testing and installing equipment in accordance with manufacturer's recommendations, and maintaining equipment until such time as project is accepted by Owner. Perform all work and provide materials and connections for Owner furnished equipment in accordance with drawings and scope of work under all related specifications.

E. The following summarizes the general responsibilities of the equipment manufacturer:
   1. Provide shop drawings and submittal data.
   2. Manufacture and delivery of equipment including coordination of exact delivery date and supervision of rigging, unloading, and setting.
   3. Lead equipment check-out, testing, and start-up process and submit report(s).
   4. Provide touch up paint.
   5. Provide O&M documentation.
   6. Provide Owner training and participate in commissioning process.

1.2 SCHEDULE

A. Schedule:
   1. The following schedule is anticipated relative to the prepurchased equipment delivery, installation and activation. This is a preliminary schedule and exact dates are to be coordinated with the Owner and Contractor.
      a. Equipment Delivery: October 2025
      b. Installation, Start-Up & Commissioning: November 2025 – November 2026

B. Manufacturer shall be able to produce, test, and deliver the equipment (FOB) to a location dictated by the Contractor per the schedule described above.

C. Contractor shall plan construction to allow for equipment to be received and installed at the job site within the above delivery window. If Contractor is unable to install equipment upon coordinated delivery date(s), it is the Contractor's responsibility to provide appropriate storage for equipment, local to the University, and provide transportation of equipment from storage site to job site.

1.3 DESCRIPTION

A. Provide three (3), 480V, electric, factory assembled, centrifugal chillers complete with compressor, motor, unit mounted variable speed drive (VSD)/adjustable frequency drive (AFD), evaporator, condenser, microprocessor controls, graphics and all required ancillary equipment including mobile refrigerant pump out unit. The chillers shall be configured as a simplex compressor unit with integrated controls and will be field installed to operate in a headered, variable primary chilled water pumping system. The chillers will also be connected to a new headered condenser water system.

B. Each chiller shall have a guaranteed capacity of 1,400 tons at the design conditions that are listed in the table in Part 5 of this section.

C. Based on space limitations within the existing ECP, the maximum chiller dimensions cannot exceed the following:

1. Overall unit length: 22’-0”.
2. Chiller width including unit mounted VSD: 12'-0".
3. Chiller height: 12’-9”.

D. The opening(s) in the north wall of the existing plant building will limit the height of the chillers being rigged into position. The available height between the existing finished floor elevation and the underside of the exterior soffit is 11’-0” not including the proposed 0’-3.5” concrete housekeeping pads, neoprene rubber isolation pads, or any rigging devices or equipment. See image below.

If the chiller being offered cannot be moved into the plant fully assembled, the manufacturer shall be responsible for any, and all, disassembly or reassembly that may be required. The manufacturer shall be responsible for coordinating the chiller shipping breakdown and related requirements for rigging the chiller and/or its components into the plant with the installing Contractor.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The equipment Manufacturer shall provide Industrial equipment that is the manufacturer's standard product.

B. Service Representatives: The equipment service representative shall be a factory trained and certified agent of the equipment manufacturer.

C. Single source responsibility: Provide a source with responsibility and accountability to answer and resolve problems regarding compatibility, installation, performance and service. All chiller components, which includes VSD/AFD shall be supplied and serviced by chiller manufacturers local branch organization.

D. Comply with referenced code and standards. Provide listings/approval stamp, label or other markings on equipment made to specified codes or standards.

E. Codes and Standards: Products shall be designed, tested, rated, and installed in compliance with the latest edition of the following standards, as applicable.
   1. ANSI/ASHRAE STANDARD 15 - Safety Code for Mechanical Refrigeration.
   2. ANSI/ASHRAE 90.1 Energy-Efficient Design of New Nonresidential & High-Rise Residential Buildings.
   3. ASME Boiler and Pressure Vessel Code/Section VIII, Division 1.
   4. AHRI Standard 550 / Centrifugal or Rotary Water Chilling Packages.
   5. ASME B31.5 Code for Pressure Piping – Refrigerant Piping.
   6. ABMA – Anti-Friction Bearing Manufacturer's Association.
   7. HEI - Heat Exchange Institute

F. Ratings and Certifications: Products shall be rated and certified in accordance with the following:
   1. Conform to AHRI Standard 550/590 for rating and testing of centrifugal chillers.
   2. Conform to UL 465 for construction of centrifugal chillers and provide UL/CUL label.
   3. Conforms to ASME Boiler and Pressure Vessel Code/Section VIII, Division 1.
   4. Conform to ANSI/ASHRAE Standard 15 (latest edition) for construction and operation of centrifugal chillers, safety code for Mechanical Refrigeration.

1.5 BID SUBMITTALS

A. The following shall be provided with the equipment bid proposal:

1. Complete chiller bid summary data sheet included in Part 5 of this section and submit with other bid documentation to allow for evaluation and selection of the best overall value equipment by the Owner for each chiller. Voluntary alternates will be accepted and considered for evaluation.
2. Cover letter with compliance table listing each specification section and indicating compliance “C”, deviation for alternate “D”, or exception with explanation “E”. Any deviation or exception shall be accompanied with detailed explanation of how design intent is being upheld for evaluation by the Owner and Designer.
3. Detailed drawings of the proposed equipment shall be provided including a top view, right side view, left side view and front view. The drawings shall indicate the dimensions of the unit, locations and sizes of all connections, and recommended service clearances.
4. Detailed electrical wiring diagram that indicates all required field wiring for power, control and communication.
5. Detailed description of controls interface requirements (physical and communication) between the equipment’s local control system and the plant/Owner’s Distributed Control System (DCS).

B. Product data including:
1. Type of motor (open or hermetic).
2. Number of compressors and stages.
3. Type of refrigerant.
4. Refrigerant charge (lbs).
5. Number and type of bearings.

C. References: a complete list of references shall be provided with each Proposal. The list shall include a minimum of five (5) references where equipment of similar manufacturer type and capacity has been installed. The list shall indicate the name of the facility where the equipment has been installed, location (city and state) of the equipment, installation date, equipment capacity, contact name and contact telephone number of each reference.

D. Scheduled Maintenance Requirements: A complete list of the recommended scheduled maintenance requirements for the equipment shall be provided with each Proposal. The list shall identify each recommended service item and its recommended frequency (monthly, quarterly, etc.). The list shall, at a minimum, include the scheduled maintenance items identified.

E. Other information to verify compliance with the Request for Bids.

F. Award will be based on specification compliance and best overall value for the Owner.

1.6 FABRICATION SUBMITTALS

A. Shop Drawings: Detail chiller and auxiliary equipment assemblies and indicate plans, elevations, sections, component details, attachments, and other construction elements. Include the followings:

B. General
   1. Manufacturer's name and model number
   2. Identification as referenced in the documents
   3. Type of chiller - principle of operation
   4. Installation and operating manuals.
   5. Manufacturers signed report/log of the installation and start-up.
   6. Performance
   7. Refrigerant Type
   8. Capacity (Tons)
   9. Compressor and product data in table form indicating impeller speed (RPM), number of bearings, type of bearings, high speed impeller shaft RPM, number of stages, number of sets of inlet guide vanes, amount of refrigerant charge (lbs), and amount of oil required (gal).
   10. Compressor performance curves, compressor surge map
   11. Chilled-Water Temperatures-EWT in Deg. F
   12. Chilled-Water Flow in GPM
   13. Evaporator Pressure Drop in Feet
   14. Evaporator Fouling Factor.
   15. Condenser Water Temperatures-EWT in Deg F, -LWT in Deg F.
   16. Condenser Water Flow in GPM.
   17. Condenser Pressure Drop in Feet.
   18. Condenser Fouling Factor.
   19. Certified performance data with and without “zero tolerance” requirements specified herein.
   20. Sound ratings.
   21. Heat rejection to plant space (Btu/hr).

C. Physical and Dimensional
   1. Materials of construction.
   2. General arrangement drawings in .pdf and 3D CAD/Revit files.
   3. Assembled unit dimensions.
   4. Weight loadings, distribution and structural supports.
   5. Required clearances for maintenance and operation, including working clearances for mechanical controls and electrical equipment.
   6. Size and location of field connections and piping installation requirements.
   7. Auxiliary equipment descriptions.

D. Electrical and Controls
   1. Compressor (kW), Full Load Amps, Locked Rotor Amps
   2. Motor data
   3. Unit mounted VSD/AFD Data

4. Complete interlocking and line diagrams of all electrical wiring required between machine control panel, ASD/VSD, temperature control devices and the chiller plant's control system.
5. Wiring and interlocking diagram shall include all components of system such as chillers, cooling towers, system pumps, automatic valves, flow switches.
6. Differentiate between manufacturer-installed and field-installed wiring.
7. Controls description
8. P&ID's (chilled water, condenser water, and refrigerant)
9. MODBUS object list for each chiller.

E. Complete description of the proposed equipment maintenance training program including dates and locations. Include a complete listing of all documentation that will be provided during training program. This may include installation manuals, operation full maintenance and overhaul manuals, service manuals and bulletins, troubleshooting guides, etc.

F. Factory Test Reports: Perform and interpret test results for compliance with specifications requirements as appropriate.

1.7 OPERATION AND MAINTENANCE MANUAL SUBMITTAL

A. Prior to start-up of the equipment and related Owner Training, submit operations and maintenance manual in accordance with the following.

B. Manual shall include:
1. Manufacturer's name, model number, service manual, spare parts list, and descriptive literature.
2. Names, addresses and contact information for equipment local service representative(s).
3. Copies of final approved Shop Drawings and Product Data Submittals.
4. Instructions for starting and operating the equipment provided.
5. Complete maintenance instructions including preventive maintenance instructions and schedules for equipment.
6. Detailed one-line, color-coded wiring diagrams.
7. Inspection procedures.
8. List of most frequently encountered repairs and trouble-shooting manual(s).
9. Copies of warranties.

C. Manual submission process:
1. Submit a bookmarked digital draft file (.pdf) of the O&M Manual to the Designer for review and comment.
2. Upon acceptance by the Designer submit the final digital file (.pdf) of the O&M Manual along with two (2) hard copies bound in heavy duty 3-ring binders with table of contents and appropriate dividers to the Owner for use/reference during Owner Training sessions.

1.8 SPARE PARTS

A. Provide chiller and VSD manufacturer's recommended complete spare parts kit and address of local supplier stocking location. Spare parts shall be labeled with name and part number. Spare parts shall be stored on-site.

B. Three (3) spare sets of sacrificial magnesium anodes.

C. One (1) quart of finish paint shall be provided with each chiller.

D. Turnover any chiller control panel or VSD enclosure keys to the Owner.

1.9 WARRANTY

A. Equipment Manufacturer shall provide five (5) year full parts and labor warranty from the date of Project Final Acceptance for the complete chiller and associated systems including unit mounted variable speed drives, and associated auxiliaries, including refrigerant, oil and start-up services. Start-up services and labor warranty shall be performed by factory employed service technicians. Manufacturer shall agree to replace any and all chiller related components that are provided on the project at no cost to the Owner during the selected warranty period.

B. All written warranty claims by the Owner shall be responded to by the manufacturer within 24 hours including a site visit and diagnosis. Prior to leaving the site, a repair schedule shall be mutually established between the Owner and the manufacturer. If the manufacturer fails to meet the repair schedule, the Owner reserves the right to make the necessary repairs. The cost for the Owner to make the repairs shall be invoiced to the manufacturer by the Owner. Through submittal of a bid on this project, the manufacturer is obligated to reimburse the Owner for such repairs (Net 30 days).

PART 2 - PRODUCTS

2.1 CENTRIFUGAL REFRIGERATION MACHINES

A. Acceptable Manufacturers:
   1. Daikin
   2. Trane
   3. York
   4. Carrier

B. General:
   1. The chiller shall be designed, selected, and constructed to use refrigerant R-513a, R-514a, or R-1233zd(E) and meet the capacity requirements specified herein. Units with low pressure refrigerants shall also be provided with high efficiency purge. All chillers shall be provided with a full charge of oil and refrigerant.

2. Chiller shall consist of, but not limited to, a complete system with compressor, motor, evaporator, condenser, lubrication system, integral sub-cooler or flash economizer, capacity controller, control panel, unit mounted variable speed drive, and other items as specified herein or required.

C. Performance

1. Bids shall include name of manufacturer, model number, and performance data, including capacity (tons (kW)), input electrical power (KW), part load data at 100%, 85%, 80% and 75% and kW/tons (kW/kW) (IPLV value) in accordance with AHRI Standard 550/590-98 and maximum sound pressure measured in accordance with AHRI Standard 575-94.
2. Chillers shall conform to the latest edition of ASHRAE 15 Safety Code.
3. Evaporator shall be designed to allow for the flow rate to be reduced to the rate of 1.0 gpm per ton without entering laminar flow to allow for variable chilled water flow and facilitate chilled water pump energy savings. The chiller shall be able to operate in a stable fashion at this condition for at least 8 hours continuously independent of condenser water flow rate or condenser water temperature relief.
4. Condenser shall be designed to allow for the flow rate to be reduced to 1.5 gpm per ton without entering laminar flow to allow for variable condenser water flow and facilitate condenser water pump energy savings. The chiller shall be able to operate in a stable fashion at this condition for at least 8 hours continuously independent of chiller water flow rate or condenser water temperature relief.
5. Each chiller shall be capable of extended operation and start-up with 55°F entering condenser water temperature (ECWT) to take full advantage of off-design performance. Manufacturer shall provide a written guarantee, signed by and officer of the company, that the chiller will operate continuously at low ECWT. Variations in condenser water flow may be permitted, but must be noted at the time of submission of the bid.

D. Evaporator and Condenser Vessels:

1. Two-pass Shell-and-tube type, designed and constructed and so stamped and registered with National Board, in accordance with the latest ASME Code Section VIII, Division 1 for unfired pressure vessels. Provide taps for vents and drains.
    a. Design water side for 150 psig working pressure and perform hydrostatic pressure test at 225 psig.
    b. The refrigerant side shall be hydrostatically tested at Manufacturer's factory in accordance with ASME Code. Low pressure machines may be air tested in lieu of hydro tested and tested in accordance with the ASME Code.
2. Evaporator and condenser shells to be fabricated from carbon steel. Tube sheets to be carbon steel, drilled and reamed to accommodate the tubes, and welded to the end of each shell. Intermediate tube supports to be fabricated of carbon steel plates, maximum spacing 4'-0".
3. Each tube shall be roller expanded into the tube sheets providing a leak-proof seal. Tubes to be individually cleanable and replaceable with tube ends rolled into annular grooves/holes in tube sheets.

a. Condenser tubes to be seamless copper tubing with minimum tube wall thickness of 0.028" at the root of any fins. All condenser tubes shall be the exact same diameter to accommodate an automatic tube cleaning system.

b. Evaporator tubes to be seamless copper tubing with minimum tube wall thickness of 0.025" at the root of any fins.

4. A suction baffle or aluminum mesh eliminators shall be installed along the entire length of the evaporator to prevent liquid refrigerant carry over into the compressor. Oil eductors, capable of returning oil to the oil sump, shall be provided on all evaporators.
5. Evaporator shall be of such design to prevent liquid refrigerant from entering compressor.
6. Provide two (2) 2” sight glasses on chiller vessels to view refrigerant levels.
7. Size and location main evaporator and condenser fluid piping connections shall be as shown on the drawings.
   a. Piping connections to unit 2-1/2" in diameter and larger shall be flanged type, Class 150, welding neck style, ASTM A181 or A105, ANSI B16.5, hot forged steel. Slip on type flanges or grooved connections are not acceptable. Piping connections to unit 2" in diameter and smaller shall be screwed FNPT.
8. Furnish marine water boxes on the pipe connection end of chillers and hinged cover plates on the opposing end. Marine water boxes shall be equipped with hinged of davited cover plates for complete access for condenser and evaporator without removal of system piping on either end. Water boxes shall have vents, drains, covers and suitable tappings for control sensors, gauges and thermometers.
9. Provide factory applied protective ceramic coating on all wetted steel surfaces of the condenser bundles.
   a. Coating shall be warranted by the Chiller Manufacturer for no less than the same warranty period as the chiller.
   b. Surface preparation to be performed in strict accordance with coating manufacturers instructions.
   c. Stainless steel materials shall be provided where a coating is ineffective in protecting the substrate such as on the removable waterbox baffles, baffle channels, and threaded couplings.
   d. Waterboxes shall be designed and constructed to facilitate protective coating performance, considerations such as no sharp edges or internal seams included.
   e. The assembled bundles shall be hydro leak tested after coating is applied.
10. Provide sacrificial magnesium anodes on each end of the condenser bundles. Anodes shall be replaceable from the outside without removal of the end plate. The quantity of anodes is based on the size and volume of the chiller and shall be determined by the chiller manufacturer. All hardware associated with the mounting/attachment of the sacrificial anodes shall be stainless steel.

E. Compressors:
   1. Shall be direct driven or gear driven, single or multiple stage design.

2. Capacity control shall be provided by fully modulating variable inlet guide vanes and shall allow capacity modulation from 100% to 20% of design capacity without hot gas bypass.
3. Airfoil shaped cast manganese bronze pre-rotation guide vanes (PRV) shall be precisely positioned by solid vane linkages connected to an externally mounted electric PRV actuator.
4. Compressor shall have a cast-iron casing.
5. Impeller shall be high strength, cast aluminum-alloy, statically and dynamically balanced.
6. Compressor assembly shall be overspeed tested at the factory at minimum of 115% of the design impeller shaft speed.
7. Balance and align motor-compressor assembly to a maximum vibration amplitude of 1.0 mil as measured at the shaft.
8. Factory alignment and vibration reports shall be completed and submitted to the Designer.
9. Chiller shall be able to unload down to 25% at constant entering condenser water (85 F) without going into surge.

F. Compressors coupled with Open Motor:
1. Shall be direct driven or gear driven, single or multiple stage design.
2. Capacity control shall be provided by fully modulating variable inlet guide vanes and shall allow capacity modulation from 100% to 20% of design capacity without hot gas bypass.
3. Airfoil shaped cast manganese bronze pre-rotation guide vanes (PRV) shall be precisely positioned by solid vane linkages connected to an externally mounted electric PRV actuator.
4. Compressor shall have a close grain cast-iron casing.
5. Impeller shall be fully shrouded and made of high strength, cast aluminum-alloy.
6. The impeller shall be statically and dynamically balanced.
7. Insert type journal and thrust bearing constructed of aluminum alloy shall be provided.
8. The shaft seal shall be provided with a double bellows ceramic seal.
9. Compressor assembly shall be overspeed tested at the factory at minimum of 120% of the design impeller shaft speed.
10. Balance and align motor-compressor assembly to a maximum vibration amplitude of 1 mil as measured at the shaft.
11. Factory alignment and vibration reports shall be completed and submitted to the Designer.
12. Chiller shall be able to unload down to 25% at constant entering condenser water (85°F) without going into surge.

G. Motors:

1. Shall be premium efficiency, open drip-proof or hermetically sealed, non-reversing squirrel cage, induction suitable for the voltage shown on the equipment schedule and operation with the unit mounted variable speed drive. Full load operation of the motor shall not exceed nameplate rating.
2. Open motors shall be provided with a NEMA D-flange configuration for open motors. Bolted cast iron adapter shall be provided to allow the motor to be rigidly coupled to the compressor, providing factory alignment of motor and compressor shafts, and to allow access to the motor for repair without removing refrigerant charge from the chiller.
3. Hermetically sealed motors shall premium efficiency, squirrel cage, induction. The motor shall be rigidly coupled to the compressor, providing factory alignment of motor and compressor shafts.
4. Furnish motors with insulated bearings as required to prevent bearing to shaft current.
5. Chillers utilizing open motors shall be provided with an oil reclaim basin. Shaft seal shall be double face bellows type or floating carbon ring, oil film type. Maximum oil and refrigerant leakage rate of the shaft seals shall be less than 25 fluid ounces of oil per 1,000 hours of chiller operation and less than 5 fluid ounces of refrigerant per 1,000 hours of chiller operation.
6. General:
    a. Motor shall meet the following requirements:
        1) Service factor - 1.04 (minimum)
        2) Locked rotor torque - 60 percent of full load torque
        3) Pull-up torque - 60 percent of full load torque
        4) Breakdown torque - 175 percent of full load torque
        5) Hot locked-rotor damage time - 125 percent of calculated acceleration time.
        6) Minimum efficiency – 96%
    b. Motor shall operate successfully at rated load, with rated frequency and +10 percent of rated voltage.
    c. Motor shall operate successfully at rated load, with rated voltage and +5 percent of rated frequency.
    d. Motor shall operate successfully at rated load with +10 percent combined variation of voltage and frequency, frequency variation not to exceed +5 percent.
7. Enclosure(Open Motors):
    a. Motor enclosure shall be open drip-proof guarded type or hermetically sealed of cast iron frame and bracket construction with welded steel top cover if required. 360 degrees concentric rabbet fits shall be utilized without dowels for bracket to frame alignment. Provide lifting lugs with a 5x safety margin.
    b. Provide acoustical motor enclosure as required to meet the noise criteria specified later in this section.

c. Provide oversized conduit box and appropriate termination kit to allow for connection of feeder cables of the size shown on the “E” series drawings with ground to motor leads.

8. Enclosure (Hermetically Sealed)
   a. Motor enclosure shall be hermetically sealed of cast iron frame and bracket construction. Provide lifting lugs with a five times (5x) safety margin.
   b. Provide oversized conduit box and appropriate termination kit to allow for connection of feeder cables with ground to motor leads.
9. Stator:
   a. Laminations shall be high permeability, low loss silicone steel with C7 core plate.
   b. Magnet wire is enamel film rectangular copper wire.
   c. Insulation shall be rated Class H components with 800°C temp rise at 1.0 service factor when ambient temperature is 400°C.
   d. Stator winding slot material shall be Nomex type as a minimum.
   e. Stator coils shall individually receive surge comparison testing per IEEE 522 after insulation and prior to insertion of coils into each stator. In addition, surge testing is required prior to final connection of each coil after all are inserted, and on the final fully connected stator, before VPI processing.
   f. Sealed wound stators shall be provided in conformance to NEMA MG1-20.49.
   g. Stator processing shall utilize 100% solids epoxy resin with a minimum of two VPI/baking cycles (both sides). Stators shall not be processed while in the motor frame.
   h. Every complete, finished wound stator shall receive and pass the water submersion test per NEMA MG1-20.49.1. A certified report shall be provided for each submersion test.
10. Rotor/Shaft:
    a. Rotors shall be copper bars.
    b. Rotor laminations shall be manufactured and tested the same as described for stator laminations.
    c. Rotors shall be keyed to the motor shaft and utilize an interference fit to the shaft.
    d. Shafts shall be designed to carry 4x rated torque.
    e. The rotor/shaft assembly shall be dynamically balanced.
11. Bearings
    a. Conventional or Magnetic bearings are acceptable.
    b. Conventional Type Bearings:
       1) Sleeve bearings shall be split type and have SAE 12 high tin content Babbitt in a SAE 40 bronze backed shell. Iron or steel backed sleeve bearing shells are not acceptable.
       2) Sleeve bearings shall have their oil sump cast as an integral part of the end shield/bracket.

3) Sleeve bearings shall utilize solid oil rings for self lubrication, and shall be provided with a means of visually observing oil rings during operation. Two oil rings shall be supplied, both with trapezoidal cross section.

4) The bearing caps shall be removable, such that the bearings may be inspected and replaced without disturbing the compressor/motor coupling.

5) An oil level sight gauge shall be supplied to monitor oil level.

6) Insulated bearings shall be provided where required. A minimum of one in the opposite drive and on anti-friction bearings, two (each end) on sleeve bearings. Insulation shall be located on the bearing shell. Insulated capsules are not acceptable.

7) Motor oil shall be synthetic turbine oil with rust and oxidation inhibitors with a viscosity of 150-180 SSU at 100°F (37.8°C) (ISO-VG-32). Viscosity index shall not be less than 95.

c. Magnetic Type Bearings:

1) Levitated shaft shall be actively controlled and monitored by an X-, Y-, and Z-axis digital position sensor.

2) The compressor shall be capable of coming to a controlled, safe stop in the event of a power failure by utilizing integral backup power to the magnetic bearing control system.

12. Accessories:

a. Provide oversized conduit box and appropriate termination kit to allow for connection of feeder cables with ground to motor leads.

b. Winding Temperature Sensors:

1) Provide winding temperature sensing devices and wire to the chiller starter control module for safety interlocks.

2) Six elements, two in each phase, are to be embedded in the calculated hottest portion of the stator winding. All leads are to be brought out to terminals in auxiliary terminal box. Each lead and each terminal shall be clearly and individually identified. All elements shall be grounded in terminal box.

3) Sensors are to be resistance thermometer (RTD) elements, platinum wire, 100 ohms, at 0°C, 3 lead type with stainless steel armor shielding for use with General Electric "IRT" or Westinghouse "CT" or "DT3" thermal relays.

4) Motor Manufacturer is to recommend trip setting for thermal relays.

5) Provide drawings showing the location and number of each sensing element in the stator winding.

c. Bearing Temperature Sensors:

1) Provide a minimum of one bearing temperature sensor for each bearing and wire to the chiller starter control module for safety interlocks.

2) Sensors shall be installed in bottom half of bearing, preferably within 10 to 20 degrees of the operating load point and drilled so that the sensor is separated from babbitt by 30 +5 mils of metal backing. Sensor leads shall be adequately protected against oil and mechanical damage and exit the bearing housing through an oil-tight fitting. Weatherproof terminal head with moisture-resistant terminals shall be provided outside the bearing housing. Sensor sheath or raceway shall not bypass the bearing insulation. Guides shall be provided so that the sensor may be removed and reinstalled without disassembling the bearing housing or disturbing the wiring system. Means shall be provided for spring loading the sensor tip against the bearing backing.

3) RTDs shall be platinum wire, 100 ohms, at 0°C, tip sensitive-probe type, three wire, with stainless steel armor shielding.

d. Accessory Terminal Boxes:

1) Box(es) shall be provided for leads from stator-temperature devices and bearing-temperature devices.

2) Box(es) shall be weatherproofed and gasketed with bolt on removable covers in front. Box(es) shall be outside motor enclosure or accessible by removing a gasketed subpanel on enclosure.

3) Box(es) shall be suitable for conduit entry through top or bottom.

4) Terminal points shall be furnished in the box(es) for all wiring. Terminal points shall be clearly identified per NEMA standard notation.

5) Permanent nameplates shall be provided on all terminal boxes.

e. Noise Level:

1) Motor noise level shall not exceed 85 dBA measured at one meter from motor enclosure surface in any direction.

2) Motor manufacturer shall correct motor noise levels exceeding the level specified above at no expense to the Owner.

3) Noise tests are to be conducted in accordance with IEEE Standard No. 85.

f. Testing:

1) Routine testing shall meet or exceed NEMA minimum standards.

2) A dynamic three phase locked rotor test shall be performed as part of the routine test.

3) All vibration testing, routine and other, shall be performed on a rigid base, mounted to a seismic mass isolated from the building foundation.

4) Efficiency date shall be in accordance with IEEE Standard 112 Method B as defined by NEMA MG1-12.53a and 1-12.53b.

H. Refrigerant Flow Control:

1. Refrigerant flow to the evaporator shall be controlled by either a variable or fixed orifice. The variable orifice control shall automatically adjust to maintain proper refrigerant level in the condenser and evaporator. This shall be controlled by monitoring refrigerant liquid level in the condenser assuring optimal sub-cooler performance.

a. Provide each unit with fully automatic capacity control system, complete with variable speed drive and inlet guide vanes, capable of fully modulating performance down to 10% of full load without surge at all ARI condenser inlet temperatures.
b. Capacity control system to permit stable operation of machine at any point within 10% to 100% capacity range.
c. Provide feed forward adaptive control to anticipate and compensate for load changes.

I. Capacity Control System:
1. Furnish each unit with fully automatic capacity control system, complete with inlet guide vanes, capable of fully modulating performance down to 10% of full load without surge.
2. Capacity control system to permit stable operation of machine at any point within 10 to 100% capacity range.
3. Control system to include automatic stopping when load falls below 10% and automatic restarting when load rises again to 10%.

J. Lubricating System:
1. Furnish unit with forced feed type lubrication system for proper lubrication of transmission and bearings providing positive supply of oil to all rotating surfaces even during power failure shutdown. System to include oil pump assembly, factory mounted oil pump starter, motor controls, cooler, heater, relief valve, pressure regulator, and filter for delivering thermostatically controlled clean oil at proper temperature.
2. Use chilled water source for cooler if required.

K. Accessories:
1. Purge System:
a. For low pressure chillers furnish each unit with factory installed, wired, and piped purge system suitable for removing non-condensable gases and water.
b. Purge system shall operate when chiller is off.
c. Purge system shall be high efficiency type complete with compressor, coil separator, air, water or refrigerant cooled condenser, purge tank, sight glass and necessary controls, and shall not purge more than 0.02 lbs (9g) of refrigerant per lbs (454g) of air when operating at condensing refrigerant temperature higher than 80ºF (27ºC).
d. Provide complete with excess purge shutdown with indicating light and alarm relay. Provide purge duration timer and refrigerant moisture indicator.
e. Provide a totalizer for number of purge starts.
2. Safety Relief Devices:

a. Provide redundant and re-seatable safety devices in accordance with ANSI B9.1 safety code ASME B31.5 and the latest version of ASHRAE Std. 15 on the evaporator and condenser consisting of rupture discs in series with spring loaded re-seatable relief valves. Provide valved and capped test port inline between rupture disc and relief valve to detect rupture disc failure. Multiple relief devices shall be brought to a common vent connection.

3. Vibration Isolation:
   a. Manufacturer to furnish properly sized 3/4" thick (min.) 50 duromater, neoprene rubber pads to Contractor to install below chiller support feet.

L. Control Panel and Instrumentation:
1. Furnish each unit with control center in locked enclosure, factory mounted and wired. Prior to shipment, controls test shall be executed to check for proper wiring and ensure proper control operation.
2. Control Panel: 10" minimum color display mounted on control panel door or on articulated arm. Color display shall show all system parameters in the English language with numeric data in English units. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays, switches and remote equipment including refrigerant leak detection system.
3. Controls shall be microprocessor based for automatic operation, display system parameters, programming of essential set points and failsafe safety control of machine. Controls to include the following:
   a. System pressure display to include evaporator/condenser refrigerant, and lubricating oil pressure.
   b. System temperature display to include return/leaving chilled water, return/leaving condenser water, and evaporator/condenser refrigerant saturation temperature.
   c. Indicators to highlight operation of oil pump and compressor loading/unloading/auto control.
   d. Set point programming to include leaving chilled water temperature, and demand limiting.
   e. Provide battery backup if memory is volatile.
   f. Annunciation of all safety controls indicating cause of shutdown and type of restart required.
   g. One set of dry contacts for remote indication of any safety trip or alarm condition.
   h. Adjustable rate at which chiller is allowed to load.
   i. Capability of manual operation of oil pump, compressor loading and unloading.
   j. Anti-recycle control to ensure safe time intervals between successive compressor motor starts.

k. Automatic safety shut-down for low evaporator refrigerant temperature or pressure, high condenser refrigerant pressure, low oil pressure, high compressor discharge temperature, high motor winding temperature, motor over current, over voltage, under voltage, power phase reversal, and bearing high temperature. Each of these cutouts shall have manual reset and cause alarm indication.

l. Provide self-diagnostics, including history for at least previous 10 shutdowns with time/date stamp and description.

m. Elapsed operating hours and number of starts meter.

n. Remote chiller start-stop upon input from building management system. Provide one set of dry contacts for remote indication of local-remote control and one set of dry contacts to indicate On/Off status of chiller.

o. Chilled water supply temperature reset proportionally based on remote 4-20 mA or 0-10 VDC input signal. Provide bypass switch to disable chilled water reset.

p. Chiller current limit input to limit maximum demand based on remote 4-20 mA or 0-10 VDC input signal in addition to programmed loading rate. Provide bypass switch to disable current limit.

q. Security:

1) Security access shall be provided to prevent unauthorized change of set points, to allow local or remote control of chiller, and to allow manual operation of the pre-rotation vanes and oil pump. The operating program shall be stored in non-volatile memory (EPROM) to eliminate chiller failure due to AC power failure or battery discharge. Programmed set points shall be retained in lithium battery-backed RTC memory for a minimum of 5 years.

r. Power failure restart: After a power failure and restoration of normal power, chilled water flow and condenser water flow, chiller must be capable of starting and reaching 100% load within 12 minutes or less without experiencing surge or stall.

4. Chiller Control System Interface Translator:

a. The main chiller control panel shall communicate using the Read (Initiate) and Write Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135, to communicate Modbus objects to the existing chiller plant control system. No third party device (translator) should be used to interface to the needed control points for proper operation.

b. The chiller control panel shall be capable of communicating all available information from the chiller mounted control panel including all available operational, safety and informational control points and these points shall be mapped to the DCS unless otherwise indicated by the Owner. Manufacturer shall supply the Modbus object list to the Owner for each chiller for what is accessible to the Modbus internetwork. Coordinate with the Owner to supply the specific points and control to include on the DCS.

5. Integration With Distributed Control System (DCS)

a. In addition to the Interface Translator Modbus communication link, the chiller microprocessor based control system or chiller starter control panel shall be capable of communicating the following hard wired input/output signals with the DCS:
    1) Chiller start/stop
    2) Chilled Water Supply Temp Setpoint
b. Chiller status
    1) Chiller fault
    2) Run load amps
c. If the control system provided with the chiller cannot communicate any of the above hard wired control points with the DCS, an auxiliary lockable, NEMA 1 rated enclosure shall be provided for the communication of these points. The auxiliary control panel shall be factory installed, wired and tested including all required terminal strips, instruments, temperature indicators, relays, signal conditioner/loop isolators, switches and gauges.
d. Web Connection
    1) Provide IP or Web based control interface that is configured for HTTPS.
    2) The Chiller Manufacturer shall coordinate setup of IP devices on Local Area Network parameters with Owner as coordinated by Contractor.
    3) Include explanation of any algorithms and learning periods that are required by the OEM controls.
    4) Security: Security access shall be provided to prevent unauthorized change of set points, to allow local or remote control of the chiller and to allow manual operation of the pre-rotation vanes and oil pump. Security shall be at least three levels, view only, operator screen, and integration / technician access. See passwords protections in this specification. The operating program shall be stored in non-volatile memory (EPROM) to eliminate chiller failure due to AC power failure or battery discharge. Programmed set points shall be retained in lithium battery-backed RTC memory for a minimum of 5 years.
    5) Graphic screens shall provide for:
        a) Chiller overview
        b) Evaporator
        c) Condenser
        d) Compressor/refrigerant circuit
        e) Motor
        f) Capacity control diagram
        g) Manual/Auto stations for all control outputs
        h) Approaches
        i) Power
        j) Key timers
        k) Alarms, alarm history

6) The operator web interface shall provide display of all major operating parameters in both graphical and list type screen displays. The graphics shall mimic the standard graphics on the chiller control panel. PID control loop set points and Manual/Auto functions shall be accomplished by the operator web interface as well as through the Owners DCS control system. Alarm indicators on the graphic display screen shall provide annunciation and an alarm history screen to which show the most recent alarms, with the time and date of occurrence. Trip status screens shall be provided which show the values of all analog inputs at the time of the last 128 chiller safety shutdowns. The time and date of each shutdown should also be shown.

M. Interlocking and Control Sequence:
   1. Unit manufacturer shall carefully coordinate unit controls with automatic control sequence requirements and provide all necessary auxiliary contacts and integral wiring required to meet these functions.
   2. Chilled water pumps and condenser water pumps shall be in operation and flow proven before refrigeration machine automatic control sequence is initiated.
   3. Provide condenser and evaporator proof of flow switches or differential pressure transmitters required for chiller start-up and operation. Switches or transmitters shall be either mounted on chiller or remote in system piping and interconnected with the chiller control panel as required by manufacturer.

N. Acoustic Performance:
   1. Chiller Sound Pressure Level (SPL) at approximately 3 ft (1 m) from machine and at height of approximately 5 ft (1.5 m) above floor when measured in accordance with AHRI Standard 575-94 or the latest edition, shall be noted by manufacturer on Bid form, but shall not exceed the following:

	SPL at 25-30% of Full Load							
	in db re: 2 x 10-5 N/m2							
Freq. (hz)	63	125	250	500	1000	2000	4000	8000
	84	86	86	86	87	85	78	78

   2. If chiller noise generation exceeds these levels, the Manufacturer shall provide acoustical devices and treatments with the chiller to reduce the noise generation to the level specified.

O. Painting
   1. Chiller shall be provided with a factory applied prime coat plus two coats of finish paint.
   2. All exposed surfaces and insulation shall be primed and painted with an alkyd-modified, vinyl enamel or acrylic, machinery primer and paint system.
   3. Finish paint color shall be the manufacturer's standard.
   4. One (1) quart of finish paint shall be provided with each chiller.

P. Insulation:
   1. Refer to Part 4 of this specification.

Q. Factory Performance Tests:
   1. All factory controls shall be tested for functionality.
   2. Refer to Part 3 of this specification for performance test requirements.

2.2 UNIT MOUNTED VARIABLE FREQUENCY DRIVE (VFD)

A. GENERAL
   1. Provide a VFD system to control each chiller compressor. All equipment and devices shall be provided for a complete and operational system in an integrated package, factory tested with the chiller and motor. The VFDs shall be provided by the Manufacturer as a coordinated system.
   2. Each Chiller shall have a single input cabinet. The input cabinet shall be arranged to accept a single 480V, 3 phase circuit per VFD/chiller compressor, two 480V, 3 phase circuits in total.
   3. Each VFD shall have internal 5%-line reactor as well as harmonic trap filter (with optional drop-out contactor at low load) and shall meet IEEE-519 requirements with the PCC measured at the input terminals.
   4. Each VFD cabinet shall include CTs, PTs, line reactor, harmonic filter, and step-down transformers to accommodate all auxiliary 480V, 120V, and LV loads at the VFD and at the chiller.
   5. The VFD shall be provided with integrated refrigerant-based or chilled water-based cooling system. All cooling system refrigerant or chilled water piping shall be provided by the unit manufacturer. No additional power or other utilities shall be necessary for the cooling system. The chilled water based system shall include all necessary pumps, piping, mixing valves and specialties. Chilled water source shall originate from the chiller heads, marine water, boxes, etc. as applicable. The chiller shall be sized to accommodate the chilled water requirements for VFD cooling while maintaining the zero tolerance tonnage to the Owner.
   6. The VFD control logic shall be specifically designed to interface with the chiller controls. The VFD control shall adapt to the operating ranges and specific characteristics of the chiller, and chiller efficiency is optimized by coordinating compressor motor speed and compressor inlet guide vane position. Chilled water control and VFD control shall work together to maintain the chilled water set point, improve efficiency and avoid surge.

B. QUALITY ASSURANCE
   1. Provide equipment in full accordance with the latest applicable rules, regulations and reference standards, including but not limited to:
      a. NEMA Listed - ISC-6, ISC-7
      b. ANSI - Instrument Transformers C57.13
      c. CSA - Industrial Control Equipment C22.2 No 14
      d. IEEE 1100 AND IEEE 519 – 1992
      e. NFPA 70, National Electric Code - latest edition
      f. System registered to ISO 9001

2. All fully assembled controls shall be combined-tested for performance and functionality at the manufacturer's factory with fully loaded VFD rated induction motors. The combined test data shall then be analyzed to insure adherence to quality assurance specifications.

C. ELECTRICAL NOISE CRITERIA
   1. Voltage and current distortion generated by VFD and attenuation devices measured at input and output of VFD assembly and as installed in place, shall not exceed the following criteria as referenced by IEEE Standard 519:
      a. Total harmonic distortion (THD) shall not exceed 5% RMS of fundamental input voltage at full load with maximum 3% RMS on any single harmonic.
      b. Total harmonic current demand distortion (TDD) shall not exceed 5% in amplitude of fundamental input current.
   2. Note that harmonic trap filter on each VFD must be provided. Provide harmonic trap filter and VFD information to Owner and Designer for use by others in overall plant harmonic analysis study.

D. DESIGN AND FABRICATION
   1. Voltage:
      a. Each VFD shall accept single-point connection from nominal plant power of 480 volts.
      b. The supply input voltage tolerance shall be +/-10% of nominal line voltage.
   2. Current:
      a. Each VFD has a "normal duty" rating of 100% continuous current with a short time duty rating of 110% overload for one minute, once every 10 minutes or continuous operation at 104%.
   3. Frequency:
      a. The drive system shall provide controlled speed over the range from 38 to 60 Hz.
   4. Power Factor:
      a. Each VFD shall be capable of maintaining a minimum displacement power factor of 0.99 at all loads.
   5. Efficiency:
      a. VFD efficiency shall be a minimum of 97%.
   6. Environmental Ratings:
      a. Storage ambient temperature range -40°F (-40°C) to 158°F (70°C)
      b. Operating ambient temperature range 32°F(0°C) to 104°F (40°C)
      c. The relative humidity range is 0% to 95% non-condensing
      d. Operating elevation: up to 3,300 ft (1000m) without derating.
   7. Audible Noise:
      a. The maximum audible noise from the VFD shall comply with OSHA Standard 3074, Hearing Conservation, which limits noise level to 85 dBA.
   8. Motor Compatibility:

a. The VFD shall be capable of operating the chiller motor over the speed range specified. Drives which require motors with higher insulation values will not be acceptable. The VFD drive shall provide near sinusoidal voltage and current waveforms to the motor at all speeds and loads. VFD induced torque pulsations to the output shaft of the chiller shall be less than 1% to minimize the possibility of exciting a resonance.

b. The motor insulation system shall not be compromised thermally or due to dv/dt stress. Dv/dt at the motor terminals (line-to-line) shall be limited to 10 volts per microsecond. If dv/dt at the motor terminals (line-to-line) exceeds 10 volts per microsecond, the vendor must state the actual value in the attached data sheets and include steps taken to guarantee the long term life of the motor insulation system.

c. The VFD shall be designed for a maximum availability of 99.9%. The VFD shall be designed for a mean time between failure (MTBF) of 100,000 hours. The VFD shall be designed for a minimum life expectancy of 20 years, based on 5,000 hrs of operation per year. The VFD shall have a control power monitoring system that monitors all power supply voltages and signals Power switch device diagnostics shall detect and protect against device short, over and under gate voltage, loss of gating, loss of diagnostic feedback, heat sink temperature feedback as well as overload monitoring and protection. Failed power switch components shall be replaceable without the removal of the entire power module. Special tools or force measuring transducers shall not be required.

9. Control Logic:
   a. The VFD shall be capable of operating with the output short circuited at full current. The drive system shall provide controlled speed over the range from 38 to 60 hz. Speed accuracy within this range, expressed as a percent of top speed, shall be within 0.5% of base speed without encoder or pulse tachometer feedback (0.1% with encoder or pulse tachometer feedback). The VFD shall have a " normal duty " rating of 100% continuous current with a short-time duty rating of 110% overload for one minute, once every 10 minutes (suitable for variable torque loads).
10. Auto Tuning:
    a. The VFD, in conjunction with the chiller controller shall have an auto tuning function which includes optimizing the chillers system energy efficiency.
11. Starting Mode:
    a. The VFD shall offer two starting modes. The S-curve profile shall consist of both non-linear and linear portions. The Ramp mode shall be programmable with four ramp speed break points.
12. Auto-Restart Capability with the Chiller:
    a. The VFD in conjunction with the chiller controller shall be capable of automatically restarting in the event of a momentary power loss, or a clearing of a VFD auto-restart trip.
13. Protective Features:

a. Fault information shall be accessible through the VFD human interface. The VFD shall have comprehensive protective diagnostics for line side, VFD system, and load side.
b. Kirk key for interlocking the system which prevents unsafe access to doors.
c. Output line-to-line and line-to-ground short circuit protection shall be provided.
d. Input protection shall be provided via surge arrestors.

14. Enclosure:
    a. VFD enclosure shall be NEMA 1G (IP21). Door latches shall be heavy-duty 1/4 turn type units which are operated with an Allen wrench. The VFD shall be designed for front access to allow for installation with no rear access. Equipment that requires rear access shall not be accepted.
    b. The VFD shall be designed for top or bottom entry line power (via optional tophat) and back load power exit directly to the motor. The power cable connections are bolted type. Lugs shall be provided. Use copper conductors only for terminal connections.
15. Structural Finish:
    a. All VFD exterior metal parts shall be painted with hybrid epoxy powder paint. “Tophat” raceway provided by the Contractor for cable transition from conduit into the VFD shall be painted to match the VFD for consistency.
16. Power Bus:
    a. All power bus bars, when part of the standard design and other current carrying parts shall be high-conductivity, low loss copper with nickel or tin plating for corrosion resistance. Power bus bar joints shall be nickel or tin plated.
17. Disconnects:
    a. The VFD shall include a main disconnect device (molded case thermal magnetic circuit breaker rated 65KAIC with shunt trip option) with an interlocked and pad lockable handle mechanism.
    b. When multiple doors are supplied, all doors shall be electrically interlocked with the disconnect device. The interlocks shall include provisions to manually override for test and repair.
18. Protection and Metering Equipment:
    a. Provide a microprocessor based motor protective relay for protection, control and monitoring of each motor. Basis of Design: Allen Bradley 825P.
    b. Relay(s) shall monitor remote resistance temperature detection (RTD) modules for measurement of motor windings and bearing temperatures if not provided in chiller control panel. Chiller shall be furnished complete with interconnecting wiring for these points from motor to protective relay control panels.
    c. Provide relay protection and metering capabilities. Relay(s) shall provide the following protective functions:
        1) Undervoltage
        2) Lock rotor current (overcurrent)
        3) Instantaneous overcurrent

4) Undercurrent
5) Phase loss
6) Phase unbalance
7) Phase reversal
8) Unbalance/ negative sequence
9) Zero sequence ground fault with run and start time delay
10) Mechanical jam/stall
11) Thermal trip
12) Custom overload curve
13) Stator winding over-temperature (6 inputs)
14) Motor bearing over-temperature (2 inputs)
15) Relay(s) shall provide the following control functions:
16) Incomplete sequence delay
17) Antiback spin timer
18) Relay(s) shall provide a digital display of the following measured parameters:
19) Three phase average current
20) Individual phase currents
21) % of full load current
22) Individual winding temperatures
23) Individual bearing temperatures
24) Phase to phase voltage
25) Number of starts
26) Provide metering to indicate the following:
27) Motor current as percent of full load amperes
28) Run time (hours)
29) Total KWH/incoming
30) Instantaneous KW complete with 4-20 ma output
31) Instantaneous motor KW complete with 4-20 ma output

d. Current transformers used for overload protection shall be of linear response through six times full load motor current and shall have adequate burden capacity for devices they supply. Linear response shall be per ANSI accuracy classification.

e. All control, protection and metering equipment shall be mounted in separate isolated low voltage compartment.

19. Operator Interface:

a. The VFD shall have a user friendly operator interface integrated into the chiller control panel. The following values shall be indicated locally and remotely at the BAS:

1) Output speed in hertz and rpm
2) Input line Volts, Amps, Hz, KW, KVA, PF

3) Output line Volts, Amps, Hz, KW, KVA, PF
4) Average current in % RLA
5) Internal VFD temperature and cooling unit controls.
6) All relay and other protective settings. They shall be adjustable from the control panel.
7) Fault and alarm summary

20. Communications:
    a. The VFD shall be provided with a digital communication capability to allow for direct control and full comprehensive communications, including diagnostics, with the chiller controller and the plant control system.
21. Spare parts:
    a. Provide manufacturer's recommended complete spare parts kit and address of local supplier stocking location. Spare parts shall be labeled with name and part number. Spare parts shall be stored on-site.

2.3 REFRIGERANT PUMPOUT SYSTEM:

A. Provide a single mobile refrigerant pumpout system with the chillers.

B. The system shall include refrigerant compressor and drive with oil separator, storage receiver, heater, water cooled condenser, filter drier, relief devices and other necessary valves, manifolds and hoses to remove, store and return the entire refrigerant charge to each chiller.

C. Power connection including compressor motor shall be suitable for 480 volt, 3 phase, 60 hertz power.

D. Compressor shall be tank mounted with and shall include all necessary controls and safety devices and storage tank shall be mounted on casters.

E. System shall be complete with piping, four valve manifold, relief devices and hose connections to accommodate all of the chillers being purchased for the plant.

F. Provide unit with 50 feet of electrical cabling and NEMA L16-30 (30A) locking plug connection.

G. Water cooled condenser shall be suitable for operation utilizing 60 degrees F domestic water or 85°F condenser water and shall be constructed for working pressures to 150 psig and test pressures to 225 psig. Air cooled condensers or combination air cooled/water cooled condensers are not allowed.

H. Storage vessel construction to meet ASME code and shall be provided with a full range water column type sight glass for monitoring level and re-seatable safety devices in accordance with latest edition of the Mechanical Refrigeration Safety Code, ANSI/ASHRAE 15, consisting of a stainless steel rupture disc upstream and in series with re-seatable relief valve(s).

I. Vessel shall be constructed for the same pressure ratings as refrigerant side of unit and shall be of sufficient capacity to hold one (1) 1,400 ton chiller refrigerant charge when 80% full at 90˚F.

J. Provide a valved and capped test port between each rupture disk and associated relief valve(s) and plugged tee for connection of portable purge unit that will be used to vent non-condensables from the tank.

PART 3 – EXECUTION – BY EQUIPMENT MANUFACTURER

3.1 CHILLER FACTORY TESTING

A. Manufacturer shall conduct factory performance witness test for one of the three scheduled chillers for ECP. Certified performance test reports shall be provided for the two remaining chillers prior to shipment, with ability to witness virtually available.

B. Notify Owner and Designer two (2) weeks in advance of factory performance test so that representatives of the Owner and Designer may witness test. Manufacturer shall be responsible for the costs of providing transportation and accommodations for two (2) representatives of the Owner and one (1) representative of the Designer. If a retest is required at a later date, the Owner and Designer shall witness the retest. Manufacturer shall be responsible for the cost of the transportation and accommodations of the Owner and Designer to witness the factory performance retest.

C. Factory performance test shall be in accordance with AHRI 550/590 test procedures, except as modified below, to verify design capacity and part load capacity points indicated on the Bid Summary Data Sheet included in Part 5 of this section.

1. Conduct test at an approved AHRI certified test facility of the Manufacturer. Owner/Designer may elect to contact AHRI for verification of performance and test conditions.
2. Instrumentation used for testing must be calibrated within six (6) months of the test date and traceable to the National Bureau of Standards. All documentation verifying NBS traceability shall be included in a bound folder for presentation to the Owner/Designer.
3. Test chiller with water temperature and adjustment cooler/condenser per standard AHRI 550/590 to simulate specified fouling versus no fouling during test. Verification of this procedure will require inside surface area and number of tubes per vessel. This information is to be submitted with proposal for formula verification of fouling per AHRI 550/590.
    a. A downward temperature adjustment per AHRI 550/590 shall be made to the design leaving evaporator water temperature to adjust from the design fouling to the clean tube condition.
    b. An upward temperature adjustment per AHRI 550/590 shall be made to the design entering condenser water temperature to adjust from the design fouling to the clean tube condition.

c. There shall be no exceptions to conducting the performance test with clean tubes and with temperature adjustments in (1) and (2). The manufacturer shall clean tubes, if necessary, prior to test to obtain a test fouling factor of 0.0000.

D. Modifications to AHRI Standard shall be as follows:
   1. Chiller tonnage shall be equal to or greater than specified value when producing water at project required conditions (no tolerance allowed).
   2. Chiller energy consumption (kW) shall not exceed value submitted on the Chiller Bid Summary Data Sheet or energy consumption penalty will be imposed (no tolerance allowed).
   3. All design conditions, part load performance data and full load performance data is to be evaluated with 480 volt, three phase, 60 hertz power supplied to chiller VFD.
   4. The performance test shall be a four-point test per chiller. Points to be tested will be selected at time of test.
      a. One test point will be at full load and full lift conditions.
      b. The other three points will be part load points selected by Owner from the Chiller Bid Summary Data Sheet submitted with the bid.

E. During the test, all machinery performance data including, but not limited to, oil pressures, gas pressures, and component temperatures shall be recorded at fifteen (15) minute intervals and compared to standard conditions supplied by the manufacturer. If at any time during the test, the recorded machinery performance data is in excess of the standard conditions, the test will be considered not valid and the test shall be restarted for and additional period.

F. Defective work or material shall be replaced or repaired, as necessary, and inspection and test repeated. Repairs shall be made with new materials. Tests for various items of equipment shall be as specified in their respective specification sections. Defective work includes the following:
   1. Compressor VFD kW input in no case shall exceed that indicated in these specifications for full load conditions (no AHRI tolerance allowed). Capacity must meet or exceed tonnage indicated on the Chiller Bid Summary Data Sheet. In other words, there is zero tolerance allowed on both efficiency and capacity.
      a. If chiller assembly fails to meet full load capacity, the Manufacturer will be allowed to adjust and retest the machine. If the Manufacturer cannot successfully pass the full load test, the Owner can either reject the machine or accept the machine as is and assess a penalty charge as described herein.
   2. If an unacceptable performance test is determined by the Designer or Owner, additional subsequent test(s) may be required at the discretion of the Owner. The complete cost of the additional test(s) requested or caused by equipment operation condition exceeding standard conditions or not meeting the overall operating efficiency, shall be borne by the Manufacturer.
   3. Penalties for not meeting performance data as shown on the Chiller Bid Summary Data Sheet shall be as follows:

a. If a chiller fails to meet full load capacity, Owner may elect not to accept delivery until chiller is modified at Manufacturer's expense to meet design capacity or to assess penalty charge of $5,000 per ton (pro-rated per fraction of a ton) that chiller capacity falls short of full load capacity. If Manufacturer elects to modify the chiller a retest of the chiller will be required.

b. If a chiller fails to meet any of part load performance data supplied by Manufacturer with the bid, Owner may elect not to accept delivery until chiller is modified at Manufacturer's expense to meet all points of design and part load performance data or to assess penalty charge equal to twenty-five (25) years operating cost differential. This differential is to be determined by using 4 point part load data included in bid form and data obtained from performance test, subtracting bid data annual operating cost from test data annual operating cost, and multiplying by annual load, average electricity cost, and 25-year present value factor noted below.

c. All bids will be analyzed on a 25-year present value basis using the run hours noted below:

1) All chillers will be offline 3.8% of the year
2) Zero annual load increase
3) Average electricity cost of $0.08/kWh
4) 25-year Present Value Factor for Industrial Electricity of 19.46 from NISTIR Table Ba-3

G. A certified test report of all data shall be submitted to the Owner and Designer prior to shipment. The factory certified test report shall be signed by an officer of the manufacturer’s company. Preprinted certification will not be acceptable; certification shall be in the original.

H. After completion of Factory Performance Tests, the chillers shall be flushed with clean water, drained, and dried in preparation for shipment to prevent any surface corrosion on normally wetted surfaces.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Assembled chiller or all major components (compressor, evaporator, condenser, and intercooler) to be factory leak tested evacuated and protectively charged with nitrogen before shipment by the Manufacturer.

B. Each unit shall include initial charge of refrigerant shipped separately by bulk tank delivery, initial charge of compressor and driveline component oil shipped separately.

C. Any sensor or other device protruding from the equipment shall be protected from normal shipping hazards by the Manufacturer.

D. Secure all component connections to protect mating surfaces and keep out foreign materials.

E. The Manufacturer shall shrink wrap each entire unit with an environmentally recyclable material standard. The material shall include an imbedded desiccant to minimize/eliminate internal moisture.

F. Units shall be shipped by the Manufacturer with attached metal plates that indicate name of manufacturer, chiller model number, compressor type, refrigerant type and quantity.

G. Upon delivery, Manufacturer shall Advise the Contractor in regard to proper rigging methods and reassemble the chiller inside the plant as required, and perform a leak test matching factory requirements. Once leak test is complete, the Manufacturer shall evacuate the chiller and protectively charge the chiller with nitrogen until it is ready to be charged and put into service.

3.3 INSTALLATION / START-UP:

A. Intent is to provide for equipment that meets all functional and applicable code requirements. This includes but is not limited to all electrical, controls (including the Owner's plant control system), piping, drains, vents and mounting. This manufacturer shall be responsible for coordinating all such requirements of units provided under this specification with the Contractor and the Owner. Any additional installation or redesign costs associated with the installation of the equipment provided that is different than that illustrated on the submitted shop drawings shall be the responsibility of the equipment manufacturer.

B. A factory-trained service representative of the manufacturer shall supervise the field-assembly (if any), final installation, pressure testing, checkout, start-up, adjusting and balancing of the chiller. Prepare and submit manufacturer's written report/log of the installation and start-up signed by the service representative and the Owner. The Manufacturer's Representative shall supervise leak testing, evacuation, dehydration, and charging of oil and refrigerant. If the chiller is found to have lost its shipping pressure prior to the time of installation, then the machine shall be leak tested, and shall be evacuated a minimum of 24 hours. Other special provisions for unit testing and setups as recommended by the equipment manufacturer in operations and maintenance manuals shall also be followed. The Manufacturer shall provide 40 hours of time for each chiller.

C. Before acceptance by Owner/Designer, unit manufacturer shall approve, in writing, the complete installation, including piping and wiring connections, and proper functioning of all operational and protective/safety controls.

3.4 FIELD TESTING:

A. Pressure Test: The Manufacturer shall conduct a standing pressure test on the refrigerant circuit for a period of 12 hours using nitrogen with exceeding test pressure recommended by the manufacturer in operations and maintenance manuals. Conduct a standing vacuum test on the vessel equal to 1 mm Hg absolute for a 24-hour period. Machine shipped pre-charged need not comply with this requirement unless the factory pre-charge or holding charge is lost during shipment or prior to start-up, in which case, the Manufacturer shall test as indicated. Perform all test and start-up in such a manner as not to introduce moisture into the machine.

3.5 TRAINING

A. The equipment manufacturer shall provide full operating, service and maintenance training programs for the Owner's maintenance personnel. All costs associated with Owner Training shall be included in the base proposal, including travel and per diem expenses. Training shall occur at the Owners facility. Training will be scheduled separately at a time determined by the Owner.

B. Up to two separate courses shall be provided, one for equipment fundamentals, one for the chiller and associated VFD/ASD.

C. The fundamentals course shall include:
   1. Start-up, check-out and routine maintenance
   2. Refrigeration cycle
   3. Lubrication cycle
   4. Electrical control sequence and trouble shooting.

D. The fundamentals course shall include a minimum of 8 hours of general training plus six (6) technical sessions (bi-monthly) not less than 4 hours in length or more than 8 hours in length. These sessions shall cover the most appropriate operation and maintenance issues for the given season and provide technicians an opportunity to ask and discuss issues from their experiences in operating and maintaining the chiller.

E. The fundamentals course shall be conducted at the Owner’s facility for up to six (6) of the Owner's maintenance personnel. Instruction time periods shall be approved by the Owner and conducted during normal working hours of 8:00 AM to 4:30 PM Monday through Friday. Instruction shall be a combination of classroom instruction and hands-on training.

F. The chiller and variable frequency drive course shall include a minimum of 8 hours of training time. The chiller variable frequency drive manufacturers shall provide training for the complete operation and maintenance of the variable frequency drive and protection/control modules. This includes, but is not limited to, how to use the equipment for troubleshooting, real time and historic features, terminology definitions, adjustments and settings, etc.

G. The chiller and variable frequency drive course shall be conducted at the Owner’s facility for up to six (6) of the Owner's maintenance personnel.

H. Instruction time periods shall be approved by the Owner and conducted during normal working hours of 8:00 AM to 3:00 PM Monday through Friday. Instruction shall be a combination of classroom instruction and hands-on training.

I. A complete syllabus and O&M Manuals shall be submitted and approved by Owner four weeks prior to training.

J. At the end of each training course, the manufacturer shall provide to the Owner complete service manuals and bulletins that would be equal to the manuals that would be provided to the manufacturer's own service technicians. The manufacturer shall include the Owner on their update mailing list to make available for purchase by the Owner, all updates to the service manuals and new service bulletins that are issued after the completion of the training program.

K. Owner may video tape training sessions for their use in future training of their operations and maintenance staff.

3.6 COMMISSIONING

A. Upon construction completion, the chiller plant and associated equipment will be commissioned by the Owner. Manufacturer will be responsible for providing a factory trained technician on site for a minimum of 40 hours during this commissioning process. This time shall be in addition to any other start-up, training, etc. Scheduling of commissioning will be by the Owner.

PART 4 – EXECUTION – BY INSTALLING CONTRACTOR

4.1 DELIVERY, STORAGE, AND HANDLING

A. Contractor to coordinate and expedite delivery of chillers to the project site with the manufacturer and provide unloading and rigging of equipment into place as part of setting/reassembly process as recommended or required by the manufacturer.

B. Units will be stored and handled in accordance with Manufacturer's instructions by the Contractor.

C. Contractor will protect chiller and controls from physical damage and Contractor will leave factory shipping covers in place until installation.

4.2 INSTALLATION

A. Receiving, rigging and setting of chillers and associated refrigerant pump out unit including coordination of exact delivery date with Manufacturer.

B. Install equipment as shown on drawings, and in accordance with manufacturer's installation instructions.

C. Provide concrete housekeeping pads/curbs and install rubber pads provided by equipment manufacturer under chiller support feet.

D. Extend chilled water, condenser water, any auxiliary water, and refrigerant pump out piping as required by the equipment and insulate each as specified.

E. Pipe refrigerant relief devices and any purge unit vents to building exterior. Discharge pipes shall not be less than relief device outlet size. Discharge from more than one relief device or purge unit per refrigeration machine may be combined into a common header, provided cross-sectional area of common header is at least sum of the cross-sectional areas of the connected pipes. When length of discharge piping exceeds 50 feet, piping shall be increased one pipe size.

F. Piping connections to pumps shall not create stress on chiller flanges and nozzles. After final connections are completed, remove bolts from flanged connections at chillers. Piping shall remain aligned with pump connections after bolts have been removed, or if bolts cannot be removed by hand, revise piping to align piping with chiller connection. Piping/chiller alignment verification shall be completed in the presence of the Owner's representative. If after completion of the strain-free verification of the piping system must be disassembled at any point in the system, the strain-free verification shall be repeated.

G. Install control devices, raceway systems and/or wiring between the chillers and VFD's and the Owners control system.

H. Extend electrical service to the chillers including feeders to the VFD's, motors and associated auxiliary devices.

I. Touch up paint on the entire chiller prior to applying insulation.

J. Install necessary piping with insulation for lubricating system cooler if required.

K. All chiller surfaces below 65°F when the chiller is operation shall be insulated by the Contractor after all piping connections are made to eliminate any condensation from forming and dripping on the plant floor. This includes, but is not limited to the evaporator shell, water boxes, cover plates, suction elbow, vent and drain connections, etc. Water piping and connections shall also be insulated by the Contractor.

L. Secure registration and installation permits as required by the State and local authorities and complete these requirements before system is placed in operation.

M. Contractor shall schedule and expedite the manufacturers start-up process and support the Owners commissioning activities. Contractor shall coordinate exact timing of these activities and arrange for appropriate manufacturer personnel to be on-site.

N. After successful completion of equipment installation, the Contractor shall assemble and incorporate equipment shop drawings, operating/maintenance instructions, and part lists into the Contractor's project operation/maintenance manuals.

PART 5 - PERFORMANCE

5.1 CHILLER BID SUMMARY DATA SHEET

A. Complete and submit the following form **with Bid** submittal. Provide separate form if submitting voluntary alternatives.

100% Design Data	**Specified Value**	**Input Bid Value**
Manufacturer	-	
Model No.	-	
Refrigerant	R-513A, R-514A or R-1233zd(E)	
Total Capacity of three (3) chillers with 42°F LEWT, 56°F EEWT, 85°F ECWT and 95°F LCWT (Tons)	4,200 total (1,400 tons per chiller)	
Voltage AC	480	
Phase	3	
Evaporator Data Per Chiller		
Flow (GPM)	2,400 per chiller	
Entering Water Temperature	56˚F	
Leaving Water Temperature	42˚F	
Fouling Factor	0.0001	
Total Maximum Pressure Drop in series (Feet)	18.5	
Condenser Data Per Chiller		
Flow (GPM)	4,200 per chiller	
Entering Water Temperature	85˚F	
Leaving Water Temperature	95˚F	
Fouling Factor	0.00025	
Total Maximum Pressure Drop in series (Feet)	18.5	
Electrical Data Per Chiller		
Max. Power Input (Kw)	-	
LRA (LH)	-	
RLA (LH)	-	
LRA (RH)	-	
RLA (RH)	-	

B. Complete the table below by inputting kW/Ton (zero tolerance on kW and tonnage) values for each operating condition. Data provided will be utilized for factory chiller performance test verification and bid evaluation.

1. The leaving evaporator water temperature shall be held constant at 42°F.
2. The evaporator water and condenser water flow rates shall be held constant as scheduled above.
3. If condition listed below is not possible due to turndown or maximum capacity of the chiller, identify with “N/A” in table.

Percent Load	85˚F ECWT	75˚F ECWT	65˚F ECWT	55˚F ECWT
100				
90				
85				
80				
75				
70				
60				
50				
40				
30				
20				
Minimum = ____%				

5.2 LIFE CYCLE COST ANALYSIS FORM

A. Complete and submit the following form **with Bid** submittal. Provide separate form if submitting voluntary alternatives.

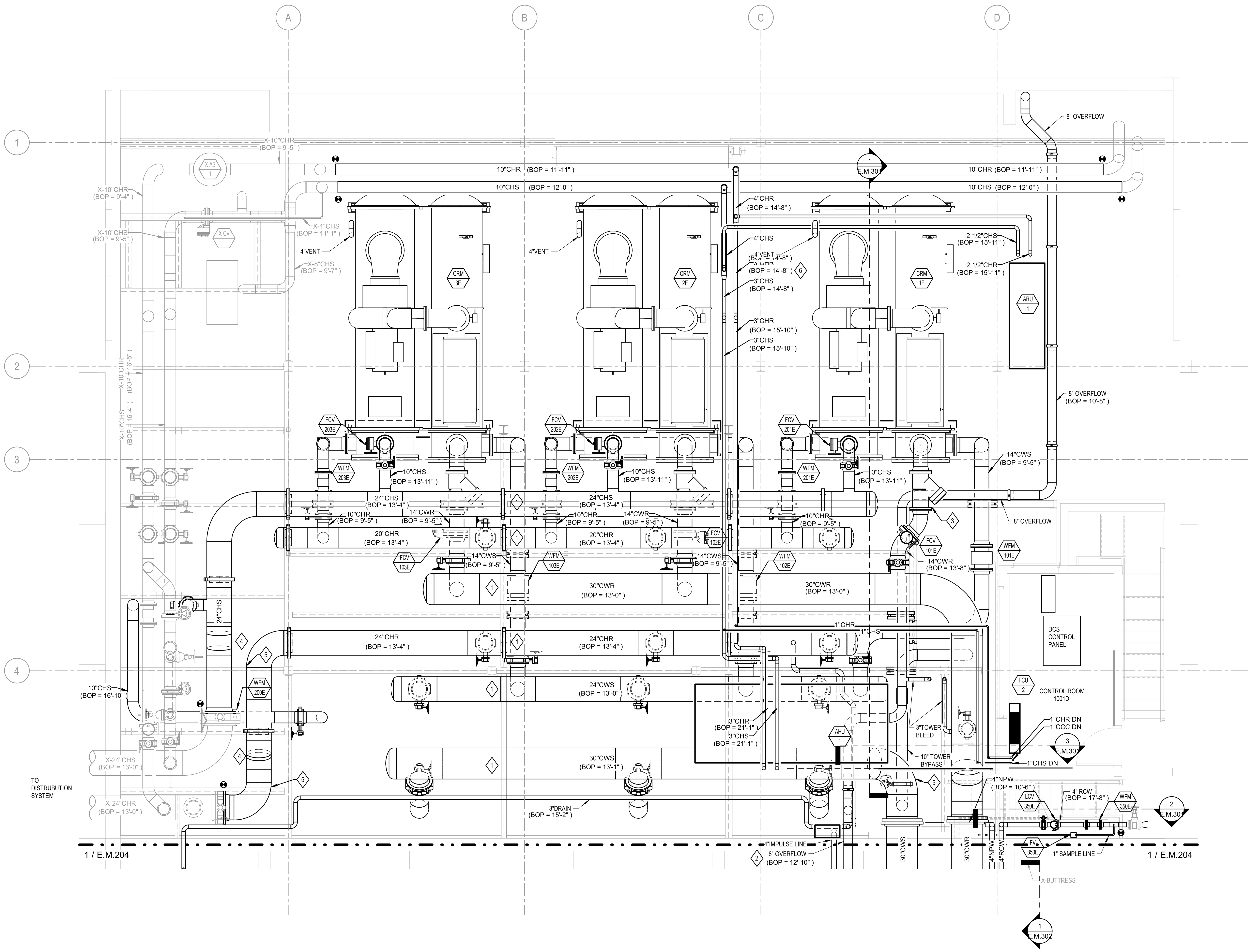
NC SCO LCCA Form - CHILLERS 200 TONS AND LARGER	
Project Owner:	University of North Carolina
Project Title:	Chilled Water Infrastructure Expansion - ECP
Project ID#:	22-25588-02G

Design Data			
Load %	Load (Tons)	Hours Per Year	Ent. Cond. Wtr. Temp (°F)
100	1,400	500	85.0
85	1,190	2,000	75.0
80	1,120	1,500	65.0
75	1,050	1,000	55.0

Manufacturer Data - Input Specified "Zero Tolerance" Data for Tonnage and kW				
Manufacturer Name	Carrier	Daikin	Trane	York
Model Number				
Load Per Tons @ 100%				
Load Per Tons @ 85%				
Load Per Tons @ 80%				
Load Per Tons @ 75%				
Input kW @ 100% Load				
Input kW @ 85% Load				
Input kW @ 80% Load				
Input kW @ 75% Load				

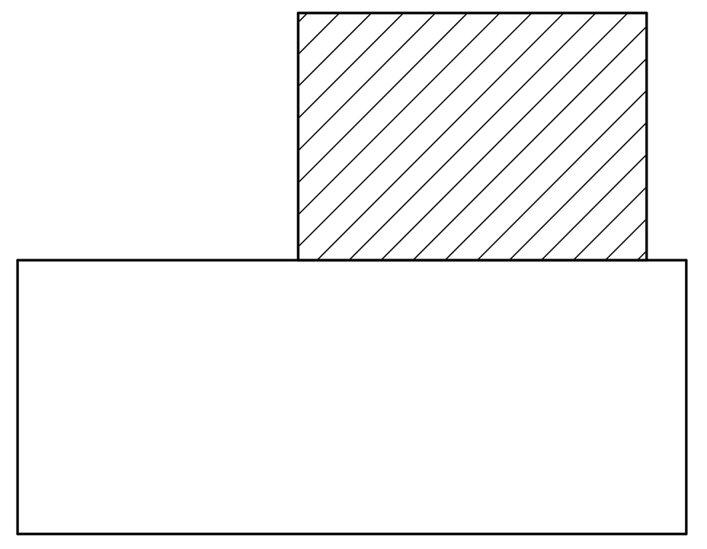
Life Cycle Calculation (To Be Completed by Designer)				
1st Year ($)				
1st Year x 20 ($)				
Bid Price ($)				
LCC ($)				
Formula: LCC = Bid Price ($) + 1st Year ($) x 20 Years				
Electricity Cost Calculated Based on $0.08 / kWh				

END OF SECTION



1 **MECHANICAL NEW WORK PLAN - UPPER LEVEL**

SCALE: 1/4" = 1'-0"



KEYPLAN

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NORTH CAROLINA PROFESSIONAL SEAL 031487 ENGINEER NATHAN D. CESARZ

12/06/24

Sheet Keynotes:

1. ANCHOR NEW HEADER TO NEW SUPPORT STEEL AT LOCATION INDICATED. REFER TO DETAIL 7/E.M.501 AND 8/E.M.501.
2. OVERFLOW DRAIN BOP REFLECTS 1% MINIMUM SLOPE.
3. SHIM DISTANCE BETWEEN NEW SUPPORT STEEL AND NEW CONDENSER WATER LINE WITH (2) 1' LONG PIECES OF 4" TUBE STEEL.
4. UTILIZE MITERED OR CUT DOWN FITTING TO ACHIEVE NEW TO EXISTING CONNECTION ELEVATION.
5. INTSTALL SHORT RADIUS 90 DEGREE ELBOW AT LOCATION INDICATATED.
6. CONTRACTOR IS TO PROVIDE SUPPLEMENTAL STEEL SPANNING ROOF SRUCTURE TO SUPPORT ALL PIPING 4" AND SMALLER AND ALL DUCTWORK. SUPLEMENTAL STEEL SHALL BE ATTACHED TO ROOF STRUCTURE WITH A CONCENTRICALLY LOADED CLAMP.

Rev	Date	Description of Issue
B	10/18/24	CD FOR REVIEW
A	05/24/24	SD / DD

Project

THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL

Chilled Water Infrastructure Expansion

SCO# 22-25588-02B
CODE: 42123-355 / 42323-305
UNC BLDG. NO 505

Sheet Title

MECHANICAL NEW WORK PLAN - UPPER LEVEL

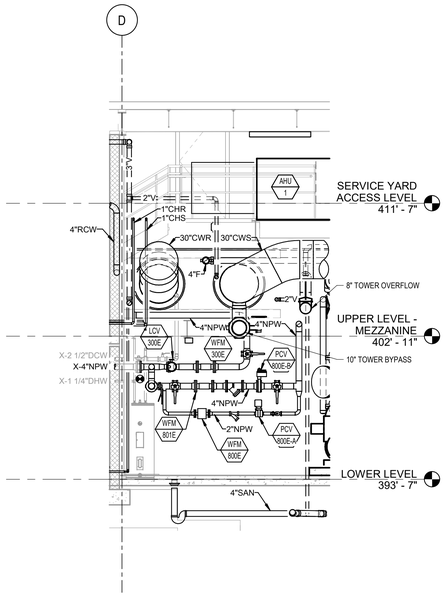
Scale: 1/4" = 1'-0"

Date: 10/18/24 | Drawn By: DVS

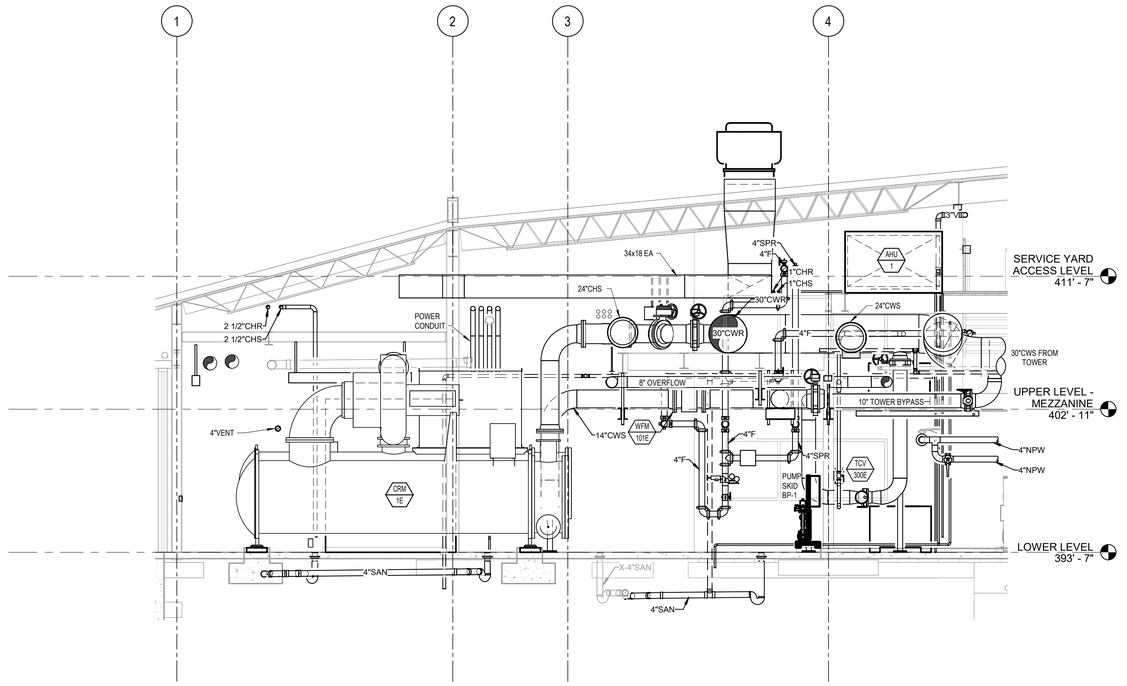
Project No.: 23480-02 | Checked By: BJP

Sheet No.

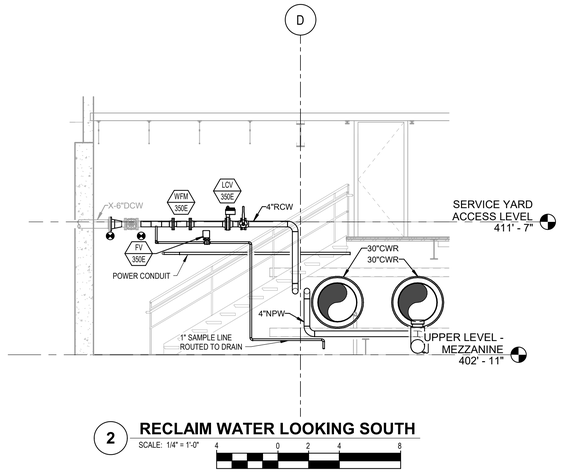
E.M.203



3 MAKEUP WATER LOOKING SOUTH
SCALE: 1/4" = 1'-0"



1 CHILLER AND PUMP LOOKING EAST
SCALE: 1/4" = 1'-0"



2 RECLAIM WATER LOOKING SOUTH
SCALE: 1/4" = 1'-0"

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NORTH CAROLINA PROFESSIONAL SEAL 031487 ENGINEER NITHAN D. CESAR

12/06/24

Sheet Keynotes:

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Project

THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL

Chilled Water Infrastructure Expansion

SCO# 22-25588-02B
CODE: 42123-355 / 42323-305
UNC BLDG. NO 505

Sheet Title

MECHANICAL SECTIONS

KEYPLAN

Scale
1/4" = 1'-0"

Date	Drawn By
10/18/24	DVS

Project No.	Checked By
23480-02	BJP

Sheet No.

E.M.301

CHILLERS

23 6000

MARK (CRM)	LOCATION	TYPE	CAPACITY (TONS)	MAXIMUM KW/TON	EVAPORATOR GPM	EVAPORATOR EWT (°F)	EVAPORATOR LWT (°F)	EVAPORATOR PASS	EVAPORATOR MAX. PD (FT)	EVAPORATOR FOULING FACTOR	REMARKS OWNER PRE-PURCHASED AND FURNISHED TO THE CONTRACTOR
1E	CHILLER BAY-GROUND LEVEL	CENT	1,400	0.612	2,400	56	42	2	18.1	0.0001	
2E	CHILLER BAY-GROUND LEVEL	CENT	1,400	0.612	2,400	56	42	2	18.1	0.0001	
3E	CHILLER BAY-GROUND LEVEL	CENT	1,400	0.612	2,400	56	42	2	18.1	0.0001	

CHILLERS

MARK (CRM)	CONDENSER GPM	CONDENSER EWT (°F)	CONDENSER LWT (°F)	CONDENSER PASS	CONDENSER MAX. PD (FT)	CONDENSER FOULING FACTOR	ELECTRICAL MAX. POWER INPUT (KW)	ELECTRICAL FLA	ELECTRICAL LRA	ELECTRICAL INRUSH	ELECTRICAL VOLTS	ELECTRICAL PH	STARTER TYPE
1E	4,200	85	95	2	18.5	0.00025	858	1080	6235	-	480	3	VFD (UNIT MOUNTED)
2E	4,200	85	95	2	18.5	0.00025	858	1080	6235	-	480	3	VFD (UNIT MOUNTED)
3E	4,200	85	95	2	18.5	0.00025	858	1080	6235	-	480	3	VFD (UNIT MOUNTED)

COOLING TOWERS

MARK (CTF)	LOCATION	GPM EACH CELL	MAX. PD (FT)	TEMPERATURE (°F) AIR WB	TEMPERATURE (°F) EWT	TEMPERATURE (°F) LWT	FAN MOTOR MAX. HP	FAN MOTOR VOLT	FAN MOTOR PHASE	REMARKS OWNER PRE-PURCHASED AND FURNISHED TO THE CONTRACTOR
301E	EQUIPMENT YARD SOUTH OF PLANT	4200	55	80	95	85	125	480	3	(1)
302E	EQUIPMENT YARD SOUTH OF PLANT	4200	55	80	95	85	125	480	3	(1)
303E	EQUIPMENT YARD SOUTH OF PLANT	4200	55	80	95	85	125	480	3	(1)

NOTES:
(1) PROVIDED WITH DIRECT DRIVE PMR TYPE MOTORS AND COMPANION VFDS.

VARIABLE FREQUENCY DRIVES

23 0514

MARK (VFD)	EQUIPMENT	LOCATION	HP	VOLTS	RPM	PULSE	INPUT CIRCUIT BREAKER	INPUT LINE REACTOR	OUTPUT DV/DT FILTER	BYPASS STARTER	HARMONIC TRAP	SINGLE ENCLOSURE	NEMA ENCLOSURE TYPE	SCCR (MIN)	REMARKS OWNER PRE-PURCHASED AND FURNISHED TO THE CONTRACTOR
P-201E	CHW PUMP	MECHANICAL ROOM	200	480	1800	6	Y	Y	N	N	N	Y	12	65kAIC	
P-202E	CHW PUMP	MECHANICAL ROOM	200	480	1800	6	Y	Y	N	N	N	Y	12	65kAIC	
P-203E	CHW PUMP	MECHANICAL ROOM	200	480	1800	6	Y	Y	N	N	N	Y	12	65kAIC	
P-101E	CW PUMP	MECHANICAL ROOM	200	480	1200	6	Y	Y	N	N	N	Y	12	65kAIC	
P-102E	CW PUMP	MECHANICAL ROOM	200	480	1200	6	Y	Y	N	N	N	Y	12	65kAIC	
P-103E	CW PUMP	MECHANICAL ROOM	200	480	1200	6	Y	Y	N	N	N	Y	12	65kAIC	
CTF-301E	CT FAN	EXTERIOR ELECTRICAL ENCLOSURE	125	480	180	6	Y	Y	N	N	N	Y	1	65kAIC	
CTF-302E	CT FAN	EXTERIOR ELECTRICAL ENCLOSURE	125	480	180	6	Y	Y	N	N	N	Y	1	65kAIC	
CTF-303E	CT FAN	EXTERIOR ELECTRICAL ENCLOSURE	125	480	180	6	Y	Y	N	N	N	Y	1	65kAIC	

VALVES

23 0902

MARK	LOCATION	SYSTEM	SERVICE	TYPE	OPERATING	SIZE (IN)	GPM	Cv@100% STROKE MIN	Cv@100% STROKE MAX	SHUTOFF PRESSURE DIFFERENTIAL (PSIG)	FAIL POSITION FC, FO OR OR FIP (1)	ACTUATOR TYPE	ACTUATOR VOLTAGE	REMARKS
FCV/201E	CHILLER ROOM	CHS	CRM 1E	BUTTERFLY	MODULATING	10	2,400	3,500	4,500	100	FIP	ELECTRIC	120	
FCV/202E	CHILLER ROOM	CHS	CRM 2E	BUTTERFLY	MODULATING	10	2,400	3,500	4,500	100	FIP	ELECTRIC	120	
FCV/203E	CHILLER ROOM	CHS	CRM 3E	BUTTERFLY	MODULATING	10	2,400	3,500	4,500	100	FIP	ELECTRIC	120	
TCV/200E	CHILLER ROOM	CHR	MINIMUM FLOW / STARTUP BYPASS	BUTTERFLY	MODULATING	6	1,200	400	500	100	FIP	ELECTRIC	120	
FCV/101E	CHILLER ROOM	CWR	CRM 1E	BUTTERFLY	MODULATING	14	4,200	7,000	8,000	100	FIP	ELECTRIC	120	
FCV/102E	CHILLER ROOM	CWR	CRM 2E	BUTTERFLY	MODULATING	14	4,200	7,000	8,000	100	FIP	ELECTRIC	120	
FCV/103E	CHILLER ROOM	CWR	CRM 3E	BUTTERFLY	MODULATING	14	4,200	7,000	8,000	100	FIP	ELECTRIC	120	
TCV/300E	CHILLER ROOM	CWR	TOWER BYPASS	BUTTERFLY	MODULATING	8	2,100	2,000	2,500	100	FIP	ELECTRIC	120	
FV/301E	EQUPMENT YARD	CWR	CTF 1E	BUTTERFLY	TWO POSITION	14	4,200	7,000	8,000	100	FIP	ELECTRIC	120	
FV/302E	EQUPMENT YARD	CWR	CTF 2E	BUTTERFLY	TWO POSITION	14	4,200	7,000	8,000	100	FIP	ELECTRIC	120	
FV/303E	EQUPMENT YARD	CWR	CTF 3E	BUTTERFLY	TWO POSITION	14	4,200	7,000	8,000	100	FIP	ELECTRIC	120	
LCV/350E	CHILLER ROOM	RCW	CONDENSER WATER MAKE-UP	V-BALL	MODULATING	3	200	200	225	100	FC	ELECTRIC	120	
LCV/300E	CHILLER ROOM	DCW	CONDENSER WATER MAKE-UP	V-BALL	MODULATING	3	200	200	225	100	FC	ELECTRIC	120	
FCV/300E	CHILLER ROOM	CWR	TOWER BLEED	V-BALL	MODULATING	2	65	-	-	100	FC	ELECTRIC	120	
FV/350E	CHILLER ROOM	RCW	RECLAIM WATER MAKE-UP SAMPLE	BALL	TWO POSITION	1	-	-	-	100	FC	ELECTRIC	120	STAINLESS STEEL BODY, BALL, ETC.
PCV/800AE	CHILLER ROOM	DCW	CHILLED WATER MAKE-UP	V-BALL	MODULATING	2	80	27	32	100	FC	ELECTRIC	120	30 DEGREE PORT ANGLE
PCV/800BE	CHILLER ROOM	DCW	CHILLED WATER MAKE-UP	V-BALL	MODULATING	4	470	330	350	100	FC	ELECTRIC	120	90 DEGREE PORT ANGLE

(1) FC=FAIL CLOSED, FO=FAIL OPEN, FIP=FAIL IN PLACE

WATER FLOW METERS

23 0903

MARK (FIT)	SYSTEM	SERVICE	TYPE	CAPACITY (GPM)	SIZE (IN)	MAX. PD (FT)	VOLTAGE	REMARKS
800E	DCW	CHILLED WATER MAKE-UP	INLINE MAGNETIC	80	2	N/A	24VDC	
801E	DCW	CHILLED WATER MAKE-UP	INLINE MAGNETIC	470	4	N/A	24VDC	
200E	CHS	MINIMUM FLOW BYPASS	INLINE MAGNETIC	1200	10	N/A	24VDC	
201E	CHR	CRM 1E	INLINE MAGNETIC	2400	10	N/A	24VDC	
202E	CHR	CRM 2E	INLINE MAGNETIC	2400	10	N/A	24VDC	
203E	CHR	CRM 3E	INLINE MAGNETIC	2400	10	N/A	24VDC	
101E	CWS	CRM 1E	INLINE MAGNETIC	4200	14	N/A	24VDC	
102E	CWS	CRM 2E	INLINE MAGNETIC	4200	14	N/A	24VDC	
103E	CWS	CRM 3E	INLINE MAGNETIC	4200	14	N/A	24VDC	
300E	CWS	TOWER BLEED	INLINE MAGNETIC	65	2	N/A	24VDC	
350E	RCW	CONDENSER MAKEUP	INLINE MAGNETIC	200	4	N/A	24VDC	
300E	DCW	CONDENSER MAKEUP	INLINE MAGNETIC	200	4	N/A	24VDC	

PUMPS

MARK (P)	LOCATION	SERVICE	TYPE	CAP. (GPM)	HEAD (FT)	MAX. NPSHR (FT)	MIN. EFF. (%)	SIZE (IN) SUCT.	SIZE (IN) DISCH.	ELECTRICAL CHARACTERISTICS MOTOR VFD	HP	RPM	VOLT	PH	REMARKS OWNER PRE-PURCHASED AND FURNISHED TO THE CONTRACTOR
201E	MECHANICAL ROOM	CHILLED WATER	HORIZONTAL SPLIT CASE	3600	160	19.2	85.5.	12	10	YES	200	1800	480	3	
202E	MECHANICAL ROOM	CHILLED WATER	HORIZONTAL SPLIT CASE	3600	160	19.2	85.5	12	10	YES	200	1800	480	3	
203E	MECHANICAL ROOM	CHILLED WATER	HORIZONTAL SPLIT CASE	3600	160	19.2	85.5	12	10	YES	200	1800	480	3	
101E	MECHANICAL ROOM	CONDENSER WATER	HORIZONTAL SPLIT CASE	6300	90	13.2	85.5	16	14	YES	200	1200	480	3	
102E	MECHANICAL ROOM	CONDENSER WATER	HORIZONTAL SPLIT CASE	6300	90	13.2	85.5	16	14	YES	200	1200	480	3	
103E	MECHANICAL ROOM	CONDENSER WATER	HORIZONTAL SPLIT CASE	6300	90	13.2	85.5	16	14	YES	200	1200	480	3	

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12/06/24

Sheet Keynotes:

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Project

THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL

Chilled Water Infrastructure Expansion
SCO# 22-25588-02B
CODE: 42123-355 / 42323-305
UNC BLDG. NO 505

Sheet Title

MECHANICAL SCHEDULES

Scale: NONE

Date: 10/18/24 Drawn By: DDC

Project No.: 23480-02 Checked By:

Sheet No.

E.M.601