SECTION 23 64 27

AIR COOLED WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide an overall price (“base bid”) for the complete equipment package specified; complete with all accessories and services specified.

B. This Section includes specification for Air Cooled Water Chillers and their accessories. This section includes;

1. Chiller package.
2. Charge of refrigerant.
3. Control and control connections.
4. Chilled water connections.
5. Variable Speed Controllers.
6. Electrical power connections.
7. Manufacturer startup.

1.3 REFERENCES

A. ANSI/AHRI 550/590-2003 - Standard for Water Chilling Packages using the Vapor Compression Cycle.

B. AHRI 370 – Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment.

C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.

D. ANSI / ASHRAE 34 – Number Designation and Safety Classification of Refrigerants

E. ANSI/ASHRAE 90. - Energy Efficient Design of New Buildings.

F. ANSI/NFPA 70 - National Electric Code (NEC)

G. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code

H. ANSI/NEMA MG 1 - Motors and Generators.

I. ANSI/UL 1995 - Central Cooling Air Conditioners.

J. ANSI/UL 984 - Safety Standard for Hermetic Motor Compressors.

K. International Energy Conservation Code

L. Refer to structural drawings for baseline seismic requirements.

1.4 RELATED SPECIFIED WORK REQUIREMENTS

A. Division 22: Plumbing

B. Section 23 05 00: Common Work Results for HVAC

C. Section 23 05 93: Testing, Adjusting, and Balancing for HVAC

D. Section 23 09 00: HVAC Instrumentation and Controls
E. Section 23 09 93: HVAC Sequence of Operation
F. Section 23 21 13: Hydronic Piping
G. Division 26: Electrical

1.5 DEFINITIONS

A. BAS: Building Automation System.
B. 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.
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 calculated per the method defined by AHRI 506/110 and referenced to AHRI standard rating conditions.
E. 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.
F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 506/110 and intended for operating conditions other than AHRI standard rating conditions.

1.6 SUBMITTAL DOCUMENTATION REQUIREMENTS

A. All documentation associated with this bid proposal and contract including submittals, shop drawings, O&M manuals, and test reports shall be furnished as follows:
    1. Submittals shall be provided in a color portable document format (PDF). Submit a single PDF document that is word-searchable (not scanned) which shall include bookmarks (for main and subsections) that match the table of contents. The table of contents shall include subsections for each document included. Submittals consisting of multiple PDF files with non-descript file names may be disqualified from bid and/or rejected. Submittals failing to comply with the requirements of this section will be rejected.
    2. Drawings files for BIM shall be submitted in REVIT, and documents shall be submitted in Microsoft Word and Excel.
    3. When revisions are required, provide written responses to each submittal comment made on the cover sheet and comments noted within, in revised submittal. Where submittal content is changed, highlight and bubble changes only on pages with changes on them. Revised submittals without written responses and notations of revised content will be rejected without review.
B. Bidders shall provide a compliance review of the specifications and drawings. The compliance review shall be a line-by-line review of the specifications with the following information: “C,” “D,” or “E” marked in the margin of the original specification and any subsequent addenda. This specification overview is to be provided with the bidder’s proposal. The Owner and Engineer of Record (EOR) will determine whether the bidder has compiled with all of the requirements of the specification:
    1. “C”: Comply with no exceptions.
    2. “D”: Comply with deviations. For each deviation, provide a numbered footnote with reasons for the proposed deviation(s); also state how the intent of the specification will be satisfied.

3. “E”: Exception, do not comply. For each and every exception, provide a numbered footnote with reasons for the exception.

1.7 SUBMITTALS

A. Drawings of exact unit configuration with all connection points shown. Drawings shall indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate accessories where required for complete system.
B. Product data indicating rated capacities, weights, specialties and accessories, and electrical requirements.
C. Provide full load kW versus outside ambient air temperature for scheduled capacity through the entire operating range of the weather data range of the installation location up to a minimum of 130°F. State unit efficiency (EER) or kW/ton at each condition.
D. Performance at 25%, 50%, 75% and 100% capacities with constant design entering condenser air-temperatures at design maximum and minimum ambient temperatures.
E. Provide sound data at 25%, 50%, 75% and 100% capacities at varying ambient temperatures. 100% capacity shall be at the n=20 ambient condition for the site.
F. Sequence of operations for the unit including failure mode of control components.
G. Delivery schedules with bid.
H. Provide a points list of all the chiller points that can be brought across from the chiller controller to the building automation system.
I. Provide data on mean time between failure (MTBF).
J. Submit manufacturer's installation instructions.
K. Performance standards:
    1. Performance at AHRI standard conditions and at conditions indicated and standard unloading conditions.
    2. Minimum evaporator flow rate.
    3. Refrigerant capacity of the chiller.
    4. Fluid capacity of the chiller.
    5. Characteristics of safety relief valves.
    6. Minimum/maximum entering condenser air-temperature.
    7. Schematic diagrams showing operating modes and flows.
    8. Certified fan sound power ratings.
    9. Certified coil performance ratings with system operating conditions.
    10. Motor ratings, electrical characteristics and motor fan accessories
    11. Material gages and finishes.
L. Factory certified performance ratings indicating conformance with the operating efficiencies and related characteristics indicated in this specification and in the equipment data provided with the submittals.
M. Wiring diagrams: power, signal, and control wiring diagrams.
N. Grounding and bonding requirements and connection points will be provided.
O. Factory run test: Chiller shall be pressure tested, evacuated and fully charged with refrigerant, and shall be factory operational run tested with water flowing through the vessel.

P. Provide power factor based on factory testing. Engineer or Owner may request power factor verification testing for submitted unit.

Q. Provide length of time to start after power failure and length of time to achieve both 80% and 100% cooling capacity.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation data.

B. Submit maintenance data.

C. Include start-up instructions for chiller, controls, and accessories.

1.9 CLOSEOUT SUBMITTALS

A. The closeout submittal shall be considered a final record submittal that includes but is not limited to as-built shop drawings, product data, maintenance manuals, service intervals, spare parts list, normal and emergency operation procedures, warranty information (including start and end date), applicable special warranties, usernames and password (this shall include the main HMI and any other subcomponents, as applicable). See specification 01 78 23 for additional information.

B. Submit Operation and Maintenance Manuals (O&M) for the equipment and components to include emergency, operation and maintenance manuals as specified in the following Sections:
   1. 01 77 00 Closeout Procedures
   2. 01 78 23 Operation and Maintenance Data
   3. 01 91 13 Commissioning Requirements.

C. In addition to requirements included in the Sections above, include the following:
   1. List of special tools recommended to be stored at the site for ready access. Manufacturer to provide price list for all requested special tools.
   2. Copy of approved shop drawings.
   3. Document indicating the recommended service intervals for all equipment.
   4. Field Test Reports: Submit written test reports and include the following:
      a. Test procedures used.
      b. Test results that comply with performance requirements.

         1) Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.10 REGULATORY REQUIREMENTS

A. Conform to ANSI/AHRI 550/590-2003 Standard for testing and certified rating of Water Chilling Packages using the Vapor Compression Cycle.

B. Conform to UL standards and be provided with a UL listing and stamp. In the event the unit is not UL approved, the manufacturer shall, at manufacturer expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.

C. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of water chillers.

D. Conform to ANSI/ASHRAE 15 code for construction and operation of water chillers.

E. Chiller must be built in an ISO 9001 classified facility.

1.11 STORAGE AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units from physical damage. Factory coil shipping covers shall be kept in place until installation.

C. Unit controls shall be capable of withstanding 140 Deg F storage temperatures in the control compartment for an indefinite period of time.

1.12 WARRANTY

A. Provide a general one year (12 months) limited parts only warranty from substantial completion of the project.

B. Provide an add alternate to include a full parts and labor maintenance plan for five years as follows: Beginning at acceptance by the Owner, or substantial completion, provide a separate annual price for years one, two, three, four and five for twelve months' full maintenance by skilled employees of the manufacturer's own service organization.

1.13 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. QA/QC Process: Manufacturer, upon request by Engineer or Owner, shall provide information on the quality assurance / quality control programs that they have in place. An example of the QA/QC documentation and checklists will be provided with proposal and submittal.

C. Codes and Standards: Provide systems conforming to the requirements of the latest edition of the following:

1.14 COORDINATION

A. Provide submittal drawings clearing indicating sizes, locations, and anchoring attachment points for securement to structural-steel support structures.

1.15 FACTORY WITNESS TESTING

A. Factory Witness Test: The manufacturer shall provide an alternate bid for a Factory Witness Test of the submitted product. If accepted, provide minimum 14-working day notice to allow adequate time for travel and lodging coordination:

1. Provide the following additional submittal information for the Factory Test:
    a. Performance test schedule: A test schedule shall be provided for review and comment a minimum of 30 days before the scheduled test. The test shall include a full load test, rapid-restart test, minimum flow verification, and minimum load testing. For all tests, the AHRI 550 tolerance shall apply.
    b. For all tests, input amperage, supply temperature, return temperature, and flow shall be trended, documented and provided to the Owner.
    c. Full load test: Operate the machine at the scheduled ambient conditions and flow and verify that the unit can meet the scheduled leaving chilled water

setpoint within the normal machine operating parameters. This condition shall be operated for a minimum of 30 minutes.

d. Rapid-restart test: With the chiller operating at full load, the power shall be cut and then restored. The time shall be documented between the time it takes for the chiller to reach 80% and 100% capacity with the pump operating at full flow.
e. Minimum flow verification: Operate the pumps below the minimum flow rate. Increase the flow rate above the minimum flow and document the flow rate required to start the Chiller.
f. Minimum load testing: While operating the pumps at the minimum flow rate, start the test with the scheduled entering and leaving water temperatures. Gradually reduce the entering water temperature until the chiller loses stability or shuts down. Document the minimum load.
g. Power Input Analysis: Utilizing the TMY3 BIN data for location-of-installation conduct an annualized PUE or Energy Cost analysis for the Chiller. BINs shall be sorted into 5°F increments. Provide total hours modeled in each BIN. At 100% load, report the kWh consumed in each BIN at total for the site. BIN information to include:

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Trane
B. York
C. Multistack
D. Or Approved Equal

2.2 PERFORMANCE

A. Seismic performance: chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 according to structural design requirements.
   1. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subject to the seismic forces specified and the unit will be fully operational after the seismic event.”
   2. Chillers shall be designed and built to accommodate a structural frame deflection up to L/480.
B. Units will be provided with low noise fans.
C. Each unit shall be provided with 8x8 neoprene isolators with a minimum of 0.2” of deflection. The isolators shall be sized for loads shown on the manufacturer’s submittal. An alternate isolator may be submitted by the manufacturer for review and approval by the Owner and Engineer. Isolators are specified in 23 05 48 (Mechanical Vibration and Seismic Controls).
D. Performance Tolerance: Standard AHRI Tolerance shall apply
E. Provide total unitary harmonic power distortion at 100, 75, 50 and 25 percent nameplate horsepower.
F. Unit power factor (PF) will be 0.95 minimum.
G. Minimum flow value shall provide appropriate conditions for published heat rejection at specified conditions.

H. Each unit shall meet or exceed the scheduled performance parameters on the mechanical drawings.

2.3 OWNER PERFORMANCE WARRANTY

A. Performance warranty.
   1. The manufacturer is to fully warrant the performance of the air-cooled chiller. The system is to be warranted for the following:
      a. Full scheduled capacity at design ambient and no more than scheduled power draw at this condition.

2.4 COMPRESSORS

A. Chiller to have centrifugal magnetic bearing, oil-free, single-stage, hermetical centrifugal compressor. Compressor to be provided with variable speed drive.
B. Statically and dynamically balance rotating parts.
C. Provide variable speed compressor motor, suction gas cooled with robust construction and system design protection, provided with manufacturer installed, wired and tested variable speed controller with zero electrical inrush current.
D. Compressor shall be equipped with means of evacuating liquid refrigerant that may get trapped in the compressor when chiller is off. If not provided, manufacturer shall confirm that compressor startup with liquid refrigerant present will not harm the compressor or compromise the unit warranty in any way.
E. Compressor to be microprocessor controlled. Compressor to be networked to master controller via Etherbus connection with a refresh rate of 50 microseconds and the micro processor of the compressor to control the variable speed drive to maximize unit efficiency.
F. The compressor shall be mechanically and electrically isolated to facilitate flexibility in maintenance, service and removal.
G. The compressor shall be capable of coming to a controlled safe stop in the event of a power outage. Unit shall be capable of auto restart in the event of a power outage once power has been restored.

2.5 EVAPORATOR

A. The evaporator shall be designed, tested, and stamped in accordance with ASME code.
B. Insulate the evaporator and water boxes with a minimum of 3/4 inch (K=0.26) insulation.
C. Evaporator heaters shall be factory installed and shall protect unit down to ASHRAE 20-year minimum. Contractor shall wire separate power to energize heaters and protect cooler while chiller is disconnected from the main power.
D. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned copper tubes, roller expanded into tube sheets.
E. Provide ability to remove evaporator tubes from either end of the heat exchanger.
F. Water connections shall be grooved pipe. Evaporator shall have only one entering and one leaving connection.
G. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired. Flapper-switches to prove flow will not be acceptable.

H. Contractor shall provide heat trace directly downstream/upstream of evaporator beneath insulation to protect from freezing at minimum design conditions.

2.6 CONDENSER AND FANS

A. Provide vertical discharge direct driven variable speed propeller type condenser fans with fan guard on discharge. Entire fan assembly shall be statically, and dynamically balanced and fan assembly shall be either painted or zinc coated steel. Fan guard shall be PVC, chrome, or zinc coated.

B. Provide ECM fan motors with permanently lubricated ball bearings and variable speed drives (ECM motors are acceptable).

C. Chiller shall be able to operate in ambient conditions down to design minimum (-5F°).
   1. Power optimization and mild-ambient operation is accomplished with a fan speed control.
   2. Flooded condenser control shall be provided to ensure stable operation and start-up at extreme low ambient temperatures.
      a. If flooded condenser control is not possible, the manufacturer shall clearly explain how they are achieving low ambient start-up.

D. Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test coils under water to a minimum of 1.25 times the relief valve pressure.
   1. Alternate: construct condenser coils of aluminum microchannel.

E. Condenser coils will be protected from weather and hail with V-guards and end caps that will have no impact on the published performance.

2.7 ENCLOSURES

A. House components in galvanized steel frame and mounted on welded structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.

B. Unit panels and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.

C. Mount variable speed controllers and terminal blocks in weatherproof panel provided with full opening access doors. If a disconnect or circuit breaker is chosen, it should be a lockable, through-the-door type with an operating handle and clearly visible from outside of unit indicating if power is on or off.

D. Each unit will have power connections as defined below.
   1. Each chiller shall be provided with a single point power connection.
   2. Each onboard chilled water pump shall receive a single point power connection separate from the chiller’s power connection.
   3. Manufacturer to clearly identify if separate power connections are required for heat trace, convenience outlet, water box heater, or uninterruptable power supply (UPS) backed controls power.

E. 480V power connections shall be compatible with 2-hole long barrel compression lugs.

F. 20 amp 115 Volt convenience outlets factory wired in weather proof enclosure near the service panel of the chiller.

G. Circuit breaker with 65,000 amp SCWR

H. Unit shall include integral harmonic filter. Filter shall meet following specification:
   1. Filter shall be provided in a UL Type 3R enclosure
   2. Filter shall be factory installed integral to the chiller and tested as part of the chiller factory functional test prior to shipment.
   3. Filter shall be designed to allow for a maximum Harmonic Current Distortion in Percent (TDD) of 5%.
   4. Filter shall include integral fusing with 65,000 amp SCWR

I. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating of the unscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.

2.8 REFRIGERANT CIRCUIT

A. Chillers shall be built with a single refrigerant circuit to optimize efficiency at partial load (and lift) points. Provide for each refrigerant circuit:
   1. Compressor Isolation Valves (for each compressor)
   2. Condenser Coil Isolation Valves (for each condenser coil)
   3. Liquid line shutoff valve.
   4. Motorized Suction Service Valve
   5. Filter (replaceable core type).
   6. Liquid line sight glass.
   7. Electronic or thermal expansion valve sized for maximum operating pressure.
   8. Charging valve.
   9. Discharge check valves.
   10. High side pressure relief valve.
   11. Refrigerant receiver for flooded condenser operation

B. Capacity Modulation: Provide capacity modulation that includes linear unloading to maintain leaving water temperature control. Unit shall be capable of operation down to 20% of design capacity.

2.9 CONTROLS

A. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Controls shall include the following safeties and diagnostics.
   1. Phase reversal/unbalance/single phasing and over/under voltage protection.
   2. Low chilled water temperature protection (field adjustable).
   3. High and low refrigerant pressure protection (field adjustable).

4. High chilled water temperature shutdown with adjustable time delay and adjustable shutdown set point.
5. Loss of chilled water flow.
6. Load limit thermostat to limit compressor loading on high return water temperature.
7. Component failure indication and alarm for condenser fans, compressors, heaters, and UPS
8. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes.

B. Unit will have rapid restart control algorithms pre-programmed into controller. Rapid restart cooling capacity shall be a minimum of:
   1. 2.5-minutes after 480V power is restored = Substantial fluid cooling (80% capacity)
   2. 4-minutes after 480V power is restored = full load heat rejection (100% capacity)
   3. 5-minutes after 480V power is restored = unit will be operating at steady state maintaining leaving fluid temperature ±2°F.
   4. If the unit controller is required to remain online through a power outage to achieve rapid restart, power shall be supplied by an onboard UPS. The onboard UPS shall be provided by the chiller manufacturer and remain operational at the minimum (-20°F) and maximum (120°F) ambient conditions.
C. Hardwire Control Points: Start / Stop, CHW supply temperature set point, Input Current Limit.
D. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Operator shall not be exposed to >120V when view display if opening a panel door is required. Provide user interface with a minimum of the following features:
   1. Entering and leaving chilled water temperature output
   2. Percent RLA output for each compressor
   3. Ambient temperature
   4. Voltage input
   5. Current limit setpoint adjustment from LCD input.
   6. Remote leaving water temperature setpoint
   7. Alarm indicating light and relay
E. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
F. Control panel shall integrate into the BAS system through BacNet MSTP protocol. Any safeties listed herein or points listed in the 23 09 93 specifications shall be capable of being read and communicated to the BAS.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers at delivery and before installation. Alert the owner or owner’s representative to any chillers that are damaged in any way.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping and electrical connections to verify actual locations, sizes and other conditions affecting chiller performance, maintenance and operation before installation.
   1. Final chiller locations indicated on drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
C. Proceed with installation only after unsatisfactory conditions have been documented and corrected.
D. General: Rig and install in full accordance with Manufacturer's requirements, recommendations, project documents / drawings and contract documents.
E. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per manufacturer instructions. Adjust and level chiller on support structure.
F. Components: Installing contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.
G. Electrical: coordinate electrical requirements and connections for all power feeds with Electrical Contractor.
H. Controls: Coordinate all control requirements and connections with Controls Contractor.
I. Finish: Installing contractor shall paint damaged and abraded factory finish with factory provided touch-up paint matching factory finish.

3.2 CHILLER INSTALLATION

A. Install chillers on manufacturer's vibration isolation infrastructure pre-positioned on support structure indicated.
B. Maintain manufacturer's recommended clearances for service and maintenance.
C. Install separate devices furnished by manufacturer and not factory installed.
D. Fill coils with water and test coils and connections for leaks.
E. Adjusting:
   1. Comply with requirements in Section 23 05 93 Testing, Adjusting and Balancing.
F. Cleaning:
   1. After completing system installation and testing, adjusting, and balancing chillers and after completing startup service, clean exterior and inside of any enclosures on chillers to remove foreign material and construction dirt and dust.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 - Hydronic Piping. Drawings indicate general arrangement of piping, fittings and specialties.
B. Install piping adjacent to chiller to allow service and maintenance.
C. Connections to chiller will be flanged or mechanical coupling(s).
D. Connect each chiller drain connection with a union and drainpipe. Provide shutoff valve at each drainpipe connection.

3.4 STARTUP

A. The manufacturer shall provide start-up service by factory trained service technician. Startup services shall include:

1. Complete installation and startup checklist according to manufacturer's written instructions.
2. Verify supply and return piping connections are correct.
3. Verify that refrigerant charge is sufficient, and chiller has been leak tested.
4. Verify that thermometers and gages are installed.
5. Operate chiller for manufacturer's recommended run-in period.
6. Verify proper motor rotation.
7. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.

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

C. Startup reports shall be provided to Commissioning contractor for verification of readiness.

3.5 COMMISSIONING:

A. Contractor shall provide a startup test plan for chiller(s) coordinating with the chiller manufacturer, controls contractor and electrical contractor. Plan shall include test schedules and names and titles of the test personnel who will be participating in the commissioning tests.

B. Manufacturer shall provide on-site technician support during level 4 commissioning (functional testing) and Level 5 commissioning (integrated system testing).

3.6 ON-SITE PERSONNEL TRAINING

A. Chiller manufacturer must provide four (8) hours of detailed training on the maintenance of the Units. This time is in addition to above listed time requirements.

3.7 SPARE PARTS

A. Provide a minimum of (6) spare part kits. Spare parts kits shall include all components recommended by the manufacturer and shall include a minimum of (1) compressor.

PART 4 - ALTERNATE BIDS

4.1 FACTORY WITNESS TESTING

A. Provide an alternate bid to include a Factory Witness Test as outlined in Section 1.15.

4.2 MANUFACTURER'S SUPPORT SERVICES (AFTER TURNOVER)

A. Provide a cost for a separate maintenance contract as outlined in Section 1.12.

END OF SECTION 23 64 27