

ADDENDUM NO. 3

CITY OF SAN ANTONIO
CAPITAL IMPROVEMENTS MANAGEMENT SERVICES

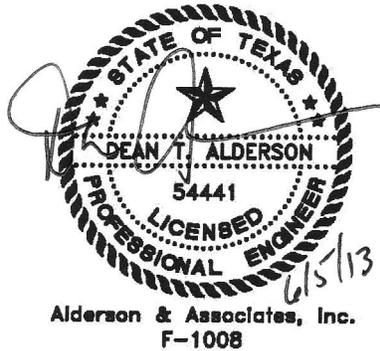
PROJECT NAME: **INTERNATIONAL CENTER REPLACEMENT COOLING TOWERS/CHILLERS**

DATE: 06/05/2013

ADDENDUM NO.3

This addendum should be included in and be considered part of the plans and specifications for the name of the project. The contractor shall be required to sign an acknowledgement of the receipt of this addendum and submit with their bid.

CIMS PROJECT NO.: 40-00268



Formal Invitation for Bid and Contract:

SPECIFICATION SECTION 23 64 12 WATER COOLED WATER CHILLERS

- Added ArcticCool as an acceptable chiller manufacturer in Section 2.1.

Note: Addenda Acknowledgement Form for Addendum 3 is attached herein. This form must be signed and submitted with the bid package.

CITY OF SAN ANTONIO
DEPARTMENT OF CAPITAL IMPROVEMENTS MANAGEMENT SERVICES
CONTRACT SERVICES DIVISION

RECEIPT OF ADDENDUM NUMBER(S) 3 IS HEREBY ACKNOWLEDGED FOR PLANS AND

SPECIFICATIONS FOR CONSTRUCTION OF INTERNATIONAL CENTER REPLACEMENT COOLING TOWERS/CHILLERS

FOR WHICH BIDS WILL BE OPENED ON TUESDAY, JUNE 11, 2013 AT 2:00 P.M.

THIS ACKNOWLEDGEMENT MUST BE SIGNED AND RETURNED WITH THE BID PACKAGE.

Company Name: _____

Address: _____

City/State/Zip Code: _____

Date: _____

Signature

Print Name/Title

SECTION 23 64 12

WATER-COOLED WATER CHILLERS - CENTRIFUGAL

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes chiller package, charge of refrigerant and oil, controls and control connections, chilled water connections, condenser water connections, auxiliary water connections, starters, and electrical power connections. (Note: Machines using R123 will not be acceptable.) Basis of Design: Magnetic bearing machine. Deductive Alternate #1 for conventional oil-lubricated machine.
- B. Related Sections:
1. Section 23 07 00 - HVAC Insulation: Product requirements for insulation for placement by this section.
 2. See Drawings for sequences of operation for chillers specified in this section.
 3. Section 23 21 13 - Hydronic Piping: Execution requirements for chilled water and condenser water piping specified by this section.
 4. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
 5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection to chillers specified by this section.

1.2 REFERENCES

- A. Air-Conditioning, Heating and Refrigeration Institute:
1. AHRI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.
 2. AHRI 575 – Method of Measuring Machinery Sound Within an Equipment Space.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
 2. ASHRAE 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings.
- C. American Society of Mechanical Engineers:
1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- D. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. Underwriters Laboratories Inc.:
1. UL 1995 - Heating and Cooling Equipment.

1.3 DEFINITIONS

- A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.
- B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

1.4 SUBMITTALS

- A. Section 23 05 00 - General Mechanical Requirements: Submittal procedures.
- B. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- C. Product Data: Submit rated capacities, specialties and accessories, electrical requirements and wiring diagrams. Include/highlight any features that deviate from specified features. Include control diagram indicating field interface points.
- D. Design Data: Indicate energy input versus cooling load output from 25 to 100 percent of full load at specified and manufacturer's recommended minimum condenser water temperature.
- E. Test Reports: Indicate results of factory performance test. (Note Owner/Engineer-witnessed test requirements below.)
- F. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions. If machine must be disassembled to allow installation through existing doorways, detail the required manufacturer's involvement in this disassembly/reassembly.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements including components not produced by manufacturer.
- H. Manufacturer's Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.
- I. Provide job names and references in Texas with submittal.
- J. Each chiller shall undergo a four point certified Owner/Engineer-witnessed performance test on an AHRI certified test stand with water at job conditions (excluding glycol applications). A manufacturer's engineer shall oversee the testing in the presence of the Owner or Owner's representative, certify the accuracy of the computerized results, and then translates the test data onto an easy-to-read spreadsheet provided to the Owner. The tests are to be run as specified in advance and are run to within AHRI tolerance of capacity and power. Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Any

deviation in performance or operation shall be remedied prior to shipment and the unit retested if necessary to confirm repairs or adjustments. The manufacturer shall pay for the cost (travel, meals and lodging) for one Owner's personnel or representative to witness this test. This cost shall be included in bid and be no additional cost to the Owner. A certified 4 point witnessed test will be required on both chillers.

1.5 CLOSEOUT SUBMITTALS

- A. Section 23 05 00 - General Mechanical Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble- shooting guide.

1.6 QUALITY ASSURANCE

- A. Construction and rating in accordance with AHRI 550/590; comply with AHRI 575 and ISO certification requirements.
- B. Performance Ratings: Design Performance and Integrated Part-Load Value (IPLV) not less than prescribed by ASHRAE 90.1, or as scheduled
- C. Conform to ASHRAE 15 code for construction and operation of chillers.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience [and with service facilities within 50 miles of Project. Provide job names and references in Texas with submittal.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION COORDINATION

- A. Coordinate with General Contractor and other involved trades prior to unit layout, moving and installation.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 23 05 00 - General Mechanical Requirements: Product storage and handling requirements.
- B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- C. Protect units from physical damage. Leave factory covers in place until installation. Store unit in protected location out of sun, rain.

1.10 WARRANTY

- A. Coordinate with General Contractor to provide product warranties and product bonds.

- B. The chiller manufacturer's warranty shall cover parts and labor costs for the repair or replacement of defects in material or workmanship, and include refrigerant for the entire unit, for a period of one year from equipment startup or 18 months from shipment, whichever occurs first, and also include an additional extended parts and labor warranty for 4 (four) additional years on the entire unit, including refrigerant coverage. Warranty support shall be provided by company direct or factory authorized service permanently located within 50 miles of the job site.

1.11 MAINTENANCE

- A. Maintenance of the chillers in accordance with manufacturer's recommendations as published in the installation and maintenance manuals shall be the responsibility of the Owner.

1.12 MAINTENANCE MATERIALS

- A. Furnish two containers of lubricating oil, as applicable. Deliver to Owner's representative.

PART 2 PRODUCTS

2.1 WATER CHILLERS

- A. Manufacturers:
 - 1. Smardt.
 - 2. McQuay.
 - 3. Multistack.
 - 4. ArcticCool.**
 - 5. DEDUCTIVE ALTERNATE #1: If alternate using conventional oil-lubricated machines is taken, JCI/York, Trane or Carrier are also acceptable manufacturers.
- B. Product Description: Basis of Design: Factory assembled and tested, packaged, water cooled, liquid chillers consisting of dual centrifugal compressors with magnetic bearings, compressor motor(s), condenser, evaporator, refrigeration accessories, instrument and control panel including indication, auxiliary components and accessories, and motor starters. Chillers shall have minimum of two oil-free, magnetic bearing, semi-hermetic centrifugal compressors (no exceptions). Each compressor shall have an integrated variable-frequency drive operating in concert with inlet guide vanes for optimized full and part load efficiency. On two-compressor units, the evaporator and condenser refrigerant sides and the expansion valve shall be common and the chiller shall be capable of running on one compressor with the other compressor or any of its auxiliaries inoperable or removed.
- C. Deductive Alternate (#1) for conventional Oil-Lubricated Machines: in addition to the following applicable requirements, see additional requirements listed below.
- D. General: Provide a complete water-cooled, semi-hermetic, oil-free, centrifugal compressor water chiller as specified herein. The unit shall be provided according to standards indicated above. In general, unit shall consist of two magnetic bearings, completely oil-free centrifugal compressors, refrigerant, condenser and evaporator, and

control systems including integrated variable frequency drive, operating controls and equipment protection controls. Chillers shall be charged with refrigerant HFC-134a. (R-123 is not acceptable.)

- E. The entire chiller system, including all pressure vessels, shall remain above atmospheric pressure during all operating conditions and during shut down to ensure that non-condensables and moisture do not contaminate the refrigerant and chiller system.
- F. Performance: Refer to chiller performance rating requirements in the schedule.
- G. Acoustics: Sound pressure for the unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured in dB according to AHRI Standard 575 and shall include overall dBA. Data shall be the highest levels recorded at all load points.

SOUND PRESSURE:									
% Load	A-Weighted Overall	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz	8000hz
100	81.5	37.5	51.5	59.5	72.0	75.0	72.5	76.5	75.0
75	78.0	37.0	50.5	62.5	66.5	70.0	69.5	74.0	70.5
50	75.0	37.5	50.0	60.0	65.0	65.5	66.0	71.5	66.0
25	73.5	37.5	49.0	59.0	63.0	65.0	66.0	69.5	64.0
Sound pressure (dB) measured in accordance with ANSI/AHRI Standard 575-2008 (A-weighted)									

- H. For Deductive Alternate #1: Lubrication: Direct drive, positive displacement oil pump, with oil cooler, pressure regulator, oil filters, thermostatically controlled oil heater, oil cooler and motor controls. Interlock to start before chiller motor and run after motor is shut down. Furnish sight glass for monitoring oil level.
- I. As part of Deductive Alternate #1 for oil-lubricated machines, furnish at no charge to the Owner:
 - 1. Lubrication: Direct drive, positive displacement oil pump, with oil cooler, pressure regulator, oil filters, thermostatically controlled oil heater, oil cooler and motor controls. Interlock to start before chiller motor and run after motor is shut down. Furnish sight glass for monitoring oil level
 - 2. Annual Oil/Refrigerant Analysis
 - a. The manufacturer shall also include at no charge for a period of 5 years an annual oil and refrigerant analysis report to identify chiller contamination due to vacuum leaks.
 - b. If the analysis identifies water, acid, or other contaminant levels higher than specified by the manufacturer, the oil and/or refrigerant must be replaced or returned to the manufacturer’s original specification at no cost to the Owner.
 - 3. Manufacturer shall meet the scheduled capacities and efficiencies.

2.2 CHILLER COMPONENTS

A. Compressors:

1. The unit shall utilize magnetic bearing, oil-free, semi-hermetic centrifugal compressors. The levitated shaft position shall be digitally controlled and shall be monitored by X-axis position sensor, Y-axis position sensor, and Z-axis position sensor. The compressor drive train shall be capable of coming to a controlled, safe stop in the event of a power failure by diverting stored power to the magnetic bearing controls system.
2. The motor shall be of the semi-hermetic type, of sufficient size to efficiently fulfill compressor horsepower requirements. It shall be liquid refrigerant cooled with internal thermal sensing devices in the stator windings. The motor shall be compatible with variable frequency drive operation.
3. If unit contains an atmospheric shaft seal, the manufacturer shall provide the following at no additional charge:
 - a. 5 year warranty and all preventive maintenance required to maintain the shaft seal including appropriate disposal of all oil lost through the shaft seal. Such disposal shall be done in a manner consistent with all Federal, state, and local laws pertaining to disposal and documentation of appropriate disposal shall be provided.
 - b. Replacement and re-charging on a semi-annual basis, or more often if required, of all oil lost through the shaft seal.
 - c. 5 year refrigerant replacement warranty for any loss of refrigerant that can be directly attributable to the failure of the atmospheric shaft seal.
4. If the compressor drive motor is an open design the chiller manufacturer shall provide at no additional charge a self contained air conditioning system in the mechanical space sized to handle the maximum heat output the open drive motor. The energy required to operate this air conditioning system shall be added to the chiller power at all rating points for energy evaluation purposes.
5. Deductive Alternate #1: If the compressor drive motor uses any form of antifriction bearings (oil-lubricated roller, ball, etc) the chiller manufacturer shall provide the following at no additional charge:
 - a. A 5 year motor bearing warranty and all preventative maintenance, including lubrication, required to maintain the bearings as specified in the manufacturer's operating and maintenance instructions
 - b. At start up a three axis vibration analysis and written report which establishes a baseline of motor bearing condition.
 - c. An annual three axis vibration analysis and written report to indicate the trend of bearing wear.
6. The chiller shall be equipped with an integrated Variable Frequency Drive (VFD) to automatically regulate compressor speed in response to cooling load and the compressor pressure lift requirement. Movable inlet guide vanes and variable compressor speed, acting together, shall provide unloading. The chiller controls shall coordinate compressor speed and guide vane position to optimize chiller efficiency.
7. Each compressor circuit shall be equipped with a 5% rated line reactor to help protect against incoming power surges and help reduce harmonic distortion.
8. The unit shall have a minimum of a 0.90 power factor at compressor full load.

B. Evaporator:

1. The evaporator shall be separate vessels of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure, but not less than 200 psig. The tubes shall be individually replaceable and secured to the intermediate supports without rolling or expanding to facilitate replacement if required.
2. The evaporator shall be flooded type with 0.025 in. wall copper internally and externally enhanced tubes rolled into carbon steel tubesheets. The water side shall be designed for a minimum of 150 psig. The refrigerant side shall be designed for a minimum of 200 psi. Provide intermediate tube supports at a maximum of 18 inch spacing. The heads shall be carbon steel and the tubesheets shall be carbon steel. Water connections shall be grooved, suitable for Victaulic couplings. The evaporator shall have dished heads with valved drain and vent connections. The evaporator shall have connections as indicated on the drawings.
3. An electronic expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have moisture indicating sight glass.
4. Re-seating type, spring-loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves as required. Rupture disks are not acceptable.
5. The evaporator, including water heads, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier. Provide the head insulation for field installation.
6. Provide factory-mounted and wired, thermal-dispersion water flow switches on each vessel to prevent unit operation with no or low water flow. Paddle and pressure differential type switches are not acceptable due to high rates of failure and false indications from these types of flow indicators.
7. Furnish thermometer wells for temperature controller and low temperature cutout.
8. Provide 2 independent refrigerant circuits, with refrigerant isolation valves to isolate refrigerant in either evaporator.

C. Condenser:

1. The condenser shall be separate vessels of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure, but not less than 200 psig. The tubes shall be individually replaceable and secured to the intermediate supports without rolling or expanding to facilitate replacement if required.
2. The condenser shall have 0.025 in. wall copper internally and externally enhanced tubes rolled into carbon steel. Water connections shall be grooved suitable for Victaulic couplings. The water side shall be designed for a minimum of 150 psig and the refrigerant side shall be designed for a minimum of 200 psi. Provide intermediate tube supports at a maximum of 18 inch spacing. The condenser shall have dished heads with valved drain and vent connections. The heads shall be carbon steel and the tubesheets shall be carbon steel. The condenser shall have connections as indicated on the drawings.

3. Provide sufficient isolation valves and condenser volume to hold the full unit refrigerant charge in the condenser at 90°F in accordance with ANSI/ASHRAE 15 during servicing or provide a storage tank sufficient to hold the charge of the largest unit being furnished.
4. Re-seating type, spring-loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The condenser shall be provided with dual relief valves equipped with a transfer valve so one relief valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the condenser. Provide 2 independent refrigerant circuits, with refrigerant isolation valves to isolate refrigerant in either condenser. Rupture disks are not acceptable.
5. Provide factory-mounted and wired, thermal-dispersion water flow switches on each vessel to prevent unit operation with no or low water flow. Paddle and pressure differential type switches are not acceptable due to high rates of failure and false indications from these types of flow indicators.
6. Furnish thermometer wells for temperature controller and low temperature cutout.

2.3 DEDUCTIVE ALTERNATE #1 – LONG-TERM RELIABILITY

- A. Features required:
1. All compressor/motor designs that require oil to lubricate their respective roller/ball bearing system must denote exactly how many gallons of oil are required for safe operation. The manufacturer must then provide the engineer and owner with a real world energy analysis showing the energy degradation over time due oil contamination of heat transfer surfaces.
 2. Chillers containing oil shall include a 5 year parts and labor warranty on all oil system components including:
 - a. Pumps
 - b. Starter
 - c. Piping
 - d. Tank
 - e. Heater
 - f. Cooler
 - g. Controls
 - h. Valves
 3. Manufacturer shall be responsible for covering all costs associated with annual oil and oil filter changes plus oil analysis as required.

2.4 OPTIONS

- A. The following options shall be provided:
1. Provide manufacturer-recommended neoprene waffle-type vibration isolators for each corner of the unit.
 2. Refrigerant monitor, with local alarm and inputs to building automation system.
 3. Chiller will have to fit through existing door without removing any walls, panels or roof penetrations. The chiller manufacturer will be responsible for breaking down the chiller as required to fit through the allotted space. Any break down and reassembly of the chiller must be done by the manufacturer's certified service representative.

2.5 CONTROLS

- A. The unit shall have a microprocessor-based control system consisting of a 15-inch VGA touch-screen operator interface and a unit controller.
- B. The touch-screen shall display the unit operating parameters, accept setpoint changes (multi-level password protected) and be capable of resetting faults and alarms. The following parameters shall be displayed on the home screen and also as trend curves on the trend screen:
 - 1. Entering and leaving chilled water temperatures
 - 2. Entering and leaving condenser water temperatures
 - 3. Evaporator saturated refrigerant pressure
 - 4. Condenser saturated refrigerant pressure
 - 5. Percent of 100% speed (per compressor)
 - 6. % of rated load amps for entire unit
- C. In addition to the trended items above, all other important real-time operating parameters shall also be shown on the touch-screen. These items shall be displayed on a chiller graphic showing each component. At a minimum, the following critical areas must be monitored:
 - 1. Compressor actual speed, maximum speed, percent speed
 - 2. Liquid line temperature
 - 3. Chilled water setpoint
 - 4. Compressor and unit state and input and output digital and analog values
- D. A fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. Time interval scale shall be user selectable as 20 mins, 2 hours, or 8 hours. The alarm history shall be downloadable from the unit's USB port. An operating and maintenance manual specific for the unit shall be viewable on the screen.
- E. All setpoints shall be viewable and changeable (multi-level password protected) on the touch screen and include setpoint description and range of set values.
- F. Automatic corrective action to reduce unnecessary cycling shall be accomplished through preemptive control of low evaporator or high discharge pressure conditions to keep the unit operating through abnormal transient conditions.
- G. Chiller plant optimization software for multiple chillers shall be provided including automatic control of: at least two (2) chillers, evaporator and condenser pumps (primary and standby), up to 3 stages of cooling tower fan cycling control and a tower modulating bypass valve or cooling tower fan variable frequency drives.
- H. The factory mounted controller(s) shall support operation on a BACnet® network via one of the data link / physical layers as specified by the successful Building Automation System (BAS) supplier: BACnet MS/TP master (Clause 9), BACnet IP (Annex J), or BACnet ISO 8802-3 (Ethernet).
- I. All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

- J. The factory supplied VFD and controls should include the following:
 - 1. High short circuit panel rating of 35kA with a matching circuit breaker
 - 2. Phase loss protection
 - 3. Under/over voltage protection

- K. Energy saving software logic shall at a minimum offer the following:
 - 1. User programmable compressor soft loading
 - 2. Chilled water reset
 - 3. Demand limit control
 - 4. Staging options lead lag between multiple compressors on a single chiller or on multiple chillers
 - 5. Plotting of historic trends for optimizing efficiency.

2.6 CHILLER PERFORMANCE – See schedule on drawings.

2.7 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: In accordance with Section 26 05 03 and the schedule on drawings.
- B. Power connection shall be single point to a factory-mounted disconnect switch.

2.8 SOURCE QUALITY CONTROL (AND TESTS)

- A. Coordinate with General Contractor to provide all required testing, inspection and analysis requirements.
- B. Owner/Engineer witnessed (4 PT.) Certified Performance Test at factory in accordance with procedures and to the tolerances contained in AHRI Standard 550/590. Provide for transportation, lodging and meals for one representative.
- C. Conform to ARI 550/590 code for testing of chillers. Furnish report of factory full performance test.
- D. Conform to ASME Section VIII for construction and testing of chillers.
- E. Furnish 30 days notice before Owner/Engineer witnessed test is scheduled.
- F. If machine must be disassembled/reassembled to fit space, provide subsequent testing/commissioning sufficient to maintain Manufacturer's extended warranty.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install chiller on concrete housekeeping pad minimum 5-1/2 inches (138 mm) high and 6 inches (150 mm) wider than chiller base on each side.
- B. Install units on vibration isolation pads, as supplied by chiller manufacturer.
- C. Install the detailed piping accessories on evaporator chilled water piping connections.
- D. Provide auxiliary water piping for oil cooling units condensers, as recommended by manufacturer.
- E. Insulate evaporator and cold surfaces not factory insulated with minimum 3/4" flexible unicellular insulation equal to Armaflex.
- F. Install the detailed piping accessories on condenser water piping connections.
- G. Arrange piping for easy dismantling to permit tube cleaning.
- H. Install piping from pressure relief valves to outdoors. Size as recommended by manufacturer.
- I. Install chiller accessories furnished loose for field mounting. Comply with manufacturer's recommendations.
- J. Install electrical devices furnished loose for field mounting. Comply with manufacturer's recommendations.
- K. Install control wiring between chiller control panel and field mounted control devices.
- L. Provide for connection of electrical wiring between starter and chiller control panel, and oil pump (as applicable). Refer to Section 26 05 03.

3.2 FIELD QUALITY CONTROL

- A. Coordinate with General Contractor to provide for field inspecting, testing, adjusting, and balancing.
- B. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Coordinate with General Contractor to provide manufacturers' field services.
- B. Factory Start-Up Services: Provide for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period

of start-up, the start-up technician shall instruct the owner's representative in proper care and operation of the unit.

- C. Furnish initial charge of refrigerant and oil if not installed by manufacturer.

3.4 DEMONSTRATION AND TRAINING

- A. Coordinate with General Contractor to provide for demonstration and training.
- B. Demonstrate system operations and verify specified performance.
- C. At completion of commissioning process, provide 8 hours of formal training (4 hours on site & 4 hours classroom), for Owner's representatives (up to 4 people) to familiarize personnel with all operation and maintenance requirements of units. After 6 weeks of chiller operation and at the Owner's discretion, provide an additional 8 hours of on-site training.

3.5 SCHEDULES – See Drawings.

END OF SECTION