

## **ADDENDUM NO. 2**

CITY OF SAN ANTONIO  
CAPITAL IMPROVEMENTS MANAGEMENT SERVICES

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

DATE: 06/03/2013

### **ADDENDUM NO.2**

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:**

#### **BID FORM 020**

- Revised bid form to include a line for Commissioning Firm name.
- Revised bid form to include a line for Controls Manufacturer name.

#### **SPECIFICATION SECTION 01 50 00 TEMPORARY FACILITIES AND CONTROLS**

- Revised section 1.14.B to require temporary fencing to be 8 feet in height.
- Added contractor's security requirements for after hours building access to section 1.15.

#### **SPECIFICATION SECTION 23 09 23 BAS FOR HVAC**

- Revised specification section title to reflect 23 09 23.
- Revised section 1.1.A.3 to reflect ANSI/ASHRAE Standard 135-2010, BACnet as a requirement.
- Revised section numbering to be continuous. Section 1.10 is now Section 1.9 and Section 1.11 is now Section 1.10. (Section 1.9 was previously omitted.)
- Added Alerton as an acceptable DDC manufacturer in Section 2.1.
- Revised section 2.8.J to indicate Filter Monitoring requirement.
- Deleted NEMA 4 enclosure requirement from section 2.9.C.

## **SPECIFICATION SECTION 23 21 23 HYDRONIC PUMPS**

- Added Aurora as an acceptable pump manufacturer in Section 2.1.

## **SPECIFICATION SECTION 23 25 00**

- Added Section 1.11.D which indicates current status of building chemical treatment maintenance.

## **SPECIFICATION SECTION 23 64 12 WATER COOLED WATER CHILLERS**

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

## **PLAN SHEET ME2.1**

- Revised keyed note #10 to indicate ventilation fan, VF-1 to remain in its current condition.
- Added temporary door patch and eventual door/frame replacement requirements for Service Bay 101 exterior double doors.

## **PLAN SHEET M10.1**

- Added Owner Requested Graphics requirements to Cascaded Graphic User Interface Requirements.

## **PLAN SHEET M10.2**

- Revised bypass valve AI point to indicate a feedback signal type.

## **PLAN SHEET M10.5**

- Added end switch to EF-1 control damper (detail #1)
- Added duct static pressure high limit switch to detail #2.
- Revised water flow meter point type to be Analog Input (condenser water make up and blowdown meters).
- Deleted cooling tower basin water level control requirement (duplication of level control indicated on sheet M10.2).
- Added fan coil unit control diagram (detail #4).

## **PLAN SHEET E1.2**

- Added Add Alternate #3 keyed note description. Added key note symbol to AHU-3 controller per add alternate (install new VFD).

## **PLAN SHEET E2.1**

- Added Add Alternate # 2 & 3 keyed note descriptions.
- Added relative keyed note symbols to AHU-3 & AHU-4 controllers per add alternate (install new VFD's).

**Note: Addenda Acknowledgement Form for Addendum 2 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) 2 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

---

# CITY OF SAN ANTONIO

---

Project Name: International Center Cooling Towers and Chiller Replacement  
ID NO.: 40-00268

Date Issued: June 3, 2013  
Page 1 of 2

---

020

## BID FORM

The estimated construction budget for this contract is \$1,363,000.00

### I. BASE BID

Commissioning Work included in Base Bid (Insert Firm, Amount in Words and Numbers):

Commissioning Firm: \_\_\_\_\_

\_\_\_\_\_ \$ \_\_\_\_\_

Controls Work included in Base Bid (Insert Manufacturer, Amount in Words and Numbers):

Manufacturer: \_\_\_\_\_

\_\_\_\_\_ \$ \_\_\_\_\_

Total Amount of Base Bid (Insert Amount in Words and Numbers):

\_\_\_\_\_ \$ \_\_\_\_\_

### II. ALTERNATES

Amount of each Alternates (if applicable) insert in Numbers:

Additive Alternate #1 - DP-1 Power Metering & BAS Integration \_\_\_\_\_

Total Amount of Bid for Additive Alternate #1 (Insert Amount in Words and Numbers):

\_\_\_\_\_ \$ \_\_\_\_\_

Additive Alternate #2 - Variable Frequency Drive replacement for AHU-1, 2 &3 \_\_\_\_\_

Total Amount of Bid for Additive Alternate #2 (Insert Amount in Words and Numbers):

\_\_\_\_\_ \$ \_\_\_\_\_

Additive Alternate #3 - Single Zone VAV Controls for AHU-4 \_\_\_\_\_

Total Amount of Bid for Additive Alternate #3 (Insert Amount in Words and Numbers):

\_\_\_\_\_ \$ \_\_\_\_\_

Deductive Alternate #1 Oil-Lubricated Centrifugal Chiller Alternate \_\_\_\_\_

Total Amount of Bid for Deductive Alternate #1 (Insert Amount in Words and Numbers):

\_\_\_\_\_ \$ \_\_\_\_\_

### III. UNIT PRICES

Bidders shall submit unit pricing on the 025 Unit Pricing form, and it shall be attached immediately following this sheet.

**IV. ALLOWANCES: N/A**

\_\_\_\_\_  
Official Name of Company (legal)

\_\_\_\_\_  
Telephone No.

\_\_\_\_\_  
Address

\_\_\_\_\_  
Fax No.

\_\_\_\_\_  
City, State and Zip Code

\_\_\_\_\_  
E-mail Address

Name of the proposed **Project Manager:** \_\_\_\_\_

Name of the proposed **Site Superintendent:** \_\_\_\_\_

## SECTION 01 50 00

## TEMPORARY FACILITIES AND CONTROLS

## PART 1 GENERAL

## 1.1 SECTION INCLUDES

- A. Temporary Utilities:
  - 1. Temporary electricity.
  - 2. Temporary heating.
  - 3. Temporary cooling.
  - 4. Temporary ventilation.
  - 5. Temporary sanitary facilities.
  
- B. Construction Facilities:
  - 1. Field offices and sheds.
  - 2. Vehicular access.
  - 3. Parking.
  - 4. Progress cleaning and waste removal.
  - 5. Traffic regulation.
  - 6. Fire prevention facilities.
  
- C. Temporary Controls:
  - 1. Barriers.
  - 2. Enclosures and fencing.
  - 3. Security.
  - 4. Dust control.
  - 5. Noise control.
  - 6. Pest control.
  - 7. Pollution control.
  - 8. Rodent control.
  
- D. Removal of utilities, facilities, and controls.

## 1.2 TEMPORARY ELECTRICITY

- A. Utilize Owner's existing power service.
  
- B. Provide temporary electric feeder from existing building electrical service at location as directed by Engineer and as indicated on Plans. Do not disrupt Owner's use of service.
  
- C. Permanent convenience receptacles may be utilized during construction.

## 1.3 TEMPORARY HEATING

- A. Existing facilities may be used.

#### 1.4 TEMPORARY COOLING

- A. Provide and pay for cooling devices and cooling as needed to maintain specified conditions during construction operations.

#### 1.5 TEMPORARY VENTILATION

- A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

#### 1.6 TEMPORARY SANITARY FACILITIES

- A. Existing building restroom facilities shall be utilized for the duration of the project. Use of mobile/temporary facilities is not permitted..
- B. At end of construction, return existing facilities used for construction operations to same or better condition as original condition.

#### 1.7 FIELD OFFICES AND SHEDS

- A. Do not use existing facilities for field offices. Prior to installing any temporary facilities, submit plans for approval to Owner.

#### 1.8 VEHICULAR ACCESS

- A. Provide unimpeded access for emergency vehicles. Maintain 20 feet (6 m) wide driveways with turning space between and around combustible materials.
- B. Provide and maintain access to fire hydrants and control valves free of obstructions.
- C. Use existing roads for construction traffic.

#### 1.9 PARKING

- A. On-site parking is not available except for immediate loading/unloading. All construction personnel shall park off-site at the contractor's expense.
- B. The area utilized for loading/unloading operations shall, at the contractor's expense, be returned to pre-construction condition prior to project closeout.

#### 1.10 PROGRESS CLEANING AND WASTE REMOVAL

- A. Use of Owner's dumpsters and trash receptacles is strictly prohibited. The contractor shall be responsible for all construction waste removal. Construction dumpster size and location shall be coordinated with and require approval of the Owner prior to delivery.
- B. Maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.

- C. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing spaces.
- D. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- E. Collect and remove waste materials, debris, and rubbish from site periodically weekly and dispose off-site.
- F. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

#### 1.11 TRAFFIC REGULATION

- A. Signs, Signals, And Devices:
  - 1. Traffic Cones and Drums, Flares and Lights: As approved by authority having jurisdiction.
  - 2. Flagperson Equipment: As required by authority having jurisdiction.
- B. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.
- C. Flares And Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.
- D. Haul Routes:
  - 1. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.
- E. Requirements of the authority having jurisdiction (AHJ) to use public right-of-way for any purpose during construction is exclusively the responsibility of the contractor and includes but is not limited to applications and fees associated with public right-of way usage.

#### 1.12 FIRE PREVENTION FACILITIES

- A. Prohibit smoking with buildings under construction and demolition. Designate area on site where smoking is permitted. Provide approved ashtrays in designated smoking areas.
- B. Establish fire watch for cutting and welding and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.
- C. Standpipes: Maintain existing standpipes in usable condition to height within one floor of floor being demolished.
- D. Portable Fire Extinguishers: NFPA 10; 10 pound capacity, 4A-60B: C UL rating.
  - 1. Provide one fire extinguisher at each stair on each floor of buildings under construction and demolition.

2. Provide minimum one fire extinguisher on roof during roofing operations using heat producing equipment.

### 1.13 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, allow for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by authorities having jurisdiction for public rights-of-way and for public access to existing building.
- C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

### 1.14 ENCLOSURES AND FENCING

- A. Construction: Commercial grade chain link fence with 100% visual screen. Screen material shall be designed/developed at the contractor's expense specifically for this project and shall include Owner supplied graphics covering a minimum of 25% of the screen area.
- B. Provide **8 feet** (1.8 m) high fence around ground level construction equipment and materials. Note that the temporary HVAC equipment area shall be fenced/screened in addition to any addition contractor utilized exterior space.
- C. No materials may be stored at the site for more than 30 days and at no time may the contractor use an area larger than 200 square feet outside the building for storage of materials. The exact location of the outside storage area shall be subject to Owner approval.

### 1.15 SECURITY

- A. **Contractor shall be responsible for all costs associated with building security Monday thru Sunday during hours of 11PM to 7AM. The contractor shall employ Allied Barton Security for all security needs during this time frame. (Allied Barton Security is the current security contractor at this building.) The contractor shall coordinate with Allied Barton Security to ensure that security personnel are familiar with the security requirements of the existing building.**

**Allied Barton Security Contact Info:**

**Primary Contact – Candace Kleck (210) 384-5173**

**Alternate Contact – Andy Spinks (210) 384-5120**

**Note: After hours security is only required by COSA in the event that after hours building access is required. Security monitoring of construction areas located exterior to the building shall be at the contractor's sole discretion.**

- B. Security Program:
  1. Protect Work from theft, vandalism, and unauthorized entry.

2. Initiate program in coordination with Owner's existing security system at project mobilization.
  3. Maintain program throughout construction period until Owner acceptance precludes need for Contractor security directed by Engineer.
- C. Entry Control:
1. Restrict entrance of persons and vehicles into Project site and existing facilities.
  2. Allow entrance only to authorized persons with proper identification.
  3. Maintain log of workers and visitors, make available to Owner on request.
  4. Owner will control entrance of persons and vehicles related to Owner's operations.
- D. Personnel Identification:
1. Provide COSA issued identification badge to each person authorized to enter premises.
  2. Badge To Include: Personal photograph, name and assigned number expiration date and employer.
  3. Maintain list of accredited persons, submit copy to Owner on request.
  4. Require return of badges at expiration of their employment on the Work.
  5. All personnel to report shall report to 515 Frio St. for contractor photo and badge issuance.
- 1.16 DUST CONTROL
- A. Execute Work by methods to minimize raising dust from construction operations.
  - B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.
- 1.17 NOISE CONTROL
- A. Provide methods, means, and facilities to minimize noise from and noise produced by construction operations.
- 1.18 PEST CONTROL
- A. Provide methods, means, and facilities to prevent pests and insects from damaging the Work and/or entering facility.
- 1.19 POLLUTION CONTROL
- A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.
  - B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

1.20 RODENT CONTROL

- A. Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

1.21 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

**SECTION 23 09 23****DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

## PART 1 GENERAL

## 1.1 REFERENCES

- A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:
1. ANSI MC85.1 - Terminology for Automatic Control.
  2. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
  3. **ANSI/ASHRAE Standard 135-2010, BACnet.**
  4. International Building Code (IBC), including local amendments, IECC and IMC.
  5. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
  6. National Electrical Code (NEC).
  7. FCC Part 15, Subpart J, Class A
  8. EMC Directive 89/336/EEC (European CE Mark)
- B. City, county, state, and federal regulations and codes in effect as of contract date.
- C. Except as otherwise indicated the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.
- D. All BAS system components (electronic DDC hardware and all software) shall be of one manufacturer as indicated in manufacturer's trade catalog. Hybrid systems assembled from various manufacturers shall not be acceptable. This requirement does not apply to field devices.
- E. Controls contractor to provide personnel for commissioning as required.

## 1.2 SYSTEM DESCRIPTION

- A. The system shall be a browser based Building Automation System (BAS) accessible with standard browsers such as Internet Explorer and Google Chrome. Systems requiring workstation software licenses shall not be acceptable.
- B. Systems based on Lonworks shall not be acceptable.
- C. General Description:
1. Install the Building Global Controller the 2<sup>nd</sup> floor mechanical room.
  2. **THE DIRECT DIGITAL CONTROL (DDC) SYSTEM SHALL CONTROL EQUIPMENT AS INDICATED ON THE DRAWINGS.**

### 3. WORK INCLUDED

- a. Provide a Building Engineer workstation equal to:
  1. Four Core Xeon Processor @ 3 GHz.
  2. Windows 7 operating system.
  3. 4GB 1600 MHz RAM.
  4. 1.0 GB NVIDIA dual graphics card.
  5. 250 GB SATA hard drive.
  6. 8X DVD +/- RW.
  7. Keyboard.
  8. Mouse.
  9. 2 17" HD monitors.
  10. 4 USB ports.
  11. HDMI port.
  12. VGA port.
- b. Provide blow-down valve for chemical treatment system. Monitor blow-down valve.
- c. Chiller manufacturer and BAS contractor share the sequence of operation for the chiller plant. See mechanical drawings for specific coordination instructions.
- d. Provide a complete Facility Management and Control System.
- e. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.
- f. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.
- g. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
- h. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.
- i. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.
- j. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.
- k. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.
- l. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.
- m. Provide a comprehensive operator and technician training program as described herein.
- n. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

- o. Provide computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified and detailed.

#### D. SYSTEM REQUIREMENTS

1. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be based on ANSI/ASHRAE Standard 135-2010, BACnet. This system is to control all mechanical equipment, including all unitary equipment, all air handlers and any other listed equipment using BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.
2. It shall be the responsibility of the Controls Contractor to coordinate all interface requirements with the respective equipment vendors to provide a complete and working system in all respects.
3. The Web Server should be designed to harness the power of the Internet and provide efficient integration of standard open protocols (i.e. BACnet). The Network Server creates a powerful network environment with comprehensive database management and messaging services. In addition, the Web Server shall provide an engineering environment and graphical user interface.
4. The web server shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the web server. It shall be capable of executing application control programs to provide:
  - a. Calendar functions
  - b. Scheduling
  - c. Trending
  - d. Alarm monitoring and routing
  - e. Time synchronization
  - f. Integration of controller data for each applicable protocol
  - g. Network Management function for all network devices
5. All application controllers for every terminal unit (VAV, etc.) air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller via BACnet LAN.
6. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

#### 1.3 SUBMITTALS

- A. Section 23 05 00 – General Mechanical Requirements: Submittal procedures.
- B. Shop Drawings: Indicate the following:
  1. Indicate routing of MS/TP networks on floor plans. Indicate location of Global Building Controllers and servers. Provide IP connection requirements.
  2. Provide proposed campus, floor-plan, equipment and summary graphics with submittal.

3. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
  4. Connected data points, including connected control unit and input device.
  5. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
  6. Description and sequence of operation for operating, user, and application software.
  7. Electrical drawing showing all system internal and external connection points, terminal block layouts and terminal identification.
  8. Complete bill of materials, valve schedule and damper schedule.
  9. For all system elements (building controllers) provide BAC net protocol implementation conformance statements (PICS) as per ANSI/ASHRAE Standard 135-2010.
  10. Provide complete description and documentation of all services and/or objects used in the system
  11. Manufacturer's Installation Instructions: Submit installation, maintenance, operation instructions for each control system component.
  12. Use terminology in submittals conforming to ASME MC85.1.
- C. Product Data: Submit data for each system component and software module.
- D. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
  2. Submit data specified in "Submittals" in final "Record Documents" form.
- B. Operation and Maintenance Data:
1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered system components and devices.
  2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
  3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience, and with service facilities within 50 miles of Project.

- B. Installer: Company specializing in performing Work of this section with minimum five years experience.

## 1.6 PRE-INSTALLATION MEETINGS

- A. Pre-installation meeting.
  - a. Contractor shall attend a pre-installation meeting at the job site with all related contractors and trades on the job. At a minimum the following shall be addressed and coordinated:
    - 1) BAS wiring diagrams, work assignments and trade responsibilities.
    - 2) Chiller plant interface requirements, wiring diagrams, work assignments and trade responsibilities.
    - 3) 120VAC power requirements for any and all locations.
    - 4) Coordinate IP connection requirements with Owners IT department.
    - 5) Review campus, floor-plan, equipment and summary graphics and obtain approval of Owner and Engineer prior to assembling the final graphics package.
    - 6) Chemical treatment vendor to coordinate blow-down signal.
    - 7) Chiller Manufacturer: Coordinate chiller interface requirements and sequences of operation with chiller manufacturer.
- B. Convene prior to commencing work of this section.
- C. Keep meeting minutes and submit to Engineer of Record within 5 business days of meeting.

## 1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

## 1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of control systems for one year from Date of Substantial Completion.
- B. Furnish two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls. Submit written report after each inspection.
- C. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- D. Perform work without removing units from service during building normal occupied hours.
- E. Provide emergency call back service at all hours for this maintenance period.

- F. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- G. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.
- H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

#### 1.9 RELATED WORK IN OTHER SECTIONS

- A. Refer to Division 0 and Division 1 for related contractual requirements.
- B. Refer to Section 23 05 00 for General Mechanical Provisions
- C. Refer to Section 26 05 00 for General Electrical Provisions
- D. Refer to section 23 08 00 for Project Commissioning requirements.
- E. Refer to section 23 21 23 for Pump provisions.
- F. Refer to section 23 25 00 for Water Treatment provisions.
- G. Refer to section 23 34 00 for Fan provisions.
- H. Refer to section 23 64 12 for Chiller provisions.
- I. Refer to section 23 65 00 for Cooling Tower provisions.

#### 1.10 BAS GENERAL REQUIREMENTS

- A. All electrical control wiring shall be furnished and installed under this section, unless shown on the electrical drawings. Low voltage wiring shall be run in EMT conduit in exposed areas and in vertical risers between floors. Low voltage plenum rated wire may be used without conduit in concealed but assessable areas. All conduit on roofs or exteriors shall be rigid with rain tight fittings. Line voltage wiring control wiring shall be run EMT conduit or rigid if outdoors or on roofs. All network cabling shall be installed with J-hooks and D-rings. Tie-wraps shall not be used.
- B. Space Sensor Installation: Provide conduit stub-ups with junction box in new walls. Wire mold may be used on existing block walls. Provide nylon bushing at the end of all conduit whips for space sensors to prevent chafing of wire.
- C. All 120 volt and higher power wiring associated with the control system shall be provided by Division 26-Electrical. Electrical contractor under the direction of the controls contractor shall provide 120VAC and higher power to all control panels as required. All transformers with secondary voltages of 24 volts or less shall be provided by controls contractor with the exception of the transformers for factory mounted controls such as VAV boxes. In the case

- of factory mounted controls the manufacturer doing the mounting shall provide control transformers and coordinate the voltages. Indicate location of all control panels requiring power on submittal shop drawings for coordination with Electrical Contractor during pre-installation meeting described in section 1.6 above.
- D. Control valves and separable wells for immersion elements and couplings for flow and pressure switches furnished under this section shall be installed by the Mechanical Contractor.
  - E. All automatic dampers furnished under this section shall be installed by the Mechanical Contractor. It shall be the responsibility of the Mechanical Contractor to provide and install blank off plates when the control application requires dampers smaller than duct size.
  - F. All finished painting required for Control piping and equipment shall be done by the General Contractor.
  - G. All cutting and patching necessary for the installation of the Control System shall be done by the General Contractor.
  - H. All sealing of any penetration of the under floor supply air plenum shall be accomplished by the trade making the penetration.
  - I. Enclosures: Equipment room controllers or relay packs shall not be installed in the room's ceiling. If the equipment is in a mechanical room, electrical room, chiller room or other dedicated room the associated controller and relays shall be mounted in a NEMA-1 fabricated and hinged metal enclosure with lock within sight of the equipment it controls. Fabricated panel means built in a shop environment with templates and not constructed on site. Extensions to controllers for additional controlled or monitored items for a given area shall be mounted adjacent to the equipment controls.
  - J. Space Local Indication: Each IDS (Indicating Digital Space) sensor, where specified, shall display digital readouts of temperature and temperature setpoint. The Operator shall be able to delete these readouts from the Central Workstation on an individual IDS basis as desired.
  - K. Local Override Buttons: Shall be integral to the sensor and installed in all areas except common areas such as lobbies, bathrooms, hallways, etc. Equipment room sensors shall not be equipped with override buttons.
  - L. Space Temperature Sensor Local Adjustment: Areas specified to have adjustment shall have a temperature setpoint adjustment that can be limited in software to plus or minus 2 Deg F adjustment range from setpoint.
  - M. Duct Smoke Detectors: Shall be provided, installed and wired for fan shutdown by Division 26 contractor. The Building Automation System or controller shall not be used in the life safety control or shutdown of the building in any way. A duct smoke detector is to be mounted at the return air of each air handler unit, over 2,000 CFM which will stop the unit upon a detection of smoke.
  - N. Smoke and Fire Dampers: Shall be provided and installed by the Mechanical Contractor with

- UL-555 actuators (when specified) and shall be interlocked to the Fire Alarm system by the Division 26 contractor.
- O. Air Balance: The test and balance contractor shall set the OA damper positions on all units to the scheduled and OA amounts by coordination with the controls contractor.
  - P. Actuators: All valve and damper actuators shall be electronic type (Belimo or equal). OA dampers actuators shall be spring return as indicated.
  - Q. DDC Outputs: Separate DDC outputs will be provided for each valve and damper actuator.
  - R. DDC Control: All sensors and actuators shall be controlled/monitored by the direct digital control system. Thermostats and humidistats wired to actuators will not be allowed.
  - S. Coordinate with project Commissioning Agent (CxA). See specification section 23 08 00.
  - T. Wide Area Network: Connect all networks of points specified above to the owner's network to allow for real time communication. Auto dial up modems are not allowed.

## PART 2 PRODUCTS

### 2.1 DIRECT DIGITAL CONTROLS

- A. Browser based, open protocol, with all components listed by BTL as BACnet compliant  
Acceptable manufactures are:
  1. Automated Logic
  2. **Alerton**
  3. Alternate System Approval: Submit paragraph by paragraph compliance document to Engineer for consideration 21 days prior to proposal due date. Request must include local (within 50 miles) service personnel resumes and the company's place of business. Only BACnet systems as listed through BACnet Testing Laboratories and supported locally will be considered.

### 2.2 OPERATING SYSTEM SOFTWARE

- A. Input/output Capability From Operator Station:
  1. Request display of current values or status.
  2. Command selected equipment to specified state.
  3. Initiate logs and reports.
  4. Change analog limits.
  5. Add, delete, or change points within each control unit or application routine.
  6. Change point input/output descriptors, status, alarm descriptors, and unit descriptors.
  7. Add new control units to system.
  8. Modify and set up maintenance scheduling parameters.
  9. Develop, modify, delete or display full range of color graphic displays.
  10. Automatically archive select data even when running third party software.

11. Capability to sort and extract data from archived files and to generate custom reports.
  12. Support printer operations.
  13. Accommodate daylight savings time adjustments.
- B. Operator System Access: Via software password with multiple access levels at work stations and at each control unit.
- C. Data Base Creation and Support: Control unit automatically checks workstation data base files upon connection and verify data base match. Include the following minimum capabilities:
1. Add and delete points.
  2. Modify point parameters.
  3. Change, add, or delete English language descriptors.
  4. Add, modify, or delete alarm limits.
  5. Add, modify, or delete points in start/stop programs, trend logs, and other items.
  6. Create custom relationship between points.
  7. Create or modify DDC loops and parameters.
  8. Create or modify override parameters.
  9. Add, modify, and delete applications programs.
  10. Add, delete, develop, or modify dynamic color graphic displays.
- D. Dynamic Color Graphic Displays:
1. Utilizes custom symbols or system supported library of symbols.
  2. Sixteen (16) colors.
  3. Real-time live dynamic data for each graphic.
  4. Dynamic graphic data.
- E. Operator Station:
1. Accept data from LAN as needed without scanning entire network for updated point data.
  2. Interrogate LAN for updated point data when requested.
  3. Allow operator command of devices.
  4. Allow operator to place specific control units in or out of service.
  5. Allow parameter editing of control units.
  6. Store duplicate data base for every control unit and allow down loading while system is on line.
  7. Control or modify specific programs.
  8. Develop, store and modify dynamic color graphics.
  9. Data archiving of assigned points and support overlay graphing of this data
- F. Alarm Processing:
1. Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state or value and alarms causing automatic dial-out.
  2. Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
  3. Print on line changeable message, up to 60 characters in length, for each alarm point specified.

4. Display alarm reports on video. Display multiple alarms in order of occurrence.
  5. Define time delay for equipment start-up or shut down.
  6. Allow unique routing of specific alarms.
  7. Operator specifies when alarm requires acknowledgment.
  8. Continue to indicate unacknowledged alarms after return to normal.
  9. Alarm notification:
  10. Print automatically.
  11. Display indicating alarm condition.
  12. Selectable audible alarm indication.
- G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change of state, specified state, or alarm occurrence or return to normal.
- H. Automatic Restart: Automatically start field equipment on restoration of power. Furnish time delay between individual equipment restart and time of day start/stop.
- I. Messages:
1. Automatically display or print user-defined message subsequent to occurrence of selected events.
  2. Compose, change, or delete message.
  3. Display or log message at any time.
  4. Assign any message to event.
- J. Reports:
1. Manually requested with time and date.
  2. Long term data archiving to hard disk.
  3. Automatic directives to download to transportable media for storage.
  4. Data selection methods to include data base search and manipulation.
  5. Data extraction with mathematical manipulation.
  6. Data reports to allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
  7. Generating reports either normally at operator direction, or automatically under workstation direction.
  8. Either manually display or print reports. Automatically print reports on daily, weekly, monthly, yearly or scheduled basis.
  9. Include capability for statistical data manipulation and extraction.
  10. Capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.
- K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.
- L. Data Collection:
1. Automatically collect and store.
  2. Archiving of stored data for use with system supplied custom reports.

- M. Graphic Display: Support graphic development on work station with software features:
  - 1. Page linking.
  - 2. Generate, store, and retrieve library symbols.
  - 3. Single or double height characters.
  - 4. Sixty (60) dynamic points of data for each graphic page.
  - 5. Pixel level resolution.
  - 6. Animated graphics for discrete points.
  - 7. Analog bar graphs.
  - 8. Display real time value of each input or output line diagram fashion.
- N. Maintenance Management:
  - 1. Run time monitoring, for each point.
  - 2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
  - 3. Equipment safety targets.
  - 4. Display of maintenance material and estimated labor.
  - 5. Target point reset, for each point.

2.3 LOAD CONTROL PROGRAMS (systems shall be capable of all programs listed; however not all are required by the current sequences of operations)

- A. Demand Limiting:
  - 1. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
- B. Duty Cycling: Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
- C. Automatic Time Scheduling: Self-contained programs for automatic start/stop/scheduling of building loads. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary schedules.
- D. Start/Stop Time Optimization:
  - 1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
  - 2. Adaptive and self-tuning, adjusting to changing conditions.
  - 3. For each point under control, establish and modify:
    - a. Occupancy period.
    - b. Desired temperature at beginning of occupancy period.
    - c. Desired temperature at end of occupancy period.
- E. Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set-point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.
- F. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.

- G. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.
- H. Direct Digital Control: Furnish software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
- I. Trend logging:
  - 1. Each control unit capable of storing samples of control unit's data points.
  - 2. Update file continuously at operator assigned intervals.
  - 3. Automatically initiate upload requests and then stores data on hard disk.
  - 4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
  - 5. Co-ordinate sampling with specified on/off point- state.
  - 6. Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

## 2.4 HVAC CONTROL PROGRAMS

- A. Optimal Run Time: Control start-up and shutdown times of HVAC equipment for both heating and cooling. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room temperature. Employ adaptive model prediction for how long building takes to warm up or cool down under different conditions.

## 2.5 PROGRAMMING APPLICATION FEATURES

- A. Trend Point: Sample points, real or computed, with each point capable of collecting samples at intervals specified in minutes, hours, days, or month. Output trend logs as line-graphs or bar graphs.
- B. Alarm Messages:
  - 1. Allow definition of messages, each having sufficient characters for each individual message.
  - 2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totaled point's warning limit, hardware elements advisories.
  - 3. Output assigned alarm with "message requiring acknowledgment".
  - 4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.
- C. Weekly Scheduling:
  - 1. Automatically initiate equipment or system commands, based on selected time schedule for points specified.
  - 2. Program times for each day of week, for each point, with one minute resolution.
  - 3. Automatically generate alarm output for points not responding to command.
  - 4. Allow for holidays
- D. Interlocking:

1. Permit events to occur, based on changing condition of one or more associated master points.

## 2.6 BUILDING COMMUNICATIONS CONTROLLER

### A. General Requirements

1. BACnet Conformance
  - a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.
  - b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
2. Building controller shall be of modular construction such that various modules may be selected to fit the specific requirements of a given project. At a minimum, modules shall consist of a power supply module, a BACnet Ethernet-MS/TP (master slave token passing) module, a BACnet MS/TP-only module, and a modem module for telephone communication. Those projects that require special interfaces may use Modbus modules as needed. However, all Ethernet communications and all controllers—including central plant controllers, advanced application controllers and unitary controllers—supplied by BAS manufacturer shall utilize the BACnet protocol standard.
3. Modules shall be selected to fit the particular project application. Up to seven modules shall be powered by a single power supply module. All modules shall be panel-mounted on DIN rail for ease of addition and shall be interconnected using a simple plug-in cable. A module in the middle shall be replaceable without removing any other modules.
4. All modules shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller. The software program implementing these strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a WAN or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.
5. Programming shall be object-oriented using control function blocks, and support DDC functions, 1000 Analog Values and 1000 Binary Values. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.
6. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.
7. Controller shall have sufficient memory to ensure high performance and data reliability. Battery shall provide power for orderly shutdown of controller and

- storage of data in nonvolatile flash memory. Battery backup shall maintain real-time clock functions for a minimum of 20 days.
8. Global control algorithms and automated control functions shall execute using 32-bit processor.
  9. Schedules
    - a. Each building controller module shall support a minimum of 80 BACnet Schedule Objects and 80 BACnet Calendar Objects.
    - b. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.
  10. Logging Capabilities
    - a. Each building controller shall log as minimum 320 values. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
    - b. Logs may be viewed both on-site and off-site using WAN or remote communication.
    - c. Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.
    - d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
  11. Alarm Generation
    - a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
    - b. Each alarm may be dialed out as noted elsewhere.
    - c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
    - d. Controller must be able to handle up to 320 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.
  12. Demand Limiting
    - a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
    - b. Load shedding programs in building controller modules shall operate as defined in section 2.1.J of this specification.
  13. Tenant Activity Logging
    - a. Tenant Activity logging shall be supported by building controller module. Each independent module shall support a minimum of 80 zones.
    - b. Tenant Activity logging shall function as defined in section 2.1.K of this specification.

## 2.7 APPLICATION CONTROLLERS

- A. Provide one or more native BACnet application controllers as needed for all equipment. All controllers shall interface to building controller via BACnet/IP or BACnet MS/TP. Controllers shall include input, output and self-contained logic program as needed for

complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be system resident. No auxiliary or non-BACnet controllers shall be used.

- B. BACnet Conformance
1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as native BACnet devices. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
    - a. Files Functional Group
    - b. Reinitialize Functional Group
    - c. Device Communications Functional Group
  2. Refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
  3. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- C. Application controllers shall include universal inputs with 10-bit resolution that accept 3K and 10K thermostats, 0–10VDC, 0–5 VDC, 4–20 mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of 3 inputs that accept pulses. Controller shall also include support and modifiable programming for interface to Intelligent Room Sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0–10VDC or 0–20mA. Software shall include scaling features for analog outputs. Application controller shall include 24VDC voltage supply for use as power supply to external sensors.
- D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.
- E. Application controller shall include support for Intelligent Room Sensor (see Sensors and Miscellaneous Devices section). Display on Intelligent Room Sensor shall be programmable at application controller and include an operating mode and a field service

mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor.

## 2.8 SENSORS AND MISCELLANEOUS DEVICES

### A. Temperature Sensors

1. All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches about finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day. Averaging type sensors shall be used for all duct sensors upstream of the supply fan except return air.

### B. Wall Sensor

1. Standard wall sensor shall use solid-state sensor and shall be packaged in aesthetically pleasing enclosure. Sensor shall provide override function, warmer/cooler lever for set point adjustment and port for plug-in of Field Service Tool for field adjustments. Override time shall be stored in controller and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller. All programmable variables shall be available to Field Service Tool through wall sensor port. Sensors shall fit neatly over the rough-in box without the need for additional dress plates.

### C. Intelligent Thermostat

1. Thermostat shall be a communicating wall mounted sensor-controller with a touch screen user interface and built in temperature and humidity with an on-board fully programmable DDC controller. The on-board DDC controller shall have a minimum of 3 universal inputs, 6 binary outputs and 2 analog outputs. Each sensor-controller shall communicate via BACnet MS/TP and be daisy chained together to communicate with the global controller(s). The sensor-controller shall utilize a super-capacitor backup that maintains a local real-time clock and self contained operating schedules.

### D. Outside air relative humidity sensor

1. Provide outside air relative humidity sensors as indicated per the control diagrams. Humidity sensors shall meet, at minimum, the following requirements:
  - a. Non-corroding outdoor shield to minimize wind effects and solar heating. Wall mount weather proof enclosure with conduit fitting.
  - b. Two wire, 4-20 mA output proportional to relative humidity range of 0% to 100%.
  - c. ± 2% accuracy (5 - 95% RH).
  - d. Humidity sensor shall be replaceable.

### E. Interior air relative humidity sensor

1. Provide wall mounted relative humidity sensors as indicated per the control diagrams. Humidity sensors shall meet, at minimum, the following requirements:
  - a. Wall mount enclosure with white cover.
  - b. Two wire, 4-20 mA output or digitally communicating proportional to relative humidity range of 0% to 100%.
  - c. Humidity sensor shall be replaceable.
  - d.  $\pm 2\%$  accuracy (5 - 95% RH).
  - e. Mounted 48 inches above floor .
- F. Duct mounted relative humidity sensor
  1. Provide duct mounted relative humidity sensors as indicated per the control diagrams. Humidity sensors shall meet, at minimum, the following requirements:
    - a. Duct mounted moisture resistant enclosure with conduit fitting.
    - b. Two wire, 4-20 mA output proportional to relative humidity range of 0% to 100%.
    - c. Humidity sensor shall be replaceable.
    - d.  $\pm 2\%$  accuracy (5 - 95% RH).
    - e. 8 inch probe length.
- G. Outside air flow measuring stations (or Engineer approved equal):
  1. Ebtron Model GTA116-PC
  2. The equipment vendor shall include in its price the cost to attend a pre-installation meeting and shall include the costs to commission its devices certifying proper operation.
- H. Carbon Dioxide Sensors – Duct and Wall Mount
  1. Output signal: 4 – 20ma signal.
  2. Accuracy: +/- 30 ppm.
  3. Range: 0 – 2000 ppm.
  4. Calibration interval: 5 years.
  5. Response time: 2 minutes or less.
  6. Display: 4 digit LCD.
  7. Operating Humidity: 0% to 95% non-condensing.
  8. Operating temperature: 32F to 122F.
  9. Enclosure: NEMA 1.
- I. Rosemont/Emerson 2051 Differential Pressure Transmitter – Chiller Evaporator and Condenser Differential Pressure Measurement for Flow Control (or Engineer approved equal):
  1. Measurement Type: Differential pressure.
  2. Accuracy +/- 0.075% of span.
  3. Signal Output: 4 – 20 ma.
  4. Long Term Stability: 0.1% of URL for 2 years.
  5. Rangdown: 100:1
- J. Photohelic Differential Pressure Switch and Gauge – Auto Reset – **Filter Monitoring**
  1. Contact Type: Two DPDT
  2. Indication: Visible magnehelic pressure indication.

3. Range: Select appropriate range.
  4. Accuracy: 2% full scale.
  5. Setpoints: Visible.
  6. Dial: 4"
- K. Static Pressure Switches – Manual Reset
1. Range: Select appropriate range for anticipated pressures.
  2. Duct Static Pressure Tip: Provide tips as required.
  3. Contact Type: One DPDT
  4. Operating Temperature: -30F to 180F.
  5. Reset Type: Manual
- L. Differential Pressure Transmitters - Duct
1. Output Signal: 4 – 20 ma.
  2. Overpressure: 10 psig.
  3. Accuracy: 1% full scale.
  4. Diaphragm: Stainless steel.
  5. Non-Repeatability: 0.1% full scale.
  6. Hysteresis: 0.2% full scale.
  7. Compensated Temperature Range: 0F to 155F.
- M. Onicon Flow Meter for Cooling Tower Make Up & Blowdown Water Measurement– Insertion Type
1. Output Signal: 4 – 20 ma.
  2. Model: F-1200
  3. Accuracy: NIST traceable factory calibration +/- 0.5%.
  4. Turn Down: 175:1
  5. Operating Range: 0.17 to 30 ft/second.

## 2.9 ENCLOSURES

- A. All controllers, power supplies and relays shall be mounted in enclosures.
- B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.
- C. ~~Outdoor enclosures shall be NEMA 4 Stainless steel within 50 miles of the coastline.~~  
**Otherwise Outdoor enclosures shall be NEMA 3R.**
- D. Enclosures shall have hinged, locking doors.
- E. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8" thick sized appropriately to make label easy to read.

## 2.10 ELECTRONIC ACTUATORS AND VALVES

- A. Execution Details for Actuators and Valves
1. Install “Hard Wire” interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.
  2. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting.
  3. VAV box damper actuation shall be Floating type or Analog (2-10vdc, 4-20ma).
  4. Primary valve control shall be Analog (2-10vdc, 4-20ma).
- B. Actuators for Damper and Control Valves ½" to 6" shall be Electric unless otherwise specified, provide actuators as follows:
1. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify Actuators.
  2. 5 year Manufacturers Warranty. Two-year unconditional + Three year product defect from date of installation.
  3. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
  4. Position indicator device shall be installed and made visible to the exposed side of the Actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the Actuator.
  5. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for Butterfly Valve actuators.
  6. A push button gearbox release shall be provided for all non-spring actuators.
  7. Modulating actuators shall be 24Vac and consume 10VA power or less.
  8. Conduit connectors are required when specified and when code requires it.
- C. Damper Actuators:
1. Outside Air and Exhaust Air Damper Actuators shall be Mechanical Spring Return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
  2. Economizer Actuators shall utilize Analog control 2-10 VDC, Floating control is not acceptable.
  3. Electric damper actuators (including VAV box actuators) shall be direct shaft mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.
  4. One electronic actuator shall be direct shaft mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.

5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per damper section. (See below execution section for more installation details.)
- D. Valve Actuators ½" to 6"
1. Mechanical spring shall be provided on all actuators for pre-heat coil and actuators for AHU heating or cooling coil when units are mounted outside. See plans for fail save flow function: Normal Open or Normal Closed. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
  2. All zone service actuators shall be non-spring return unless otherwise specified.
  3. The valve actuator shall be capable of providing the minimum torque required for proper valve close off for the required application.
  4. All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.
  5. Override handle and gearbox release shall be provided for all non-spring return valve actuators.
- E. Control Dampers. The control contractor shall furnish and size all automatic control dampers unless provided with packaged equipment. The sheet metal contractor shall install all dampers unless provided with packaged equipment.
1. All dampers used for modulating service shall be opposed blade type arrange for normally open or normally closed operation as required. The damper is to be sized so that when wide open the pressure drop is a sufficient amount of its close-off pressure drop for effective throttling.
  2. All dampers used for two-position or open-close control shall be parallel blade type arranged for normally open or closed operation as required.
  3. Damper linkage hardware shall be constructed of corrosion resistant zinc & nickel-plated steel.
  4. Frame shall utilize a heavy duty 5in. by 1 in. 13 gauge galvanized steel hat channel frame designed for installation inside the ductwork. Frame shall have reinforced corners and low profile head and sill on dampers less than 17 in high.
  5. Blades shall be 3-V, single thickness of 16 gauge galvanized steel
  6. Shafts shall be ½ in. diameter square plated steel axles positively locked to the blades to eliminate slippage between blades and axles. Actuator shaft shall be removable.
  7. Provide molded synthetic (acetal) bearings in a polished extruded frame raceway.
  8. Blade-to-blade linkage shall be concealed within the frame
  9. Provide dampers with flexible metal compression-type jamb seals and extruded vinyl blade seals for low leakage performance. Seals shall be silicone.
  10. Dampers shall be Model D642 manufactured by Honeywell or equal.
- F. Characterized Control Valves
1. NPS 2 and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc. NPS ¾" and Smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi, chrome plated brass

ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

2. NPS 2-1/2 and 3: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
3. Close off pressure rating: 200 psi.
4. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.
5. NPS 2” and smaller characterized control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain a strainer/shut-off ball valve/drain with a P/T port. The return side of the coil shall contain a union fitting with a P/T port, characterized control valve, an integrated pressure independent automatic balancing valve/union/isolation ball valve/manual air vent with P/T port. Shut-off valves as an integrated part of the characterized control valve are prohibited. For 3-way installations, supply an integrated 100% port isolation valve/manual air vent with a P/T port for field installation in the bypass of the circuit.

#### G. Butterfly Valves – High Performance

1. Valve body shall be full lugged carbon steel ANSI Class 150 body with a 316 stainless steel disc without a nylon coating, RTFE seat, and be ANSI Class 150/300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed TFE bushings. Valve packing shall be Chevron TFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 2” insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.
2. Disk: Full rated disk @ 200 psi.
3. Sizing:
  - a. Two-Position: Line size or size using a pressure differential of 1 psi.
  - b. Modulating: 5 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position with the design velocity less than 32 feet per second.
4. Flow Characteristics: Modified equal percentage, unidirectional
5. Close-Off Pressure Rating: 150 psi bubble tight shut-off.
6. Media Temperature Range: ANSI Class 150 limitations
7. Differential Pressure: 285 psi @ 100 deg F for ANSI 150 (725 psi @ 100 deg F for ANSI 300).

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify conditioned power supply is available to control units and to operator workstation.

- B. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

### 3.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operation.
- C. Install with 120 volts alternating current, 15 amp circuit to each programmable control unit. Controls for life safety equipment shall be on emergency power circuit.
- D. Install conduit and electrical wiring in accordance with Section 26 05 03.
- E. Install electrical material and installation in accordance with appropriate requirements of Division 26.

### 3.3 MANUFACTURER'S REPRESENTATIVE FIELD SERVICES

- A. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Furnish service technician employed by system installer to instruct Owner's representative in operation of systems plant and equipment.
- C. Furnish service technician with laptop to cooperate with the Commissioning Agent for testing and setup work; allow 5 days of technician's time.

### 3.4 DEMONSTRATION AND TRAINING

- A. Furnish basic operator training for multiple persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 16 hours instructor time for onsite training and 4 hours of hands on class environment training.
- B. Demonstrate complete and operating system to Owner and Engineer.

### 3.5 SEQUENCES OF OPERATION SOFTWARE

- A. See drawings for sequences.

### 3.6 System Graphics - browser based displays.

- A. See drawings for sequences.

3.7 Trend Points List

- A. Control contractor to start trends on all points during commissioning.

**END OF SECTION 23 05 23**

## SECTION 23 21 23

## HYDRONIC PUMPS

## PART 1 GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Vertical in-line pumps, with manufacturer's integral variable frequency drives.
  - 2. Side-stream filters/feeder.
  - 3. Vortex separator/pump system.
- B. Related Sections:
  - 1. Section 23 05 00 – General Mechanical Requirements: Product requirements for motors for placement by this section.
  - 2. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment: Product requirements for vibrations isolators installed with pumps.
  - 3. Section 23 21 13 - Hydronic Piping: Execution requirements for connection to pumps specified by this section.
  - 4. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties installed in hydronic systems adjacent to pumps.
  - 5. Section 23 25 00 - HVAC Water Treatment: Requirements for flushing and treating hydronic systems.
  - 6. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to pumps specified by this section.

## 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. Underwriters Laboratories Inc.:
  - 1. UL 778 - Motor Operated Water Pumps.

## 1.3 PERFORMANCE REQUIREMENTS

- A. Provide pumps to operate at system fluid temperatures indicated on Drawings without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

## 1.4 SUBMITTALS

- A. Section 23 05 00 – General Mechanical Requirements: Submittal procedures.
- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model

number, dimensions, service sizes, and finishes. If parallel pumps, provide individual and paralleled pump curves.

- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 23 05 00 – General Mechanical Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
- C. Provide name, address and phone number of local manufacturer's representative.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience, and with service facilities within 100 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

#### 1.7 PRE-INSTALLATION COORDINATION

- A. Coordination with General Contractor and related trades before final layout of pumps is done. Meet as required.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 23 05 00 – General Mechanical Requirements: Product storage and handling requirements.
- B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

#### 1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.10 WARRANTY

- A. Furnish five year manufacturer warranty for pumps and motors, and integral variable frequency drives.

#### 1.11 EXTRA MATERIALS

- A. Furnish 2 sets of cartridges for each side-stream filter/feeder.

## PART 2 PRODUCTS

## 2.1 VERTICAL IN-LINE PUMPS

- A. Manufacturers:
  - 1. Armstrong.
  - 2. **Aurora.**
  - 3. Bell & Gossett.
  - 4. Taco.
  - 5. Grundfos/Paco.
  - 6. Substitutions: As approved by Engineer prior to bid date.
- B. Type: Vertical, single stage, close coupled, radial or horizontally split casing, for in-line mounting, for 175 psig working pressure.
- C. Casing: Cast iron with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- D. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- E. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- F. Shaft Sleeve: Aluminum bronze.
- G. Seal: Carbon rotating against stationary ceramic seat, 212 degrees F maximum continuous operating temperature.
- H. Provide with integral variable frequency drive (VFD) mounted on pump, with factory control package for pressure control without remote sensors.
- I. Performance: See schedule on drawings.
- J. Electrical Characteristics and Components:
  - 1. Electrical Characteristics: In accordance with the schedule on drawings.
  - 2. Motors: In accordance with Section 23 05 00. 1750 rpm unless specified otherwise.
  - 3. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

## 2.2 SIDE-STREAM FEEDER FILTRATION SYSTEM

- A. System: Flow meter, filter housing with removable top, 5 micron (minimum) cartridge filter(s), shut-off valves, and flow control valve. See also drawing details.
- B. Performance: Design flow 8 gal/min with maximum pressure drop of 3 psig. (See also drawing details.)
- C. Chilled Water Filter Housing: Reinforced polypropylene plastic housing suitable for 125 degrees F and 125 psig operating conditions.
- D. Cartridges: 30 micron for start-up and 5 micron for system operation.

## 2.3 VORTEX SEPERATOR/PUMP SYSTEM

- A. Manufacturers:
  - 1. Lakos
  - 2. Puroflux
  - 3. Substitutions: As approved by Engineer prior to bid date. .
- B. Supply a packaged separator system with pump, completely factory assembled. The packaged system shall include a centrifugal vortex type separator, integral pump and schedule 80 PVC interconnecting piping. The complete system shall be mounted on an epoxy coated steel skid.
- C. The separator shall be a dumbbell type design with a true tangential entry to ensure proper helical flow. The separator shall have an expected solids performance rating of 98% efficient at 74 microns and larger (with a specific gravity of 2.6 or greater) on a single pass. The unit shall be equipped with inlet/outlet gauges to monitor pressure drop and a manual air relief valve shall be provided at the top of the vessel.
- D. The separator shall be fabricated of carbon steel, rated at 150 psi working pressure (temperature dependent). The separator vessel shall be hydro tested at 1.5 times the design pressure and finished with a fusion bonded epoxy coating.
- E. The system pump shall be a cast iron bronze fitted close couple, end suction type, sized for the proper flow rate of the package. The pump shall be of cast iron construction and include a cast iron pre-strainer with a perforated stainless steel basket. The pump shall be provided with a standard efficiency TEFC motor.
- F. Purging of the accumulation chamber shall be accomplished without interrupting flow or excessive loss of system fluid.
  - 1. The separator shall be equipped with automatic controls consisting of an electrically actuated two-way brass ball valve with a HOA switch and solid state purge timer mounted in the control panel.
- G. The separator shall be equipped with automatic controls consisting of a motor start/stop device with overload short circuit protection, pump HOA selector switch, mounted in a NEMA 4X fiberglass enclosure. The unit shall have have a single point electrical connection.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings.
- C. Install pumps on vibration isolators. Refer to Section 23 05 48.

- D. Install flexible connectors at or near pumps where piping configuration does not absorb vibration. Refer to Section 23 21 16.
- E. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve combination pump discharge valve on pump discharge. Refer to Section 23 21 16. Refer also to details on drawings
- F. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide Armaflex or equal insulation on supports to prevent condensation.
- G. Provide air cock and drain connection on horizontal pump casings.
- H. Provide drains for bases and seals.
- I. Lubricate pumps before start-up.
- J. Provide side-stream filtration/feeder system for chilled water systems. Install across pump with flow from pump discharge to pump suction from pump taps. Coordinate with initial system finish and treatment. Record system information (system volume, chemical amounts) for Owner.

### 3.2 FIELD QUALITY CONTROL

- A. Comply with Section 23 05 93 – Test, Adjust and Balancing for HVAC.

### 3.3 DEMONSTRATION

- A. Furnish sixteen hour training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of pump systems. Arrange course at start up of systems.

### 3.4 SCHEDULES (See drawings)

END OF SECTION

## SECTION 23 25 00

## HVAC WATER TREATMENT

## PART 1 GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. System cleaner.
  - 2. Closed system treatment (water).
  - 3. Condenser water system treatment.
  - 4. Chemical feeder equipment including associated feeders, pumps, tanks, controls, meters and valves.
  - 5. Test equipment.
- B. Related Sections:
  - 1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

## 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

## 1.3 PERFORMANCE REQUIREMENTS

- A. Perform base-line testing of the existing closed loop chilled water and open loop cooling tower water so as to provide the Owner known baseline conditions. Baseline conditions shall be submitted to the Engineer, Owner and CxA for review.
- B. Provide system to treat water at project site to maintain the acceptable characteristics of water in closed and open loop systems. Acceptable characteristics shall be defined as characteristics that will not impact equipment efficiency, performance or warranties. Suitable characteristics of water shall be determined by a certified water treatment professional and shall be submitted to the Engineer, Owner & CxA for review.

## 1.4 SUBMITTALS

- A. Section 23 05 00 – General Mechanical Requirements: Submittal procedures.
- B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- C. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

- F. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
- B. Operation and Maintenance Data: Submit data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

#### 1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with SAWS Works standard for addition of non-potable chemicals to building systems and for discharge to public sewers.

#### 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 100 miles of Project with water analysis laboratories and full time service personnel.
- B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

#### 1.8 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.

#### 1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.10 WARRANTY

- A. Furnish five year manufacturer warranty for pumps, valves and water meters.

#### 1.11 MAINTENANCE SERVICE

- A. Furnish monthly technical service visits, for one year starting at Date of Substantial Completion, to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements and corrective actions needed. Submit two copies of field service report after each visit.
- B. Furnish laboratory and technical assistance services during this maintenance period.
- C. Furnish on site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

- D. Note: COSA currently does not have a chemical treatment maintenance contract (all water treatment is performed in house). Moving forward, COSA will contract with a chemical treatment maintenance provider.**

#### 1.12 MAINTENANCE MATERIALS

- A. Furnish all chemicals for treatment and testing during warranty period.

### PART 2 PRODUCTS

#### 2.1 SYSTEM CLEANER

- A. Product Description: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tri-Poly phosphate and sodium molybdate.
- B. Biocide; chlorine release agents including sodium hypochlorite or calcium hypochlorite, or microbiocides including quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

#### 2.2 CLOSED SYSTEM TREATMENT (WATER)

- A. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
- B. Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazone, low molecular weight polymers, phosphonates, sodium molybdate, or sulfites.
- C. Conductivity enhancers; phosphates or phosphonates.

#### 2.3 CONDENSER WATER SYSTEM TREATMENT (COOLING TOWERS)

- A. Sequestering agent to inhibit scaling; phosphonates, sodium polyphosphates, lignin derivatives, synthetic polymer polyelectrolytes, or organite phosphates.
- B. Acid to reduce alkalinity and pH; sulphuric acid.
- C. Corrosion inhibitor; zinc-phosphate, phosphonate-phosphate, phosphonate-molybdate and phosphonate-silicate, sodium totyltriazone, or low molecular weight polymers.
- D. Biocide; chlorine release agents including sodium hypochlorite or calcium hypochlorite, or microbiocides including quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

#### 2.4 SOLUTION METERING PUMP

- A. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.
- B. Electrical Characteristics:  
1. 120 volts, single phase, 60 Hz.

2. Cord and Plug: Furnish unit with 6 foot (2 m) cord and plug for connection to electric wiring system including grounding connector.

## 2.5 SOLUTION TANKS

- A. 30 gallon capacity, polyethylene, self-supporting, 5 gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch. Locate tanks containing hazardous chemicals in full volume catchment basin.

## 2.6 AGITATOR

- A. Totally enclosed Explosion-proof electric motor, cast iron stainless steel clamp and motor mount, 1/2 inch (13 mm) diameter coated Type 316 stainless steel propeller.
- B. Electrical Characteristics:
  1. 120 volts, single phase, 60 Hz.
  2. Cord and Plug: Furnish unit with 6 foot (2 m) cord and plug for connection to electric wiring system including grounding connector.

## 2.7 LIQUID LEVEL SWITCH

- A. Polypropylene housing with integrally mounted PVC air trap, receptacles for connection to metering pump, and low level alarm.
- B. Electrical Characteristics:
  1. 120 volts, single phase, 60 Hz.

## 2.8 CONDUCTIVITY CONTROLLER

- A. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit and recorder.
- B. Electrical Characteristics:
  1. 120 volts, single phase, 60 Hz.

## 2.9 WATER METER

- A. Displacement type cold-water meter with sealed, tamper-proof magnetic drive, impulse contact register, single-pole, double-throw, dry contact switch.
- B. Electrical Characteristics:
  1. 120 volts, single phase, 60 Hz.

## 2.10 SOLENOID VALVES

- A. Forged brass body globe pattern, normally open or closed as required, general-purpose explosion- proof and watertight solenoid enclosure, and continuous duty coil.
- B. Electrical Characteristics: 120 volts, single phase, 60 Hz.

## 2.11 TIMERS

- A. Electronic timers, infinitely adjustable over full range, 150 second and five minute range, mounted together in cabinet with hands-off-automatic switches and status lights.
- B. Electrical Characteristics:
  - 1. 120 volts, single phase, 60 Hz.

## 2.12 TEST EQUIPMENT

- A. Furnish white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titration burettes and associated reagents.
- B. Furnish following test kits:
  - 1. Alkalinity titration test kit.
  - 2. Chloride titration test kit.
  - 3. Sulphite titration test kit.
  - 4. Total hardness titration test kit.
  - 5. Low phosphate test kit.
  - 6. Conductivity bridge, range 0 - 10,000 micro-ohms.
  - 7. Creosol red pH slide, complete with reagent.
  - 8. Portable electronic conductivity meter.
  - 9. High nitrite test kit.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Operate, fill, start and vent systems prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.

### 3.2 CLEANING

- A. Concentration:
  - 1. As recommended by manufacturer.
- B. Chilled Water Systems:
  - 1. Circulate for 48 hours, then drain systems as quickly as possible.
  - 2. Refill with clean water, circulate for 24 hours, then drain.
  - 3. Refill with clean water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and acceptance of Engineer.
- D. Flush open systems with clean water for one hour minimum. Drain completely and refill.
- E. Remove, clean, and replace strainer screens.
- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

### 3.3 CLOSED SYSTEM TREATMENT

- A. Provide one side-stream filter/feeder on each system (See Section 23 21 23).

### 3.4 CONDENSER WATER SYSTEMS (COOLING TOWERS)

- A. Provide automatic condenser water control systems for inhibitor feed, blow-down, and biocide feeds.
1. Provide meter activated inhibitor application.
  2. Provide conductivity activated blow-down.
  3. Provide meter fed biocide with blow-down locked out to ensure biocide retention time.
  4. Coordinate re-use of new open loop water treatment system components with Engineer & Owner where possible.
- B. Incorporate solid state integrated circuits and digital LED displays, in NEMA 250 Type 12 steel enclosure. Provide lockable door with gaskets.
- C. Base dissolved solids control on conductivity and include:
1. LED digital readout display (micro-ohm/cm).
  2. Temperature compensated sensor probe adaptable to sample stream manifold.
  3. High, low, normal conductance indicator lights (LED).
  4. High or low conductance alarm light (flash or steady switch), trip points field adjustable. Furnish flash or steady switch with silence position.
  5. Illuminated legend indicating "ALARM" whenever alarm condition exists.
  6. Hand-off-automatic switch for solenoid bleed valve.
  7. Illuminated legend indicating "BLEED" when valve is operated.
  8. Adjustable hysteresis or dead-band (internal).
- D. Base inhibitor feed control on make-up volume and include:
1. Solid state counter (1-15 field selectable).
  2. Solid state timer (adjustable 1/4 to 5 minutes).
  3. Test switch.
  4. Hand-off-automatic switch for chemical pump.
  5. Illuminated legend indicating "FEED" when pump is activated.
  6. Solid state lockout timer (adjustable 1/4 to 3 hours) and indicator light. Lockout timer to deactivate pump and activate alarm circuits.
  7. Panel total (quantity of makeup), Electro-mechanical type.
- E. Biocide programmer to include:
1. 24-hour timer with 14 day skip feature.
  2. Precision solid state bleed lockout timer (0-9 hours) and biocide pump timer (0 - 2-1/4 hours), clock controlled.
  3. Solid state alternator to enable use of two different formulations.
  4. Digital display of time of day (24 hours).
  5. LED display of day of week (14 days).
  6. Fast and slow clock set controls (internal).
  7. Battery back-up so clock is not disturbed by power outages, quartz timekeeping accuracy.
  8. Hand-off-automatic switches for biocide pumps.

9. Illuminated legend indicating "BIOCIDE A" or "BIOCIDE B" when pump is activated.
- F. Provide water meter on system make-up, wired to control system.
- G. Provide solution pumps to feed sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Provide agitator in accordance with treatment supplier's recommendations.
- H. Provide conductivity controller to sample condenser water and operate 11 inch (275 mm) solenoid bleed valve and piping to blow-down controller. Wire sampler to open when condenser water pump is operating.
- I. Introduce biocide to tower by intermittent slug feed.
- J. Provide liquid level switch in each solution tank to de-activate solution pump and agitator, signal BAS; refer to Section 23 09 53.

### 3.5 DEMONSTRATION

- A. Furnish sixteen hour training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.

END OF SECTION

## 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. 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.

<b>SOUND PRESSURE:</b>									
% 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

THIS DRAWING, INCLUDING SPECIFICATIONS AND OTHER DOCUMENTS PREPARED BY CONTRACTOR FOR THE PROJECT AND ANY CHANGES TO THE DRAWING'S SERVICE FOR USE SHALL BE SUBJECT TO THE PROJECT'S TERMS AND CONDITIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS.



**Alderson & Associates, Inc.**  
 Mechanical & Electrical Engineers  
 7700 South Loop West  
 Suite 101  
 San Antonio, TX 78229  
 Phone: (210) 615-8549  
 Fax: (210) 615-8549  
 © 2013 Alderson and Associates, Inc.  
 F-1008  
 PROJECT # 12154

**HVAC UPGRADES**  
**INTERNATIONAL CENTER**  
 203 SOUTH ST. MARY'S, SAN ANTONIO, TX 78205

**MECHANICAL & ELECTRICAL 1ST FLOOR PLAN NEW WORK**

PROJECT: 12-154  
 DRAWN: AAI  
 CHECKED: DTA  
 DATE: 2013-05-02

SHEET  
**ME2.1**  
 OF:

**GENERAL NOTES**

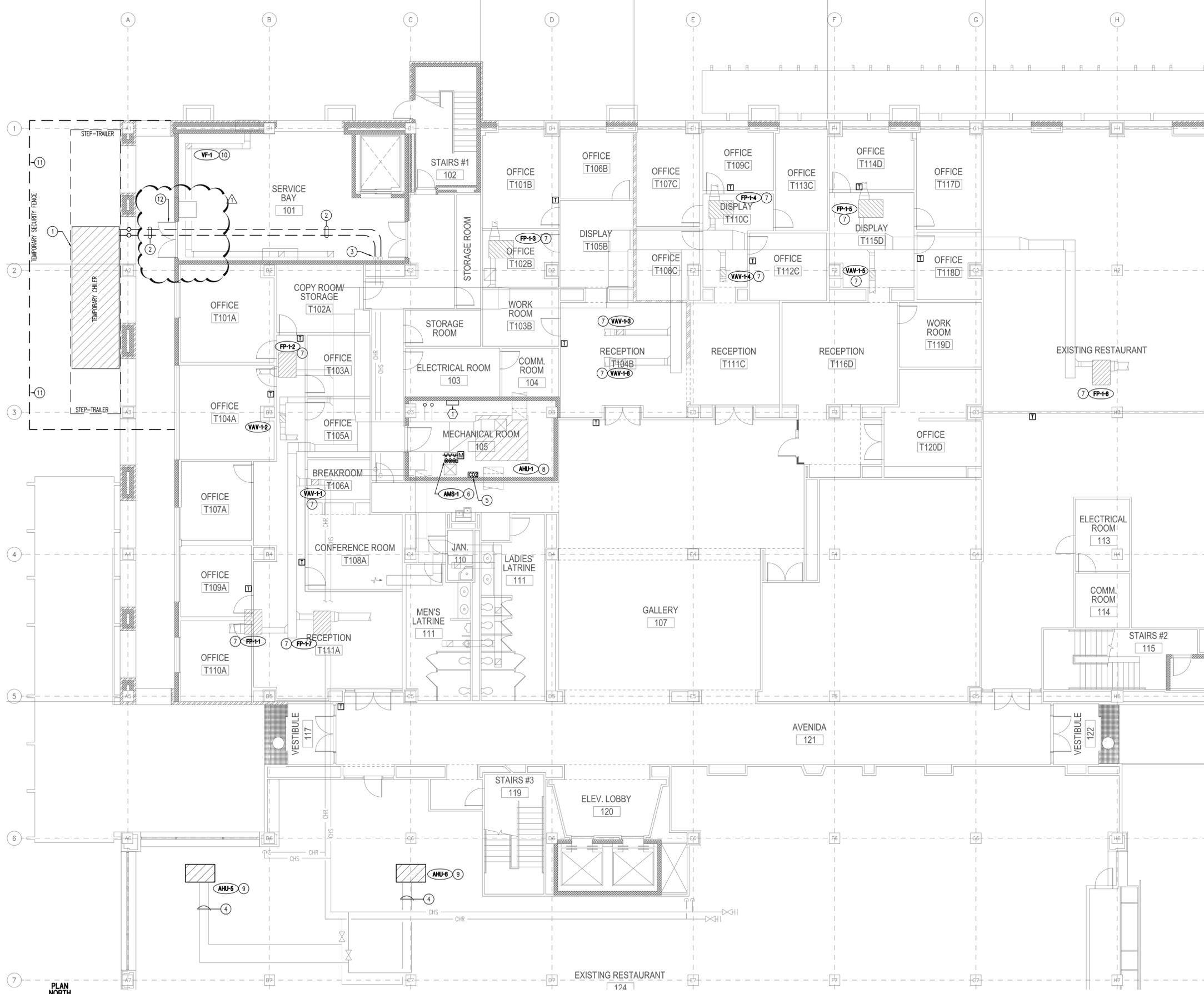
1. ALL SYSTEMS AND EQUIPMENT SHALL REMAIN IN SERVICE UNLESS OTHERWISE INDICATED.
2. THE OWNER WILL OCCUPY THE SPACE FOR DURATION OF CONSTRUCTION. THE CONTRACTOR SHALL SUBMIT FOR APPROVAL A SCHEDULE OF WORK INCLUSIVE OF ANY WORK REQUIRING A UTILITY OUTAGE. ANY WORK THAT REQUIRES AN OUTAGE OR WOULD PREVENT THE OWNER/TENANTS FROM OCCUPYING THEIR RESPECTIVE SPACES SHALL BE COORDINATED WITH THE BUILDING OWNER AND SHALL HAPPEN AFTER REGULAR BUILDING HOURS OF OPERATION.

**KEYED NOTES:** (APPLIES TO THIS SHEET)

1. LOCATE TRAILER MOUNTED TEMP. AIR COOLED CHILLER AS INDICATED. COORDINATE FINAL LOCATION WITH EXISTING CONDITIONS AND COSA AUTHORIZED AGENT. RE: M7.1 FOR TEMP. CHILLER REQUIREMENTS.
2. APPROXIMATE ROUTING OF TEMPORARY CHW PUMP S/R HOSES. COORD. ROUTING WITH EQUIP. RENTAL CO..
3. CONNECT TEMP. CHW S/R HOSES TO EXISTING 6" DIA. EMERGENCY TAPS IN SERVICE BAY. RE: KEYED NOTE #23, #1/M6.1 FOR ADDITIONAL INFORMATION.
4. PROVIDE TEMPERATURE SENSORS IN CHW S/R PIPING AT NEAR AHU COIL CONNECTION FOR MONITORING PURPOSES. RE: SEQUENCES.
5. LOCATE NEW CO2 SENSOR ON MECHANICAL ROOM WALL. RE: AHU SEQUENCES FOR ADDITIONAL INFORMATION.
6. LOCATE NEW AIR FLOW MEASURING STATION IN O/A DUCT. COORDINATE EXACT PLACEMENT OF AMS WITH AMS EQUIPMENT REPRESENTATIVE. MODIFY EXISTING DUCTWORK AND/OR EXTEND EXISTING DUCT AS REQUIRED TO ENSURE PROPER AMS OPERATION. ALSO, PROVIDE NEW 24V MOTORIZED CONTROL DAMPER EQUAL TO RUSKIN M#CD-60 OR APPROVED EQUAL IN O/A DUCT FOR MODULATING AIRFLOW CONTROL. RE: AHU SEQUENCES FOR ADDITIONAL INFORMATION.
7. INSPECT, CLEAN AND REFURBISH EXISTING TERMINAL UNIT AS REQUIRED TO ENSURE PROPER/EFFICIENT OPERATION. REPLACE EXISTING TERMINAL UNIT DDC CONTROLLER AND ASSOCIATED SPACE TEMPERATURE SENSOR PER SEQUENCES AND SPECIFICATIONS. AFTER CONTROLLER/SPACE SENSOR REPLACEMENT, RE-BALANCE TERMINAL UNIT TO AIRFLOWS INDICATED ON BALANCING SCHEDULE. FIELD VERIFY LOCATION OF SPACE SENSOR AS REQUIRED.
8. INSPECT, CLEAN AND REFURBISH EXISTING AHU AS REQUIRED TO ENSURE PROPER/EFFICIENT OPERATION. REBALANCE EXISTING AHU (CHILLED WATER AND AIRFLOWS) PER EQUIPMENT BALANCING SCHEDULE. PROVIDE NEW CONTROL/HYDRONIC DEVICES AS REQUIRED PER AHU SEQUENCES, PIPING SCHEMATICS AND COIL CONNECTION DETAILS.
9. REBALANCE EXISTING AHU CHILLED WATERFLOW PER EQUIPMENT BALANCING SCHEDULE. ASSOCIATED CONTROLS SHALL REMAIN IN PLACE AND SUPPLY FAN SHALL REMAIN AS CURRENTLY BALANCED.
10. EXISTING VENTILATION FAN TO REMAIN IN ITS CURRENT CONDITION.
11. FIELD COORDINATE LOCATION OF TEMPORARY SECURITY FENCING.
12. REMOVE BOTTOM 1/3 OF EXISTING EXTERIOR DOOR. TEMPORARILY PATCH WITH 3/4" PLYWOOD AND PROVIDE PENETRATIONS TO ACCOMMODATE CHILLED WATER HOSES. UPON REMOVE OF TEMPORARY CHILLER, REPLACE EXISTING EXTERIOR HOLLOW CORE DOUBLE DOORS AND FRAME. NEW DOORS AND FRAME SHALL MATCH EXISTING AND SHALL MEET CURRENT CODE REQUIREMENTS. PAINT DOORS AND FRAME TO MATCH EXISTING. EXISTING DOOR SECURITY EQUIPMENT SHALL BE REUSED.

**ADD ALTERNATE NOTES:** (APPLIES TO THIS SHEET)

1. **ADD ALTERNATE #2:** REPLACE EXISTING VFD SERVING AHU-1. VFD FURNISHED BY DIVISION 23 AND INSTALLED BY DIVISION 26. RE: DIVISION 23 SCHEDULES/SPECS.



**MECHANICAL & ELECTRICAL FLOOR PLAN - 1ST FLOOR, NEW WORK**  
 SCALE: 1/8" = 1'-0"

THESE DRAWINGS, ACCOMPANYING SPECIFICATIONS AND OTHER DOCUMENTS PREPARED BY THE ENGINEER FOR THE PROJECT AND ANY OTHER DOCUMENTS PREPARED BY THE ENGINEER OR THE CONTRACTOR FOR THE PROJECT ARE SOLELY FOR THE PROJECT AND ANY OTHER DOCUMENTS PREPARED BY THE ENGINEER OR THE CONTRACTOR FOR THE PROJECT ARE SOLELY FOR THE PROJECT AND ANY OTHER DOCUMENTS PREPARED BY THE ENGINEER OR THE CONTRACTOR FOR THE PROJECT ARE SOLELY FOR THE PROJECT.



**Alderson & Associates, Inc.**  
 7700 South Loop West  
 Suite 101  
 San Antonio, TX 78229  
 Phone (210) 615-8549  
 Fax (210) 615-8549  
 © 2013 Alderson and Associates, Inc.  
 PROJECT # 12154

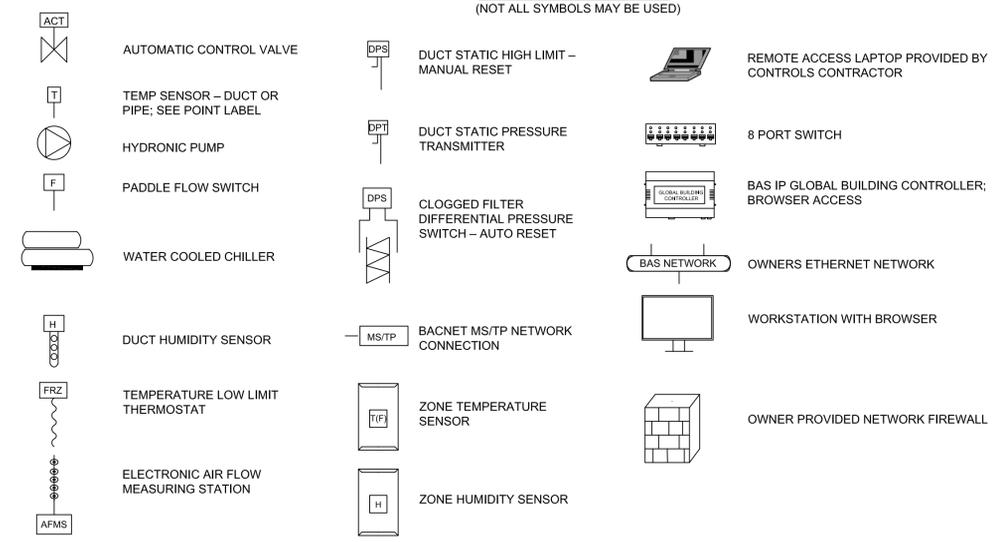
**HVAC UPGRADES**  
**INTERNATIONAL CENTER**  
**203 SOUTH ST. MARY'S, SAN ANTONIO, TX 78205**

**MECHANICAL CONTROL SEQUENCES AND DIAGRAMS**

PROJECT: 12-154  
 DRAWN: AAI  
 CHECKED: DTA  
 DATE: 2013-05-02

SHEET  
**M10.1**  
 OF:

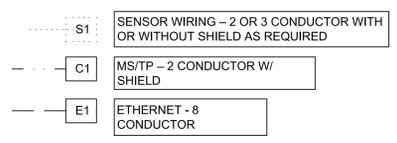
**SYMBOLS LEGEND**  
 (NOT ALL SYMBOLS MAY BE USED)



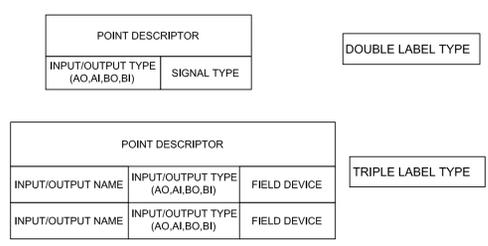
**LIST OF ACRONYMS FOR CONTROL DIAGRAMS**

AI	ANALOG INPUT
AO	ANALOG OUTPUT
ASHRAE	AMERICAN SOCIETY OF AIR CONDITIONING AND REFRIGERATION ENGINEERS
BACNET	BUILDING AUTOMATION AND CONTROL NETWORK (ASHRAE 135-2010)
BI	BINARY INPUT
BO	BINARY OUTPUT
BO BO	TRI-STATE, FLOATING POINT OR 3 WIRE CONTROL
ACT	ACTUATOR
AFMS	AIR FLOW MEASURING STATION
AVG	AVERAGING TEMPERATURE ELEMENT
CSR	CURRENT SENSING RELAY
CTX	CURRENT TRANSDUCER
D2%	DUCT HUMIDITY 2% ACCURACY
DDC	DIRECT DIGITAL CONTROL
DX	DIRECT EXPANSION
DPS	DIFFERENTIAL PRESSURE SWITCH
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
FREEZE	LOW TEMPERATURE SENSOR WITH RELAY OR FREEZE STAT
E/D	ENABLE/DISABLE
HUM	HUMIDITY
IMMR	IMMERSION TEMPERATURE SENSOR
IP	INTERNET PROTOCOL
MOD	MODULATING CONTROL (2-10VDC, 0-5VDC R 4-20MA)
MS/TP	MASTER SLAVE TOKEN PASSING
PFS	PADDLE FLOW SWITCH
RIB	RELAY IN A BOX (VERIS INDUSTRIES OR EQUAL)
RLY	RELAY
SCR	SILICON CONTROLLED RECTIFIER
SP	SINGLE POINT TEMPERATURE ELEMENT (12" OR 24" AS REQUIRED)
S/S	START/STOP
TRISTATE	FLOATING POINT OR 3 WIRE CONTROL OF AN ACTUATOR
TS	TERMINAL STRIP
VAV	VARIABLE AIR VOLUME
VFD OR VSD	VARIABLE FREQUENCY OR SPEED DRIVE
VIB	VIBRATION SWITCH
VPN	VIRTUAL PRIVATE NETWORK

**WIRING LEGEND**



**POINT LABEL LEGEND**



**BAS GENERAL REQUIREMENTS**

**ADJUSTMENT OF SETPOINTS AND TIME DELAYS/CONSTANTS:** ALL SETPOINTS, TIME DELAYS AND TIME CONSTANTS SHALL BE EXPOSED FOR ADJUSTMENT DURING TEST & BALANCE AND COMMISSIONING REGARDLESS IF THE VALUE IS MARKED (ADJ) IN THE SEQUENCE.

**USER ADJUSTMENT OF SETPOINTS AND TIME CONSTANTS:** ALL SETPOINTS AND TIME CONSTANTS SHALL BE ADJUSTABLE BY THE USER WITH APPROPRIATE LOGIN CREDENTIALS.

**ALARMS:** PROGRAM TWO LEVELS OF ALARMS: CRITICAL AND EQUIPMENT. CRITICAL ALARMS SHALL BE DEFINED AS THOSE ALARMS WHICH IF NOT RESPONDED TO WILL RESULT IN SUBSTANTIAL DAMAGE TO EQUIPMENT OR IMPACT PERSONNEL SAFETY. EQUIPMENT ALARMS SHALL BE DEFINED AS THOSE ALARMS WHICH ARE MORE ROUTINE WHICH CAN BE CLEARED DURING THE NEXT SCHEDULED MAINTENANCE VISIT. COORDINATE WITH OWNER AS REQUIRED.

**FREEZE PROTECTION:** ALL AHU TEMPERATURE SENSORS ARE LOW TEMPERATURE DEVICES IN THE BAS.

**OUT-OF-SERVICE FLAGS:** THE BAS SHALL BE PROGRAMMED WITH OUT-OF-SERVICE FLAGS FOR EACH PIECE OF EQUIPMENT SUCH THAT AN OPERATOR OR THE BAS CAN REMOVE A PIECE OF EQUIPMENT FROM SERVICE. WHEN ANY PIECE OF EQUIPMENT HAS ITS OUT-OF-SERVICE FLAG SET, THE EQUIPMENT SHALL NOT BE AUTOMATICALLY ENABLED BY THE BAS. THE BAS SHALL HAVE A SUMMARY PAGE LISTING ALL EQUIPMENT AND THE ASSOCIATED OUT-OF-SERVICE FLAG STATUS WITH A CHECKBOX FOR THE USER TO SET THE OUT-OF-SERVICE FLAG.

**RECOGNITION OF FAILED EQUIPMENT:** THE BAS SHALL AUTOMATICALLY SET AN OUT OF SERVICE FLAG FOR ANY PIECE OF EQUIPMENT THAT FAILS TO INDICATE RUN STATUS ON THREE CONSECUTIVE ATTEMPTS TO RUN BY THE BAS.

**DEAD-BANDS:** ALL HEATING AND COOLING SETPOINTS SHALL BE SEPARATED BY A MINIMUM OF 5F (ADJ)

**COSA BAS DESIGN STANDARDS:** CONTROL CONTRACTOR TO REFERENCE AND INCORPORATE COSA BAS DESIGN STANDARDS AS REQUIRED.

**GLOBAL POINTS:** OUTSIDE AIR TEMPERATURE AND HUMIDITY SHALL BE MEASURED AT THE BUILDING AND USED GLOBALLY.

**SYSTEM DESIGN:** THE BAS SHALL MONITOR ALL POINTS AS INDICATED ON THE CONTROL DIAGRAMS AND ON THE PLANS. IF ADDITIONAL POINTS ARE NEEDED TO ACHIEVE A WORKING SYSTEM OR SEQUENCE OF OPERATION THE CONTROLS CONTRACTOR SHALL PROVIDE THOSE DEVICES, INSTALLATION, PROGRAMMING AND GRAPHIC GENERATION AS REQUIRED AND WITHOUT ADDITIONAL COST TO THE OWNER.

**OWNERS PROGRAM REQUIREMENTS:**  
 OCCUPIED SCHEDULE - 7AM TO 5:30PM M-F; 8 - NOON SATURDAY  
 UNOCCUPIED SCHEDULE - 5:30PM TO 7AM M-F; NOON TO MIDNIGHT SATURDAY; ALL DAY SUNDAY  
 OCCUPIED SETPOINTS:  
 COOLING SETPOINT - 75F  
 HEATING SETPOINT - 70F  
 DEHUMIDIFICATION SETPOINT - 60%RH  
 UNOCCUPIED SETPOINTS:  
 COOLING SETPOINT - 85F  
 HEATING SETPOINT - 63F

**EQUIPMENT LABELS:** DESIGNATION OF EQUIPMENT SHALL FOLLOW STANDARDS INDICATED ON DRAWINGS.

**CASCADED GRAPHIC USER INTERFACE REQUIREMENTS**

**GENERAL - ON ALL GRAPHICS**

- DISPLAY TIME, OUTSIDE AIR TEMPERATURE AND OUTSIDE AIR HUMIDITY ON EACH GRAPHIC.
- PROVIDE NAVIGATION LINKS TO SCHEDULING, TRENDS, & ALARMS.
- PROVIDE NAVIGATION LINK TO THE CAMPUS LEVEL GRAPHIC AND BUILDING LEVEL GRAPHIC.
- ENSURE STANDARD OPERATION OF BACKWARD AND FORWARD BUTTON ON BROWSER.
- PROVIDE COLOR ANIMATION TO INDICATE RUN STATUS.

**BUILDING LEVEL GRAPHIC**

- DISPLAY EQUIPMENT ON FLOORPLANS.
- OUTLINE EACH HVAC ZONE WITH BOLD LINES.
- DISPLAY THERMOGRAPH ON FLOORPLAN (I.E. COLOR SHADING TO REPRESENT TEMPERATURE DEVIATION FROM SETPOINT).

**EQUIPMENT GRAPHICS**

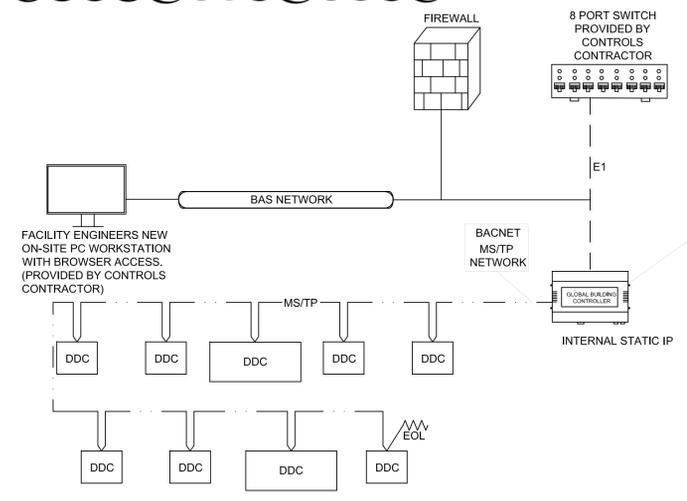
- DISPLAY EQUIPMENT GRAPHIC THAT DEPICTS THE ACTUAL CONFIGURATION OF THE EQUIPMENT.
- DISPLAY EACH POINT VALUE IN THE APPROPRIATE PLACE ON THE EQUIPMENT.
- PROVIDE OVERRIDE CAPABILITY FOR OUTPUT POINTS FROM EQUIPMENT GRAPHIC.
- PROVIDE ANIMATION TO INDICATE OPERATIONAL POINTS.
- PROVIDE INDICATION OF PROGRAM OUTPUTS SUCH AS, BUT NOT LIMITED TO COOLING MODE, DEHUMIDIFICATION, OCCUPIED/UNOCCUPIED, ECONOMIZER, ETC.
- DISPLAY OUT OF SERVICE FLAG STATUS WITH CHECKBOX TO TOGGLE OUT OF SERVICE FLAG.

**SUMMARY PAGE GRAPHICS**

- PROVIDE SUMMARY LIST OF ALL AHU DISCHARGE AIR TEMPERATURES, DISCHARGE AIR TEMPERATURE SETPOINTS AND OCCUPIED/UNOCCUPIED SCHEDULE STATUS.
- PROVIDE A SUMMARY LIST OF ALL TERMINAL UNIT SUPPLY TEMPERATURES, ZONE TEMPERATURES AND ZONE TEMPERATURE SETPOINTS.
- PROVIDE SUMMARY LIST OF ALL EQUIPMENT WITH OUT OF SERVICE FLAGS
- PROVIDE SUMMARY LIST OF ALL EXHAUST FAN STATUS.
- PROVIDE SUMMARY OF TERMINAL UNIT AIR FLOW REQUEST STATUS PAGE PER AHU (I.E. SUPPLY/SETPOINT AIRFLOW WITH RATIO, ZONE TEMPERATURE AND ZONE SETPOINT.
- PROVIDE A SUMMARY LIST OF ALL OUTSIDE AIR UNIT ENTERING TEMPERATURE AND HUMIDITY; LEAVING TEMPERATURE AND HUMIDITY.

**OWNER REQUESTED GRAPHICS**

- PROVIDE OWNER REQUESTED GRAPHICS FOR SPECIFIC BUILDING PERSONNEL AND OPERATIONS.
- COORDINATE WITH COSA STAFF, COMMISSIONING AGENT AND ENGINEER AS REQUIRED TO ACHIEVE OWNER DESIRED GRAPHICS PAGES.



**1 BAS NETWORK DIAGRAM**  
 NO SCALE

REVISIONS:  
 ADDENDUM #2 06/03/13

THIS DRAWING, ACCOMPANYING SPECIFICATIONS AND OTHER DOCUMENTS PREPARED BY THE ENGINEER FOR THE PROJECT AND INTENDING TO BE USED BY THE CONTRACTOR SHALL BE THE SOLE RESPONSIBILITY OF THE CONTRACTOR. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM ALL AFFECTED AGENCIES AND SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS FROM ALL AFFECTED AGENCIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS FROM ALL AFFECTED AGENCIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS FROM ALL AFFECTED AGENCIES.



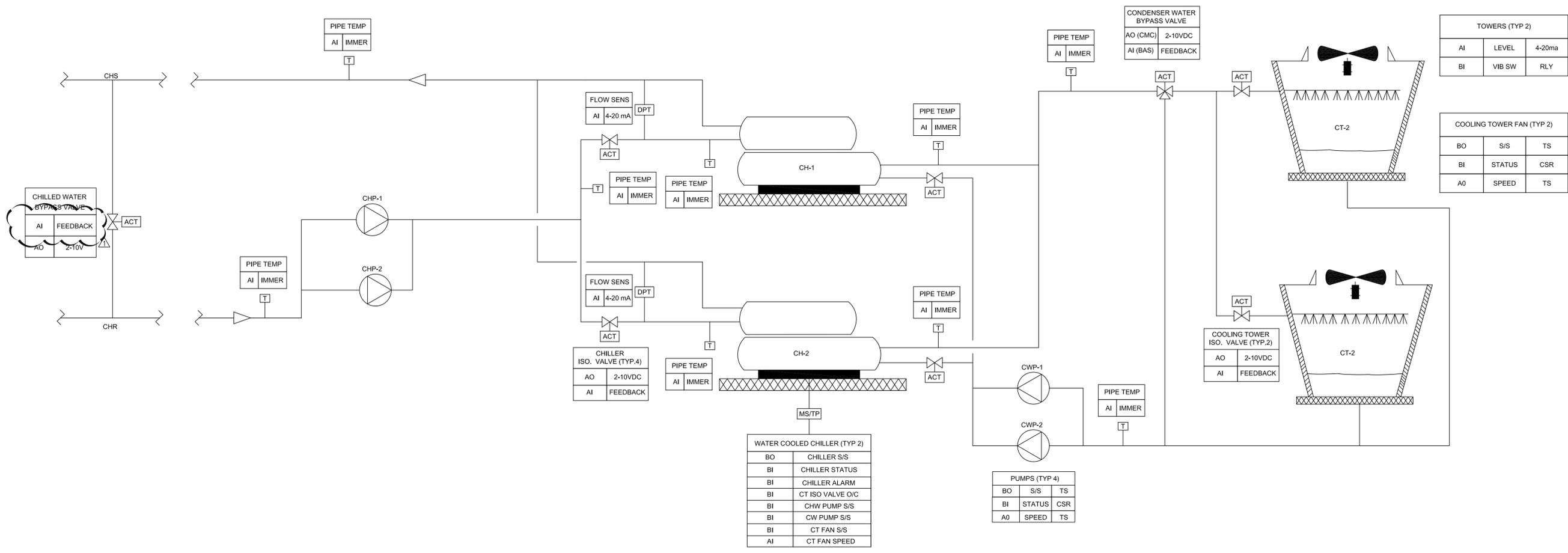
**Alderson & Associates, Inc.**  
 7700 South Loop West  
 Suite 101  
 San Antonio, TX 78229  
 Phone (210) 615-8549  
 Fax (210) 615-8549  
 © 2013 Alderson and Associates, Inc.  
 PROJECT # 12154

**HVAC UPGRADES**  
**INTERNATIONAL CENTER**  
 203 SOUTH ST. MARY'S, SAN ANTONIO, TX 78205

**MECHANICAL CONTROL SEQUENCES AND DIAGRAMS**

PROJECT: 12-154  
 DRAWN: AAI  
 CHECKED: DTA  
 DATE: 2013-05-02

SHEET  
**M10.2**  
 OF:



**1 CHILLER PLANT CONTROL DIAGRAM**  
 NO SCALE

**CONTROL SEQUENCE FOR CHILLED WATER SYSTEM:**

**SYSTEM DESCRIPTION:** THE SYSTEM IS A VARIABLE PRIMARY CHILLED WATER FLOW SYSTEM WITH THE FOLLOWING:  
 TWO WATER-COOLED, MAGNETIC-BEARING, CENTRIFUGAL CHILLERS, WITH MOTORIZED CONDENSER AND CHILLED WATER ISOLATION VALVES.  
 TWO MANIFOLDED CONDENSER WATER (LEAD/LAG) PUMPS WITH STAGED SPEED CONTROL.  
 TWO MANIFOLDED CHILLED WATER (LEAD/LAG) PUMPS WITH VARIABLE SPEED CONTROL.  
 TWO COOLING TOWERS WITH CONNECTED SUMPS, VARIABLE SPEED FANS AND MOTORIZED ISOLATION VALVES.  
 CONDENSER WATER BY-PASS VALVE (IN PLANT).  
 CHILLED WATER BY-PASS VALVE NEAR THE END OF THE LINE FOR MINIMUM CHILLED WATER FLOW CONTROL.  
 CONTROL WILL BE SHARED BETWEEN THE CHILLER MANUFACTURER'S CONTROLS (CMC) AND THE BUILDING AUTOMATION SYSTEM (BAS).  
 IF ALTERNATE CHILLERS ARE PROPOSED, CONTRACTOR SHALL SUBMIT TO THE ENGINEER A RECOMMENDED SEQUENCE COORDINATED BETWEEN THE BAS AND THE CHILLER MANUFACTURER. SUBMIT WITH THE CONTRACTOR'S ALTERNATE BID PACKAGE. APPROVAL OF AN ALTERNATE CHILLER AND MODIFIED SEQUENCE SHALL BE AT THE SOLE DISCRETION OF THE OWNER/ENGINEER.

**BAS - GENERAL:**  
 ENABLE OF EACH CHILLER INDIVIDUALLY AND CONTROL OF MOTORIZED CHILLER ISOLATION VALVES ON CONDENSER AND EVAPORATORS; MONITOR VALVE POSITION STATUS VIA END SWITCHES AT BAS. ALSO MONITOR CHILLER STATUS FROM CMC VIA BACNET MS/TP. NOTE: CHILLER NETWORKING SHALL NOT BE PERMITTED. BACNET MS/TP IS PERMITTED.  
 CONTROL OF SPEED OF CONDENSER WATER PUMPS (HI/LOW) BASED ON SINGLE OR TWO CHILLER OPERATION. CONTROL OF VARIABLE SPEED OF CHILLED WATER PUMPS BASED ON REMOTE DIFFERENTIAL PRESSURE SENSOR, WITH A MINIMUM FLOW MAINTAINED, PER FLOW SENSOR AT EACH CHILLER. (CMC ENABLES PUMPS.)  
 CONTROL OF CHILLED WATER BYPASS VALVE BASED ON DIFFERENTIAL PRESSURE SENSOR AT EACH CHILLER.  
 SEQUENCING (ENABLE/DISABLE) OF CHILLERS BASED ON CHILLED WATER RETURN TEMPERATURE, AND CONTROL OF TRANSITIONAL WATER FLOWS DURING STAGING.  
 BAS SHALL ENABLE CHILLER(S) BASED ON THE RETURN WATER TEMPERATURE. THE BAS SHALL ENABLE THE CHILLER VIA BACNET MS/TP. OPEN THE CHILLED WATER AND CONDENSER WATER ISOLATION VALVES. VERIFY ISOLATION VALVES ARE OPEN, START THE CHILLED WATER AND CONDENSER WATER PUMPS AND CONTROL THE SPEED OF THE PUMPS AS DESCRIBED IN SECTION 2 BELOW.

**CMC - GENERAL:**  
 AFTER CHILLER IS ENABLED BY BAS, CMC STARTS SELECTED CHILLER'S LEAD AND LAG COMPRESSORS, AFTER CONDENSER WATER AND CHILLED WATER ISOLATION VALVES OPEN AND PUMPS ARE RUNNING.  
 CMC CONTROLS COMPRESSOR SEQUENCING BASED ON CMC'S INTERNAL ALGORITHMS AND CHILLER'S SUPPLY WATER TEMPERATURE.  
 CMC CONTROLS COOLING TOWER ISOLATION VALVES, FAN SPEED AND CONDENSER WATER BY-PASS VALVE IN SEQUENCE, PER CMC'S INTERNAL ALGORITHMS.

**BAS/CMC - SPECIFIC SEQUENCES:**

- GENERAL:** LEAD/LAG STATUS SHALL BE ROTATED BY BAS WEEKLY FOR CHILLERS, PUMPS AND COOLING TOWERS AT OFF-PEAK/UNOCCUPIED PERIOD. LEAD/LAG COMPRESSOR AND COOLING TOWER/FAN STATUS SHALL BE CONTROLLED BY CMC.
- STARTUP:**
  - BAS OPENS THE REMOTE CHILLED WATER BYPASS VALVE FULLY; CONFIRM STATUS VIA END SWITCH.
  - BAS OPENS THE LEAD CHILLER'S 2-POSITION CONDENSER AND CHILLED WATER ISOLATION VALVES; VERIFY VALVES POSITION VIA END-SWITCH; ALARM BAS IF VALVES FAIL TO OPEN.
  - ON VALVES OPENING, BAS ENABLES THE LEAD CHILLER (VIA BACNET MS/TP TO CMC).
  - CMC SHALL OPEN LEAD COOLING TOWER ISOLATION VALVE (IN TOWER SUPPLY WATER) AND START TOWER FAN. CMC SHALL CONTROL TOWER FAN SPEED VIA FAN'S VFD VIA CMC'S INTERNAL ALGORITHM. BAS SHALL MONITOR/ALARM ISOLATION VALVE POSITION VIA END SWITCH, AND SHALL MONITOR FAN VFD SPEED. BAS SHALL SWITCH TO LAG CHILLER AND LAG TOWER OPERATION UPON FAILURE OF VALVE OR FAN. CMC TO PROVIDE BAS WITH COOLING TOWER ISOLATION VALVE OPEN COMMAND AND COOLING TOWER FAN VFD COMMAND VIA BACNET MS/TP FOR LAG UNIT OPERATION.
- UPON CHILLER ENABLE COMMAND TO CMC THE BAS DETERMINES PUMPS' SPEEDS VIA SIGNAL TO PUMPS' VFD (SEE BELOW). BAS MONITORS PUMPS' STATUS VIA CURRENT SENSORS (ADJUSTED BY TAB CONTRACTOR TO "MAKE" AT MINIMUM FLOWS). CMC SHALL START CHILLER AND AFTER 30 SECONDS (ADJ.), BAS SHALL READ CHILLER STATUS FROM CMC. CMC TO NOTIFY BAS OF DISABLED CHILLER AND ALARM BAS IF LEAD CHILLER FAILS. BAS SHALL DISABLE/CLOSE FAILED EQUIPMENT/VALVES AND OPEN LAG CHILLER'S VALVES, ENABLE LAG CHILLER AND ENABLE LAG PUMPS AS NECESSARY IN EVENT OF LEAD FAILURE.**
- CMC SHALL CONTROL CHILLER'S COMPRESSORS SPEED AND STAGING PER INTERNAL ALGORITHMS TO MAINTAIN SETPOINT READ FROM BAS.

- BAS SHALL CONTROL CONDENSER WATER PUMP SPEED TO 50% FLOW (SET AT TAB) FOR ONE CHILLER OPERATION.
- BAS SHALL CONTROL CHILLED WATER PUMP'S VFD TO PROVIDE MINIMUM FLOW OF 185 GPM WITH BYPASS VALVE OPEN. (CONFIRM WITH CHILLER MANUFACTURER FOR MINIMUM FLOW.) AFTER DELAY OF 2 MINUTES (ADJ.), CHILLED WATER BYPASS VALVE SHALL CLOSE UNLESS REQUIRED TO MAINTAIN MINIMUM FLOW. PUMP VFD SHALL ADJUST TO MAINTAIN DIFFERENTIAL PRESSURE SETPOINT AS NEEDED.
- BAS TO MONITOR CHILLER FLOW AT A DIFFERENTIAL PRESSURE (FLOW) SENSOR AT ENTERING WATER SIDE OF EACH CHILLER.
- BAS SHALL ENABLE CONTROLS FOR AHU'S CONTROL VALVES. AFTER ADJUSTABLE INTERVAL (INITIALLY SET TO 5 MINUTES), ALLOW DIFFERENTIAL PRESSURE SENSOR (REMOTE, NEAR FURTHEST AHU) TO CONTROL CHILLED WATER PUMP SPEED FROM THE MINIMUM FLOW UP TO FULL DESIGN FLOW OF ONE CHILLER (NOMINALLY 280 GPM).
- CMC SHALL STAGE/SEQUENCE CHILLERS' COMPRESSORS AND SPEEDS TO FOLLOW BUILDING LOAD, BASED ON CHILLED WATER RETURN TEMPERATURE AND INTERNAL ALGORITHMS.
- CMC SHALL CONTROL CONDENSER WATER BYPASS VALVE VIA ITS INTERNAL ALGORITHMS TO MAINTAIN OPTIMAL CONDENSER WATER TEMPERATURE.

**5. ADDING A CHILLER:**

- BAS SHALL SLOWLY INCREASE THE CHW PUMPS' VFD SPEED TO PROVIDE MINIMUM FLOW TO BOTH CHILLERS, AS DETERMINED BY THEIR DP SENSOR, OR APPROXIMATELY 370 GPM (VERIFY WITH CHILLER MFG AND SET AT TAB). THE RATE OF CHANGE IN FLOW (FROM SINGLE CHILLER DESIGN FLOW OF APPROXIMATELY 280 GPM) SHALL BE LIMITED TO 5% OF FLOW PER MINUTE (GPM/MINUTE), TAKING APPROXIMATELY 10 MINUTES. THE CONDENSER WATER PUMP'S VFD SPEED SHALL BE RAMPED UP FROM 50 TO 100% OVER THE SAME TIME PERIOD.
- IF CHILLED WATER RETURN TEMPERATURE IS GREATER THAN THE CHILLED WATER RETURN SETPOINT, THE BAS SHALL GRADUALLY (OVER THE SAME TIME PERIOD AS ABOVE - APPROX. 10 MINUTES) OPEN CHW AND CONDENSER WATER ISOLATION VALVES ON THE LAG CHILLER (AS ABOVE) AND ENABLE IT.
- CMC SHALL SEQUENCE COMPRESSOR(S) AND CONTROL THE LEAD CHILLER (AND TOWERS/BYPASS) AS NEEDED TO MAINTAIN CHW SUPPLY TEMPERATURE SETPOINT PER INTERNAL ALGORITHMS.
- BAS SHALL THEN CONTROL CHW PUMPS' VFD FROM THE MINIMUM FLOW FOR TWO MACHINES UP TO THE FULL DESIGN FLOW FOR TWO CHILLERS AS REQUIRED TO MAINTAIN CHILLED WATER DIFFERENTIAL PRESSURE SETPOINT AT THE REMOTE SENSOR.

**4. SUBTRACTING A CHILLER:**

- AS BUILDING LOAD DECREASES AND THE RETURN WATER TEMPERATURE DROPS BELOW CHILLED WATER RETURN SETPOINT, THE LAG CHILLER SHALL BE DISABLED BY BAS, AND THE CHW PUMPS' VFD SHALL BE SLOWED TO THE SINGLE CHILLER DESIGN FLOW (APPROX. 280 GPM) OVER A PERIOD OF APPROXIMATELY 10 MINUTES (ADJ.); THE CONDENSER PUMP SHALL RAMP FROM 100% TO 50% FLOW OVER THE SAME TIME PERIOD. DURING THIS SLOWDOWN PERIOD, THE ISOLATION VALVES ON THE LAG MACHINE SHALL BE GRADUALLY CLOSED.
- THE CMC SHALL THEN CONTROL THE COMPRESSOR(S) ON THE LEAD MACHINE AS REQUIRED TO MAINTAIN CHILLED WATER SUPPLY TEMPERATURE SETPOINT. CHW PUMPS' VFD THEN CONTROLS OFF DIFFERENTIAL PRESSURE AS REQUIRED FOR BUILDING LOAD, DOWN TO THE MINIMUM FLOW RATE FOR THE LEAD CHILLER, WITH THE BYPASS VALVE MODULATING OPEN AS NEEDED.

**5. CHILLER FREEZE PROTECTION:**

- IN THE EVENT OF AN EVAPORATOR LOW TEMPERATURE ALARM, THE BAS SHALL ENABLE THE CHILLED WATER PUMP, OPEN THE CHILLED WATER ISOLATION VALVE, OPEN THE REMOTE CHILLED WATER BYPASS VALVE TO FULL OPEN POSITION AND RAMP THE CHILLED WATER PUMP TO 100% CHILLED WATER DESIGN FLOW RATE.
- IN THE EVENT OF A CONDENSER LOW TEMPERATURE ALARM, THE CMC SHALL OPEN THE COOLING TOWER ISOLATION VALVE. THE BAS SHALL ENABLE THE CONDENSER WATER PUMP, RAMP THE CONDENSER WATER PUMP TO 100% CONDENSER WATER DESIGN FLOW RATE.
- CONDENSER WATER PUMP TO 100% CONDENSER WATER DESIGN FLOW RATE.



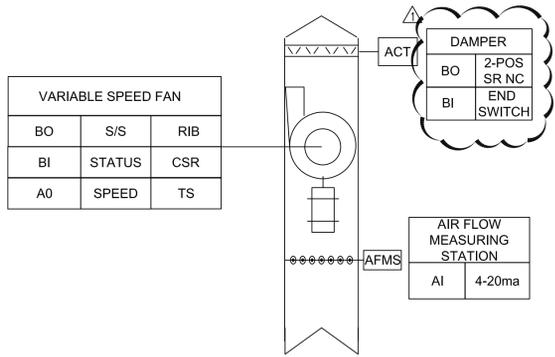
**Alderson & Associates, Inc.**  
 Mechanical Engineers  
 7700 South Loop West  
 Suite 101  
 San Antonio, TX 78229  
 Phone (210) 615-8549  
 Fax (210) 615-8549  
 © 2013 Alderson and Associates, Inc.  
 PROJECT # 12154

**HVAC UPGRADES**  
**INTERNATIONAL CENTER**  
 203 SOUTH ST. MARY'S, SAN ANTONIO, TX 78205

**MECHANICAL CONTROL SEQUENCES AND DIAGRAMS**

PROJECT: 12-154  
 DRAWN: AAI  
 CHECKED: DTA  
 DATE: 2013-05-02

SHEET  
**M10.5**  
 OF:



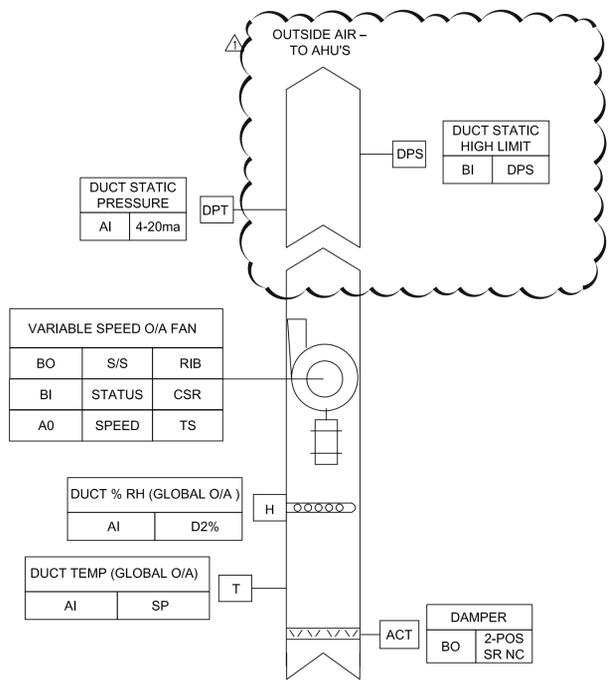
**EXHAUST FAN SEQUENCE OF OPERATION:**

**OCCUPIED MODE:** FAN SHALL BE ENABLED DURING OCCUPIED MODE. THE BAS SHALL OPEN THE CONTROL DAMPER. WHEN THE CONTROL DAMPER IS OPEN AS PROVEN BY THE DAMPER POSITION END SWITCH, THE VFD SHALL SOFT START THE FAN WHICH SHALL THEN MODULATE TO MAINTAIN AN EXHAUST AIRFLOW 740 CFM LESS THAN TOTAL OUTSIDE AIRFLOW BEING DELIVERED TO ALL AHU'S. EXHAUST AIRFLOW SHALL BE MEASURED AT AN ELECTRONIC AIRFLOW MEASURING STATION LOCATED IN DUCT SERVING EXHAUST FAN, EF-1.

**UNOCCUPIED MODE:** FAN SHALL BE DISABLED AND ASSOCIATED CONTROL DAMPER SHALL BE CLOSED.

**ALARMS:** FAN FAILURE, LOW BUILDING PRESSURE.

**1 VAV EXHAUST FAN CONTROL DIAGRAM (EF-1)**  
 NO SCALE



**OUTSIDE AIR FAN SEQUENCE OF OPERATION:**

**OCCUPIED MODE:** FAN SHALL BE ENABLED DURING OCCUPIED MODE. THE BAS SHALL OPEN THE CONTROL DAMPER. WHEN THE CONTROL DAMPER IS OPEN AS PROVEN BY THE DAMPER POSITION END SWITCH, THE VFD SHALL SMOOTHLY MODULATE THE SPEED OF THE FAN IN RESPONSE TO THE DUCT STATIC PRESSURE SETPOINT (SETPOINT SHALL BE DETERMINED DURING TEST AND BALANCE).

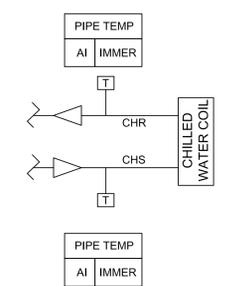
**UNOCCUPIED MODE:** FAN SHALL BE DISABLED AND ASSOCIATED CONTROL DAMPER SHALL BE CLOSED.

**DUCT STATIC HIGH LIMIT:** THE BAS SHALL MONITOR THE MANUAL RESET DUCT STATIC HIGH LIMIT. IF THE DUCT STATIC HIGH LIMIT SWITCH MAKES, THE VFD SHALL BE STOPPED AND REQUIRE RESET BY THE OPERATOR. INITIAL SETPOINT SHALL BE 3.5"W.C.

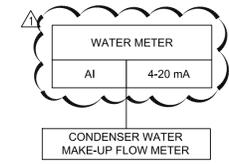
**ALARMS:** FAN FAILURE, DAMPER FAILURE, DUCT STATIC HIGH LIMIT.

**2 VAV OUTSIDE AIR FAN CONTROL DIAGRAM (OAF-1)**  
 NO SCALE

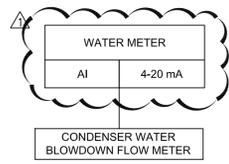
**RE-USE OF EXISTING CONTROL END DEVICES AND WIRING SHALL NOT BE PERMITTED. REPLACE AND/OR ADD END DEVICES AND WIRING PER THESE DRAWINGS AND SPECIFICATIONS.**



**AHU-5 & AHU-6 CHILLED WATER TEMPERATURE MONITORING:**  
 CHILLED WATER SUPPLY AND RETURN TEMPERATURE SHALL BE MONITORED AT BRANCH CONNECTION TO EACH AHU.

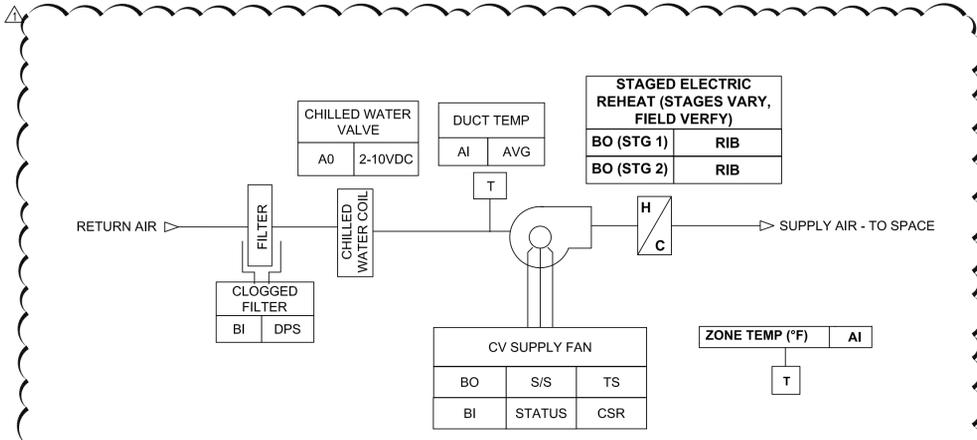


**MAKE-UP WATER METER:**  
 THE BAS SHALL MONITOR CONSUMPTION AND TOTALIZE THE VALUE. THE BAS SHALL RESET THE TOTAL AT MIDNIGHT ON THE FIRST DAY OF EACH MONTH (ADJ.).



**BLOWDOWN WATER METER:**  
 THE BAS SHALL MONITOR BLOWDOWN AND TOTALIZE THE VALUE. THE BAS SHALL RESET THE TOTAL AT MIDNIGHT ON THE FIRST DAY OF EACH MONTH (ADJ.).

**3 MISCELLANEOUS CONTROL DIAGRAMS**  
 NO SCALE



**4 CONSTANT VOLUME FAN COIL UNIT CONTROL DIAGRAM (FCU-1)**  
 NO SCALE

**CV AIR HANDLING UNIT SEQUENCE OF OPERATION:**

**OCCUPIED/UNOCCUPIED SCHEDULE:** THE BAS SHALL AUTOMATICALLY CHANGE THE HEATING AND COOLING SETPOINTS TO FOLLOW THE OCCUPIED AND UNOCCUPIED SCHEDULE AS REQUIRED.

**ANYTIME AN FAN COIL IS ACTIVE (OCCUPIED OR UNOCCUPIED) THE BAS SHALL COMMAND THE CHILLER PLANT TO OPERATE AND MAINTAIN THE CHILLED WATER SUPPLY SETPOINT.**

**UNIT START:** THE BAS SHALL START THE SUPPLY FAN AND MODULATE THE CHILLED WATER VALVE OR STAGE THE ELECTRIC HEATER TO MAINTAIN SPACE TEMPERATURE.

**CHILLED WATER VALVE:** THE BAS SHALL MODULATE THE CHILLED WATER VALVE TO MAINTAIN A STEADY AND CONSISTENT 55F DISCHARGE AT THE DISCHARGE OF THE FAN COIL UNIT DURING COOLING MODE OPERATION.

**ELECTRIC HEATER:** THE BAS SHALL CYCLE THE STAGES OF ELECTRIC RESISTANCE HEAT DURING HEATING MODE TO MAINTAIN SPACE TEMPERATURE SETPOINT.

**MAINTAIN OUTSIDE AIRFLOW SETPOINT.**

**FREEZE PROTECTION:** IF ANY TEMPERATURE SENSOR INDICATES A TEMPERATURE BELOW 35F, THE BAS SHALL AUTOMATICALLY MODULATE THE CHILLED WATER VALVE 100% OPEN, OPERATE THE CHILLED WATER PUMPS TO PROVIDE CIRCULATION IN THE CHILLED WATER COIL, AND STOP THE SUPPLY FAN.

**UNIT STOP:** ANYTIME THE UNIT IS COMMANDED TO SHUTDOWN THE CHILLED WATER VALVE SHALL CLOSE, THE HEATER SHALL BE OFF AND THE SUPPLY FAN SHALL BE OFF.

**ALARMS:** FAN FAILURE, LOW TEMPERATURE ALARM, HIGH SUPPLY AIR TEMPERATURE, DIRTY FILTER.

**DP-1 POWER METERING (ADD ALTERNATE #1):**

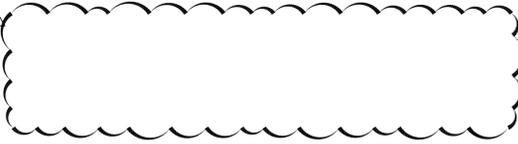
THE BAS SHALL MONITOR POWER CONSUMPTION AT DISTRIBUTION PANEL DP-1, TOTALIZE THE VALUE AND DISPLAY IN A GRAPHICAL FORMAT. THE BAS SHALL AUTOMATICALLY RESET THE TOTALS AT MIDNIGHT ON THE FIRST DAY OF EACH MONTH (ADJ.).

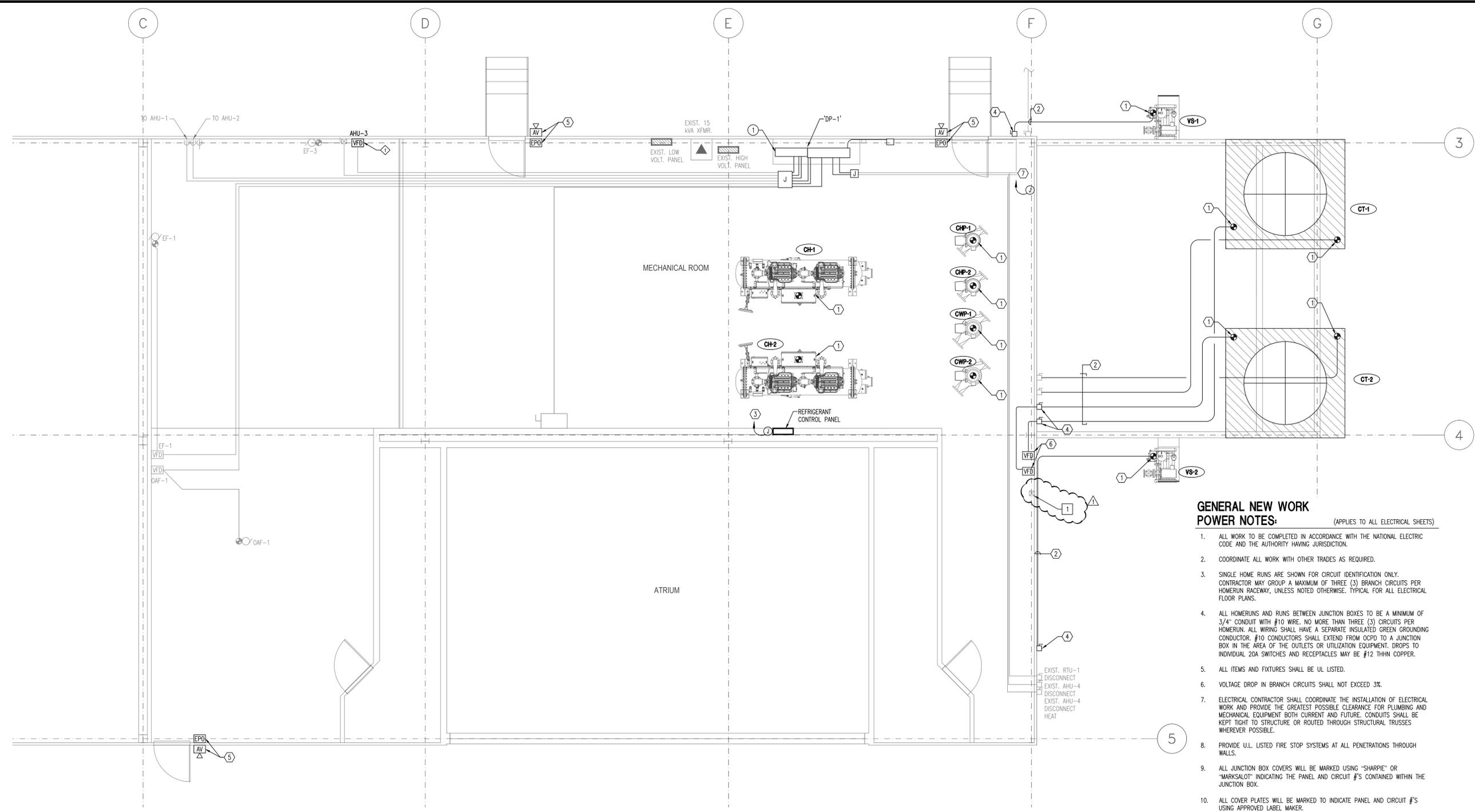
**REFRIGERANT MONITOR:**

ALARM THE BAS UPON DETECTION OF REFRIGERANT IN PENTHOUSE. REFRIGERANT MONITOR SYSTEM SHALL OPERATE A/V STROBES INDEPENDENTLY OF BAS.

**WATER TREATMENT:**

THE FOLLOWING SHALL BE REPORTED TO/MONITORED BY THE BAS:  
 1. CHEMICAL STORAGE CONTAINER LOW LEVEL ALARM  
 2. CONDENSER WATER HIGH/LOW PH LEVEL  
 3. CONDENSER WATER CONDUCTIVITY  
 NOTE THAT WATER TREATMENT SHALL BE PERFORMED BY THE WATER TREATMENT CONTROLLER.





**ELECTRICAL ROOF PLAN - POWER - NEW WORK PHASE 3**

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

**ADD ALT. #3 KEYED NOTES:** (APPLIES TO THIS SHEET) □

1. PROVIDE NEW VFD FOR AHU-4. VFD SHALL BE FURNISHED BY DIVISION 23 AND INSTALLED BY DIVISION 26. SEE E3.1 FOR ADDITIONAL INFORMATION.

**ADD ALT. #2 KEYED NOTES:** (APPLIES TO THIS SHEET) ◇

1. NEW VFD, FURNISHED BY DIVISION 23 INSTALL BY DIVISION 26. SEE E3.1 FOR ADDITIONAL INFORMATION.

**ADD ALT. #1 KEYED NOTES:** (APPLIES TO THIS SHEET) ○

1. PROVIDE A NEW EXTERNAL POWER METER. SEE E2.1 FOR ADDITIONAL INFORMATION.

**GENERAL NEW WORK POWER NOTES:** (APPLIES TO ALL ELECTRICAL SHEETS)

1. ALL WORK TO BE COMPLETED IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE AND THE AUTHORITY HAVING JURISDICTION.
2. COORDINATE ALL WORK WITH OTHER TRADES AS REQUIRED.
3. SINGLE HOME RUNS ARE SHOWN FOR CIRCUIT IDENTIFICATION ONLY. CONTRACTOR MAY GROUP A MAXIMUM OF THREE (3) BRANCH CIRCUITS PER HOMERUN RACEWAY, UNLESS NOTED OTHERWISE. TYPICAL FOR ALL ELECTRICAL FLOOR PLANS.
4. ALL HOMERUNS AND RUNS BETWEEN JUNCTION BOXES TO BE A MINIMUM OF 3/4" CONDUIT WITH #10 WIRE. NO MORE THAN THREE (3) CIRCUITS PER HOMERUN. ALL WIRING SHALL HAVE A SEPARATE INSULATED GREEN GROUNDING CONDUCTOR. #10 CONDUCTORS SHALL EXTEND FROM OCPD TO A JUNCTION BOX IN THE AREA OF THE OUTLETS OR UTILIZATION EQUIPMENT. DROPS TO INDIVIDUAL 20A SWITCHES AND RECEPTACLES MAY BE #12 THIN COPPER.
5. ALL ITEMS AND FIXTURES SHALL BE UL LISTED.
6. VOLTAGE DROP IN BRANCH CIRCUITS SHALL NOT EXCEED 3%.
7. ELECTRICAL CONTRACTOR SHALL COORDINATE THE INSTALLATION OF ELECTRICAL WORK AND PROVIDE THE GREATEST POSSIBLE CLEARANCE FOR PLUMBING AND MECHANICAL EQUIPMENT BOTH CURRENT AND FUTURE. CONDUITS SHALL BE KEPT TIGHT TO STRUCTURE OR ROUTED THROUGH STRUCTURAL TRUSSES WHEREVER POSSIBLE.
8. PROVIDE UL LISTED FIRE STOP SYSTEMS AT ALL PENETRATIONS THROUGH WALLS.
9. ALL JUNCTION BOX COVERS WILL BE MARKED USING "SHARPIE" OR "MARKSALOT" INDICATING THE PANEL AND CIRCUIT #'S CONTAINED WITHIN THE JUNCTION BOX.
10. ALL COVER PLATES WILL BE MARKED TO INDICATE PANEL AND CIRCUIT #'S USING APPROVED LABEL MAKER.
11. FLEXIBLE METALLIC CONDUIT (FMC) CAN BE USED ONLY FOR FINAL CONNECTIONS TO LIGHT FIXTURES. EQUIPMENT CONNECTIONS LONGER THAN 6' WILL NOT BE ALLOWED.
12. LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) SHALL BE USED FOR CONNECTIONS TO EQUIPMENT AND MOTORS. EQUIPMENT CONNECTIONS LONGER THAN 6' WILL NOT BE ALLOWED.

**KEYED NOTES:** (APPLIES TO THIS SHEET) ○

1. REFER TO EQUIPMENT CONNECTION SCHEDULE FOR FEEDER SIZE AND ADDITIONAL INFORMATION.
2. KEEP CONDUIT RUNS OFF OF ROOF TOP SO AS NOT TO VOID THE WARRANTY OF THE ROOF TOP.
3. PROVIDE A NEW CIRCUIT TO POWER REFRIGERANT CONTROL PANEL. CIRCUIT TO EXISTING SPARE BREAKER SEE E3.1 FOR ADDITIONAL INFORMATION.
4. FURNISH AND INSTALL A NEW DISCONNECT SWITCH. SEE E3.1 FOR ADDITIONAL INFORMATION.
5. PROVIDE A 3/4" C WITH PULL STRING BACK TO REFRIGERANT CONTROL PANEL. VERIFY EXACT LOCATION WITH REFRIGERANT PROVIDER.
6. NEW VFD FURNISHED BY DIVISION 23 INSTALLED BY DIVISION 26. SEE E3.1 FOR ADDITIONAL INFORMATION.
7. CIRCUIT RELOCATED CHEMICAL FEED TO EXISTING 20A BREAKER IN PANEL 4LB.

REVISIONS:

ADDENDUM #2	06/03/13



**Alderson & Associates, Inc.**  
 7700 South Loop West  
 Suite 101  
 San Antonio, TX 78229  
 Tel: (210) 615-8549  
 Fax: (210) 615-8549  
 © 2013 Alderson and Associates, Inc.  
 F-1008

**HVAC UPGRADES**  
**INTERNATIONAL CENTER**  
 203 SOUTH ST. MARY'S, SAN ANTONIO, TX 78205

**ELECTRICAL ROOF PLAN POWER NEW WORK**

PROJECT:	12-154
DRAWN:	AAI
CHECKED:	DTA
DATE:	2013-05-02

SHEET  
**E1.2**  
 OF:

THIS DRAWING, ACCOMPANYING SPECIFICATIONS AND OTHER DOCUMENTS PROVIDED BY THE ARCHITECT FOR THE PROJECT AND ANYTHING ELSE REQUIRED FOR THE PROJECT ARE HEREBY ACCEPTED BY THE ENGINEER'S SERVICE FOR USE SOLELY IN CONNECTION WITH THE PROJECT AND SUBJECT TO THE TERMS AND CONDITIONS SET FORTH IN THE ARCHITECT'S CONTRACT AND OTHER RELEVANT DOCUMENTS. THE ENGINEER'S SERVICE SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OF ANY INFORMATION OR DATA PROVIDED BY ANY OTHER PARTY OR FOR THE CONSEQUENCES OF ANY RELIANCE ON SUCH INFORMATION OR DATA. THE ENGINEER'S SERVICE SHALL NOT BE RESPONSIBLE FOR THE CONSTRUCTION OF ANY WORK OR FOR THE SAFETY OF ANY PERSONS OR PROPERTY. THE ENGINEER'S SERVICE SHALL NOT BE RESPONSIBLE FOR THE CONSTRUCTION OF ANY WORK OR FOR THE SAFETY OF ANY PERSONS OR PROPERTY UNLESS AUTHORIZED BY CONTRACT OR OTHER WRITTEN DOCUMENT AS EXPRESSLY INDICATED BY THE ARCHITECT.



**Alderson & Associates, Inc.**  
 7700 South Loop West  
 Suite 101  
 San Antonio, TX 78229  
 Phone (210) 615-8549  
 Fax (210) 615-8549  
 © 2013 Alderson and Associates, Inc.  
 PROJECT # 12154

**HVAC UPGRADES**  
**INTERNATIONAL CENTER**  
 203 SOUTH ST. MARY'S, SAN ANTONIO, TX 78205

**ONE-LINE DIAGRAM**

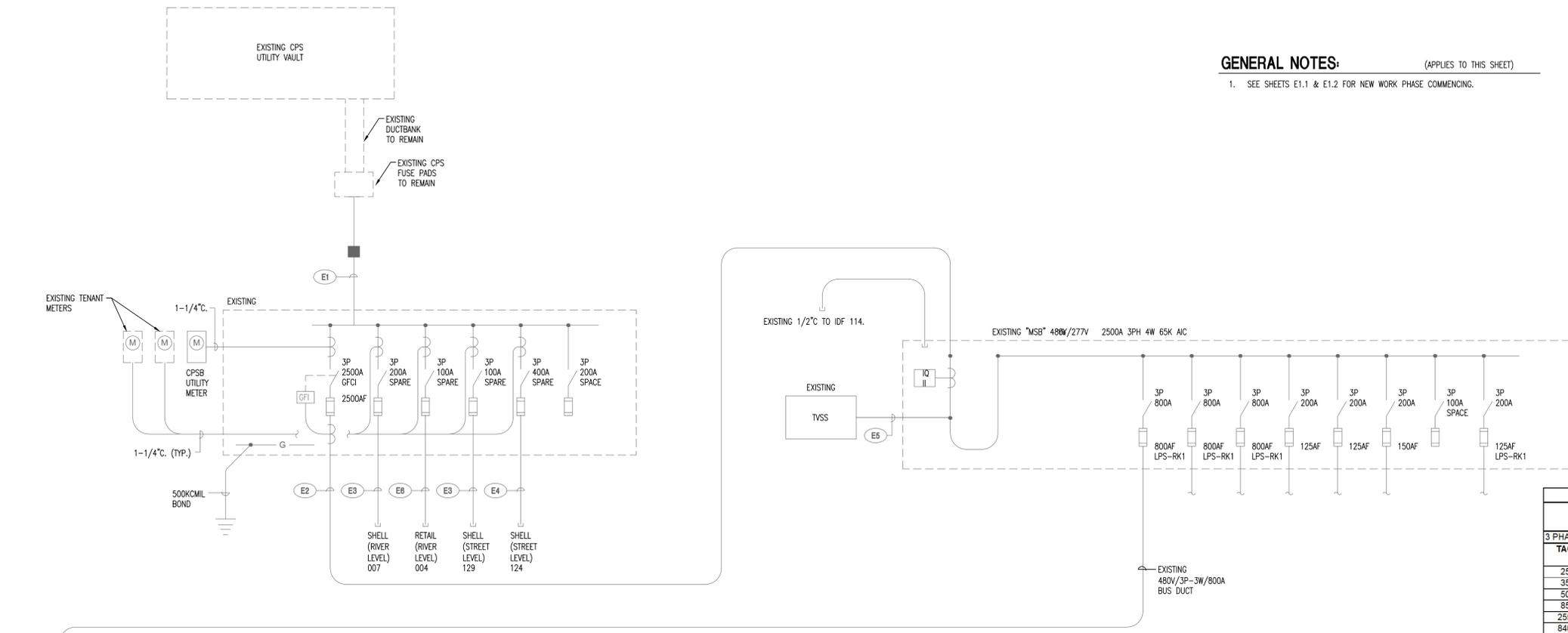
PROJECT: 12-154  
 DRAWN: AAI  
 CHECKED: DTA  
 DATE: 2013-05-02

**GENERAL NOTES:** (APPLIES TO THIS SHEET)

- SEE SHEETS E1.1 & E1.2 FOR NEW WORK PHASE COMMENCING.

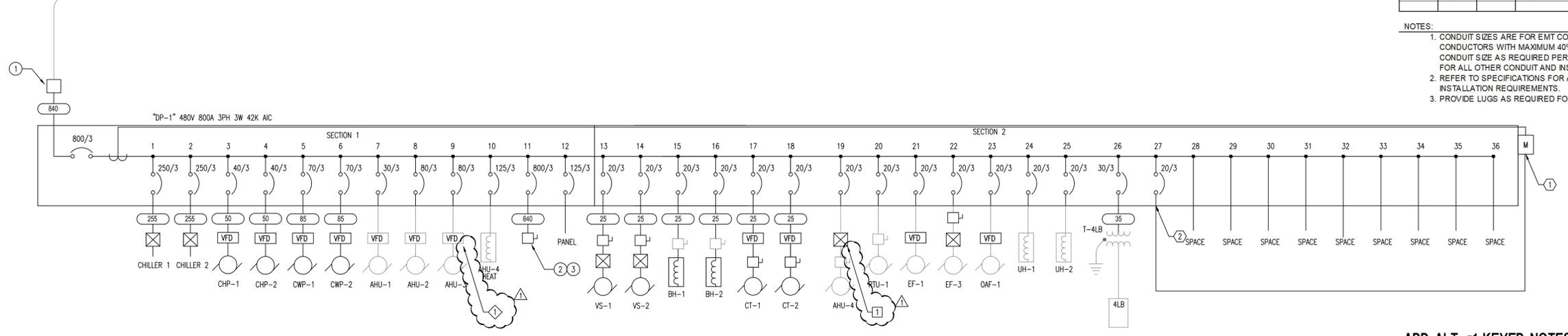
**KEYED NOTES:** (APPLIES TO THIS SHEET)

- FURNISH AND INSTALL NEW TAP BOX EQUIVALENT TO I-LINE II END CABLE TAP BOX. PROVIDE A (I-LINE II TO GE SPECTRA) MANUFACTURED ADAPTER.
- FURNISH AND INSTALL NEW 600V/3P/800A/NF/N1 DISCONNECT. TEMPORARY CHILLER WILL BE FURNISHED WITH OVER CURRENT PROTECTION ACCORDING TO THE TEMPORARY CHILLER'S REQUIREMENTS. STENCIL IN THE FOLLOWING NOTE, "DISCONNECT FOR TEMPORARY CHILLER SHALL NOT BE IN THE ON POSITION WHILE PERMANENT CHILLER IS RUNNING." SEE SPECIFICATION FOR PROPER TEXT SIZE.
- TERMINATE TEMPORARY CHILLER CABLE TO NEW DISCONNECT. CABLE PROVIDED BY OTHER. BE SURE TO TERMINATE AND SUPPORT THE TEMPORARY CABLE IN ACCORDANCE WITH NEC NEC 590.4(i) & (j).



FEEDER SCHEDULE					
STRANDED COPPER CONDUCTORS, 75 DEG. C INSULATION					
TYPE THHN/THWN					
3 PHASE, 3 WIRE					
TAG	CONDUIT		PHASE CONDUCTORS	NEUTRAL CONDUCTORS	GROUND CONDUCTORS
25	(1) 3/4"	ea. w/	(3)#10	N/A	(1)#10
35	(1) 3/4"	ea. w/	(3)#10	N/A	(1)#10
50	(1) 3/4"	ea. w/	(3)#8	N/A	(1)#10
85	(1) 1"	ea. w/	(3)#4	N/A	(1)#8
255	(1) 2"	ea. w/	(3)-250kCM	N/A	(1)#4
840	(2) 3"	ea. w/	(3)-800kCM	N/A	(1)#10

- NOTES:
- CONDUIT SIZES ARE FOR EMT CONDUIT AND THHN, THWN INSULATED COPPER CONDUCTORS WITH MAXIMUM 40% FILL. CONTRACTOR SHALL ADJUST CONDUIT SIZE AS REQUIRED PER NEC APPENDIX C, CONDUIT FILL TABLES FOR ALL OTHER CONDUIT AND INSULATION TYPES.
  - REFER TO SPECIFICATIONS FOR ADDITIONAL CONDUIT APPLICATION AND INSTALLATION REQUIREMENTS.
  - PROVIDE LUGS AS REQUIRED FOR FEEDERS INDICATED



**ONE-LINE DIAGRAM - NEW WORK**  
 SCALE: NOT TO SCALE

**ADD ALT. #1 KEYED NOTES:** (APPLIES TO THIS SHEET)

- PROVIDE A NEW POWERLOGIC POWER-MONITORING UNIT EM3500 SERIES DIN RAIL METER. POWER METER SHALL BE POWERED FROM MAIN CIRCUIT BREAKER. PROVIDE A 3/4" WITH PULL STRING BACK TO BUS
- PROVIDE A BREAKER FOR DISCONNECTING MEANS OF THE EXTERNAL METER.

**ADD ALT. #2 KEYED NOTES:** (APPLIES TO THIS SHEET)

- PROVIDE NEW VFD FOR AHU-3. VFD SHALL BE FURNISHED BY DIVISION 23 AND INSTALLED BY DIVISION 26.

**ADD ALT. #3 KEYED NOTES:** (APPLIES TO THIS SHEET)

- PROVIDE NEW VFD FOR AHU-3. VFD SHALL BE FURNISHED BY DIVISION 23 AND INSTALLED BY DIVISION 26.