SECTION 23 65 00

CLOSED CIRCUIT COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes factory assembled and tested, closed circuit mechanical induced-draft vertical discharge closed circuit cooler.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, performance curves with selected points indicated, furnished specialties, and accessories.

B. Shop Drawings: Complete set of manufacturer's prints of evaporative equipment assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.

C. Operation and Maintenance Data: Each unit to include, operation, and maintenance manual.

1.4 QUALITY ASSURANCE

A. Verification of Performance:

1. The thermal performance shall be certified by the Cooling Technology Institute in accordance with CTI Certification Standard STD-201. Lacking such certification, a field acceptance test shall be conducted within the warranty period in accordance with CTI Acceptance Test Code ATC-105, by a Certified CTI Thermal Testing Agency. The Evaporative Heat Rejection Equipment shall comply with the energy efficiency requirements of ASHRAE Standard 90.1.
2. Unit Sound Performance ratings shall be tested according to CTI ATC-128 standard. Sound ratings shall not exceed specified ratings.

B. Unit shall meet or exceed energy efficiency per ASHRAE 90.1

1.5 WARRANTY

A. Submit a written warranty executed by the manufacturer, agreeing to repair or replace components of the unit that fail in materials and workmanship within the specified warranty period.

1. Fan Motor/Drive System: Warranty Period shall be Five (5) years from date of unit shipment from Factory (fan motor(s), fan(s), bearings, mechanical support, sheaves, bushings and belt(s)).
2. The Entire Unit shall have a comprehensive one (1) year warranty against defects in materials and workmanship from startup, not to exceed eighteen (18) months from shipment of the unit.
3. Heat Transfer Coil: Warranty Period shall be One (1) year from date of unit shipment from Factory.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide closed circuit coolers manufactured by one of the following:

1. EVAPCO Model _____

2. Approved Substitute

2.2 THERMAL PERFORMANCE

A. Each unit shall be capable to cooling _____ GPM of water entering at _____°F leaving at _____°F at a design wet bulb of _____°F with a pressure drop across the coil(s) not to exceed _____psi.

B. Each unit shall be capable to cool _____ GPM of water entering at _____° F leaving at _____° F at an entering air dry bulb temperature of _____°F defined as the dry switch overtemperature, with the spray pump(s) de-energized, **no water consumption.** Pressure drop across the coil(s) not to exceed _____psi.

2.3 IBC COMPLIANCE

A. The unit structure shall be designed, analyzed, and constructed in accordance with the latest edition of International Building Code (IBC) for: $I_P$ = ___, $S_{DS}$ = ___, P = _____ psf.

2.4 COMPONENTS

A. Description: Factory assembled and tested, induced draft counter flow closed circuit cooler complete with fan, coil, louvers, accessories and rigging supports

B. Materials of Construction

1. All cold water basin components including vertical supports, air inlet louver frames and panels up to rigging seam shall be constructed of heavy gauge mill hot-dip galvanized steel.
2. Upper Casing, channels and angle supports shall be constructed of heavy gauge mill hot-dip galvanized steel. Fan cowl and guard shall be constructed of galvanized steel. All galvanized steel shall be coated with a minimum of 2.35 ounces of zinc per square foot of area (G-235 Hot-Dip Galvanized Steel designation). During fabrication, all galvanized steel panel edges shall be coated with a 95% pure zinc-rich compound.

C. Fan(s)

1. Fan(s) shall be high efficiency axial propeller type with aluminum wide chord blade construction. Each fan shall be dynamically balanced and installed in a closely fitted cowl with venturi air inlet for maximum fan efficiency.

D. Drift Eliminators

1. Drift eliminators shall be constructed entirely of Polyvinyl Chloride (PVC) in easily handled sections. Design shall incorporate three changes in air direction and limit the water carryover to a maximum of 0.001% of the recirculating water rate.

E. Water Distribution System

1. Spray nozzles shall be zero-maintenance precision molded ABS with large 1-1/4" diameter orifice threaded into branch piping with internal sludge ring to eliminate clogging. Spray header, branches, and riser shall be Schedule 40 Polyvinyl Chloride (PVC) for corrosion resistance.

F. Heat Transfer Media

1. Dry Heat transfer coil shall be constructed with 5/8" diameter Type 304L Stainless Steel tubes in a staggered arrangement. The tubing shall be roll formed, continuously welded and annealed. Tubes shall be expanded into continuous, enhanced 0.01" thick high grade aluminum fins. The fins shall have fully drawn collars completely covering the tubes for maximum heat transfer efficiency. Header connections shall be Schedule 40 Type 304L Stainless Steel. The tubular stainless steel headers are fitted with carbon steel coil connections for easy field piping. Tube sheet design shall eliminate sharp edges and minimize tube fatigue. Coil shall have a design pressure of 250 psi and shall be in compliance with ASME/ANSI B31.5, Refrigeration Piping and Heat Transfer Components. The coil assembly shall be strength tested in accordance with ASME/ANSI B31.5 and subsequently leak tested using air under water.
2. Heat transfer coil shall be elliptical tubes of prime surface steel, encased in steel framework with entire assembly hot-dip galvanized after fabrication. All coil rows shall feature extended surface fins design with sloping tubes for liquid drainage. Coil shall have design pressure of 300 psi and shall be in compliance with ANSI/ASME B31.5, Refrigeration Piping and Heat Transfer Components. The coil assembly shall be strength tested in accordance with ASNI/ASME B31.5 and subsequently leak tested using air under water.

G. Pump

1. Unit shall have EISA close-coupled centrifugal pump with mechanical seal. The pump shall be installed in a vertical position so that water will drain from the pump when the cold water basin is emptied. Pump motor shall be totally enclosed with protective canopy for outdoor operation.

H. Bleed-off

1. Unit shall have a waste water bleed line with a manual adjustable valve provided.

I. Air Inlet Louvers

1. The air inlet louver screens shall be constructed from UV inhibited polyvinyl chloride (PVC) and incorporate a framed interlocking design that allows for easy removal of louver screens for access to the entire basin area for maintenance. The louver screens shall have a minimum of two changes in air direction and shall be of a non-planar design to prevent splash-out and block direct sunlight & debris from entering the basin.

J. Electronic Water Level Control

1. Electronic water level control package shall have five (5) stainless steel water level sensors (one (1) high level, one (1) high level alarm, one (1) low level, one (1) low level alarm and one (1) ground) with a NEMA 4x enclosure mounted in a cleanable Schedule 40 PVC external standpipe with slow closing solenoid valve(s) and "y" strainer(s). Wiring is not included and components must be field mounted. Valves shall be sized for 25 psi minimum to 125 psi maximum pressure. Standpipe may require heat tracing by others in cold weather applications.

K. Pan Strainer

1. Pan Strainer(s) shall be all Type 304 Stainless Steel construction with large area removable perforated screens.

2.5 MOTORS AND DRIVES

A. General requirements for motors are specified in Division 23 Section “Motors”

B. Fan Motor

1. Fan motor(s) shall be totally enclosed, ball bearing type electric motor(s) suitable for moist air service. Motor(s) are Premium Efficient, Class F insulated, 1.15 service factor design. Inverter rated per NEMA MG1 Part 31.4.4.2 and suitable for variable torque applications and constant torque speed range with properly sized and adjusted variable frequency drives.
2. Fan motor(s) shall include strip-type space heaters with separate leads brought to the motor conduit box.

C. Fan Drive

1. The fan drive shall be multigroove, solid back V-belt type with QD tapered bushings designed for 150% of the motor nameplate power. The belt material shall be neoprene reinforced with polyester cord and specifically designed for evaporative equipment service. Fan sheave shall be aluminum alloy construction. Belt adjustment shall be accomplished from the exterior of the unit.

D. Fan Shaft

1. Fan shaft shall be solid, ground and polished steel. Exposed surface shall be coated with rust preventative.

E. Fan Shaft Bearings

1. Fan Shaft Bearings shall be heavy-duty, self-aligning ball type bearings with extended lubrication lines to grease fittings located on access door frame. Bearings shall be designed for a minimum L-10 life of 100,000 hours.

2.6 MAINTENANCE ACCESS

A. Fan Section

1. Access door shall be hinged and located in the fan section for fan drive and water distribution system access. Swing away motor cover shall be hinged for motor access.

B. Basin Section

1. Framed removable louver panels shall be on all four (4) sides of the unit for pan and sump access.

C. Internal Working Platform

1. Internal working platform shall provide easy access to complete water distribution

system. The coil surface shall be an acceptable means of accessing these components.

2.7 ACCESSORIES A. Basin

Heater Package

1. Cold water basin shall be fitted with copper element, electric immersion heater(s) with a separate thermostat and low water protection device. Heaters shall be selected to maintain +40° F pan water at 0° F ambient temperature.
2. Electric immersion heater package shall include a factory-supplied NEMA 4x enclosure containing a magnetic contactor with 120 VAC control circuit, transformer, and main power disconnect. Control package wired by others.

PART 3 - Water and Energy Conservation Control System For The Closed Circuit Cooler

Part 1 – General A.

Scope

1. The Closed Circuit Cooler Manufacturer shall furnish an industrial control panel for use with the specified closed circuit cooler.
2. Terminology
    a. HMI – Human Machine Interface
    b. PLC – Programmable Logic Controller
    c. BAS – Building Automation System
    d. NCDC – National Climatic Data Center
    e. VFD – Variable Frequency Drive
    f. I/O – Input(s)/Output(s)
    g. SCCR – Short Circuit Current Rating
3. The Closed Circuit Cooler Manufacturer shall not be responsible for field wiring between the control panel and field devices, between control panels or between the control panel(s) and the Building Automation System (BAS) as indicated by the drawings.

B. Device Description

The closed circuit cooler control system shall control all motor driven and optional electrically operated equipment including (but not limited to) the fan motor(s), pump motor(s), basin heater(s), vibration switch(es), damper actuators, manufacturer supplied water treatment equipment, and manufacturer supplied electronic water level controller. The operation of all driven components shall be manually overridden for equipment startup or troubleshooting. The status of all equipment shall be clearly displayed on a 10 inch panel mounted Human Machine Interface (HMI) with a color touch screen display.

C. Submittals and Operations Manuals

1. Submittals shall include the following as a minimum:
    a. System design information sheet.
    b. Description of system operation.
    c. Control panel drawing with list of operator interfaces.
    d. Electrical power and control-wiring diagram
    e. Name and address of factory trained Service Company.
    f. A predictive energy and/or water usage analysis based on 5 year NCDC weather data and applicable load profile.
2. Submittals, which are not job specific and designed to meet the requirements of this section, shall not be acceptable.
3. Provide an electronic copy of the submittal to the consulting engineer for approval.
4. Provide an electronic copy of the Operation and Maintenance Manual prior to system start-up.

D. Electrical

1. General
    a. No wire splicing shall be permitted in cable ducts or anywhere in a panel except on identified terminal blocks.

b. Wiring shall be landed to individual terminals, as indicated on the drawings.

c. Wires shall be labeled at each end for identification as shown on the drawings using wraparound laminated-type markers.

d. Each branch circuit in the control panel shall be individually protected with either fuses or circuit breakers.

2. Wiring (Field Required)

a. Refer to Manufacturers drawings and contract documents for all required field wiring.

b. All discrete control wiring shall be a minimum of #14 AWG, 600 V minimum insulation and 75°C minimum temperature rating.

c. All signal wires (i.e. 4-20 mA) shall be #18 AWG stranded copper, shielded, twisted pair unless otherwise specified.

d. All 120 VAC and 480 VAC wiring shall be run in separate conduits from 24 VAC, 4-20 mA and Ethernet wiring, with a minimum spacing of 6 inches. Conduit runs of different voltages shall cross each other at right angles to avoid electrical noise interference.

e. All wiring shall have the same ground reference for all connected control panels.

f. VFD rated cables shall be used between the VFD in the control panel and the corresponding motor.

g. Motor leads shall be connected using approved mechanical fasteners.

h. Analog and signal wires (i.e. 4-20mA) shall be shielded individually and only grounded on the panel side.

i. A CAT5 Ethernet cable with internet connection shall be provided (by others) to the Remote Access Device.

Part 2 – Products

A. General Description

1. Closed Circuit Cooler Control System shall be provided by the Closed Circuit Cooler Manufacturer.

2. Closed Circuit Cooler Control System design and performance shall meet requirements specified on the attached datasheet

B. Design Requirements

1. The control panel manufacturer shall be listed by Underwriters Laboratories as an approved manufacturer of industrial control panels. Use of commercial grade controllers from the building automation contractor shall not be acceptable.

2. The control panel enclosure shall meet NEMA 4x requirements and include control cabinet heating and cooling to regulate enclosure temperature and humidity.

3. The closed circuit cooler control system shall have a Short Circuit Current Rating (SCCR) of 65 kA at 460 VAC.

4. Control Panel shall include the following equipment:

a. Modbus over RS-485, 2-wire connection for Building Automation System (BAS)

b. Programmable Logic Controller (PLC) with 15 percent spare I/O terminals

c. Fluid Inlet Temperature Sensor(s) [1 per cell. Refer to contract documents for quantity and location] - Field Installed

d. Fluid Outlet Temperature Sensor(s) [1 per coil outlet connection. Multiple cell and multiple unit configurations require an addition outlet sensor for common outlet temperature. Refer to contract documents for quantity and location] - Field Installed

e. Basin Temperature Sensor(s) [1 per basin. Refer to contract documents for quantity and location] – Field Installed

f. Ambient Dry Bulb Sensor(s) [1 per unit. Refer to contract documents for quantity and location]- Field Installed

g. Variable Frequency Drive (VFD) for each Fan Motor

h. Recirculating Pump Motor Starter(s)

i. Main Circuit Breaker Disconnect
j. DC Power Supply For The PLC And Instrumentation
k. Heater Package Controls with Contactor(s) and Overload Protection
l. Control Power Transformer
m. 5- Probe Electronic Water Level Control (EWLC) Package
n. High Basin Water Level Alarm Contact(s)
o. Low Basin Water Level Alarm Contact(s)
p. Fan Motor: Space Heater Control(s)
q. Relays, Fuses and Circuit Breakers for All Unit Equipment
r. Enclosure Heating Controlled by Thermostat
s. Enclosure Humidity Controlled by Hygrometer
t. Enclosure Air Conditioner Controlled by Integrated Thermostat
u. Ethernet Switch To Connect PLC, HMI and VFD(s)
v. 10” Human Machine Interface (HMI) color touch screen display
w. Remote Access Device

5. The following controls shall be included for optional accessories when provided with the Closed Circuit Cooler:
   a. Discharge Hood Damper Controls
   b. Vibration Switch Controls
6. Control panel shall include the following programming features:
   a. Ability to remotely enable/disable make-up valve for extended dry operation
   b. Power failure recovery timer with ability to restart at previous mode of operation
      1) The control system shall restart the unit to the previous unit mode of operation if the duration of a power outage is less than the user defined period of time. If the power outage duration is longer than the user defined period, the control system shall initiate the unit sequence of operation.
   c. Ability to perform fan and pump motor(s) bump testing
   d. Visual I/O status display of all components and accessories
   e. Backup of both user and factory settings
   f. Pump run time counter
   g. Fan motor run time counter
   h. Automatic or manual initiation of louver de-icing sequence
   i. Cycle Pumps routine to ensure all basin water pumps operate at least once per day when basin is full of water, to ensure adequate water treatment.
   j. Water Treatment Enable/Disable for each cell (when provided by manufacturer)
   k. Louver de-icing sequence (manually and automatically enabled)
      1) In the manual louver de-icing mode, the fan shall be operated in reverse direction at half speed for a user defined period of time.
      2) In the automatic louver de-icing mode, the user shall be able to pre-program the duration of the sequence as well as the basin water temperature in which the louver de-icing sequence begins.

C. The PLC shall provide the following values to the Building Automation System:
   1. Basin Heater Control Temperature Set Point
   2. Louver De-icing Sequence Start Temperature
   3. Duration Between De-icing Sequence
   4. Process Return Water Temperature
   5. Process Supply Water Temperature

6. Average Supply Water Temperature
7. Ambient Air Temperature
8. Basin Water Temperature
9. Pump Run Time Hours
10. Make-up Water Meter (Provided By Others)
11. Drain Water Meter (Provided By Others)
12. Conductivity (Provided By Others)
13. Active Temperature Set Point Control (HMI or BAS Control)
14. PLC Mode Of Operation (Manual or Auto)
15. Cycle Pump(s)- Time Left
16. Hot Start- Time Left
17. Louver De-icing Sequence- Time Left
18. Louver De-icing Sequence- Time Left To Begin Sequence
19. Pump Locked On - Time Left
20. VFD Speed
21. Fan Run Time(s)

D. The PLC shall provide the following indicators to the BAS:
1. Local Or Remote Temperature Setpoints
2. System Enable
3. Unit Mode of Operation
4. Make-up Solenoid (Off/On)
5. Pump Status (on/off)
6. Pump Locked On (Locked On/Unlocked)
7. Basin Heater(s)
8. Discharge Damper Actuator(s)
9. Damper Limit Switch(es) (Open/Closed)
10. Louver Deicing Sequence (Active/Non-Active)
11. Cycle Pump(s) Routine (Active/Non-Active)
12. Hot Start (Active/Non-Active)
13. VFD Running (off/on)
14. Fan Motor Space Heaters
15. Real Time Clock Low Battery Alarm
16. Heater Low Water Alarm
17. Heater Contactor Alarm
18. Pump Contactor Fault Alarm
19. Pump Overcurrent Alarm
20. High Basin Water Alarm
21. Low Basin Water Level Alarm
22. Low Basin Water Temperature Alarm
23. High Process Return Water Temperature Alarm
24. Low Process Return Water Temperature Alarm
25. High Ambient Temperature Alarm
26. Low Ambient Temperature Alarm

27. Low Process Return Water Temperature Alarm
28. VFD Fault Alarm
29. Damper Limit Switch Alarm(s)
30. Fan Vibration Alarm(s)
31. High Enclosure Temperature Alarm

E. The PLC shall provide the following values with remote modification to the BAS
1. Building Automation System (BAS) Temperature Set point
2. High Process Return Water Temperature Alarm Set Point
3. Low Process Return Water Temperature Alarm Set Point
4. Process Supply High Water Temperature Alarm Set Point
5. Process Supply Low Water Temperature Alarm Set Point
6. Ambient High Temperature Alarm Set Point
7. Ambient Low Temperature Alarm Set Point
8. Low Basin Water Temperature Alarm Set Point

F. The PLC shall provide the following indicators with remote modification to the BAS
1. Unit Priority (Water Savings or Energy Savings)
2. Building Automation System (BAS) Start/Stop
3. Pump Run Time Reset
4. Make-Up Water Meter Reset (Provided By Others)
5. Drain Water Meter Reset (Provided By Others)
6. Fan Run Time Reset
7. Acknowledge Alarms
8. Make-up Disable (Enabled/Disabled)

G. Circuit Breaker Disconnect

Molded case circuit breaker disconnect shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics and shall be adequately sized for all loads present in the panel enclosure. Circuit breaker shall be UL 489 Listed, CSA, IEC certified/rated and CE marked for global acceptance.

H. Branch Circuit Protection
1. All branch circuits shall be protected by circuit breakers or fuses.
a. Fuse holders shall be finger safe.

I. Pump Starters

All pump starters shall be full-voltage, non-reversing and contain a UL label. The contactor coil shall be 120 VAC, 60 Hz. Motor protector shall have an adjustable range for the current limit trip point.

J. Variable Frequency Drives (VFD)

Each fan motor shall have its own Variable Frequency Drive (VFD). The VFD shall be controlled by a PLC to automatically adjust the fan speed to maintain the desired process supply water temperature. The VFD shall provide alarm indication to the PLC. The VFD direction shall be dictated by the PLC and will be controlled during operation. VFD shall meet the following:
a. Logic Control Ride Through: 0.5 seconds Minimum, 2 seconds Typical
b. Overload Current: 110% for 60 seconds and 150% for 3 seconds
c. Efficiency: 97.5% Typical

K. Relays

1. Relays shall be of the plug-in base or terminal block type with integral LED indicator light. Relays shall be rated for continuous duty operation. The relays shall have gold plated contacts for corrosion resistance and reliable switching of low energy loads.

L. Alarms

1. High and low water level alarm outputs shall be included with the water level control package. Alarm outputs shall automatically reset once the water level returns to normal operating conditions.
2. Real Time Clock Low Battery Alarm
3. High and low process fluid, basin and ambient temperature alarms outputs shall be included. Alarm outputs shall automatically reset once the process fluid temperature returns to normal operating conditions.
4. Alarm settings are to be operator adjustable via the HMI or through the Building Automation System. Alarms shall be enabled or disabled via the HMI or over the Building Automation System.
5. Alarms shall remain active until condition returns to design operating range. Upon alarm deactivation, alarms shall be stored as part of the alarm history log.
6. The following list of alarms shall be monitored as part of the closed circuit cooler control system:
    a. Heater Low Water Alarm
    b. Heater Contactor Alarm
    c. Pump Contactor Fault Alarm
    d. Pump Overcurrent Alarm
    e. High Basin Water Level Alarm
    f. Low Basin Water Level Alarm
    g. Low Basin Water Temperature Alarm
    h. High Process Supply Water Temperature Alarm
    i. Low Process Supply Water Temperature Alarm
    j. High Ambient Temperature Alarm
    k. Low Ambient Temperature Alarm
    l. High Process Return Water Temperature Alarm
    m. Low Process Return Water Temperature Alarm
    n. VFD Fault Alarm
    o. Damper Limit Switch Alarm(s)
    p. Fan Vibration Alarm(s)
    q. High Enclosure Temperature Alarm

M. Human Machine Interface (HMI)

1. The operator display shall be provided as a stand-alone component with a separate programmable logic controller for control. Use of a computer for the process control shall not be acceptable.
2. The HMI shall be provided with a weather-tight cover mounted on the door of a NEMA 4x enclosure so that it will maintain the enclosure's NEMA 4x rating.
3. The HMI shall include a 10" color display and a resistive touch screen rated for at least 1,000,000 touches.
4. The HMI shall be industrially rated and certified for the following conditions:
    a. Relative Humidity: 5 to 95% (Non-condensing)
    b. HMI shall be rated for 50,000 hours of life
    c. The HMI shall be industrially rated and certified for UL/CUL.

N. Remote Access Device

1. The Remote Access Device shall provide secure access between the PLC, HMI, VFD(s) and EVAPCO thru a private Virtual Private Network (VPN).
    a. A CAT5 Ethernet cable with internet connection shall be provided (by others) to the Remote Access Device.
2. The Remote Access Device shall require a hardwired Ethernet connection to the Internet, which can be connected or removed at the Customer's discretion.
3. The Remote Access Device shall allow the manufacturer to access the Ethernet connected control components via a cloud server on the Internet for program changes, modifications and troubleshooting if necessary.

O. Operation

1. The Closed Circuit Cooler Manufacturer shall furnish a description of the Sequence of Operation for the provided control system.
2. For all supported modes of operation, the panel shall utilize adaptive logic to allow for automatic adjustment between unit modes of operation based on real time system load and ambient temperature conditions.
3. Each cell shall be able to automatically switch between the following unit modes of operation based on the real time load, ambient conditions and temperature set point as well as the desired unit priority:
    a. Evaporative Mode – In Evaporative Mode, the Closed Circuit cooler shall operate with the basin water circulation pump(s) energized and the fan motor(s) running. The fan speed shall be modulated based on real time load and ambient conditions for maximum energy efficiency.
    b. Dry Mode – In Dry Mode, the Closed Circuit Cooler shall operate with the basin water circulation pump(s) de-energized and the fan motor(s) running. The fan speed shall be modulated based on real time load and ambient conditions for maximum water and energy efficiency.
4. The unit shall be capable of prioritizing between a water savings priority and an energy savings priority based on user preference.
    a. Water Savings Priority – In the Water Savings Priority, while ensuring the desired process supply water temperature is achieved, the control system shall be able to modulate between the various unit modes of operation in the most water efficient manner possible. This shall consist of (but not be limited to) de-energizing the unit spray pump(s) and adjusting fan motor(s) speed at the system load and or ambient conditions change.
    b. Energy Savings Priority – In the Energy Savings Priority, while ensuring the desired process supply water temperature is achieved, the control system shall modulate between the various modes of operation in the most energy efficient manner possible. This shall consist of (but not be limited to) de-energizing the unit spray pump(s) and adjusting fan motor(s) speed as the system load and or ambient conditions change. The PLC shall be capable of evaluating the fan motor(s) power at various speeds as well evaluating the basin water spray pump(s) power and determine when it is more energy efficient to de-energize the spray pump(s) and increase the fan motor(s) speed.

P. Network Capabilities

The Programmable Logic Controller (PLC) shall include a MODBUS over RS-485, 2-wire connection to a Building Automation System (BAS).

3.3 Installation

A. All wiring to the control panel shall be installed by a licensed electrician. The National Electrical Code and all applicable state and local codes shall be followed when installing this equipment. Power, control and sensor field wiring between the control panel and the closed circuit cooler must be provided by others.

B. Control panel enclosure mounting brackets/stand may be necessary (by others). Refer to manufacturer's panel enclosure drawing to ensure adequate clearance around the enclosure.

C. Factory trained technician shall be on-site for Manufacturer's supplied control panel start-up and commissioning. These services include panel start-up, PLC tuning, BAS integration and owner training. Support shall consist of up to two separate trips. Each trip shall consist of up to two consecutive, 8 hour work days.

3.4 Testing/Commissioning

A. Factory Testing

1. All inputs and outputs to the PLC shall be tested for proper function at the point of field wiring.
2. The PLC and HMI programs shall be tested and setup to the customer’s specific job.
3. VFD(s) shall be programmed and tested for proper operation.
4. If multiple control panels are provided for the same project, all control panels shall be temporarily wired together and tested as a system and not individually.
5. User and Factory Backups shall be saved prior to shipping.

B. On-Site Commissioning (By Manufacturer)

1. All VFD parameters shall be verified per the electrical drawings.
2. All field wiring between multiple control panels (if necessary) shall be verified according to best wiring practices.
3. All field wiring to remote sensors and devices shall be verified according to recommended wiring practices as detailed in manufacturer's wiring diagram.
4. Rotation of all motors shall be verified for correct direction.
5. Fan and pump motor(s) amperage shall be measured and confirmed to be within motor ratings.
6. Integration with Building Automation System (if necessary) shall be verified for correct operation and monitoring.
7. Job specific set points shall be programmed according to Customer’s requirements.
8. Proper operation between the Manufacturer's supplied control system and unit shall be verified.
9. Control system shall be “tuned” for the customer’s specific system.
10. Connection to the Manufacturer's remote access device shall be verified.
11. Ethernet cabling between connected components shall be tested.

C. Field Wiring (By Others)

1. Refer to Manufacturer's electrical drawings for all required field wiring.
2. Electrical wiring best practices shall be followed
3. All discrete control wiring shall be a minimum of #14 AWG, 600 V minimum insulation and 75°C minimum temperature rating.
4. All signal wires (i.e. 4-20 mA) shall be #18 AWG stranded copper, shielded, twisted pair unless otherwise specified.
5. All 120 VAC and 480 VAC wiring shall be run in separate conduits from 24 VAC, 4-20 mA and Ethernet wiring, with a minimum spacing of 6 inches. Conduit runs of different voltages shall cross each other at right angles to avoid electrical noise interference.
6. All field wiring shall have the same ground reference for all connected control panels.
7. VFD rated cables shall be used between the VFD in the control panel and the corresponding motor.
8. Motor leads shall be connected using approved mechanical fasteners.
9. Analog and signal wires (i.e. 4-20mA) shall be shielded individually and only grounded on the panel side.
10. A CAT5 Ethernet cable with internet connection shall be provided (by others) to the Remote Access Device.