**­Design Envelope 9521 Integrated   
Tower Control System**

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Typical Specifications

**Heat Rejection System Automation**

1. GENERAL
   1. SCOPE – HEAT REJECTION CONTROL SYSTEM DESCRIPTION

This specification applies to the automation of a cooling plant Heat Rejection system, that has \_\_ *(qty*) identical headered variable speed pumps, *{Select one of the following}* {\_\_(*qty*) identical cooling towers} *or* {\_\_(*qty*) fluid coolers} and their fans.

* + 1. The cooling plant automation system shall be supplied with all the hardware, software and programming required to control up to 5 cooling tower (or fluid cooler) fan variable speed drives, up to 5 cooling tower (or fluid cooler) isolation valves, up to 5 pumps (with options for single or dual pumps, 1 system by-pass valve and 1 system distribution load by-pass valve.
    2. The quantity of cooling tower (or fluid cooler) fans, pumps and valves shall be independently configurable (from 1 to the values in paragraph A) on-site at the graphic user interface by selection from pull down menus, without requiring reprogramming or software download. All schematics, tables and menus in the graphic user interface shall show only the data and graphics corresponding to the selected configuration.
    3. The Heat Rejection control system shall be supplied with all the hardware, software and programming required to be seamlessly integrated with the reporting and remote read-write capabilities of the building automation system (BAS). The control system shall allow field adjustments of control parameters as described below.
    4. To be quoted as a separate additional price: Preventative maintenance and service shall be available directly from the manufacturer. This service should include inspection and review of key components, assessment of operation conditions, control system tuning, software upgrades as they are released, back-up and secure storage of parameters and annual training for the Building Operators.
  1. RELATED SECTIONS
     1. Section 25 50 00 Integrated Automation Facility Controls
     2. Section 23 20 00 - HVAC Piping and Pumps Plumbing Systems
     3. Section 23 09 00 – Instrumentation and Control for HVAC
     4. Section 23 65 00 – Cooling Towers
  2. STANDARDS REFERENCES AND QUALITY ASSURANCE
     1. The Heat Rejection Control System shall be assembled with components that conform to the latest edition of the following as applicable:
        1. ANSI – American National Standards Institute
        2. NEMA – National Electrical Manufacturers Association
        3. UL – Underwriters Laboratories
        4. CSA – Canadian Standards Association
        5. IEC - Degrees Of Protection Provided By Enclosures (IP Code)
        6. ASHRAE 90.1-[2013] - American Society of Heating, Refrigeration and Air-Conditioning Engineers – Energy Efficient Design of New Buildings
        7. ASHRAE 100 - American Society of Heating, Refrigeration and Air-Conditioning Engineers – Energy Efficient Design of Existent Buildings
        8. The Heat Rejection control system manufacturer must hold an ISO 9000 QA certification or approved equal.
  3. INSTALLATION AND CONTROL CONTRACTOR RESPONSIBILITIES
     1. The controls contractor is responsible for the following:
        1. Inspect interior and exterior and report any obvious damage or equipment shifting that may have taken place between the time the unit arrived on site and when in its final resting position
        2. Mechanical installation of the control package and mount in place. Re-align and level the control panels.
        3. Install all life safety equipment as needed
        4. All field electrical connections to the unit. Hook up electrical supply needed by the plant control system (including field sensors). Connect with the BAS and confirm that BAS is ready to send/receive commands to the control system. Provide internet connection to the automation system.
        5. Field connect equipment including temperature sensors and their associated wiring to the unit (a list of field installed equipment will be supplied, along with installation instructions). As required by device instructions, where necessary, calibrate all sensors and auto valves.
        6. Touch up and paint scratches and minor dents occurred during hoisting and rigging
        7. Permits and inspections needed to start up the system
        8. Start-up of system with the supervision of manufacturer personnel
  4. SUBMITTALS
     1. Provide a complete Heat Rejection Control System Submittal with all requirements as defined in the GENERAL requirements of these specifications. As a minimum, the Submittal shall include the following:
        1. Dimensional drawings of the main components, also indicating weight and any special hoisting or working space clearances requirements
        2. Description of system operation
        3. Electrical power and control wiring diagram
        4. Control layout drawing with sequence of operation
  5. Operation and maintenance manuals
     1. As a minimum, the Operation and Maintenance Manual shall include:
        1. System summary sheet
        2. Description of system operation, with equipment and control sequence of operation
        3. Electrical power and control wiring diagrams
        4. Installation and maintenance manuals from equipment manufacturers
        5. Snapshots of all graphic user interface screens, with description of all variables and recommended tuning values or tuning methods.
        6. Submittals and operation and maintenance manuals shall be assembled in a neat and orderly manner and bound in booklet form. Include a front page that identifies the job particulars followed by a table of contents.
  6. START-UP, COMMISSIONING, WARRANTY AND SERVICE
     1. The start-up and commissioning will be by a local Armstrong representative who is fully supported by Armstrong factory staff remotely.
     2. Warranty period: One (1) year parts and labor warranty (two years with warranty registration).

1. PRODUCT
   1. MANUFACTURERS
      1. Acceptable Manufacturer: The heat rejection control system shall be the Design Envelope ITC9521, by Armstrong Fluid Technology.
      2. Substitutions: Not permitted.
   2. HARDWARE
      1. HEAT REJECTION CONTROL SYSTEM and Associated Equipment
         1. The heat rejection control system shall be a stand-alone system capable of operating independently of the building automation system (BAS), and at the same time capable of receiving remote instructions from the BAS.
         2. The system automation shall be performed solely by the PLC and the PC shall not be required for plant operation, other than initial setup or configuration.
         3. The heat rejection control system shall include a combination of PC-based and PLC controller.
         4. The heat rejection control system shall have an internal circuit breaker and run on 100-240 VAC /1Ph/50-60Hz power supply.
            1. 10.4” back-lit touch screen LCD panel
            2. Operation temperature range: 0°C - 45°C (32°F-113°F) (must not be exposed to direct sunlight)
            3. Operation humidity range: (10% - 85%) non-condensing
            4. Ambient air temperature for storage: 0°C - 60°C (32°F-140°F)
            5. Power supply: AC 100-240V, 400 W
            6. *{select one of the following}* {UL mark, FCC compliant} or {CE mark, EN 61000-4-3 compliant}
         5. The control system shall have a key lockable {*select one of the following*} {NEMA 12} or {NEMA 4X} or {IP54} or {IP55} rated cabinet. All operator interface control switches, indicators and displays shall be physically separated from any field terminations. Manual backup control switches and indicators must be protected from unauthorized operation by a key lockable door.
         6. The control system shall have Hand-Off-Automatic (H-O-A) control for each pump and tower fan drive. These virtual H-O-A switches shall be accessible through the touch screen display, and in Hand mode, the control system shall allow the pump speed and the tower fan to be manually set and changed.
      2. SCREEN
         1. The heat rejection control system shall include a back-lit touch screen color display operator interface of at least 10.4” and show active-element schematic displays with links to sub-menus for status reports, data and setup menu options. Keypad based interfaces, LCD readouts, and LED displays will not be accepted. No data shall be lost during power supply interruptions.
         2. The control system shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have store in memory at least 50 faults and be able to recall them on the screen, on-screen help functions, and separate user screens for:
            1. Pump configuration (including factory default setup data)
            2. Cooling tower configuration (including factory default setup data)
            3. Sensors’ setup (including factory default setup data)
            4. Alarm history and event review
            5. Display of pump status, cooling tower or fluid cooler status and system status
            6. Best Efficiency Point speed setup (including factory default setup data)
            7. PID control parameters setup (including factory default setup data)
            8. BAS communication setup (including factory default setup data)
            9. System schematic(s) showing cooling towers, pumps and valves operating parameters and sensors readings
      3. INSTRUMENTATION
         1. The heat rejection control system shall provide the following remote mounted transmitters and sensors to be installed and wired back to the central plant control system by the installing contractor:
         2. All sensors shall be installed by the contractor as indicated in the shop drawings to modulate the heat rejection system.
         3. Temperature sensors shall be self-contained RTD type temperature transmitter with a temperature range of (-400 to 1076°F) (-240 to 580°C) for chilled water systems designed to meet NEMA-4X (IP66) construction. The temperature probe shall use a platinum, wire wound, sensing element in a 316SS sheath, spring loaded and inserted into a ½” NPT stainless steel thermo well. The thermo well shall penetrate one-half the pipe diameter. The two probes of the supply and return temperature sensors shall be matched pair. Sensors shall not be locally adjustable. The accuracy of the temperature sensor shall be 0.5% of span and shall be calibrated and traceable to NIST. The temperature transmitter shall receive its power input and send its current output, 4-20 mA, over the same pair of low voltage wires. Sensors shall be mounted such that effects of radiation from heating elements are minimized and rapid response to changing temperature is achieved. The stability of the transmitter/probe assembly shall be +/0.001% of span/100 Ohms of lead resistance. Wiring installed by the contractor between the control system and the transmitters shall be Belden 9320, 2-wire, shielded, twisted cable (or equivalent) and shall not be placed in conduit containing wiring for alternating current. Supply and return temperature sensor shall be field installed and wired by the contractor between the chillers and the bypass line.
         4. Outside Air Temperature and Humidity Sensors shall include an integral sun shield and be located north side of the building.
      4. SOFTWARE
         1. Capabilities: The heat rejection control system software shall be preprogrammed to perform, but will not be limited to, the following:
            1. Manual or automatic control system
            2. Schedule start/stop
            3. Duty cycling
            4. Automatic lock-out of malfunctioning equipment
            5. Backup sequences of control for any sensor failure
            6. Automatic temperature control
            7. Control sequences for single or dual pumps with options for duty/duty, duty/standby and lead/lag operation
            8. Optimized sequencing of the pumps
            9. Control sequences for Sensorless™ pump speed control options
            10. Scanning and alarm processing
            11. Graphic screen reporting
            12. Trend Logging
         2. User Friendliness: The heat rejection control system software shall be easy and intuitive to operate. Operators shall be able to perform the following operations after one day of training:
            1. View systems parameters
            2. Select relevant screens, systems and points
            3. Turn on and off controlled points manually
            4. Acknowledge alarms
            5. View and download logged trend data
            6. Receive, understand and respond to the notifications and recommendations of the diagnostics service
         3. Input/Output: A complete point schedule shall be provided detailing analogue and digital input and output point description, functions, types and any special requirements. The control system shall be capable of accepting and processing appropriate signals for the following dedicated terminal blocks:
            1. 1 digital inputs (DI) Remote start (through an external system; ex. BAS)
            2. 1 DI Emergency stop (Push button in the mechanical room)
            3. 1 DI Alarm silencer (Button or through external system)
            4. Up to 5 DI cooling tower inlet isolation valve open feedback
            5. Up to 5 DI cooling tower inlet isolation valve close feedback
            6. Up to 5 DI cooling tower outlet isolation valve open feedback
            7. Up to 5 DI cooling tower outlet isolation valve close feedback
            8. Up to 5 DI cooling tower onboard integrated recirculation pump running (For evaporative fluid cooler applications only)
            9. Up to 5 DI cooling tower sump low level switch
            10. Up to 5 DI cooling tower sump high level switch
            11. Up to 5 digital output (DO) cooling tower inlet isolation valve
            12. Up to 5 DO cooling tower outlet isolation valve
            13. Up to 5 DO to enable tower recirculation pump (For evaporative fluid cooler applications only)
            14. Up to 5 DO to enable water treatment (can also be used with enable auxiliary equipment via interposing relay)
            15. Up to 5 DO to enable freeze protection equipment
            16. 1 DO ITC system alarm (Signal for external system – ex. BAS)
            17. 1 DO general audible alarm (Signal for external system - ex. Horn or Siren)
            18. 1 DO to enable IPS4000 or PSPC Armstrong secondary loop controller (For secondary pumps enablement, where applicable)
            19. 1 analog inputs (AI) entering tower temperature (4-20 mA signal)
            20. 1 AI leaving tower temperature
            21. 1 AI outside air temperature
            22. 1 AI outdoor air humidity
            23. 1 AI distribution load bypass valve position feedback (0-10V DC signal)
            24. 1 AI tower bypass valve position feedback
            25. 1 analog output (AO) tower bypass valve position setpoint (0-10V DC signal)
            26. 1 AO distribution load bypass valve position setpoint (0-10V DC signal)
            27. 1 terminal block for power supply 100-240 Vac/1 phase/50-60 Hz
         4. Trending and Reporting Capabilities: The control system shall provide a data-logging feature with 1 year of data at 5 minutes intervals and shall be capable of displaying the alarm history on its graphical touch screen display. The data must be easily downloadable monthly in a csv format file.
         5. The heat rejection control system shall display live and trend data on demand. The control system shall provide graphic screens of system schematics.
         6. Communication Protocol: The heat rejection control system shall be able to communicate with the Building Automation System over one or more of the following protocols: Modbus RTU, Modbus TCP, BACnetTM MS/TP or BACnetTM IP.
         7. Remote Access: The heat rejection control system shall include webserver functionality and be accessible through an internet TCP/IP internet address with read/write functionality. This access shall allow the relevant staff to:
            1. Remotely view all screens available at the local graphic user interface (GUI), with the same functionality. I.e.: view plant status, view and modify parameters and set points, override equipment and navigate screens.
            2. View all available live and historic data
            3. Receive alarm messages, automatically processed and conveyed via the network.
            4. Upgrade the control system software from the remote stations. Such remote upgrading shall not interrupt the plant operation and shall not require local intervention, (like locking equipment in manual).
            5. BAS and Internet connection shall be provided by others, but the controls contractor installing the control system is responsible of requesting it and coordinating with the IT contractor.
            6. Remote manual override by the BAS shall be possible for the following equipment settings:

Control System ON/OFF

Plant Mechanical mode/Stand-by mode

* + - 1. Alarms: Alarms shall be generated and the alarm messages shall be displayed in clear textual form on the screen, until it is acknowledged by the operator. Alarms shall include but not limited to the following list:
         1. System sensor alarm
         2. General alarm
         3. Pumps run feedback, drive fault and communication alarms
         4. Entering and leaving tower water temperature transmitter alarms
         5. Outside air temperature& humidity transmitters alarms
         6. Bypass valves sensor and valve position alarms
         7. Tower fans run feedback, drive fault and communication alarms
         8. Cooling tower inlet isolation valve open and close feedback alarms
         9. Cooling tower outlet isolation valve open and close feedback alarms
         10. Cooling tower low and high level alarms
         11. Water treatment no feedback alarm
         12. Freeze protection no feedback alarm
         13. Critical and emergency stop alarms
         14. Tower onboard integrated circulator pump no run feedback detected alarm
      2. Safety Features shall include but not limited to the following list:
         1. Auto omission of pump in case of pump failure
         2. Backup sequences in case of temperature sensor failure.
         3. Indication of any Failure (or) malfunctioning in the touchscreen screen user interface, the remote access screens, in the BAS communication.
         4. Input for an emergency shutdown.
      3. Graphics shall be included for ease of system operation. Graphic screens shall include, but will not be limited to, the following:
         1. System schematic
      4. Access Security: The control system shall have at least three levels of password security: Level zero (view only), Level one modify all parameters visible on the HMI + and set equipment in Hand (Site Operator) and Level two (save defaults) through the screen only.
      5. Sequence of Operation:
         1. All control system settings, including the number of cooling towers and pumps can be modified at the graphic user interface (GUI) after entering the appropriate password.
         2. The control system shall enable the cooling plant locally or based on a signal input (ex: BAS) and optionally on schedule or on outside air temperature signal (if a sensor is available).
         3. When the control system is switched to manual operation mode (for commissioning), there is no automatic operation or sequencing of equipment. Operation of equipment can be manually set. When operation mode is switched back to auto, the automatic operation mode is restarted.
         4. The control system shall determine optimized pump speed by responding to load side demand with sensorless control within equipment upper and lower flow limits..
         5. It shall incorporate embedded logic to prevent hunting, pump flow surge, and motor overloading.
         6. The control system shall determine the most energy efficient combination of operation through Parallel Sensorless™ staging.
         7. It shall rotate the pumps based on a field adjustable interval of operating hours with a bump-less transfer algorithm.
         8. It shall lock out and place in alarm any VFD /pump unit that fails. In place of the failed assembly, the next available VFD/pump unit is operated. All alarms are auto-reset.
         9. The control system shall determine optimized tower fan speed based on load within a field adjustable range, utilizing leaving and entering temperature sensors.
         10. It shall operate the most efficient quantity of towers to maximize the heat transfer surface area against incremental fan and pump power for minimum flow constraints.
         11. The control system shall start auxiliary equipment via dry contact digital output for water treatment (UV biological or chemical treatment). Same dry contact signal shall be used to start basin sweepers, if applicable.
         12. Where applicable, the control system shall monitor ambient temperature and enable freeze protection equipment when necessary.
         13. With fluid cooler tower types, the control system shall enable the onboard integrated circulator pump of the operating fluid cooler.
         14. When necessary, the control system shall open the distribution load bypass valve to maintain the minimum flow required by the operating cooling towers.
         15. When necessary, the control system shall open the tower bypass valve to prevent low leaving temperature to be supplied to the distribution.
         16. System flow shall be obtained from pumps with sensorless reading capability.
         17. Automatic operation mode: When the control system is turned on, the heat rejection plant and all equipment in Auto are automatically started, sequenced and modulated entirely automatically to meet the current cooling load with optimum operating efficiency.
         18. Manual operation mode (for commissioning): When any piece of equipment in the control system is placed in manual, there is no automatic operation of that equipment. When operation mode is switched back to auto, the automatic operation mode is restarted.

1. EXECUTION
   1. ELECTRICAL WIRING AND INSTALLATION
      1. The wiring for data communication between sensors, control systems and valve actuator shall be shielded so as not to be susceptible to electrostatic, magnetic, mode and cross talk noise. Electrical wiring shall conform to the requirements of the electrical services section of the specifications and the local electrical code.
   2. TESTING
      1. Upon completion of all systems startup and checkout procedures and while the mechanical systems are being monitored and controlled in a “normal operating” condition, the manufacturer and the facility personnel shall jointly demonstrate the performance of the complete system to maintain flows, temperatures, levels and pressures for 7 days, with no alarms. The test must meet the particular building’s design requirements to be considered passed and acceptable. Any failures or alarms shall require the test to be restarted.
   3. CALIBRATION AND COMMISSIONING
      1. The heat rejection control system shall be commissioned and fully operational after delivery to the site at the practical date agreed with the building owner representative on-site. Commissioning procedure shall conform to the “Mechanical Services” section of these specifications.
      2. The calibration and commissioning procedure shall consist of validating field I/O calibration, loop checks, actuator stroking and integrated system operation validation. All commissioning information shall be documented on commissioning data sheet forms which shall be submitted to the commissioning agent, if available, or the facility personnel for approval prior to testing. Notify the facility personnel of the testing schedule so that operating personnel may observe calibration and commissioning.
   4. TRAINING
      1. The heat rejection control system manufacturer shall instruct the personnel of the facility in the operation of the control system. Drawings, operation and maintenance manuals are to be provided to the customer in a single binder, clearly indexed.

END OF THE SECTION

MINIMUM REQUIREMENTS TO OTHER SYSTEMS

PLANT DESIGN SPECIFICATIONS

The heat rejection system shall be a variable speed cooling plant with {*indicate the quantity*}, \_\_(*qty*) identical towers with variable speed fans and one drive per tower and \_\_(*qty*) identical variable speed pumps. The plant configuration shall provide {*select one of the following*} {headered distribution pumps and headered chiller} or {a headered {Tango} or {DualArm} or {single} pump}, 1 optional system decoupler lines with a 2-way bypass valve sized to prevent low leaving temperature supplied to the distribution and 1 optional system decoupler line with a 2-way bypass valve sized to provide the minimum flow required by one tower when the pump head is 40% (adjustable) of design head.

SYSTEM PUMPS SPECIFICATION

The pumps shall be Armstrong Design Envelope™ variable speed pumps sized to provide in total \_\_% of the plant design flow at their design head.   
{*Note: If there are two headered pumps sized for 100% of the design flow and one fails, the other one is capable of providing about 80% of the design flow over the same system curve, delivering about 95% of the design cooling energy. With 3 headered pumps, 2 can supply about 90% of the design flow, or 98% of the cooling energy*}

COOLING TOWER SPECIFICATIONS

The cooling tower shall include fans that will operate safely on variable frequency drive power supplies and all resonant operating frequencies shall be clearly communicated with the proposal for known supply frequency, rotational speed and or carrier frequency.

**The cooling tower shall be capable of operating with a flow turndown of 60% of full design flow or less without the use of orifices or reduction in air water surface area, by way of cooling tower pump flow/speed modulation. The cooling tower shall have a serial communication cable.**