ARMSTRONG

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IPC 9511

DESIGN
ENVELOPE

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Design Envelope
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Air cooled chilled water plant control system

Sequence of operation

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LIST OF ABBREVIATIONS:

ADJ: Field Adjustable
BAS: Building Automation System
HMI: Human Machine Interface

IPC 9511 CONTROL SYSTEM

The IPC 9511 has (1) control panel with the
following functionality:

- Operation of up to 5 pumps, single, dualArm or twin. Configuration can be headered or dedicated (only dedicated configuration is available for dualArm and twin pumps), and one pump can be selected as stand-by.
- Optional sensorless pump speed control.
- Control of up to 5 chillers.
- Monitoring of up to 5 zones.
- Communicates with IPC 3500 for IO and interface to pumps and chillers.
- Touch screen HMI with graphical displays of the system, trends and configuration with three levels of password protection.
- Option to control pumps, chillers and Chilled Water Setpoint from optimization module (OPTI-VISOR) for enhanced energy performance.
- BAS interface for Modbus RTU, Modbus TCP, BACnet MS/TP, BACnet IP or Lonworks.

OPERATION

All equipment must be set in **Auto** mode for the plant to work as described below. However, any individual equipment can be set to **Hand** or **Off** mode. Any equipment in **Hand** or **Off** mode is not operated by the automatic sequencing of the plant. Any pump placed in **Hand** mode starts immediately as long as the IPC is **On**. Any chiller placed in **Hand** mode immediately initiates its startup sequence (see point 3.2.3.5) as long as the IPC is **On**. Any isolation valve placed in **Hand** mode allows the operator to select its position: open or close. If any equipment or sensor malfunctions, an alarm is time stamped, logged in the HMI and made available to be read by the BAS.

1 GENERAL SEQUENCE

1.1   When the IPC 9511 control system is set to **Remote Start**, two conditions are required to turn **On** the control system: a command from the BAS (digital input or serial communication signal) and the IPC switch set to enable.

1.2   When the IPC 9511 control system is set to **Local Start**, the IPC will turn On as soon as the IPC switch is set to Enable.

1.3   On both conditions (Remote and Local start), the IPC turns Off when the IPC switch is set to Off.

1.4   Once the IPC is On, the plant is immediately enabled (Mechanical Mode) and remains enabled at least the time specified by plant minimum enable time (10 min adj.).

1.5   When the plant is enabled, the lead chiller begins its startup sequence which handles the required pump and valves.

1.6   Each chiller has an adjustable field to enter its capacity. The plant load (in tons and %) is displayed on the HMI. and used to Stage On and Off the chillers.

1.7   The plant is disabled if the difference between supply set point and return temperature indicates that there is no load.

1.8   Once the chillers are stopped, one pump continues to run to circulate water. The pump speed is determined to maintain the differential pressure or temperature of up to 5 zones at or above set point or by Sensorless™ control.

1.9.   The bypass valve regulates its position to maintain the flow above one chiller minimum flow.

1.10   If the Supply temperature climbs 1.5°F (adj.) over the Chilled water supply temperature set point (44°F adj.), the plant switches to the Mechanical mode.

1.11.   The operator is able to force the plant to be always enabled from the HMI.

1.12   The BAS is able to enable/disable the plant overriding the IPC 9511 logic.

1.13   The Chilled water set point can be determined by two options:

   1.13.1   Manually entered (44°F adj.) on the HMI (this is the default option).

   1.13.2   An external variable value if optimization control module is selected. This option is active when the optimization module is enabled.

1.14   Emergency shutdown: if a refrigerant leak is detected or if the Emergency Stop push button is pressed, stop all operating chillers and pumps immediately. An alarm is issued (**Refrigerant Leak alarm** or **Emergency Stop pressed**), and the IPC is locked out of operation until manually reset.

1.15   If any temperature sensor fails or the flow sensor fails, the current number of chillers running is maintained (no staging **On** nor **Off**) until the alarms are cleared.

1.16 To use ASHRAE 90.1 pressure reset, the most open cooling valve position must be available from the BAS. Pressure/temperature setpoints are adjusted to maintain this position at 95% open (adj). This option has to be enabled at the HMI.

2   CHILLED WATER PUMPS

2.1 The IPC can operate up to 5 pumps. Pump type can be single, dualArm or twin. Configuration can be headered or dedicated and, in the case of headered, 1 pump can be selected as stand-by. **Note:** DualArm and twin pumps can only operate in dedicated configuration.

2.2 The pumps are rotated periodically to balance their run hours.

2.3 Pumps in alarm are skipped by the sequencing logic and locked out of operation until manually reset.

2.4 Dual Arms are staged based on flow demand.

2.5 Pump speed is determined by Zone differential pressure, Sensorless mode or an External command (selected by the operator). In case of sensor fault, the speed is determined by safety constrains.

3   CHILLER OPERATION

3.1 The IPC can control up to 5 chillers.

3.2 Once the plant is in mechanical mode, the Lead chiller is enabled.

3.3 Lead chiller is rotated periodically.

3.4 Chillers in alarm are skipped by the sequencing logic and locked out of operation until manually reset.

3.5 The IPC stages **On** the chillers based on load, high supply temperature, high flow, high current and high kW.

3.6 The IPC stages **Off** the chillers based on load, low return temperature, low flow, low current or low kW.

3.7 Alternatively, if the user selects control from the optimizing module, the number of chillers to operate is determined by the module, overriding the IPC logic.

3.8 Before a chiller is staged **On**, to prevent freezing the running chillers, their capacity is reduced via their demand limit input or by reducing the primary flow.

3.8.1 After a chiller is staged **Off**, it is kept out of the sequencing and its status is changed to **Not Ready,** for a period of time specified by Minimum time between chiller restarts (5 min adj.). After this time elapses, the chiller status changes to **Ready** and it is incorporated into the sequencing.

3.9 After a chiller is staged **On** or **Off**, no more chillers are staged until the Time interval after chiller staging (10 min adj.) expires.

3.10 There is a chiller minimum run time (10 min adj.). **Note:** this timer takes priority over the plant disable logic from point 1.7.

3.11 The IPC maintains the minimum and maximum flow required for the number of chillers running at any given time.

3.12 If at any point during the chiller operation, the associated pump stops or goes into alarm, and there is no available pump to replace it, the chiller goes into a **Chiller No Flow Alarm**.

4   BYPASS VALVE

4.1 The bypass valve is controlled to maintain the minimum flow required by the running chillers.

4.2 If the flow meter fails, the bypass valve opens to 100%, until the alarm is reset.

5   HMI. INFORMATION TO BE DISPLAYED IS DIVIDED IN THREE CATEGORIES:

5.1 Operator screens

5.1.1 Source of control: Local or Remote

5.1.2 IPC Status: On/Off

5.1.3 System overview graphic. This display adjusts to the selected configuration (i.e. number of pumps, number of chillers, piping configuration, number of zones)

5.1.4 Plant enabled/disabled indicator

5.1.5 Chilled water temperature setpoint

5.1.6 Chilled water supply and return temperatures

5.1.7 Primary flow

5.1.8 Plant efficiency

5.1.9 Pump information: Running/Off/Alarm, Duty 1, Duty 2, Stand-by, etc.

5.1.10 Pump control: HOA switch, **Set as Duty 1** button

5.1.11 Pump VFD information: Speed, Amps, Power, Volts AC.

5.1.12 Chiller Information: Ready/Enabled/Started/Running/Shutdown/Alarm/Not Ready, Lead, Lag1, etc.

5.1.13 Chiller control: HOA switch, **Set as Lead** button

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5.1.14 Isolation valve status: Open/Close/Alarm, Hand/Auto (for a header system only)

5.1.15 Bypass valve status: Hand/Auto, percent opening

5.1.16 All enabled zones present value, setpoint and error. Indication of which one is the active zone

5.1.17 Pump and chiller hours of operation, as well as button to reset them

5.2 Alarm Screens

5.2.1 Alarms with time stamp

5.2.2 Alarm help

5.2.3 Alarm history

5.2.4 Diagnostic indicating status (OK or Bad) of PLC and communication

5.2.5 PLC Software and Firmware version

5.2.6 Alarm silencer button or digital input (from IPC3500) acknowledges alarms and silences horn

5.3 Setup screens. There are three levels of access:

5.3.1 Level 0. No password, allows view only access

5.3.2 Level 1. Operator use, allows changing the HOA mode of pumps and chillers and HA mode of valves. Allows changing Local and Remote, turning On and Off the IPS and reseting alarms.

5.3.3 Level 1. Allows operator use (as 5, 3, 2.) and modification of all parameters. Allows Restoring previously saved values (no saving)

5.3.4 Level 2. Allows operator use (as 5, 3, 2.) and modification of all parameters. Allows saving and restoring all parameters

5.4 Trends

5.4.1 Temperature sensors

5.4.2 Zone sensors

5.4.3 Load

5.4.4 Pump speed

5.4.5 Chiller & pump kW consumption

5.4.6 Plant efficiency

6 BAS

6.1. The IPC allows communication on any of the following protocols: Modbus RTU, BACnet MS/TP, BACnet IP, BACnet Ethernet and Lonworks.

6.2. The following points are available through all protocols:

6.2.1 Remote Start/Stop

6.2.2 IPC On/Off Status

6.2.3 Enable/Disable plant

6.2.4 Chilled water supply and return temperatures

6.2.5 Chilled water flow

6.2.6 Pump information: Running/Off/Alarm, HOA switch, Duty 1, Duty 2, Stand-by, etc.

6.2.7 Pump VFD information: Speed, Amps, Power, Volts AC, Head, Flow.

6.2.8 Chiller Information: Ready/Enabled/Running/Shutdown/Alarm/Not ready, HOA switch, Lead, Lag1, etc.

6.2.9 Isolation valve status: Open/Close/Alarm, Hand/Auto

6.2.10 Bypass valve status: Hand/Auto, percent opening

6.2.11 All zones present value, setpoint and error. If a zone is not enabled the error should show 999.9

6.2.12 Active Zone present value, setpoint and error

6.2.13 Pump and chiller hours of operation

6.2.14 Position of the cooling valve with the maximum opening

6.3 The IPC has the following Digital Outputs for BAS alarms (through IPC 3500):

6.3.1 Sensor Alarm (any sensor alarm)

6.3.2 General Alarm (any alarm in the IPC)