



BY JOHNSON CONTROLS



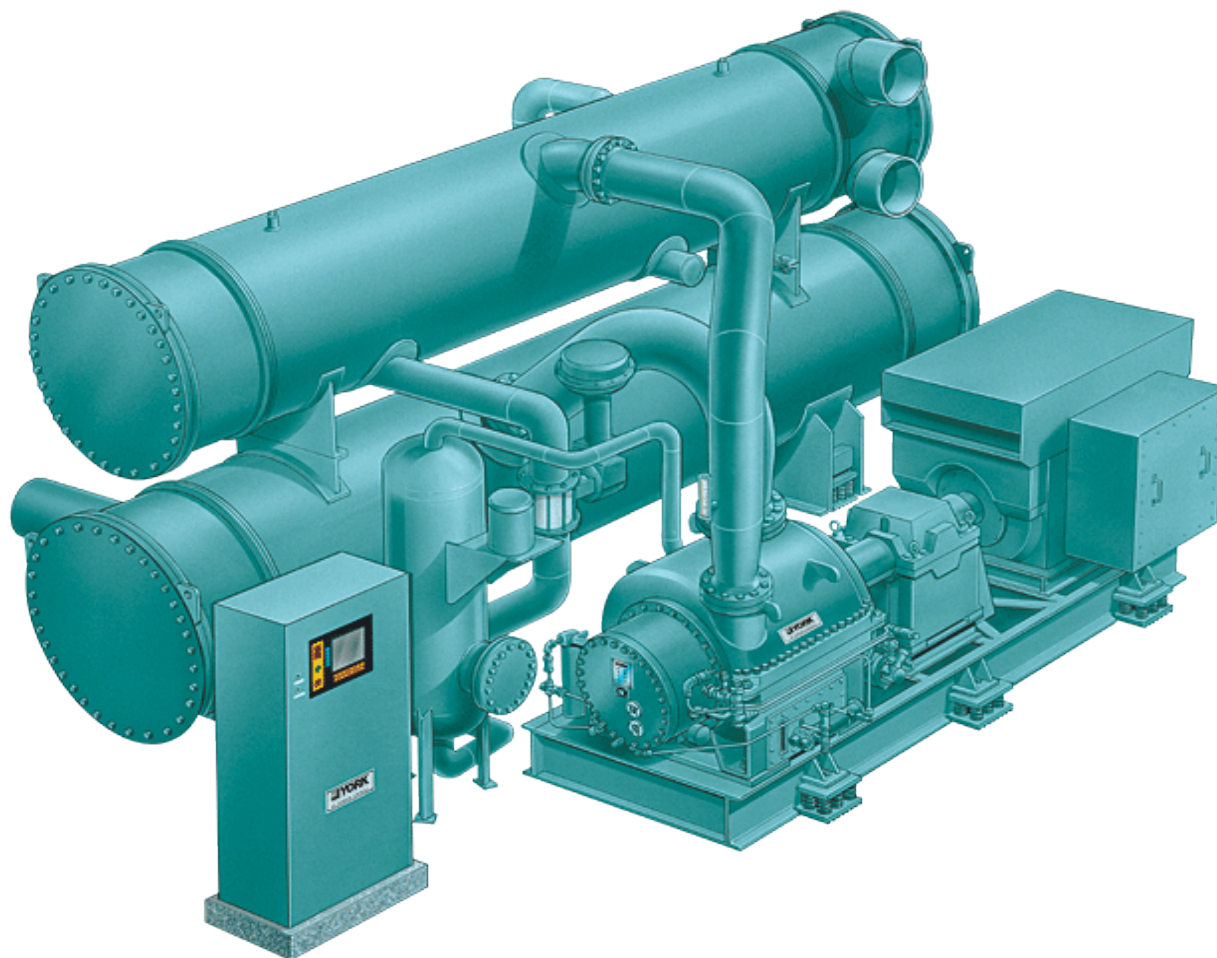
***Titan Open Multistage Electric Drive Chiller
Standard PLC Control Center***

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Equipment Overview

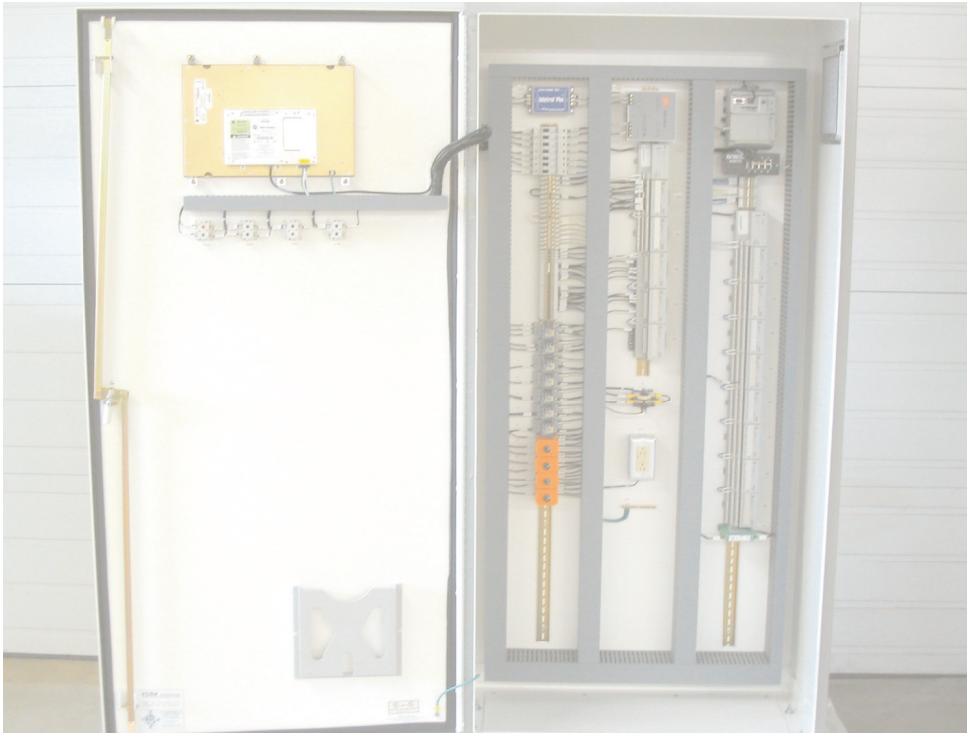


OVERVIEW

The standard TITAN chiller control system is based on an Allen-Bradley CompactLogix 1769-L35E programmable automation controller (PAC), with a Red Lion Controls model G315C230 color graphics display for operator interface. The control panel and field installed electro-pneumatic devices provide all necessary controls and control logic to provide manual operation, automatic operation, pneumatic capacity control and safety protection of the chiller unit.

Alarm annunciation is provided by alarm indicators, on the color TFT graphic screens. Also an alarm history screen is provided which shows the most recent alarms, with the time and date of occurrence. Trip status screens are provided which show the values of analog inputs at the time of the last five chiller safety shutdowns. The time and date of the shutdown are also recorded and shown.

Separate push buttons are provided on the face of the control panel for Chiller Start, Stop, Reset and Emergency Stop. All other functions are software controlled through the graphic operator interface.



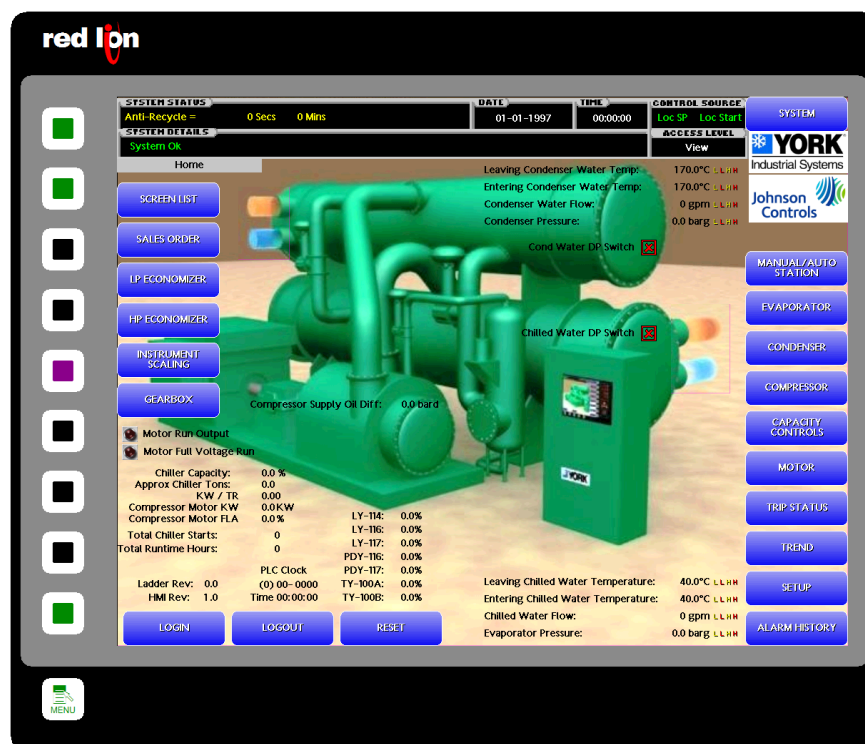
HARDWARE

All controls are arranged for easy access. Wiring is color coded black (120VAC control circuits), white (neutral), and green (ground). Wiring enclosed in shielded cables are color coded per the wiring diagram. External (field) wiring connections are made to clearly marked terminal strips and the Allen-Bradley Flex I/O terminal blocks. Removable plates are provided on the top and bottom of the enclosure for the field wiring conduit connections. The electrical installation contractor must determine the locations and size of the conduit connections. Control voltage internal panel wiring is done with MTW 16 AWG wire minimum. The panel will receive a 60 amp 120 volt 60 Hertz power supply from a 5.0 KVA transformer in the motor control center (MCC) for the oil heaters and controls. The pneumatic controls require 4-6 SCFM of clean dry filtered instrument air at 80 to 100 psig pressure, taken to a common point at the PRV actuator.

The control panel contains all necessary controls and control logic to provide stand-alone, automatic start-up, fail-safe fully automatic operation, PID capacity control and safety protection of the compressor, speed increaser, electric motor, evaporator and condenser. It also provides for automatic pre-lube and post-lube operation of the speed increaser gear and compressor auxiliary oil pumps (AOP), and operation of the AOPs during any low pressure lube condition. Controls are also included for automatic control of compressor capacity to limit maximum motor power consumption, manually adjustable 100 to 40% of chiller capacity.

All chiller operating values contained in the Input/Output list shown later in this section. All temperature and pressure displays are in English (or metric) units of measure. All points are electronically monitored from locally mounted RTDs with transmitters and pressure transducers.

The control console is factory (internally) wired in an upright front panel display style, NEMA 12 enclosure. The panel is fabricated of 10-gauge steel and includes a full height front access door. The panel enclosure is painted ANSI light gray on the outside, and gloss white on interior surfaces. Included is an Emergency Stop button bypassing all controls. It mounts on the front of the panel, together with the display. A separate, hard-wired condenser refrigerant high-pressure cutout, remotely mounted at the compressor, is provided in accordance with ANSI/ASHRAE Standard 15 Safety Code requirements.



GRAPHICS INTERFACE

The display features graphic animated display of the chiller, chiller subsystems and system parameters, allowing the presentation of several operating parameters at once.

READY TO START	Unit is ready to start in Local Mode
REMOTE START ENABLED	Unit is ready to start in Remote Mode
START / PRELUBE = XXX sec	Locally initiated start / Prelube cycle
REM START / PRELUBE = XXX sec	Remote initiated start / Prelube cycle
SYSTEM RUNNING	System Running
SYSTEM COASTDOWN = XXX sec	System stopping / Postlube cycle
SYSTEM TRIPPED	System Tripped Offline
ANTI-RECYCLE = XX:XX	Anti-recycle Countdown
Controlled Stop	Control Stop initiated
Remote Lockout	Remote mode selected / not confirmed
FAULT / ERROR	PLC processor is not responding

During startup, operation and shutdown, the system will display vital information available at any time. The locations of various chiller parameters are clearly marked and instructions for specific operation are provided on many of the screens.

The main status indicator bar at the top of the screen will display the SYSTEM STATUS with the following messages:

- On (engaged) and Off (disengaged) signals are represented by “LED” symbols. A red LED symbol indicates the unit is ON, and a grey LED symbol is OFF .
- Running Pumps are shown as RED, and pumps not running are shown as GREEN.

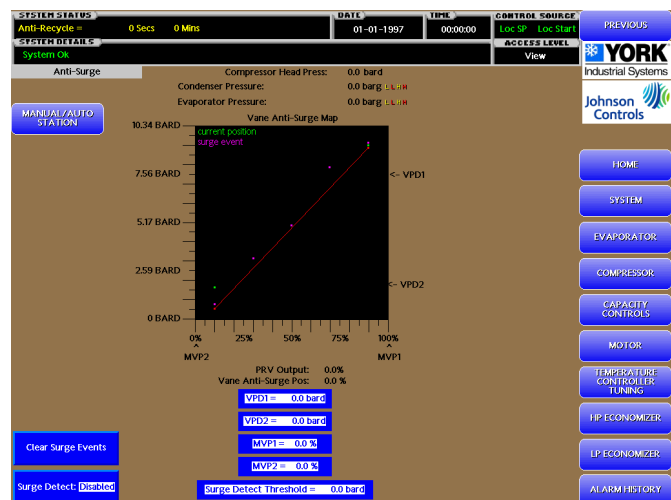
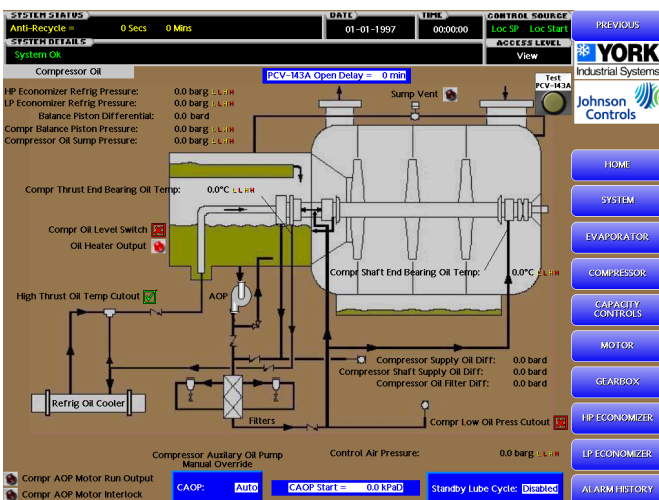
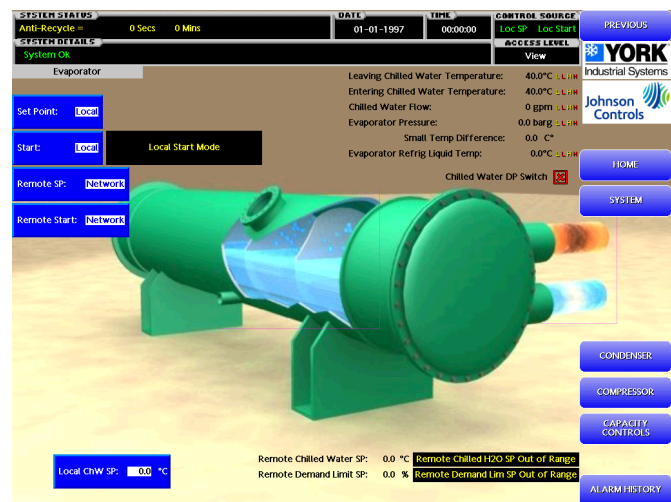
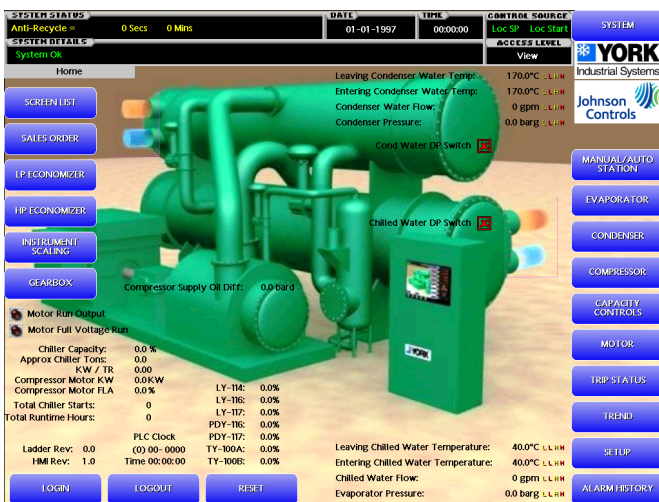
Panel - continued

- Pre-Trip Alarm (Yellow) and Trip (Red) indicators (other than described above) appear adjacent to the descriptive text of the measurement parameter whenever applicable.
- The measurement parameter text (_PSIG, _°F) changes to YELLOW blinking letters if the analog input signal goes out of range and will remain in this state until the RESET push button is pushed after the input signal returns to normal.
- The Pre-Trip Alarm indicator will automatically be reset if the abnormal condition progresses to the trip setpoint.

The Trip Alarm indicator will remain in the alarm state until the RESET push button is pressed after the conditions have returned to normal.

Graphical, animated screens provide a means of data display and service for various system components. Screens indicate all aspects of operation and sensor data pertaining to the particular component depicted.

At the top of each main screen is displayed the system status, present date and time, local or remote control source and system access level. Sub-screens may also be available for some system components, providing additional data access. Screens are selected by pressing the corresponding tabs on the sides of the display.



CAPACITY CONTROLS SYSTEM

The Capacity Controls of the Rockwell Logix 5000 based PAC control system allows efficient fully automated control, without need for operator intervention. This control system also monitors and displays all safety aspects of the chiller and provides alarms and a shutdown if safety limits are exceeded.

The Capacity Controls algorithm automatically seeks out the most efficient operation of the Titan chiller. The pre-rotation vanes are automated to obey the temperature controller to maintain Chilled Water production. In cases of low load, the pre-rotation vanes automatically throttle and are limited to a minimum anti-surge position, which is calculated from a head curve. To provide light duty operation, the hot gas recycle valve is opened or closed according to temperature demands. This keeps the centrifugal compressor out of surge and maintains cooling.

In cases of high load, which exceeds the motor kilowatt usage, the capacity controls algorithm automatically unloads the system to maintain a restriction on power consumption. In the same way, conditions of high discharge pressure or low suction pressure override the production of Chilled Water in the interests of keeping the chiller system online.

Optional compressor Variable Frequency drive is available for voltages between 4160v and 13.8kv. The integrated speed control routine also allows for three mode capacity control. With load changes the chiller varies the rotational speed allowing less energy to be consumed at low load and increases speed to meet peak demands. The speed control also benefits from anti-surge calculations to react to changes in system head.

If operator intervention is required, manual controls are provided on the Electronic Operator interface, for all I/P converters and auxiliary oil pumps.

CHILLER PLANT CONTROL SYSTEM INTERFACE

Virtual HMI

The Red Lion Controls G315 color graphic display can be accessed remotely over a LAN connection using a simple web browser. The remote virtual HMI in the web browser is exactly the same as standing in front of the control panel, without leaving the control room.

The Red Lion G315C230 model HMI has two LAN ports, one which is dedicated to remote virtual HMI, and remote IP networking.

AVAILABLE NETWORK PROTOCOLS

Plant Management/Control System Interface:

Ethernet I/P (Ethernet Industrial Protocol) is the preferred LAN (Local Area Network) between Local Chiller Control Panels. Ethernet I/P allows full management of the Allen-Bradley system from a central location.

All required analog and discrete data for communications will be arranged in blocks of IEEE Floating Point and 16-bit words within the Logix processor's data tables. All data is available remotely as read only values. The following writeable control signals are available: Remote Start, Remote Stop, Remote Leaving Chilled Water Setpoint, and Remote Demand Limit Setpoint.

TABLE 1 - AVAILABLE NETWORK PROTOCOLS

MEDIA	PROTOCOL
Cat-5 twisted pair	Ethernet Industrial Protocol www.ethernet-ip.org
RS-232	Allen-Bradley DF1 Full Duplex
RS-232	Modbus RTU Slave

Any protocol/media requirements not listed here must be called out on the factory order form.

Panel - continued

Available protocols will be implemented with additional hardware where applicable:

- Modbus RTU over RS-485
- Modbus over TCP/IP
- BACnet MS/TP
- BACnet/IP
- LONworks*
- Profibus**
- ControlNet
- Allen-Bradley DH-485

All communication interface wiring and hardware, which is required external to the chiller control panel, will be supplied and installed by the electrical installation contractor under another contract.

INSTALLATION REQUIREMENTS

Input Power Requirements

- Supply – 115VAC 5000VA (nominal), (60)HZ
- Internally Powered
- Analog Input – 4-20mA, 24VDC
- Analog Output – 4-20mA
- Digital Input – 120VAC
- Control Wiring – 120VAC, 300V, 90°C

Wire Requirements

- Supply – Insulated, stranded copper conductor 6 AWG, 300V, 90°C
- Analog Input – Shielded 2 conductor cable, 22 AWG, Belden 8761 or equivalent
- Analog Output – Shielded 2 conductor cable, Belden 8751 or equivalent
- Digital Input – Shielded 2 conductor cable, 22 AWG, Belden 8761 or equivalent
- Control Wiring – Insulated copper conductor 16 AWG, 300V 90°C

FIELD INSTALLED COMPONENTS

AMETEK Model 831T fixed range pressure transmitters are provided for points specified on the Input/Output List, and will be field installed near the process connection. Lockable stainless steel ball valves (Apollo 76-103-27) are included for each root connection.

Temperature sensors are National Basic Sensor (NBS), 3-wire, 100 ohm platinum RTDs with NBS temperature transmitters. Ranges are selected to cover all expected operating conditions, but are kept to a minimum to ensure best possible accuracy. Temperature sensors/transmitters are provided for the points specified on the Input/Output List. Bearing and oil temperature sensors are field installed locally on the drive train. Refrigerant and water temperature sensors are field installed.

The subcooler refrigerant liquid level transmitter will be a Hansen model YVLT.1 capacitance type sensor and is field installed in a connection on the lower side of the condenser.

The hardwired compressor oil high temperature switch will be ITT Neo-Dyn 100T3HC3. The hardwired compressor oil low differential pressure switch will be a ITT Neo-Dyn 160P46C3. These switches are field installed locally on the compressor.

The hardwired condenser refrigerant high-pressure switch will be a ITT Neo-Dyn 100P14C3. It is field installed without any intervening stop valve, as required by ASHRAE-15 safety code.

The hardwired evaporator water and condenser water low differential pressure switches will be ITT Neo-Dyn 160P42C3.

These switches are field installed locally near the water nozzles.

Brandt Model STD5131-6 Electro-Pneumatic Transducers with 4-20maDC input and 3-15 psi output will be provided for the compressor pre-rotation vanes, hot gas valve, and interstage valve. These devices are field installed near the controlled device.

Flow Transmitters for water will be provided by others if required. All calibrated instruments shall have traceable documentation.

TABLE 2 - INPUT/OUTPUT LIST

INPUTS			
Device Tag#	Description	Signal	Remarks
ANALOG INPUTS:			
FT-100	Chilled Water Flow rate	4-20 mA DC ^{1,6}	Flow Element & Transmitter by Others
FT-102	Condenser Water Flow rate	4-20 mA DC ^{1,6}	Flow Element & Transmitter by Others
JT-160	Motor Power (Kilowatts) 0-125% FL	4-20 mA DC ⁵	(Starter
LT-114	Subcooler Refrig. Liquid Level	4-20 mA DC	
LT-116	Flash Economizer (Intercooler) Refrig. Liquid Level	4-20 mA DC	
PT-111	Evaporator Refrigerant Pressure	4-20 mA DC	
PT-113	Condenser (Compr. Disch.) Pressure	4-20 mA DC	
PT-116	Flash Economizer (Intercooler) Refrigerant Pressure	4-20 mA DC	
PT-140	Compressor Supply Oil Pressure	4-20 mA DC	
PT-143	Compressor Sump Pressure	4-20 mA DC	
PT-144	Compressor Shaft Pump Oil Pressure	4-20 mA DC	
PT-146	Compressor Balance Piston Pressure	4-20 mA DC	
PT-150	Gear Supply Oil Pressure	4-20 mA DC	
PT-156	Gear Shaft Pump Oil Pressure	4-20 mA DC	
PT-180	Control Supply Air Pressure	4-20 mA DC	
TT-100	Chilled Water Out Temperature	4-20 mA DC	100 OHM RTD with Transmitter
TT-101	Chilled Water In Temperature	4-20 mA DC	100 OHM RTD with Transmitter
TT-102	Condenser Water In Temperature	4-20 mA DC	100 OHM RTD with Transmitter
TT-103	Condenser Water Out Temperature	4-20 mA DC	100 OHM RTD with Transmitter
TT-111	Evaporator Refrig. Liquid Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-113	Compressor Refrig. Discharge Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-114	Condenser Refrig. Liquid Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-120	Oil Separator Temp	4-20 mA DC	100 OHM RTD with Transmitter
TT-115	Subcooled Refrig. Liquid Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-142	Compressor Shaft End Brg. Oil Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-147	Compressor Thrust Brg. Oil Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-150	Gear Supply Oil Temperature	4-20 mA DC	100 OHM RTD with Transmitter
TT-151	Gear H.S. Shaft End Bearing Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-152	Gear H.S. Blind End Bearing Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-153	Gear L.S. Blind End Bearing Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-154	Gear L.S. Shaft End Bearing Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-161	Motor Shaft End Bearing Temp.	4-20 mA DC	100 OHM RTD with Transmitter
TT-162	Motor Blind End Bearing Temp.	4-20 mA DC	100 OHM RTD with Transmitter

Panel - continued

TABLE 2 - INPUT/OUTPUT LIST -CONT.

Device Tag#	Description	Signal	Remarks
DISCRETE INPUTS:			
M1R	Compr. Motor Starter "Run" Interlock	120 VAC	from starter
M2	Compr. AOP Starter Run Interlock	120 VAC	from starter
M3	Gear AOP Starter Run Interlock	120 VAC	from starter
MPDA	Starter Motor Protective Relay Trip	120 VAC	from starter
LSL-120	Oil Separator Low Level Switch	120 VAC	
LSL-143	Compressor Oil Sump Low Level Switch	120 VAC	
PSHH-113A	Cond. Refrig. High Press. Switch	120 VAC ²	
PDSLL-140A	Comp. Oil Low Diff. Press. Cutout	120 VAC ²	
PDSLL-101A	Chilled Water Low Diff. Flow Press. Sw.	120 VAC ²	
PDSLL-102A	Cond. Water Low Diff Flow Press. Sw.	120 VAC ²	
TSHH-147A	Comp. Thrust Bearing High Temp Sw.	120 VAC ²	
	Chiller Start Push-button	120 VAC	
	Chiller Stop Push-button	120 VAC	
	Emergency Stop Push-button	120 VAC ^{2,3}	
	Reset Push-button	120 VAC	

OUTPUTS:

ANALOG OUTPUTS:			
Device Tag #	Description	Signal	Remarks
LY-114	Subcooler Level Control Valve	4-20 ma	
LY-116	Flash Economizer (Intercooler) Level Control Valve	4-20 ma	
PDY-116	Interstage Control Valve	4-20 ma	
TY-100A	Compressor Pre-rotation Vanes	4-20 ma	
TY-100B	Hot Gas Bypass Control Valve	4-20 ma	
DISCRETE OUTPUTS:			
CR	Compressor Motor Starter Control Relay	120 VAC	Interposing relay in motor starter
FCV-105	Aux. Cooling Water Solenoid Valve	120 VAC	
FCV-114	Liquid Injection Solenoid Valve	120 VAC	
FCV-120	Oil Return (Jet Pump) Solenoid Valve	120 VAC	
M2	Comp. AOP Motor Starter Coil	120 VAC	
M3	Gear AOP Motor Starter Coil	120 VAC	
M5	Oil Separator Heater Contactor A	120 VAC	
M6	Oil Separator Heater Contactor B	120 VAC	
PCV-143B	Comp. Auto. Sump Vent Valve	120 VAC	
R1	Hardwired Trip Relay	120 VAC	
R2	Compressor Oil Heater Control Relay	120 VAC	
R3	Start-up Bypass Relay	120 VAC	
R4	Chilled Water Pump "Emergency" Start Relay	120 VAC ⁴	
	Chiller Run to DCS	Dry contact	
	Remote Alarm dry contact open on alarm	Dry contact	

FOOT NOTES:

- 1 Installation methods must comply with industry and manufacturer's requirements (particularly straight lengths up and downstream, coordinated pipe wall thickness).
- 2 This input will also be hardwired to trip the chiller independent of the Allen-Bradley PLC trip output.
- 3 An Emergency stop push button is provided on the front of the control panel which when pulled will stop the chiller, even in the event of a failure of the Allen-Bradley PLC output.
- 4 This contact output is energized by an evaporator low pressure condition. **The customer must establish chilled water flow through the chiller when this contact is closed to prevent tube freeze-up. It is recommended that this contact be hardwired into the chilled water pump motor starter control circuit.**
- 5 Isolated Input
6. Optional Input (not necessarily a control or safety point)

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