Installation, Operation, and Maintenance

Thermafit™ Modular Magnetic Bearing Water-Cooled Centrifugal Chiller

Model TACW

⚠ SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

August 2024

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TRANE TECHNOLOGIES

Introduction

Read this manual thoroughly before operating or servicing this unit.

Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

The three types of advisories are defined as follows:

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.
NOTICE	Indicates a situation that could result in equipment or property-damage only accidents.

Important Environmental Concerns

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants.

Important Responsible Refrigerant Practices

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified according to local rules. For the USA, the Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

⚠ WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury.

All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state/national electrical codes.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury.

Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/ sleeves, butyl gloves, safety glasses, hard hat/ bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

⚠ WARNING

Follow EHS Policies!

Failure to follow instructions below could result in death or serious injury.

- **All Trane personnel must follow the company's Environmental, Health and Safety (EHS) policies when performing work such as hot work, electrical, fall protection, lockout/tagout, refrigerant handling, etc. Where local regulations are more stringent than these policies, those regulations supersede these policies.**
- **Non-Trane personnel should always follow local regulations.**

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Revision History

- Updated maintenance schedule table headers in Maintenance Procedures chapter.
- Removed Thermafit™ TACW Schematics chapter.

Table of Contents

Model Number Descriptions

Digit 1 — Brand

T = Trane

Digit 2, 3, 4 — Model Series

ACW = Water-Cooled
ACC = Condenserless

Digit 5, 6, 7 — Condenser Type

085 = 65-90 Tons
110 = 80-115 Tons
125 = 90-135 Tons

Digit 8 — Compressor Quantity

A = 1

Digit 9, 10, 11 — Compressor Model

T30 = TT300
T35 = TT350
T40 = TT400

Digit 12 — Tube Passes (Evaporator)

1 = Single Pass
2 = Two Pass
3 = Three Pass
4 = Four Pass
5 = Five Pass
6 = Six Pass

Digit 13— Tube Passes (Condenser)

1 = Single Pass
2 = Two Pass
3 = Three Pass
4 = Four Pass
5 = Five Pass
6 = Six Pass

Model Number and Coding

When contacting Trane for technical support, customer service, or parts information, be prepared to provide the model number and serial number of the chiller modules in question. This information is located on the chiller nameplate that is affixed to each module.

Chiller Model and Serial Numbers

For future reference, record the model number, job number, and serial number for each module in the chiller system. See table below.

Refer to the Trane nameplate on each module in the installed unit for the serial number and model number

Table 1. Chiller reference data

Module	Job Number	Model Number	Serial Number
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

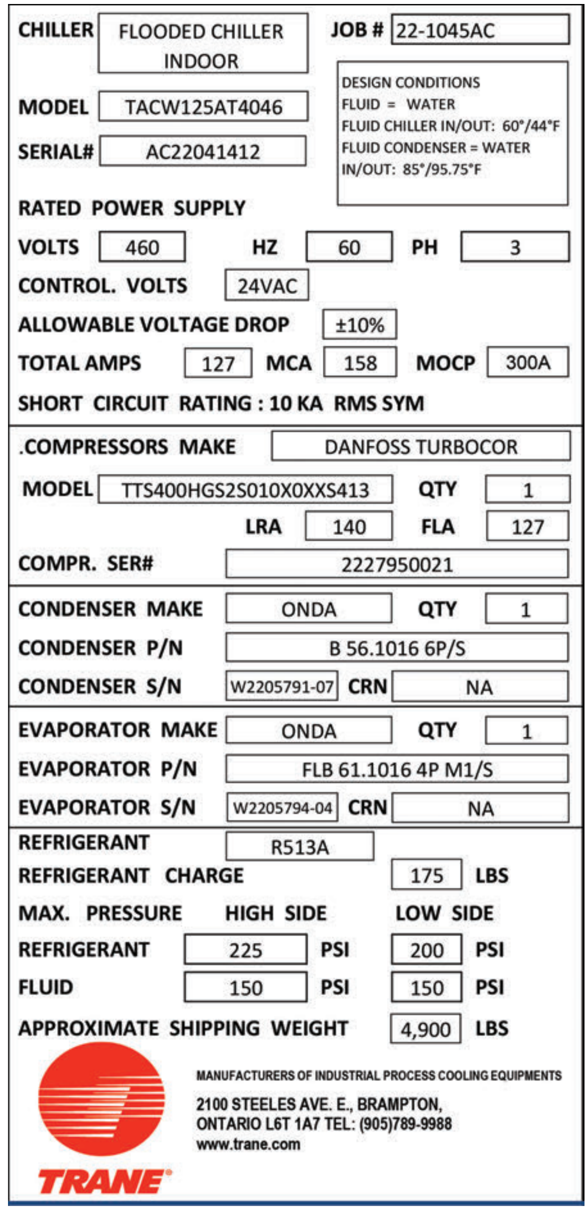
Model Number

Critical information for contacting Trane technical support. Reference to the actual chiller module serial number may also be beneficial. Each module has its own unique serial number.

Model Coding Key

Model numbers assigned to Trane systems provide a wealth of information about the features for a chiller's "as built" configuration.

Figure 1. Chiller nameplate



Chiller Description

Chiller Scope

This manual provides relevant data to properly operate, maintain, and troubleshoot the Trane Thermafit™ TACW. Operator and maintenance personnel must be a qualified refrigeration technician and have a working knowledge of high voltage systems, low voltage control circuits, and components and functions.

Chiller Capacities

The Thermafit™ TACW modular chillers utilize independent refrigeration circuits using Turbocor compressors and flooded shell and tube evaporators and condensers. They are available from 65-135 tons and up to 8 modules may connect together in a standard primary/ secondary control system. The system consists of a primary chiller module that contains the primary microprocessor controller, the power distribution panel, one or more secondary modules.

These chiller modules consist of an evaporator, condenser, twin-turbine centrifugal compressor, compressor controller, and interconnecting refrigerant piping. The chiller requires connection to the condenser and chilled water circuits, as well as the main electrical supply and control wiring.

The thermal capacity of these units is dependent on the leaving temperature of the chilled fluid, maintaining a minimum flow of fluid through the evaporator and keeping debris out of the system. In applications where it is desired to operate with a lower flow rate or higher temperature, consult the factory for recommendations.

Water quality must be monitored and maintained by a water treatment professional familiar with the materials of construction and operation of the equipment. The chiller modules arrive fully charged with refrigerant. As required under Federal regulations, installation, initial start-up, and technical servicing should only be performed by fully qualified personnel.

System Description

All Thermafit™ TACW modular chillers are designed with a very small approach to enhance the compressor performance resulting in an outstanding IPLV rating. Chiller modules are available in different configurations and with various standard options including different compressor models to customize these chillers to your specific applications.

Standard Features

- ETL and AHRI Certified
- 65 kA SCCR Rating
- One TT350 Danfoss Turbocor Variable Speed, Magnetic Bearing, Oil-Free Centrifugal Compressor
- Unprecedented Part-Load Performance, High Energy Efficiency, and Quiet Operation
- 5 percent Line Reactor per Compressor
- Mounted Fused Isolation Switch per Compressor
- Include On Off motorized isolation valve on evaporator and condenser
- Isolation Valves Located Around All Serviceable Components
- Dual Manifold Pressure Relief Valve
- Danfoss Turbocor MCX-20 Controller Complete with 10 inch Schneider HMI (Colored Monitor)
- Including a Web Server Allowing Remote Internet Monitoring, Remote Control, and Access to Operational Logs and Software Updates
- Bacnet/LonWorks/ModBus Included Standard
- Shell and Tube and Evaporator and Condenser
- ASME/CRN Certified Cleanable Flooded Shell and Tube Condenser, with Standard 150psi Design Pressure
- Standard Flow Switch Located at Evaporator and Condenser Hydronic Inlets
- An Electronic Expansion Valve per Circuit Providing Precise PLC Controlled Refrigerant Flow
- 3/4 inch (19mm) Closed-Cell Insulation
- First Year Parts and Labor Warranty

Chillers are leak and pressures tested at 200 psig at high side, 150 psig at low side, then evacuated and charged.

Self-contained chillers are equipped with a single source power source and integral hydronic piping.

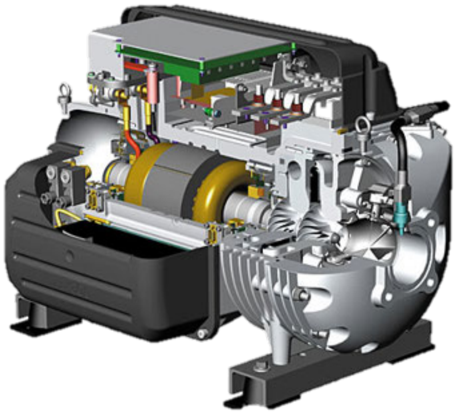
Unit panels, structural elements and control enclosure are constructed of heavy-gauge powder coated aluminum and mounted on sand blasted welded structural steel base and painted with two parts epoxy paint for weather protection.

Optional Features

- Header System including 4 headers and steel frame
- Evaporator/Condenser Waterbox Hinges
- Evaporator/Condenser 300 PSI Waterbox
- Epoxy Coated Condenser/Evaporator
- Full/Partial Knockdown
- Low Lift Pump
- Harmonic Filters
- Remote Monitoring
- Compressor Wraps
- Isolation Pads
- 1.5 inch Insulation

Component Specification

Compact Turbocor Compressor



- Exclusive design of compressor with floating magnetic bearings
- Variable speed compressor with integrated VFD
- High efficiency with oil-less operation
- Centrifugal design giving low kW/ton
- Excellent capacity control with variable speed and variable guide vanes
- Superior IPLV values resulting in high energy savings
- Sophisticated digital control/instrumentation of Danfoss Technology
- Smaller footprint
- Low noise level (less than 70 dBA)
- Lightweight

Flooded Shell and Tube Evaporator and Condenser

- Extremely compact design
- 225 PSI operating pressure
- Maximum material efficiency due to no “dead zone”
- Small hold up volume uses only fraction of heat transfer (refrigerant) medium
- Copper enhanced tubing and steel tube sheet construction
- Operates efficiently at even 1 K temperature difference
- True counter-current flow allows close temperature approach
- Liquid level sight glass
- Liquid level float switch
- Grooved fluid connection for quick disassembly for service

Refrigeration Components

- Complete internal refrigeration piping
- Suction and discharge service valves
- Discharge check valve
- Variable speed two stage Turbocor oil-free centrifugal compressor with internal guide vane
- Flooded evaporator and condenser
- Liquid line filter
- Motor cooling kits
- Relief valves

Electrical

- NEMA 4 rated wired and tested electrical enclosure
- Power block to facilitate single source power
- Circuit breakers for compressors
- Control transformer with primary and secondary fusing
- Touch screen for display and control
- Flow switch
- Interlock auxiliary contacts
- PLC control system

General Data

Table 2. General data - Thermafit TACW modular chiller

Capacity (Tons)	TACW085 (65 to 90)	TACW125 (90 to 135)
General Unit		
Number of Independent Refrigeration Circuits	Single	Single
R-134a Refrigerant Charge (lbs/module)	210	175
R-513A Refrigerant Charge (lbs/module)	210	175
Chilled Fluid Volume(gal/module) (w/headers)[a]	37.3	37.3
Condenser Fluid Volume (gal/module) (w/headers)[a]	42.6	42.6
Compressor		
Type	Centrifugal	Centrifugal
Quantity	1	1
Evaporator		
Type	Shell and Tube	Shell and Tube
Quantity	1	1
Fluid Volume (gal)	17.2	17.2
Material (tubes/shell)	Copper/Steel	Copper/Steel
Condenser		
Type	Shell and Tube	Shell and Tube
Quantity	1	1
Fluid Volume (gal)	22.5	22.5
Material (tubes/shell)	Copper/Steel	Copper/Steel

(a) Header sizes: for flow range up to 1400 gpm - 8-inch header size; for flow range 1400 gpm or higher - 10-inch header size.

Installation Mechanical

Inspect and Report Damage

Upon receipt, inventory the shipment against the Trane bill of lading to ensure all modules and components have been delivered.

Inspect each package in the shipment for visible damage. Verify the correct model number and that all skids and cartons have been delivered. Any damage must be reported to the motor carrier and Trane within five days of receipt of the shipment.

Inspect all exterior components for concealed damage as soon as possible. Do not proceed with the installation of damaged equipment without prior approval of Trane.

Do not refuse delivery of damaged goods without prior authorization. Unauthorized refusal of the shipment will result in a 20% restocking charge to the customer.

The ownership of the equipment is transferred to the consignee at point of shipment. Refusal of delivery may impede recovery of damages.

It is the consignee's responsibility to accept delivery of damaged goods unless permission to refuse delivery has been granted by Trane.

Inspection of Delivered Equipment

To report damage incurred in transit, complete the following:

1. Inspect each piece of equipment for visible damage before accepting delivery. Check for torn cartons, broken skids, bent metal and torn shrink wrap.
2. Ensure the delivery driver notes any damage on the bill of lading and completes a Carrier Inspection Report. Failure to comply may result in difficulties in resolving any claims for damage.
3. Inspect each piece of equipment for concealed damage before storage or as soon as possible after delivery.
4. In the event of suspected concealed damage, ask the driver to wait until you inspect the equipment. Concealed damage must be reported within five days of receipt of equipment.
5. If concealed damage is found, stop unpacking the shipment. Do not remove damaged material from the receiving location, take photos of the damage. The owner must provide reasonable evidence that the damage did not occur after delivery.
6. Notify the carrier of the damage as soon as possible. Request an immediate joint inspection by the carrier and consignee. A determination of responsibility will be made, and the carrier will authorize repairs in the event of admission of fault.
7. Notify your local Trane CSO immediately. Trane will coordinate repairs with the owner and carrier. Trane will coordinate repairs with the owner and carrier. Do not attempt to make repairs locally without permission.

Warranty Issues

Trane is not responsible for damages or for filing damage claims. It is the customer's responsibility to ensure that the necessary long term storage procedures have been completed and any deviations are reported to Trane immediately.

Long Term Storage Requirements

Appropriate preparation and storage of Trane chiller components during extended periods of dormancy is essential to ensure the equipment does not sustain damage or degradation due to inactivity and operates properly after installation.

The customer must notify Trane during the sales process that the chiller system may be transported by ocean freight or placed in long-term storage under any of these conditions:

- The chiller will not be placed into operation for a period exceeding six months after leaving the Trane factory. That is, the initial start-up date will not occur within a six-month maximum dormancy window.
- The chiller will be shipped using ocean transit for all or part of the delivery process.
- Cold temperature storage conditions fall below -20 °F (-29 °C).
- Ambient temperatures from 20 °F (-29 °C) to 145 °F (63 °C) with relative humidity from 0% to 100%.
- The glycol should be removed from the chiller if the unit is to be stored for extended periods.

Factory Preparation

Upon confirmation of an order requiring long-term storage or protection against extreme environments, Trane will inspect and protect vendor-supplied components before installation.

Prior to shipment, Trane will prepare each chiller system for long-term storage in coastal or tropical environments by:

- Placing silica gel packs in all electrical panels and variable speed drive panels to prevent corrosion of electrical contacts and moisture from degrading sensitive controllers.
- Shrink-wrapping each chiller using polyethylene film to limit environmental exposure and protect the chillers from damage during shipping.
- For multiple modular chiller system assemblies shipped on a common skid, shrink wrap the entire skid rather than the individual modules.

Trane will document and photograph the status of the unit prior to shipment and carry out the instructions detailed in the factory order regarding in-shop preparation of units for long-term storage.

Customer Responsibilities

Upon receipt of a chiller system, the customer must conduct thorough internal and external inspections, removing packaging material as needed for access to all components.

Visible damage must be noted on the signed and dated bill of lading. The customer may request a carrier inspection by telephone or in person, but any such request should be confirmed in writing. It is recommended that the customer request that the carrier inspect the damage within 72 hours of notification.

The customer must store the chiller system in a dry, non-corrosive, dust- and vibration-free environment due to the exposure sensitivities of the microprocessor controllers and to prevent electrical terminations from deteriorating from non-use. Conditions in storage locations should not fall below -20 °F (-29 °C) or exceed 150 °F (66 °C).

Components sealed in plastic shrink-wrap are not exempt from these storage requirements. Moisture can potentially collect inside the plastic film, resulting in corrosion of the cabinet and electronic components. Any chiller system packaging that is removed must be replaced with similar protective covering as soon as possible.

Failure to adhere to these long-term storage requirements may void the Trane warranty. Any component that is damaged or inoperable due to improper storage may have its warranty voided.

Handling of the Modules

The packaging from the factory permits lifting with a suitable crane. Ensure straps are in good working condition and that they are rated for the weight of the machines. Spreader bars may be required for effective rigging and to avoid damage to the chiller modules.

The chiller modules arrive fully charged with refrigerant. As required under Federal regulations, installation, start-up and service should be performed by fully qualified, factory-certified, personnel.

⚠ WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury.
All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state/national electrical codes.

⚠ WARNING

Electrical Shock, Explosion, or Arc Flash Hazard!

Failure to follow these instructions could result in death or serious injury.

- **Install the product in an appropriate electrical/ fire enclosure per local regulations. Do not install the product in hazardous or classified locations.**
- **Do not use the product for life or safety applications.**
- **Do not exceed the product ratings or maximum limits. Products rated only for basic insulation must be installed on insulated conductors.**
- **Current transformer secondaries (current mode) must be shorted or connected to a burden at all times.**
- **Remove all wire scraps, tools, replace all doors, covers and protective devices before powering the equipment.**

Site Preparation and Clearances

Chiller modules must be installed on a level surface that has been checked by a qualified structural engineer to support the weight of the fluid-filled modules and the connective piping to and from the chiller. Installations must account for minimum service access clearances as may be practical or required by local building codes.

Chiller Clearances

The National Electric Code or local, state, and regional building codes may require greater clearance for the modular chiller than the figures listed in this publication. Always consult local regulatory agencies to ensure additional clearances are not required by building codes.

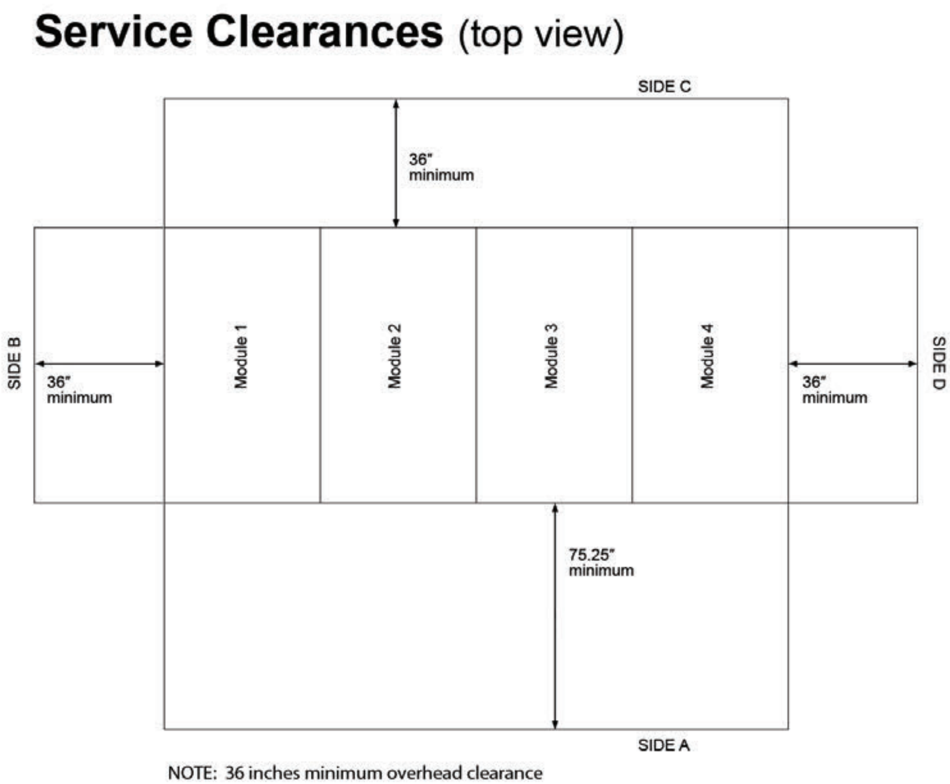
Minimum Clearances

The unit must maintain a minimum of 36” clearance on sides B, C, and D and a clearance of 75.25” on side A, with a 36” overhead height. See Figure 2, p. 13.

Service Access

Compressors, filter-driers, and manual liquid line shutoff valves are accessible on each side or end of the unit. Recommended clearance in front of the system is 75.25 inch to allow servicing of the refrigeration system.

Figure 2. Recommended chiller clearances

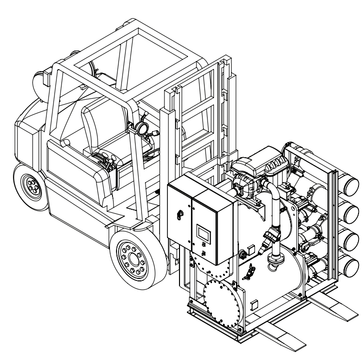


Rigging, Lifting, and Moving the Chiller

The Thermafit™ TACW modular chiller can be delivered to the customer's site as individual modules. Limitations on the methods and materials that can be used to rig, lift, or move a chiller or an individual module include:

- Maintain the module in an upright position at all times.
- Certain configurations of modules can be top-heavy. Move modules slowly with consideration for each module's center-of-gravity.
- Rig, lift, and move by strapping and lifting using a properly configured floor jack or fork lift or by overhead means.
- Position lifting beams or spreader beams to prevent lifting straps from rubbing or contacting module side panels or electrical boxes.
- Do not use cables, chains, or any other type of metalized strapping to lift a module.
- Do not push a chiller module while directly in contact with the floor using manual or mechanical means.

Figure 3. Recommended chiller rigging assembled unit



Chiller Placement

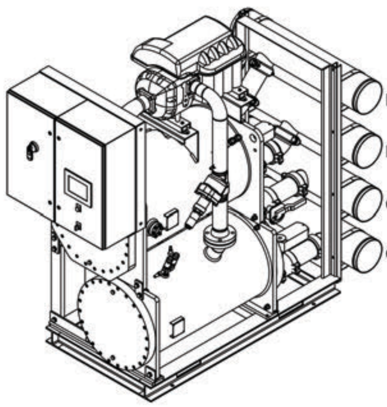
The chiller must be positioned on a firm level surface using waffle rubber isolation pads.

Installation Piping

Install Piping and External Components

Proper support of piping and pipe hangers must consider the weight of the piping as well as the water weight inside the pipes.

Figure 4. Recommended chiller piping



Initial Flushing of Piping

After installation of system piping and before connection to the chiller system, it is important to clean and remove debris, weld slag, and other contamination deposited during fabrication of the piping system.

Typical flushing includes hot water with mild detergent followed by a dilute phosphoric acid solution until all visible residue is removed.

Cleaning liquids, acids, and detergents compatible with copper and carbon steel must be used. Consult a professional fluid treatment specialist when in doubt.

After detergent and chemical cleaning, flush the water piping with fresh water for one hour to remove any remaining cleaning compounds.

Fill with Water/Glycol Solution

In most instances, the installing contractor is responsible for charging glycol into the unit. If not charged, add glycol according to these instructions:

1. Mix the concentrate of propylene glycol in a tank or drum for transfer into the chiller.
2. Mix the glycol and water externally before filling the unit to prevent clogging of the chiller piping with a heavy concentrate.

Only after the above steps have been completed should the fluid piping be connected to the chiller system.

Installation Electrical

Connecting Module Power and Control Wires

Connections are typically made at the power distribution panel of each module.

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Proper Field Wiring and Grounding Required!

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Module Main Power

Each module in the bank must be fed by its own individual power. All power wiring, up to the power panel, is the responsibility of the installing contractor.

Module Control Wiring

Every module needs to be daisy-chained together on the CAN network. Both ends of the network need end termination (jumper) installed. This work is the responsibility of the installing contractor.

BMS Wiring

The physical medium will be determined by project parameters and is the responsibility of the installing contractor.

Pre-Startup

Preparation for Initial Startup

After the system is completely installed with all wires connected and all piping securely coupled, the chiller can be prepared for initial startup.

Please ensure that the proper Request for Startup form has been completed and provided to your local representative.

Table 3. Startup readiness checklist

Hydronic Checklist	
☐	Piping complete and leak tested
☐	Pre cleaning strainers are removed from chilled water side of system
☐	Pre cleaning strainers are removed from condenser water side of system
☐	Strainer installed before entering the evaporator (barrel for chilled water)
☐	Strainer installed before entering the condenser (barrel for cooling tower water)
☐	Water quality analyzed for water treatment
☐	If applicable glycol concentration checked
☐	Water systems filled and vented of all air
☐	Pumps installed and rotations checked
☐	Water control valves (external to chiller) installed and operating
☐	Water system operating to meet design conditions
☐	Pressure gauges installed on inlets and outlets of chilled water and condenser water barrels
Electrical Checklist	
☐	Power wiring complete and in accordance with nameplate rating on unit and prepared for connection in accordance with installation manual
☐	Proper wire sizing installed
☐	Please record the wire sizing installed
☐	Tower fan controller installed and operating to control tower fan
☐	VFD’s for all pumps wired and operational

Operating Principles

This section contains an overview of the operating principles of the Thermafit™ TACW modules equipped with Danfoss MCX controllers.

Refrigeration Circuits

The refrigeration cycle makes use of a shell-and-tube evaporator design with refrigerant evaporating on the shell side and water flowing inside tubes having enhanced surfaces.

The compressor is a two-stage oil-free variable speed centrifugal magnetic bearing type. The magnetic bearings allow the compressor to operate without the use of oil for lubrication, which reduces energy losses due to friction and increases the heat transfer efficiency of the chiller. A variable speed drive on the motor allows the compressor to operate much more efficiently at partial loads.

Condensing is accomplished in a shell-and-tube heat exchanger where refrigerant is condensed on the shell side and water flows internally in the tubes. Refrigerant is metered through the flow system using an electronic expansion valve that maximizes chiller efficiency at part load. Microprocessor-based unit control modules provide for accurate chilled water control as well as monitoring, protection and adaptive limit functions. The “adaptive” nature of the controls intelligently prevents the chiller from operating outside of its limits, or compensates for unusual operating conditions, while keeping the chiller running rather than simply tripping due to a safety concern. When problems do occur, diagnostic messages assist the operator in troubleshooting.

Refrigeration Cycle

Evaporation of refrigerant occurs in the evaporator that maximizes the heat transfer performance of the heat exchanger while minimizing the amount of refrigerant charge required. A metered amount of refrigerant liquid enters a distribution system in the evaporator shell and is then distributed to the tubes in the evaporator tube bundle.

The refrigerant vaporizes as it cools the water flowing through the evaporator tubes. Refrigerant vapor leaves the evaporator as saturated vapor.

The refrigerant vapor generated in the evaporator flows to the suction end of the compressor where it enters the motor compartment of the motor. The refrigerant flows across the motor, providing the necessary cooling, then enters the compression chamber. Refrigerant is compressed in the compressor to discharge pressure conditions.

Immediately following the compression process the oil-free refrigerant vapor enters the condenser. Baffles within the condenser shell distribute the compressed refrigerant vapor evenly across the condenser tube bundle. Cooling device water, circulating through the condenser tubes, absorbs heat from this refrigerant and condenses it.

As the refrigerant leaves the bottom of the condenser, it enters an integral subcooler where it is subcooled before traveling to the electronic expansion valve. The pressure drop created by the expansion process vaporizes a portion of the liquid refrigerant. The resulting mixture of liquid and gaseous refrigerant then enters the Evaporator Distribution system. The flash gas from the expansion process is internally routed to the compressor suction, and while the liquid refrigerant is distributed over the tube bundle in the evaporator.

The TACW chiller maximizes the evaporator heat transfer performance while minimizing refrigerant charge requirements. This is accomplished by metering the liquid refrigerant flow to the evaporator’s distribution system using the electronic expansion valve.

Compressor

The compressor uses two impellers on a single, high-speed, rotating shaft. The rotating shaft and impeller assembly is the only moving part in the compressor.

The compressor has a fully integrated variable-speed drive with soft start. The variable-speed drive allows the compressor to be highly efficient, especially at partial load and the soft-start feature reduces start-up stress.

The single shaft rotates within magnetic bearings. This unique feature reduces friction, adding to the overall high efficiency, and eliminates the metal-on-metal contact of conventional bearings. This, in turn, allows the chiller to operate without the need for lubricating oil. Eliminating lubricating oil eliminates the need for several ancillary components required to support the oil system (e.g., oil pumps, oil heaters, oil separators, and oil filters).

Operating Procedures

Operator Interface

Thermafit™ TACW modular water-cooled units are complete chillers that can work on their own or work collaboratively, in banks of up to 8 units.

Chiller Panels

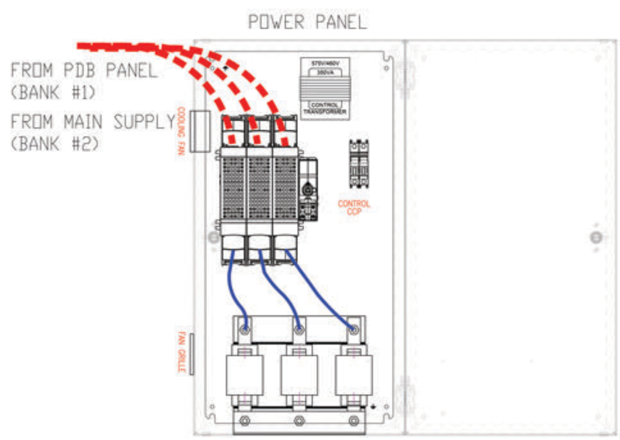
There are two different electrical panels used in the TACW chiller:

1. Power panel
2. Control panel

Power Panel

Every module requires its own dedicated power connected to built-in disconnect. See Figure 5, p. 18. The power panel contains all electrical components requiring greater than 24 Vdc or 24 Vac. including, but not limited to AC transformers, AC to DC power supply, fusing, and the line reactor.

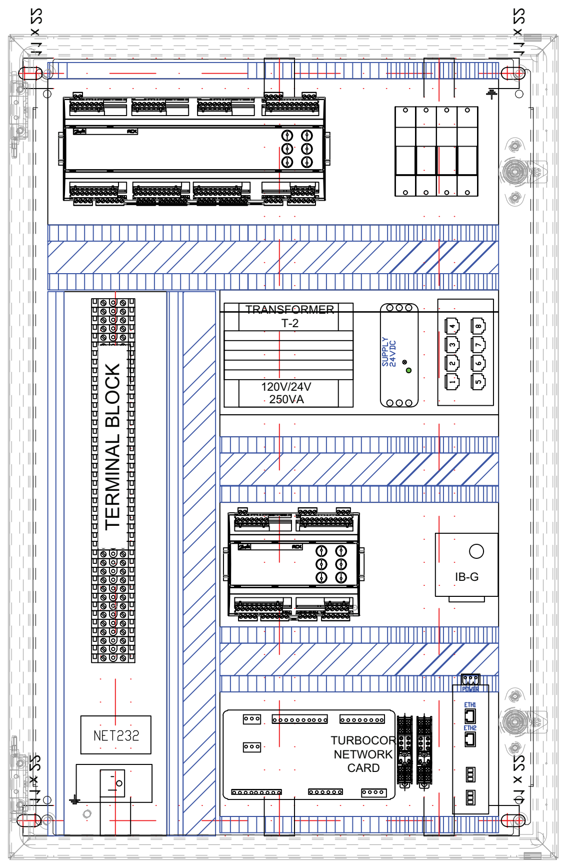
Figure 5. Power panel



Control Panel

The control panel receives power from the power panel and provides power to the control components in that module. The Control Panel includes, but is not limited to, primary and companion controllers, HMI, BMS interface, Ethernet components for internal network, low-power fusing, and a terminal strip for customer control wiring.

Figure 6. Control panel



Panel-Mounted Disconnect Handle

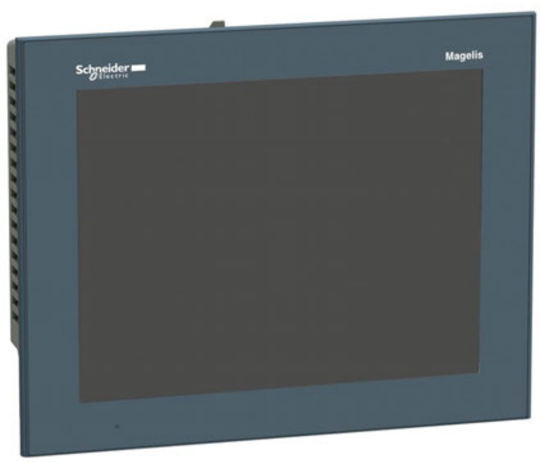
Chiller systems are equipped with a panel-mounted disconnect handle installed on the outside of the power distribution panel. The disconnect handle must be turned to the OFF position before the panel can be opened for service. When the panel door is open, the power is disengaged.

Controller and HMI

The Thermafit TACW chiller models use “Danfoss MCX microprocessor controllers and Schneider 7” touchscreen HMI to monitor and report critical operating parameters.

Figure 7. Danfoss MCX primary controller

Figure 8. Schneider 7-inch HMI Touchscreen



Operating the Microprocessor

The touchscreen interface panel is ready to use when it is connected to the Ethernet switch and chiller powered is ON.

Microprocessor Functions

For practical purposes, all essential control information and operator actions are read and responded to using the touchscreen interface panel. The touchscreen interface panel is connected to the primary and companion controllers.

NOTICE

Component Damage!

Failure to follow instructions could damage sensitive electronic components beyond repair.

To prevent arcing or surges of electrical current, do not use wires or cables to jump components or bypass the manufacturer's safety systems.

Operator Control

A touchscreen interface panel is the primary means for the operator or maintainer to monitor and modify a host of functions involving temperatures, pressures, set points alarms, elapsed operating hours, etc.

The touchscreen interface is connected to and communicates with all module controllers via the Ethernet and RS485 switch. It accesses overall chiller functions and settings as well as individual module settings.

Touchscreen Interface Tutorial

This section consists of a tutorial that first-time personnel can use to navigate through the various functions and features that are available in the interface.

Control System

This document section provides user details for the user interface of the Thermafit™ Modular TACW Chiller. The following is a typical About screen that provides you exact HMI software version and HMI Runtime version or firmware version.

Figure 9. Revision Screen

This HMI software is designed to meet the needs of all chillers with 1-6 compressors and in either air-cooled or water-cooled configurations. In addition, this software provides visibility into external special controls and optional functionalities.

Control Architecture

The control architecture is broken down in the following categories:

- Basic Controls – considers both standard water-cooled and air-cooled chillers
  - Menus
  - Data Displays
- Special Functions:
  - Hand/Off/Auto
  - Chiller Setpoint Control
  - Enhanced EXV Control
  - Condenser/Fan/Cooling Tower Control/Bypass Valve
  - Tonnage and Power Calculations

- Metric/Imperial Display
- BMS Interconnectivity
- Compressor Staging Valve Control
- Optional Functionalities
  - Free Cooling
    - ArcticBoost (Low Lift Refrigerant Pump)
  - Pump and Plant Controls
  - Data Logging
  - Chiller Array Control
  - Economizer
  - Hot Gas Bypass Valve
- Security Configuration
- Alarm Handling

Basic Controls

This section describes the basic functions of the chiller control system. We explore this from two vantages:

- Menus
- Data Displays

Menus

This system has three functional menus:

1. Main Menu – persistent across all displays.
2. Devices Menu – persistent across devices functions.
3. Settings Menu – persistent across settings functions.

Main Menu

The **Main Menu** is part of the banner of all displays:

Figure 10. Main menu

The **Main Menu** is always available as long as the HMI is functional. It has the following features:

Table 4. HMI main menu features

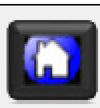
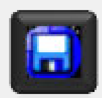
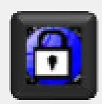
Feature	Function
Logo/Title	Displays function descriptive title for the page.
Time/Date	For reference – settable through the BIOS of the HMI. See "Settings Menu," p. 20.
	Press to return to the Main Page.
	For debugging purposes, the system provides a display of raw inputs and outputs.
	Displays compressor 1 detail. All the compressors' pages can be accessed.

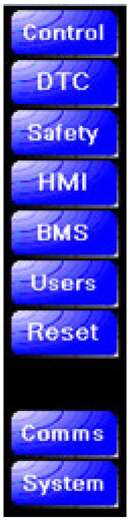
Table 4. HMI main menu features (continued)

Feature	Function
	Displays Alarm Page.
	Displays key process indicators – all fluid temperatures, suction and discharge pressures in large format and other parameters. Also, it displays ambient temperature, condenser fan speed for air-cooled chillers.
	Displays fluid temperatures against system demand in a 1-hour trend for water-cooled chillers. Displays evaporator Fluid temperatures, ambient temperature, and condenser fan speed for air-cooled chillers.
	Accesses "Devices Menu," p. 21. Subject to security level. You must be Tech level or above to invoke.
	Accesses "Settings Menu," p. 20. Subject to security level. You must be Tech level to invoke.
	Triggers data logging snapshot.
	Displays About Page.
	Accesses Log-on screen of security.

Settings Menu

The **Settings Menu**, unlike the **Main Menu**, is not always available. It appears when the **Setup** button from the **Main Menu** is pressed. It will stay available while you are in the settings section of the HMI. This menu is only available and **Setup** button is only visible to users with Tech level security or above. The following is the **Settings Menu**:

Figure 11. Settings menu



The following table show the features accessed by the **Settings Menu**:

Table 5. HMI settings menu features

Feature	Function
	Displays chiller control page which includes setpoint parameters, staging info, and the chiller PID loop controls.
	Displays the compressor parameters page. Includes individual enable/disable compressor controls.
	Displays the controller-based Faults and Warnings. ***Note:*** *Compressors have their own, independent set of safeties that should be configured with higher priority than the controller safeties.*
	Displays controls that provide the chiller identity. ***Important:*** *Settings should only be changed by Trane-trained representatives.* Accessed by Admin Level Security only.
	For debugging purposes, this page displays the complete data array that is sent to the BMS system.
	Displays user access manager for managing user passwords. ***Note:*** *If you change passwords and forget them you will no longer have access to the HMI functions.*
	Displays the setpoint reset settings page.

Table 5. HMI settings menu features (continued)

Feature	Function
	Displays communication between chiller control components. Allows control to shutdown comms to unused or faulty components.
	Provides access to the BIOS of the HMI device. Not available via WebGate (WebGate is the proper name of the HMI's built-in webserver).

Devices Menu

The **Devices Menu** appears when the **Device** button from the **Main Menu** is pressed. It will stay available while you are in the devices section of the HMI. This menu is only available and visible to users with Tech level security and above. Invoking the devices menu, displays system EXV control by default.

The following is the **Devices Menu**:

Figure 12. Devices menu

The following table shows the features accessed by the **Devices Menu**:

Table 6. HMI devices menu features

Feature	Function
	Displays a control overview of the EXV(s) in the system.
	Displays a control overview of the fan banks (optional) in the system.
	Displays a control overview of chiller pumps (optional) in the system.

Table 6. HMI devices menu features (continued)

Feature	Function
	Displays a control overview of the condenser pumps (optional) in the system.
	Displays a control overview of the condenser valve (optional) in the system.
	Displays a control overview of the economizer valves (optional) in the system.
	Displays a control overview of the hot gas bypass (load-balancing valve - optional).
	Displays (optional) the chiller array (Manager/Subordinate) configuration and status.

Data Displays

Main Menu

The following table shows the standard set of **Main Menu** HMI screens.

Table 7. HMI main menu screens

Screen	User Interface	Function	Access
Password Protected System Initialization			• Appears only after program has been loaded in HMI first time. • If correct code has been entered, it will never appear again and HMI proceeds to Main screen upon power-up.
Main		Primary Display • Displays All KPIs for the chiller: – Compressor and Chiller State and compressors key refrigeration indicators. – Evaporator and Condenser Specifics. – Hand/Off/Auto (HOA) Control (see "Special Functions," p. 31). – Demand, Capacity and Speed (see "Special Functions," p. 31). • Provides access to viewing and control of primary setpoint.	• Screen is first displayed on power-up and from the button on any other screen.  • Clicking the **Circuit Data** button invokes the following overlay: 
Chiller Circuit Information		• Provides details on all defined refrigerant circuits. • Clicking Circuit X EXV title invokes the control screen for that EXV. • Click Return button to close the overlay.	**Home > Circuit Data**

Table 7. HMI main menu screens (continued)

Screen	User Interface	Function	Access
Digital I/O		Displays current status of all hardwired digital inputs and outputs. • Provides access to Analog I/O • Provides access to Companion I/O	**Main Menu > I/O**
Analog I/O		Displays current value of all hardwired analog inputs and outputs. • Provides access to Digital I/O	**Main Menu > I/O > Analog**
Controller I/O		Displays current value of all hardwired Companion PLC inputs and outputs.	**Main Menu > I/O > Companion**
Compressor (1 for each compressor)		Provides detailed snap-shot information regarding the each compressor.	• **Main Menu > Comp > Comp X** • **Main Menu > Staging** valves control pop-up screen (see Special Functions)

Table 7. HMI main menu screens (continued)

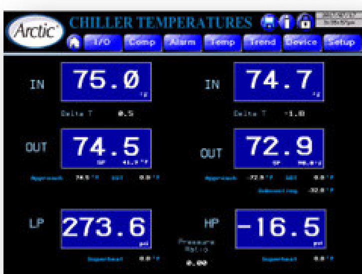
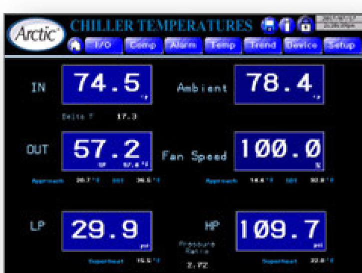
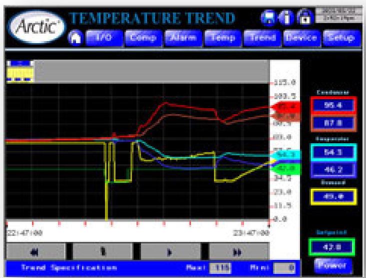
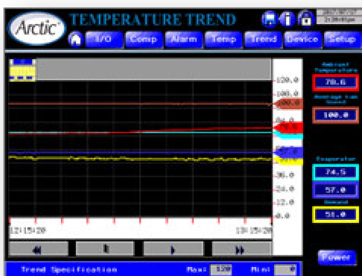
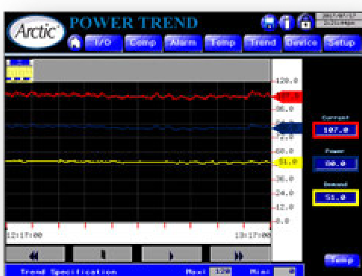
Screen	User Interface	Function	Access
Alarms		Display, acknowledge and reset system alarms. ***Note:*** *All alarms must be acknowledged and reset (green) before deletion.*	**Main Menu > Alarm**
Diagnostics		Provides information on what may be limiting the chiller.	**Settings > HMI > Alarm** • Admin access only.
Chiller Key Process Indicators	 	Displays water temperatures and system pressures in large font for easy long-distance reading. Air-cooled configuration replaces condenser water temperatures with ambient temperature and fan speed.	**Main Menu > Temp**

Table 7. HMI main menu screens (continued)

Screen	User Interface	Function	Access
Temperature Trend: Context-Sensitive to air- or water-cooled configuration.	 	• Displays trend of the last hour's data: – Evaporator water temperatures in and out. – Water-cooled: Condenser water in and out temperatures. – Air-cooled: Ambient temperature and fan speed (%). – Demand (%). • Has Y-axis runtime zoom. • Provides access to power trend.	**Main Menu > Trend**
Power Trend		• Displays trend of the last hour's data: – Calculated power (kWs) – Measured 3-phase current (amps) – Air-cooled: Ambient temperature and fan speed (%). – Demand (%). • Has Y-axis runtime zoom. • Provides access to Temperature Trend.	**Main Menu > Trend > Power**

Devices Menu

The following table shows the standard set of **Devices Menu** screens.

Table 8. HMI devices menu screens

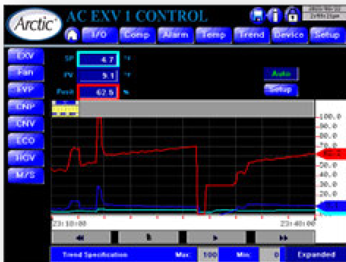
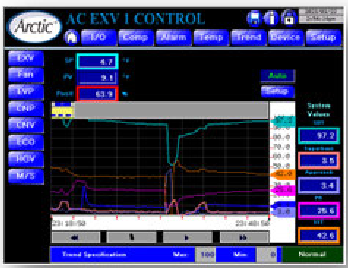
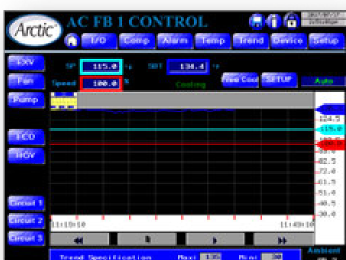
Screen	User Interface	Function	Access
EXV Control	 	• Display trend and settings of electronic expansion valves controls (see "Special Functions," p. 31). • Display expanded trend data.	**Main Menu > Devices Menu > EXV**
Fan Bank Control		• Display trend and settings of banks of fans controls (see "Special Functions," p. 31). • Provides access to free cooling fan control screen. ***Note:*** *Option not available on the Thermafit module.*	**Main Menu > Devices Menu > Fan**
Free Cooling Fan Bank Control		• Displays trend of free cooling controlled temperature against fan speed in free cooling mode and settings. • Provides access to free cooling valve control screen. ***Note:*** *Option not available on the Thermafit module.*	**Main Menu > Devices Menu > Fan > Free Cool**

Table 8. HMI devices menu screens (continued)

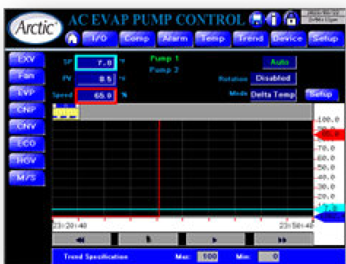
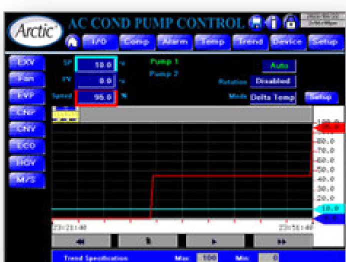
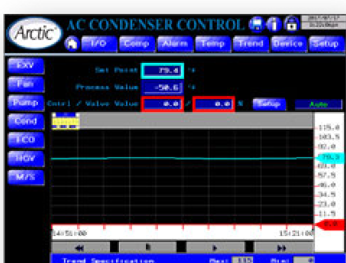
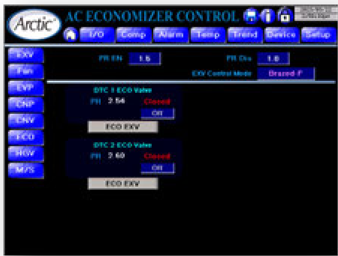
Screen	User Interface	Function	Access
Free Cooling Valve Control		• Displays trend of free cooling controlled temperature against free cooling valve position and settings. • Provides access to free cooling fan control screen. ***Note:*** *Option not available on the Thermafit module.*	**Main Menu > Devices Menu > Fan > Free Cool > Valve**
Evaporator Pumps Control		• Displays trend and settings of evaporator circuit pumps controls (see "Optional Functionalities," p. 47). • Provides access to condenser pumps control screen. ***Note:*** *Chillers in an array configuration cannot control system pumps or fans unless dedicated to the module.*	**Main Menu > Devices Menu > Pump**
Condenser Pumps Control		• Displays trend and settings of condenser circuit pumps controls (see "Optional Functionalities," p. 47). • Provides access to evaporator pumps control screen. ***Note:*** *Chillers in an array configuration cannot control system pumps or fans unless dedicated to the module.*	**Main Menu > Devices Menu > CNP**
Condenser Valve Control		Displays trend and settings of condenser circuit bypass valve controls (see "Special Functions," p. 31). ***Note:*** *Chillers in an array configuration cannot control system bypass valve unless dedicated to the module.*	**Main Menu > Devices Menu > Cond**

Table 8. HMI devices menu screens (continued)

Screen	User Interface	Function	Access
Economizer Control		Display and configure economizers settings and parameters (see "Optional Functionalities," p. 47).	**Main Menu > Devices Menu > ECO**
Hot Gas Valve Control		Displays trend and settings of Hot Gas Valve controls (see "Optional Functionalities," p. 47).	**Main Menu > Devices Menu > HGV**
Chiller Array Control		Display and configure the Manager/ Subordinate configuration (see "Optional Functionalities," p. 47 – Manager/ Subordinate).	**Main Menu > Devices Menu > M/S**

Setting Menu

The following tables shows the standard set of **Setting Menu** screens.

Table 9. HMI settings menu screens

Screen	User Interface	Function	Access
Chiller Control		• Admin Level Chiller SP Control (see "Special Functions," p. 31). • Display and adjust chiller PID settings (see section 3.8 Compressor Control of the Chiller Control manual). • Compressor staging control (see "Special Functions," p. 31). • Evaporator / Condenser DP / flow settings (if applicable). • Tonnage calculation configuration (see "Special Functions," p. 31).	**Main Menu > Settings Menu > Control**
Compressor Setup		• Display and adjust compressor specific parameters (see section 3.8 Compressor Control of the Chiller Control manual). • See T3C Documentation for specifics on the settings with the exceptions:	**Main Menu > Settings Menu > DTC**
Safety		Display and adjust safety parameters. ***Note:*** *The compressors have their own safety settings for fault and alarm. System should be configured such that the compressor settings have priority.*	**Main Menu > Settings Menu > Safety**
HMI Configuration		Enable/Disable or select **Special** and **Optional Functionalities**. Details for each function are described in the sections **Special Functions** and **Optional Functionalities**.	**Main Menu > Settings Menu > HMI** Admin access only.

Table 9. HMI settings menu screens (continued)

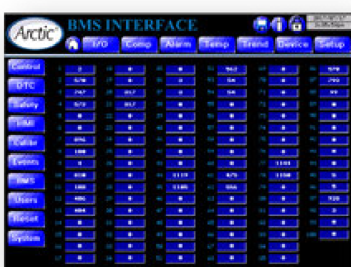
Screen	User Interface	Function	Access
Companion IO Configuration		1. The control system is comprised of a dual controller configuration: a. T3C – larger controller. Handles compressors and staging. b. Companion – small controller. Handles refrigeration circuits – EXVs, Fans, etc. and pumps. This entails more IO then is available on the small controller and therefore, some functions are sent to the T3C controller to process. c. This screen provides this transfer of control from Companion to the T3C for Digital and Analog outputs.	**Main Menu > Settings Menu > HMI > Companion to T3C IO**
Admin Parameters		1. Project and Software information. 2. Main Switch Control. 3. Reboot HMI. 4. Reset Power Consumption accumulation. 5. Reconnect off-line compressors.	**Settings > HMI > Admin Parameters** Admin access only.
BMS Interface		Display output Building Management System. ***Note:*** *This page validates the communication between Chiller and the ArcticCool BMS gateway (FieldServer).*	**Main Menu > Settings Menu > BMS**

Table 9. HMI settings menu screens (continued)

Screen	User Interface	Function	Access
User Manager		Provides an interface to the security system for the management of users and passwords.	**Main Menu > Settings Menu > Users**
Temperature Compensation		Display and configure setpoint compensation.	**Main Menu > Settings Menu > Reset**

Special Functions

The following table lists the Special Functions of this control system:

Table 10. Chiller control system special functions list

Function	Brief	Access Level
Hand/Off/Auto	Allows user to manually enable the chiller to operate based on its own signals	User
Chiller Setpoint (User)	Allows user to view the chiller's setpoint.	User
Chiller Setpoint (advanced)	Allows user to change the setpoint functions	Admin
All Other Chiller Settings	Update settings for Chiller, Compressors, Safety limits, Setpoint Resets.	Tech
EXV Control	Monitor and Control EXVs functions	Tech
Condenser Control	Monitor and Control fan banks and condenser bypass valve functions	Tech
All Other Device Control: Economizers, Pumps, HGB	Monitor and Control device functions	Tech
Tonnage and Power (View)	See pop-up display of data	User
Tonnage and Power (Control)	Adjust settings	Admin
Metric/Imperial	Set system to display either metric or imperial units	Admin
BMS Monitor and Control	Provides interface between chiller and BAS	Admin
Compressors Staging Valve Control	Monitor and Control Compressor Staging Valves	Tech

Hand/Off/Auto

The Hand/Off/Auto control consists of 2 components:

1. Display and Access button (invokes control screen).

2. Control Screen.

The Hand/Off/Auto function has 3 modes:

- Off – no function. Compressors are off and remain so regardless of loop temperatures. All display functions work as normal. Chiller Enable is White and OFF. If pumps are controlled by the chiller and they are configured to Cooling Enable, the pumps will not be enabled.
- Hand – the chiller controls the compressors based on (by default) achieving setpoint on leaving chilled water temperature. Chiller Enable displays Red and Hand. If connected, pumps will be enabled.
- Auto – this mode requires an external (hardwired) signal providing Chiller Enable; otherwise, Chiller is Off. Once Chiller Enable signal is provided, chiller controls compressors according to setpoint. Chiller Enable displays White and Auto.

Chiller Setpoint Control

Multiple chiller setpoint control modes are available. These are:

- User Setpoint
- Digital Offset
- Remote Setpoint
- Remote Offset

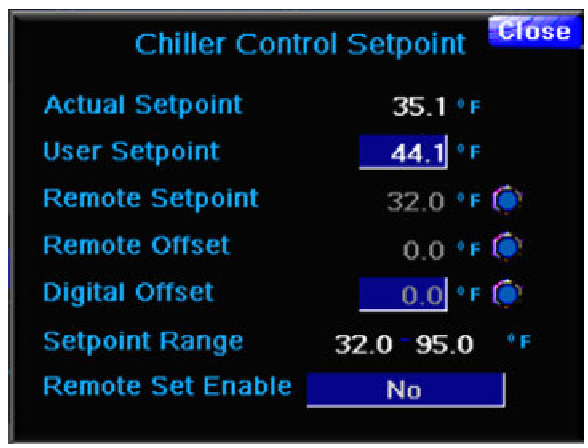
The chiller ultimately works with one value for setpoint, this value is always displayed on the Main Screen in the Evaporator Section, labeled SET POINT:

Figure 13. Main screen

User Setpoint

To Access the Chiller Setpoint control screen, select the setpoint indicator from the Main Screen or the Chiller Control screen. See the following figure:

Figure 14. Chiller setpoint control

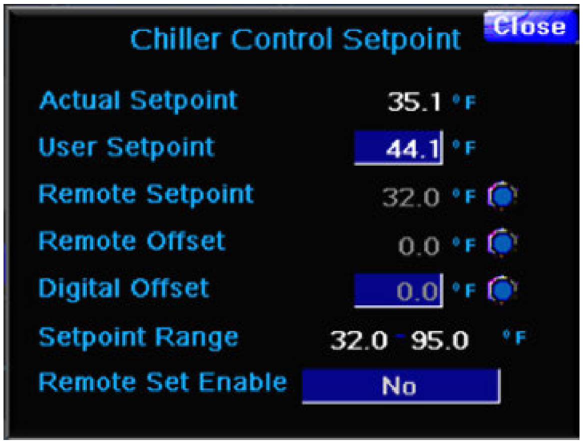


To change the setpoint, touch **User Setpoint**. A keyboard appears and allows you to enter a new value.

Note: *In user setpoint mode Actual Setpoint equals User Setpoint.*

Digital Offset

This feature requires a parameter and a digital input. The parameter, Digital Offset is exposed to the HMI on the Chiller Control Setpoint screen:



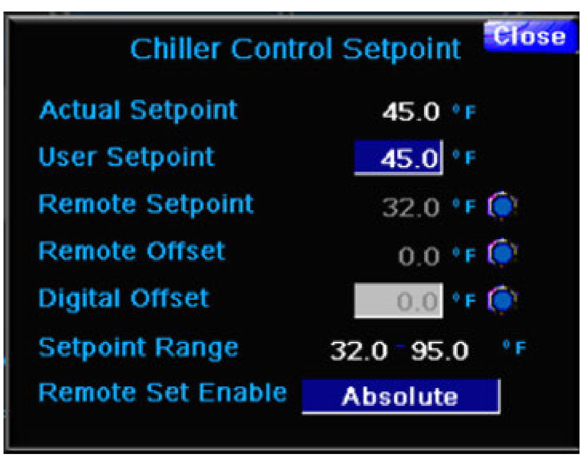
The chiller control setpoint screen allows you to enter a value within setpoint range in °C or °F depending on the HMI configuration. Digital Input #4 enables the digital offset functionality. When this input is on, the digital offset display turns blue and the accompanying pilot lights up.

Remote Setpoint

When enabled it ignores the user setpoint and reads analog input #1. This function requires:

- Inputs:
  - Remote Setpoint – Analog Input #1 – range: Settable on the admin version of the control pop-up.
  - Remote Setpoint Enable – Digital Input #3.
- Parameter:
  - Remote Set Enable – set to **Absolute**.

Figure 15. Chiller setpoint control - Remote setpoint

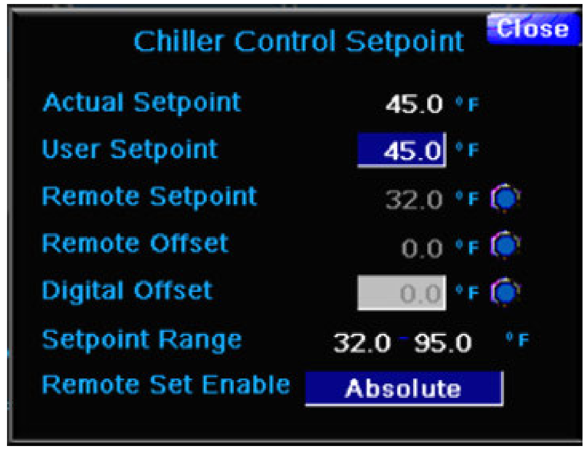


Note: *Actual Setpoint equals Remote Setpoint.*

With Digital Offset

Remote setpoint and the digital offset can be combined:

Figure 16. Chiller setpoint control - Remote setpoint with digital offset



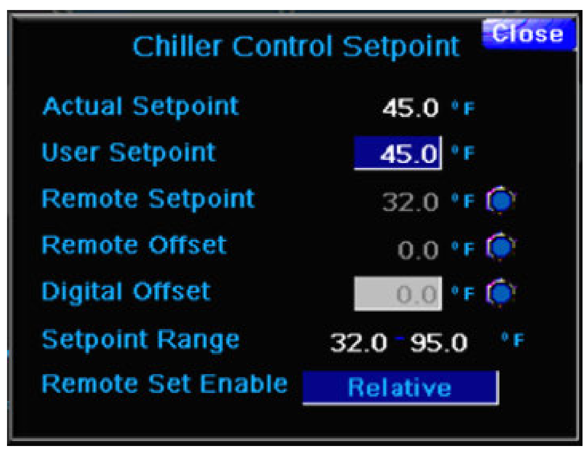
In this situation, the controller adds the offset value to the remote setpoint value.
Example: 49.3 + 1.4 = 50.7

This requires everything in the previous section plus the Remote Offset Enable input (#4).

Remote Offset

Remote Offset and Digital Offset can be used concurrently:

Figure 17. Chiller setpoint control - Remote offset with digital offset



To use this scenario the controller requires:

- Inputs:
  - Remote Offset Enable – input #4.
- Parameters:
  - Remote Set Enable – set to **Relative**.

The actual setpoint is calculated:

User Setpoint + Digital Offset+ Remote Offset
42.3 + 1.4 + 0.2 = 43.9

Enhanced EXV Control

ArcticCool Chiller has 2 options for controlling the EXV(s):

1. Disabled – Indicates that the EXV is controlled externally without any visibility at the HMI.

2. ArcticCool – ArcticCool T3C Companion Controller.

Preferred control option. See below.

The following table displays the varied EXV control screens with their options and limitations.

Table 11. EXV control options

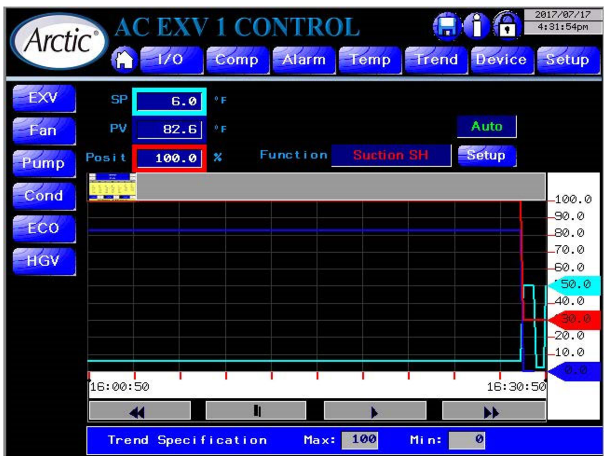
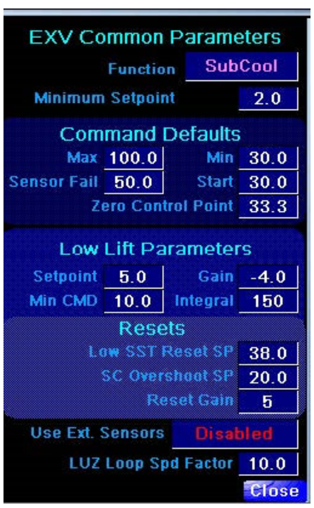
Screen	Controls
As demonstrated below, all special and optional function control screens are almost identical.	Common Controls: • Setpoint. Process Value and Control value particular to the signal measured. • Auto/Manual control. • Trend with Y-axis zoom.
	ArcticCool EXV Control. • This option requires **ArcticCool** T3C Companion Controller. The T3C Companion works with the **ArcticCool** Main Controller; they share information including Inputs and Outputs. The Companion cannot work as a stand-alone controller because it does not have the inputs and outputs to sustain the functionalities built in. It is designed as a companion relying on the Main Controller. • 5 control modes: – Liquid Level High Pressure side –requires Level sensor on the condenser. – Liquid Level Low Pressure side –requires level sensor on the Evaporator. – Suction Superheat. – Discharge Superheat. – Sub-Cooling – Requires liquid line temperature sensor. • Setpoint adjusts automatically based on chiller capacity. • Capable of controlling up to 4 refrigeration circuits. • Access: **Main Menu > Devices Menu > EXV button**.

Table 11. EXV control options (continued)

<table>
<tr><th>Screen</th><th>Controls</th></tr>
<tr><td>
</td><td>ArcticCool EXV Setup Page:
• Access: Main Menu > Devices Menu > EXV button > Setup button.
• PID Loop constants: P-Gain and Integral
– Negative Gain indicates reverse acting.
• Minimum Setpoint (for Sub-Cooling mode only).
• Master Setpoint display:
– Adjustable Setpoint for all the modes but Sub-Cooling.
– Maximum Setpoint (for Sub-Cooling mode only).</td></tr>
<tr><td>
</td><td>Circuit Common Parameters:
• Max and Min operational valve values.
• Minimum Setpoint.
• Start Position and Time.
• Sensor Failover Position.
• Low-Lift control parameters – Gain, Integral, Setpoint, Minimum Output Command.
• Resets:
– SST
– Subcooling
– Gain (no integral)
• External Sensors:
– Chillers works by compressor sensors by default. System can be set to use independent temperature and pressure sensors.</td></tr>
</table>

Condenser Control

The control system can control external devices and any devices that are local to the chiller. Two of the features are:

1. Condenser Valve Control
2. Condenser Fan Control

Note: *Although available in the software, this is not an option available on the Thermafit TACW. However, this control can be used on a module-dedicated cooling tower.*

Condenser Valve Control

The condenser valve can be a device attached to the chiller or just as simple as a device connected to the BMS. The controller provides a signal reference that is PID driven to control the condenser inlet temperature to a defined setpoint value. The chiller control system provides 2 options as selected from the HMI configuration page – HMI Condenser Control:

Disabled

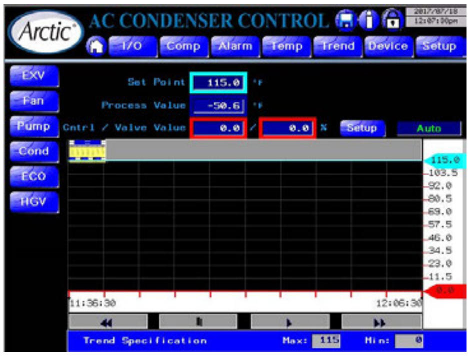
This option indicates no controllable condenser valve exists.

ArcticCool Control

This option requires ArcticCool T3C Companion Controller. The T3C Companion works with the ArcticCool Main Controller; they share information including Inputs and Outputs. The Companion cannot work as a stand-alone controller because it does not have the inputs and outputs to sustain the functionalities built in. It is designed as a companion relying on the Main Controller.

Condenser Valve Control main page:

1. Condenser Valve Control:



a. Displays trend and current values for Setpoint, Process Value and Control value.

b. Setpoint is Tech level adjustable. If corresponding option selected on **Setup** screen. See below.

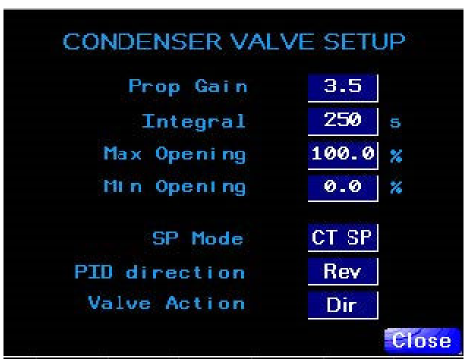
c. Valve Control Mode: Auto/Manual/Off.

d. To access other settings, click **Setup**.

e. Trend has y-axis zoom capability.

f. Access: **Main Menu > Devices Menu > Cond**.

2. Condenser Valve Setup:



a. P-Gain and I PID constants.

b. Maximum and Minimum valve opening settings.

c. SP Mode. CT SP – condenser valve shares the same SP as a cooling tower; SP – condenser valve uses individual SP adjustable on the main condenser valve screen.

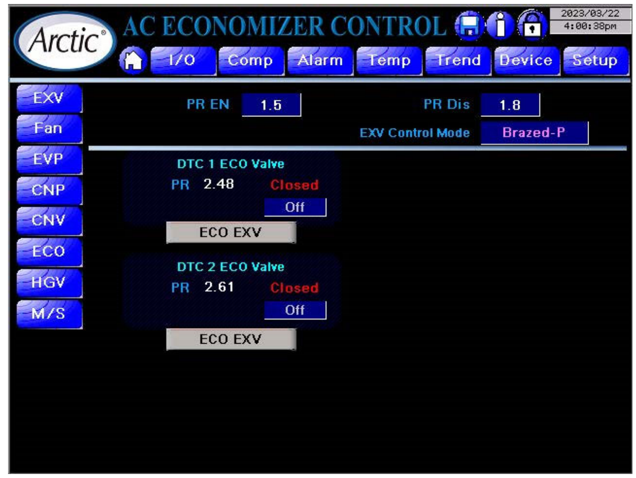
d. PID direction. Rev – PID acts in Cooling mode; Fwd – PID acts in Heating mode.

e. Valve Action. Dir – maximum PID signal corresponds to valve fully opened state; Rev – maximum PID signal corresponds to valve fully closed state.

f. Access: **Main Menu > Devices Menu > Cond > Setup**.

Economizer Control

Figure 18. Economizer control



Economizer Algorithms

Figure 19. Speed

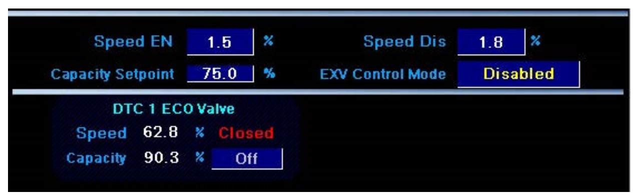


Figure 20. PR - default

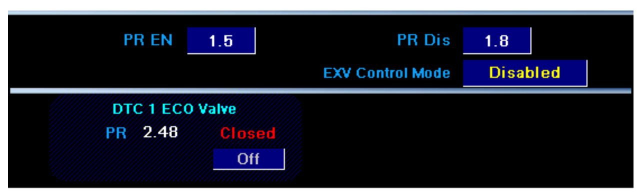
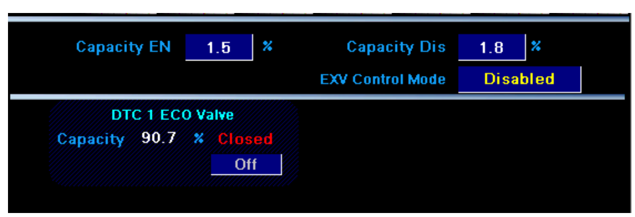


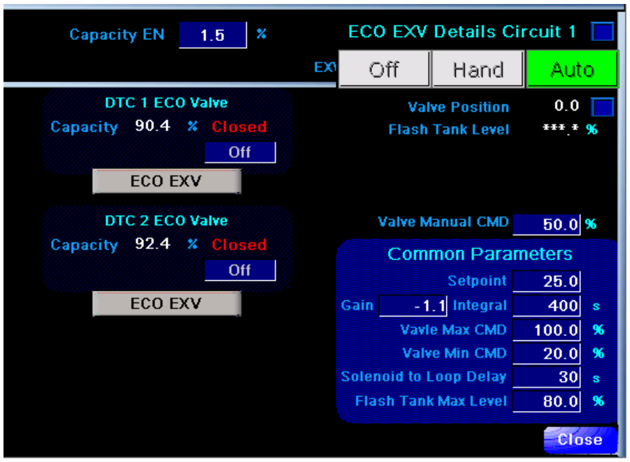
Figure 21. Capacity



Associated Modulating Control

1. Disabled.
2. Flash Tank Level.

Figure 22. Flash tank level



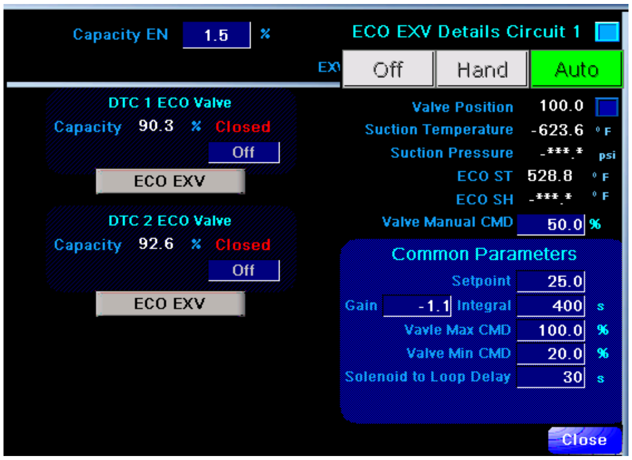
a. The chiller includes a second modulating valve to control Flash Tank Level.

b. Negative Gain indicates reverse-acting. It can be used for either inlet or outlet level control.

c. If level hits max level, solenoids close to prevent introduction of liquid at the interstage port of the compressor.

3. Brazed-Plate Suction Superheat with or without solenoid control.

Figure 23. Brazed-plate suction superheat



a. Works with independent temperature and pressure sensor on the brazed-plate heat-exchanger.

b. Suction superheat setpoint maintained on the compressor interstage line.

c. Negative Gain indicates reverse-acting PI loop.

Barrel Isolation

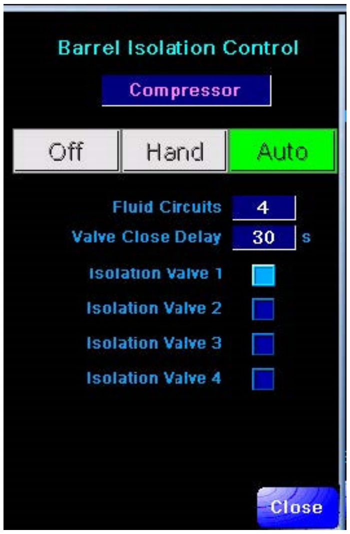
Common Features:

- User-Settable time delay on valve close, helps keep from dead-heading pumps.
- Up to 4 fluid circuits available.
- HOA works on all isolation valves – setting control in had opens all valves.

Control Algorithms:

- Disabled – No barrel isolation control.
- Compressor
  - System configures each compressor to a fluid circuit.
  - When a compressor is called to start, the associated barrel isolation valve opens.
  - When all compressors on a fluid circuit are off, and circuit is not lead, then barrel isolation valve is closed.
- Cooling EN

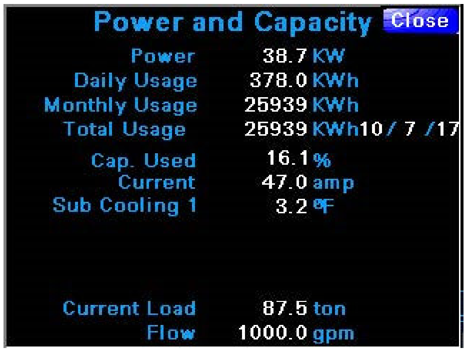
Figure 24. Barrel isolation control screen



Tonnage and Power Calculations

When a user clicks the graphic display of demand, capacity, and speed, the tonnage and power data pop-up page is displayed.

Figure 25. Power and Capacity control screen



Power and Consumption

The power calculations start from the physical value, **Power**, from the compressors – a totalized instantaneous power from all compressors in the chiller. This value is integrated over an hour period to provide **Hourly Usage**.

The **Hourly Usage** value is totalized daily for the data logging report (resets at midnight) into **Daily Usage** variable.

Also at midnight it adds up to both monthly variable **Monthly Usage** and total variable **Total Usage**. **Monthly Usage** resets on the 1st day of the month at midnight.

Total Usage however does not reset ever unless button **Reset kWh** is pressed. This button is available at **Main Menu > Settings Menu > HMI** button **> Admin Parameters** button and can be accessed by Admin user only.

Beside the **Total Usage** variable there is the date which indicates when **Total Usage** kWh count started. When **Total Usage** kWh count starts over after being reset, the date updates as well.

Tonnage

To display tonnage and flow:

1. Navigate to **HMI Configuration** screen.
2. Change **Flow Metering** mode to one of the options, see below. This will expose corresponding controls on **Chiller Control** screen.

Figure 26. Flow Metering

3. **Flow Metering** source options:
   a. User Entered – Provides **Chiller Flow Rate** data entry on the **Chiller Control** screen. Enter a theoretical flow value for the chiller.

   Figure 27. Chiller Flow Rate

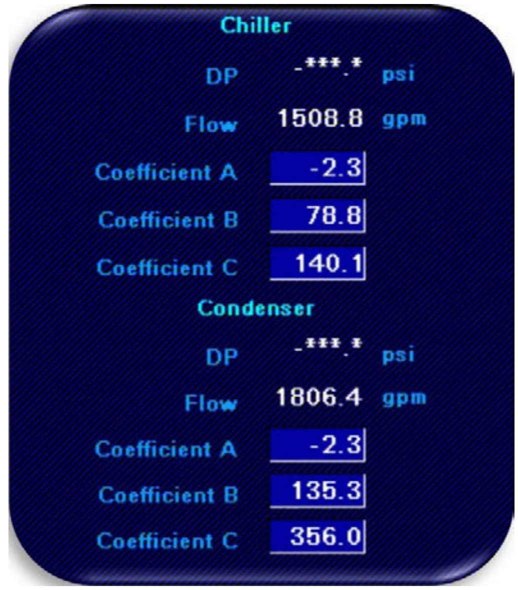
   Note: *The tonnage display will also reflect this theoretical value.*

   b. Flow Meter – relies on Main PLC analog input to have a calibrated flow rate for the chiller.
      1. Enter the **Flow Meter Maximum** value on the Chiller.

      Figure 28. Flow Meter Maximum

      2. Control screen.
      3. Differential Pressure– relies on 2 pressure sensors; one inlet and one outlet connected to Main PLC. Provides the following additional fields:



- Nominal flow – enter the design 100% load flow rate.
- Nominal Differential pressure – enter the DP reading for 100% design flow rate.
- Evaporator Flow Threshold – enter minimum value of DP that is considered a flow proof.
- Actual DP displays the difference between Entering and Leaving fluid pressures.
- Actual Flow displays the results of the internal calculation based on measured DP.

4. Enter **Fluid Compensation Factor** on the **Chiller Control** screen if the fluid used is not water.

Figure 29. Fluid Compensation Factor

Metric/Imperial Display

The System allows you to customize your display to suit your environment. Whether you prefer to see data in imperial or metric units, it is a single click of a button:

1. Navigate to the **HMI Configuration** screen – **Main Menu > Settings Menu > HMI** button.
2. Toggle the **Display Imperial** button.
   a. Button display current setting.

Figure 30. Display imperial button

BMS interconnectivity

The chiller control system supports the following BMS communication protocols:

- Modbus RTU
- Modbus IP
- BACnet MS/TP
- BACnet IP
- BACnet Ethernet (Allen-Bradley)
- LONWorks
- N2 Metasys

All chiller variables available for BMS system are read-only except for:

1. Chiller Setpoint - Variable tag CHIL_EN_01.
2. Chiller Off/Hand/Auto control - Variable tag CHIL_SP_02.

These two points will be exposed to BMS as read-write variables when corresponding options are enabled on **HMI Configuration** screen only.

Figure 31. BMS configuration screen

When BMS is connected in the preferred protocol, the entire data set is exposed. The listing is in the following table:

Table 12. BMS data listing - AV and AO

Tag Name	Description	Object Type	Array Offset	Object Instance	Modbus Address
Chiller Enable	Chiller Enable Set from BMS and Feedback	AV	0	1	40001
Chiller Setpoint	Chiller Setpoint from BMS	AV	1	2	40002
Chiller Inlet Fluid Temperature	Chiller Inlet Temperature (Integer Value with 1 implied decimals)	AO	2	3	40003
Chiller Outlet Fluid Temperature	Chiller Outlet Temperature (Integer Value with 1 implied decimals)	AO	3	4	40004
Condenser Inlet Fluid Temperature	Condenser Inlet Temperature (Integer Value with 1 implied decimals)	AO	4	5	40005
Condenser Outlet Fluid Temperature	Condenser Outlet Temperature (Integer Value with 1 implied decimals)	AO	5	6	40006
Condenser Setpoint	Condenser Setpoint (Integer Value with 1 implied decimal)	AO	6	7	40007
Chiller Limit	Chiller Limit Percent (Integer Value with 1 implied decimal)	AO	7	8	40008
Chiller State	Chiller State (see Details Page for State Enumeration)	AO	8	9	40009
Chiller Power	Chiller Power (Integer Value with 1 implied decimal)	AO	9	10	40010
Chiller 3-Phase Current	Chiller Current	AO	10	11	40011
DTC1 Compressor Power	Compressor Power (Integer Value with 1 implied decimal) - Compressor #1	AO	11	12	40012
DTC2 Compressor Power	Compressor Power (Integer Value with 1 implied decimal) - Compressor #2	AO	12	13	40013
DTC3 Compressor Power	Compressor Power (Integer Value with 1 implied decimal) - Compressor #3	AO	13	14	40014
DTC4 Compressor Power	Compressor Power (Integer Value with 1 implied decimal) - Compressor #4	AO	14	15	40015
DTC5 Compressor Power	Compressor Power (Integer Value with 1 implied decimal) - Compressor #5	AO	15	16	40016
DTC6 Compressor Power	Compressor Power (Integer Value with 1 implied decimal) - Compressor #6	AO	16	17	40017
Chiller External Load Limiting	Chiller External Load Limiting (Integer Value with 1 implied decimal)	AO	17	18	40018
DTC1 Suction Pressure	Suction Pressure (Integer Value with 1 implied decimal) - Compressor #1	AO	19	19	40020

Table 12. BMS data listing - AV and AO (continued)

Tag Name	Description	Object Type	Array Offset	Object Instance	Modbus Address
DTC2 Suction Pressure	Suction Pressure (Integer Value with 1 implied decimal) - Compressor #2	AO	20	20	40021
DTC3 Suction Pressure	Suction Pressure (Integer Value with 1 implied decimal) - Compressor #3	AO	21	21	40022
DTC4 Suction Pressure	Suction Pressure (Integer Value with 1 implied decimal) - Compressor #4	AO	22	22	40023
DTC5 Suction Pressure	Suction Pressure (Integer Value with 1 implied decimal) - Compressor #5	AO	23	23	40024
DTC6 Suction Pressure	Suction Pressure (Integer Value with 1 implied decimal) - Compressor #6	AO	24	24	40025
DTC1 Compressor State	Compressor State (see Details Page for State Enumeration) - Compressor #1	AO	35	25	40036
DTC2 Compressor State	Compressor State (see Details Page for State Enumeration) - Compressor #2	AO	36	26	40037
DTC3 Compressor State	Compressor State (see Details Page for State Enumeration) - Compressor #3	AO	37	27	40038
DTC4 Compressor State	Compressor State (see Details Page for State Enumeration) - Compressor #4	AO	38	28	40039
DTC5 Compressor State	Compressor State (see Details Page for State Enumeration) - Compressor #5	AO	39	29	40040
DTC5 Compressor State	Compressor State (see Details Page for State Enumeration) - Compressor #6	AO	40	30	40041
DTC1 Discharge Pressure	Discharge Pressure (Integer Value with 1 implied decimal) - Compressor #1	AO	43	31	40044
DTC2 Discharge Pressure	Discharge Pressure (Integer Value with 1 implied decimal) - Compressor #2	AO	44	32	40045
DTC3 Discharge Pressure	Discharge Pressure (Integer Value with 1 implied decimal) - Compressor #3	AO	45	33	40046
DTC4 Discharge Pressure	Discharge Pressure (Integer Value with 1 implied decimal) - Compressor #4	AO	46	34	40047
DTC5 Discharge Pressure	Discharge Pressure (Integer Value with 1 implied decimal) - Compressor #5	AO	47	35	40048
DTC6 Discharge Pressure	Discharge Pressure (Integer Value with 1 implied decimal) - Compressor #6	AO	48	36	40049
Chiller Capacity	Chiller Percent Capacity (Integer Value with 1 implied decimal)	AO	51	37	40052
DTC1 3-Phase Current	Compressor Current (Integer Value with 1 implied decimal) - Compressor #1	AO	52	38	40053
DTC2 3-Phase Current	Compressor Current (Integer Value with 1 implied decimal) - Compressor #2	AO	53	39	40054
DTC3 3-Phase Current	Compressor Current (Integer Value with 1 implied decimal) - Compressor #3	AO	54	40	40055
DTC4 3-Phase Current	Compressor Current (Integer Value with 1 implied decimal) - Compressor #4	AO	55	41	40056
DTC5 3-Phase Current	Compressor Current (Integer Value with 1 implied decimal) - Compressor #5	AO	56	42	40057
DTC6 3-Phase Current	Compressor Current (Integer Value with 1 implied decimal) - Compressor #6	AO	57	43	40058

Table 12. BMS data listing - AV and AO (continued)

Tag Name	Description	Object Type	Array Offset	Object Instance	Modbus Address
DTC1 Suction Temperature	Suction Temperature (Integer Value with 1 implied decimal) - Compressor #1	AO	60	44	40061
DTC2 Suction Temperature	Suction Temperature (Integer Value with 1 implied decimal) - Compressor #2	AO	61	45	40062
DTC3 Suction Temperature	Suction Temperature (Integer Value with 1 implied decimal) - Compressor #3	AO	62	46	40063
DTC4 Suction Temperature	Suction Temperature (Integer Value with 1 implied decimal) - Compressor #4	AO	63	47	40064
DTC5 Suction Temperature	Suction Temperature (Integer Value with 1 implied decimal) - Compressor #5	AO	64	48	40065
DTC6 Suction Temperature	Suction Temperature (Integer Value with 1 implied decimal) - Compressor #6	AO	65	49	40066
DTC1 Discharge Temperature	Discharge Temperature (Integer Value with 1 implied decimal) - Compressor #1	AO	76	50	40077
DTC2 Discharge Temperature	Discharge Temperature (Integer Value with 1 implied decimal) - Compressor #2	AO	77	51	40078
DTC3 Discharge Temperature	Discharge Temperature (Integer Value with 1 implied decimal) - Compressor #3	AO	78	52	40079
DTC4 Discharge Temperature	Discharge Temperature (Integer Value with 1 implied decimal) - Compressor #4	AO	79	53	40080
DTC5 Discharge Temperature	Discharge Temperature (Integer Value with 1 implied decimal) - Compressor #5	AO	80	54	40081
DTC6 Discharge Temperature	Discharge Temperature (Integer Value with 1 implied decimal) - Compressor #6	AO	81	55	40082
General Alarm Reset	Chiller General Alarm Reset (Send 1 to reset)	AO	83	56	40084
General Alarm	Chiller General Alarm (1 - New Alarm Exists)	AO	84	57	40085
Actual SP	Chiller Actual Setpoint (Integer Value with 1 implied decimal)	AO	85	58	40086
Ambient Temperature	Outside Air Temperature	AO	86	59	40087
Condenser Fan Speed	Fan Speed Control %	AO	87	60	40088
Chiller Flow	Chiller Flow Rate	AO	89	61	40090
Chiller Pump Speed	Chiller Pump Speed	AO	90	62	40091
Pump DP	Pump Differential Pressure	AO	92	63	40093
FreeCool Valve	FreeCooling Valve Position	AO	93	64	40094
Fan Bank 1 State	Fan Bank 1 Fan State	AO	94	65	40095
Fan Bank 2 State	Fan Bank 2 Fan State	AO	95	66	40096
Fan Bank 3 State	Fan Bank 3 Fan State	AO	96	67	40097
Fan Bank 4 State	Fan Bank 4 Fan State	AO	97	68	40098
Average SDT	Average SDT Temperature	AO	98	69	40099
FreeCool Fan Speed	Free Cooling Fan Speed	AO	99	70	40100

Table 13. BMS listing - BO

Tag Name	Array	Array Offset	Object Type	Object Instance	Modbus Address
DTC1 Fault: Inverter Temperature	DTC Faults	0	BO	71	10001
DTC1 Fault: Discharge Temperature	DTC Faults	1	BO	72	10002
DTC1 Fault: Suction Pressure	DTC Faults	2	BO	73	10003
DTC1 Fault: Discharge Pressure	DTC Faults	3	BO	74	10004
DTC1 Fault: 3 Phase Over Current	DTC Faults	4	BO	75	10005
DTC1 Fault: Cavity Temperature	DTC Faults	5	BO	76	10006
DTC1 Fault: Leaving Air / Water	DTC Faults	6	BO	77	10007
DTC1 Fault: Total Compression Ratio Fault	DTC Faults	7	BO	78	10008
DTC1 Fault: Generic Bearing Motor Compressor	DTC Faults	8	BO	79	10009
DTC1 Fault: Sensor Fault	DTC Faults	9	BO	80	10010
DTC1 Fault: SCR Temperature	DTC Faults	10	BO	81	10011
DTC1 Fault: Lockout Fault	DTC Faults	11	BO	82	10012
DTC1 Fault: Winding Temperature Fault	DTC Faults	12	BO	83	10013
DTC1 Fault: Super Heat Fault	DTC Faults	13	BO	84	10014
DTC2 Fault: Inverter Temperature	DTC Faults	16	BO	85	10017
DTC2 Fault: Discharge Temperature	DTC Faults	17	BO	86	10018
DTC2 Fault: Suction Pressure	DTC Faults	18	BO	87	10019
DTC2 Fault: Discharge Pressure	DTC Faults	19	BO	88	10020
DTC2 Fault: 3 Phase Over Current	DTC Faults	20	BO	89	10021
DTC2 Fault: Cavity Temperature	DTC Faults	21	BO	90	10022
DTC2 Fault: Leaving Air / Water	DTC Faults	22	BO	91	10023
DTC2 Fault: Total Compression Ratio Fault	DTC Faults	23	BO	92	10024
DTC2 Fault: Generic Bearing Motor Compressor	DTC Faults	24	BO	93	10025
DTC2 Fault: Sensor Fault	DTC Faults	25	BO	94	10026
DTC2 Fault: SCR Temperature	DTC Faults	26	BO	95	10027
DTC2 Fault: Lockout Fault	DTC Faults	27	BO	96	10028
DTC2 Fault: Winding Temperature Fault	DTC Faults	28	BO	97	10029
DTC2 Fault: Super Heat Fault	DTC Faults	29	BO	98	10030
DTC3 Fault: Inverter Temperature	DTC Faults	32	BO	99	10033
DTC3 Fault: Discharge Temperature	DTC Faults	33	BO	100	10034
DTC3 Fault: Suction Pressure	DTC Faults	34	BO	101	10035
DTC3 Fault: Discharge Pressure	DTC Faults	35	BO	102	10036
DTC3 Fault: 3 Phase Over Current	DTC Faults	36	BO	103	10037
DTC3 Fault: Cavity Temperature	DTC Faults	37	BO	104	10038
DTC3 Fault: Leaving Air / Water	DTC Faults	38	BO	105	10039
DTC3 Fault: Total Compression Ratio Fault	DTC Faults	39	BO	106	10040
DTC3 Fault: Generic Bearing Motor Compressor	DTC Faults	40	BO	107	10041

Table 13. BMS listing - BO (continued)

Tag Name	Array	Array Offset	Object Type	Object Instance	Modbus Address
DTC3 Fault: Sensor Fault	DTC Faults	41	BO	108	10042
DTC3 Fault: SCR Temperature	DTC Faults	42	BO	109	10043
DTC3 Fault: Lockout Fault	DTC Faults	43	BO	110	10044
DTC3 Fault: Winding Temperature Fault	DTC Faults	44	BO	111	10045
DTC3 Fault: Super Heat Fault	DTC Faults	45	BO	112	10046
DTC4 Fault: Inverter Temperature	DTC Faults	48	BO	113	10049
DTC4 Fault: Discharge Temperature	DTC Faults	49	BO	114	10050
DTC4 Fault: Suction Pressure	DTC Faults	50	BO	115	10051
DTC4 Fault: Discharge Pressure	DTC Faults	51	BO	116	10052
DTC4 Fault: 3 Phase Over Current	DTC Faults	52	BO	117	10053
DTC4 Fault: Cavity Temperature	DTC Faults	53	BO	118	10054
DTC4 Fault: Leaving Air / Water	DTC Faults	54	BO	119	10055
DTC4 Fault: Total Compression Ratio Fault	DTC Faults	55	BO	120	10056
DTC4 Fault: Generic Bearing Motor Compressor	DTC Faults	56	BO	121	10057
DTC4 Fault: Sensor Fault	DTC Faults	57	BO	122	10058
DTC4 Fault: SCR Temperature	DTC Faults	58	BO	123	10059
DTC4 Fault: Lockout Fault	DTC Faults	59	BO	124	10060
DTC4 Fault: Winding Temperature Fault	DTC Faults	60	BO	125	10061
DTC4 Fault: Super Heat Fault	DTC Faults	61	BO	126	10062
DTC5 Fault: Inverter Temperature	DTC Faults	64	BO	127	10065
DTC5 Fault: Discharge Temperature	DTC Faults	65	BO	128	10066
DTC5 Fault: Suction Pressure	DTC Faults	66	BO	129	10067
DTC5 Fault: Discharge Pressure	DTC Faults	67	BO	130	10068
DTC5 Fault: 3 Phase Over Current	DTC Faults	68	BO	131	10069
DTC5 Fault: Cavity Temperature	DTC Faults	69	BO	132	10070
DTC5 Fault: Leaving Air / Water	DTC Faults	70	BO	133	10071
DTC5 Fault: Total Compression Ratio Fault	DTC Faults	71	BO	134	10072
DTC5 Fault: Generic Bearing Motor Compressor	DTC Faults	72	BO	135	10073
DTC5 Fault: Sensor Fault	DTC Faults	73	BO	136	10074
DTC5 Fault: SCR Temperature	DTC Faults	74	BO	137	10075
DTC5 Fault: Lockout Fault	DTC Faults	75	BO	138	10076
DTC5 Fault: Winding Temperature Fault	DTC Faults	76	BO	139	10077
DTC5 Fault: Super Heat Fault	DTC Faults	77	BO	140	10078
DTC6 Fault: Inverter Temperature	DTC Faults	80	BO	141	10081
DTC6 Fault: Discharge Temperature	DTC Faults	81	BO	142	10082
DTC6 Fault: Suction Pressure	DTC Faults	82	BO	143	10083
DTC6 Fault: Discharge Pressure	DTC Faults	83	BO	144	10084

Table 13. BMS listing - BO (continued)

Tag Name	Array	Array Offset	Object Type	Object Instance	Modbus Address
DTC6 Fault: 3 Phase Over Current	DTC Faults	84	BO	145	10085
DTC6 Fault: Cavity Temperature	DTC Faults	85	BO	146	10086
DTC6 Fault: Leaving Air / Water	DTC Faults	86	BO	147	10087
DTC6 Fault: Total Compression Ratio Fault	DTC Faults	87	BO	148	10088
DTC6 Fault: Generic Bearing Motor Compressor	DTC Faults	88	BO	149	10089
DTC6 Fault: Sensor Fault	DTC Faults	89	BO	150	10090
DTC6 Fault: SCR Temperature	DTC Faults	90	BO	151	10091
DTC6 Fault: Lockout Fault	DTC Faults	91	BO	152	10092
DTC6 Fault: Winding Temperature Fault	DTC Faults	92	BO	153	10093
DTC6 Fault: Super Heat Fault	DTC Faults	93	BO	154	10094
DTC1 Alarm: Inverter Temperature	DTC Alarms	0	BO	155	10101
DTC1 Alarm: Discharge Temperature	DTC Alarms	1	BO	156	10102
DTC1 Alarm: Suction Pressure	DTC Alarms	2	BO	157	10103
DTC1 Alarm: Discharge Pressure	DTC Alarms	3	BO	158	10104
DTC1 Alarm: 3 Phase Current	DTC Alarms	4	BO	159	10105
DTC1 Alarm: Shaft / Cavity Temperature	DTC Alarms	5	BO	160	10106
DTC1 Alarm: Leaving Water Temperature	DTC Alarms	6	BO	161	10107
DTC1 Alarm: Total Compression Ratio	DTC Alarms	7	BO	162	10108
DTC1 Alarm: SCR Temperature	DTC Alarms	8	BO	163	10109
DTC1 Alarm: Super Heat Alarm	DTC Alarms	13	BO	164	10114
DTC2 Alarm: Inverter Temperature	DTC Alarms	16	BO	165	10117
DTC2 Alarm: Discharge Temperature	DTC Alarms	17	BO	166	10118
DTC2 Alarm: Suction Pressure	DTC Alarms	18	BO	167	10119
DTC2 Alarm: Discharge Pressure	DTC Alarms	19	BO	168	10120
DTC2 Alarm: 3 Phase Current	DTC Alarms	20	BO	169	10121
DTC2 Alarm: Shaft / Cavity Temperature	DTC Alarms	21	BO	170	10122
DTC2 Alarm: Leaving Water Temperature	DTC Alarms	22	BO	171	10123
DTC2 Alarm: Total Compression Ratio	DTC Alarms	23	BO	172	10124
DTC2 Alarm: SCR Temperature	DTC Alarms	24	BO	173	10125
DTC2 Alarm: Super Heat Alarm	DTC Alarms	29	BO	174	10130
DTC3 Alarm: Inverter Temperature	DTC Alarms	32	BO	175	10133
DTC3 Alarm: Discharge Temperature	DTC Alarms	33	BO	176	10134
DTC3 Alarm: Suction Pressure	DTC Alarms	34	BO	177	10135
DTC3 Alarm: Discharge Pressure	DTC Alarms	35	BO	178	10136
DTC3 Alarm: 3 Phase Current	DTC Alarms	36	BO	179	10137
DTC3 Alarm: Shaft / Cavity Temperature	DTC Alarms	37	BO	180	10138
DTC3 Alarm: Leaving Water Temperature	DTC Alarms	38	BO	181	10139

Table 13. BMS listing - BO (continued)

Tag Name	Array	Array Offset	Object Type	Object Instance	Modbus Address
DTC3 Alarm: Total Compression Ratio	DTC Alarms	39	BO	182	10140
DTC3 Alarm: SCR Temperature	DTC Alarms	40	BO	183	10141
DTC3 Alarm: Super Heat Alarm	DTC Alarms	45	BO	184	10146
DTC4 Alarm: Inverter Temperature	DTC Alarms	48	BO	185	10149
DTC4 Alarm: Discharge Temperature	DTC Alarms	49	BO	186	10150
DTC4 Alarm: Suction Pressure	DTC Alarms	50	BO	187	10151
DTC4 Alarm: Discharge Pressure	DTC Alarms	51	BO	188	10152
DTC4 Alarm: 3 Phase Current	DTC Alarms	52	BO	189	10153
DTC4 Alarm: Shaft / Cavity Temperature	DTC Alarms	53	BO	190	10154
DTC4 Alarm: Leaving Water Temperature	DTC Alarms	54	BO	191	10155
DTC4 Alarm: Total Compression Ratio	DTC Alarms	55	BO	192	10156
DTC4 Alarm: SCR Temperature	DTC Alarms	56	BO	193	10157
DTC4 Alarm: Super Heat Alarm	DTC Alarms	61	BO	194	10162
DTC5 Alarm: Inverter Temperature	DTC Alarms	64	BO	195	10165
DTC5 Alarm: Discharge Temperature	DTC Alarms	65	BO	196	10166
DTC5 Alarm: Suction Pressure	DTC Alarms	66	BO	197	10167
DTC5 Alarm: Discharge Pressure	DTC Alarms	67	BO	198	10168
DTC5 Alarm: 3 Phase Current	DTC Alarms	68	BO	199	10169
DTC5 Alarm: Shaft / Cavity Temperature	DTC Alarms	69	BO	200	10170
DTC5 Alarm: Leaving Water Temperature	DTC Alarms	70	BO	201	10171
DTC5 Alarm: Total Compression Ratio	DTC Alarms	71	BO	202	10172
DTC5 Alarm: SCR Temperature	DTC Alarms	72	BO	203	10173
DTC5 Alarm: Super Heat Alarm	DTC Alarms	77	BO	204	10178
DTC6 Alarm: Inverter Temperature	DTC Alarms	80	BO	205	10181
DTC6 Alarm: Discharge Temperature	DTC Alarms	81	BO	206	10182
DTC6 Alarm: Suction Pressure	DTC Alarms	82	BO	207	10183
DTC6 Alarm: Discharge Pressure	DTC Alarms	83	BO	208	10184
DTC6 Alarm: 3 Phase Current	DTC Alarms	84	BO	209	10185
DTC6 Alarm: Shaft / Cavity Temperature	DTC Alarms	85	BO	210	10186
DTC6 Alarm: Leaving Water Temperature	DTC Alarms	86	BO	211	10187
DTC6 Alarm: Total Compression Ratio	DTC Alarms	87	BO	212	10188
DTC6 Alarm: SCR Temperature	DTC Alarms	88	BO	213	10189
DTC6 Alarm: Super Heat Alarm	DTC Alarms	93	BO	214	10194
Chiller: Evaporator Flow Fault	Chiller Faults	0	BO	215	10201
Chiller: Condenser Flow Fault	Chiller Faults	1	BO	216	10202
Chiller: Communication Fault	Chiller Faults	2	BO	217	10203
Chiller: Evaporator Flow Fault with DPS	Chiller Faults	3	BO	218	10204

Table 13. BMS listing - BO (continued)

Tag Name	Array	Array Offset	Object Type	Object Instance	Modbus Address
Chiller: Condenser Flow Fault with DPS	Chiller Faults	4	BO	219	10205
Chiller: Evaporator Flow Switch	Chiller Faults	5	BO	220	10206
Chiller: Condenser Flow Switch	Chiller Faults	6	BO	221	10207
Chiller: Evaporator Pump Enable	Chiller Faults	7	BO	222	10208
Chiller: Condenser Pump Enable	Chiller Faults	8	BO	223	10209
Chiller: Low Lift Active Circuit 1	Chiller Faults	9	BO	224	10210
Chiller: Low Lift Active Circuit 2	Chiller Faults	10	BO	225	10211
Chiller: Low Lift Active Circuit 3	Chiller Faults	11	BO	226	10212
Chiller: Low Lift Active Circuit 4	Chiller Faults	12	BO	227	10213
Chiller: Barrel Isolation Circuit 1	Chiller Faults	13	BO	228	10214
Chiller: Barrel Isolation Circuit 2	Chiller Faults	14	BO	229	10215
Chiller: Evaporator Pump1 Fault	Chiller Faults	16	BO	230	10217
Chiller: Evaporator Pump1 Flow Alarm	Chiller Faults	17	BO	231	10218
Chiller: Evaporator Pump2 Fault	Chiller Faults	18	BO	232	10219
Chiller: Evaporator Pump2 Flow Alarm	Chiller Faults	19	BO	233	10220
Chiller: Condenser Pump1 Fault	Chiller Faults	20	BO	234	10221
Chiller: Condenser Pump1 Flow Alarm	Chiller Faults	21	BO	235	10222
Chiller: Condenser Pump2 Fault	Chiller Faults	22	BO	236	10223
Chiller: Condenser Pump2 Flow Alarm	Chiller Faults	23	BO	237	10224
Chiller: At Maximum Capacity	Chiller Faults	24	BO	238	10225
Chiller: No Compressor Available Fault	Chiller Faults	25	BO	239	10226

Note: *Chiller control system provides data for up to 6 compressors.*

The BMS Listing has the following characteristics:

- All values are integers.
- Some of the values like temperatures and pressures have an implied decimal place; this means that a value of 450 read from the chiller via BMS interface for Chiller Outlet Temperature, CHIL_OUT_04, means 45.0 °F (in imperial configuration).
- Some values are enumerated integers:
  - Chiller State:

Figure 32. Chiller state map

	Integer Value	Label	Font Name
Invalid			DefaultFont
0	0	IDLE	DefaultFont
1	1	START	DefaultFont
2	2	SHUTDOWN	DefaultFont
3	3	RESTART	DefaultFont
4	4	OPERATIONAL	DefaultFont
5	5	STAGE-IN	DefaultFont
6	6	STAGE-OUT	DefaultFont

  - Compressor State:

Figure 33. Compressor state map

	Integer Value	Label	Font Name
Invalid			FontResource001
0	0	Absent	FontResource001
1	1	Offline	FontResource001
2	2	Idle	FontResource001
3	3	Operational	FontResource001
4	4	Hold	FontResource001
5	5	Starting	FontResource001
6	6	Stopping	FontResource001
7	7	Retreating	FontResource001
8	8	Fault	FontResource001
9	9	Timeout	FontResource001

Table 14. Fan state map

Fan State Definition	
Value	**Label**
0	Off
1	Hand
2	Ready
3	FreeCool

Table 14. Fan state map (continued)

Fan State Definition	
4	Start
5	Cooling

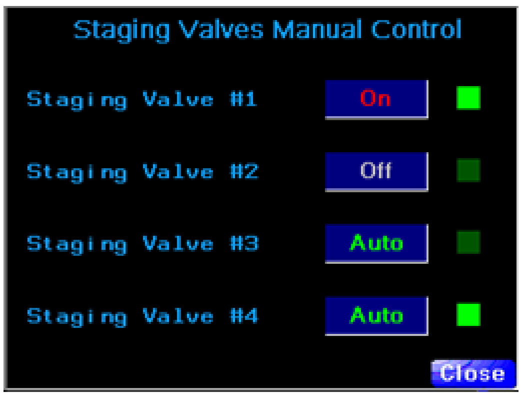
Compressor Staging Valve Control

All compressors Staging Valves controls can be accessed from compressors screen **Main Menu →Comp button → Staging** button. Controls are available for Tech level HMI users and above.

Each Staging Valve controls consist of 2 components:

1. Mode selector
2. Valve status light

Figure 34. Staging valves control screen



As per control options, each Staging Valve can be in one of the modes:

1. Off – staging valve is always off regardless of other conditions.
2. On – staging valve is forced on. Used mostly for troubleshooting or maintenance purposes.
3. Auto – staging valve is controlled automatically as compressor cycles through its states.

Optional Functionalities

The following table lists the Optional Functionalities of this control system:

Table 15. Chiller control system Optional Functionalities list

Function	Brief	Access Level
Free Cooling with ArcticBoost	Module can operate with extremely low head pressure to provide near free cooling.	Tech
Pump and Plant controls	Monitor and Control evaporator and condenser pumps functions	Tech
Data Logging	Displays chillers / compressors key data logged to CSV files	Admin
Primary/Secondary	Monitor and Control multiple chillers Primary/Secondary functions	Tech
Economizer	Monitor and Control compressors economizers functions	Tech
Hot Gas Bypass Valve	Monitor and Control compressors Hot Gas Bypass functions	Tech

Free Cooling

ArcticBoost (Low Lift Refrigerant Pump)

ArcticBoost provides free cooling without additional coils or external coolers. The ArcticBoost function allows compressors to operate at very low pressure ratios by providing a refrigerant pump to aid in motor cooling.

As condensing temperature reduce and become close to chiller side temperatures, pressure ratio (PR) reduces. When the PR drops below the Enable threshold (User-Settable – default is 1.3), the ArcticBoost function is Enabled and stays enabled until the PR rises above the Disable threshold (Enable Threshold plus 0.3).

While ArcticBoost function is Enabled, the control monitors both the Inverter and Cavity temperatures of the compressors. If either temp rises above the cooling required threshold (Default based on compressor solenoid valves but user-settable is 113.0°F), pump is enabled. When both temperatures drop below cooling no longer required threshold (Default, Settable – 108.0°F), pump is turned off and remains off for the Anti-Cycle period (Default, Settable – 30 seconds).

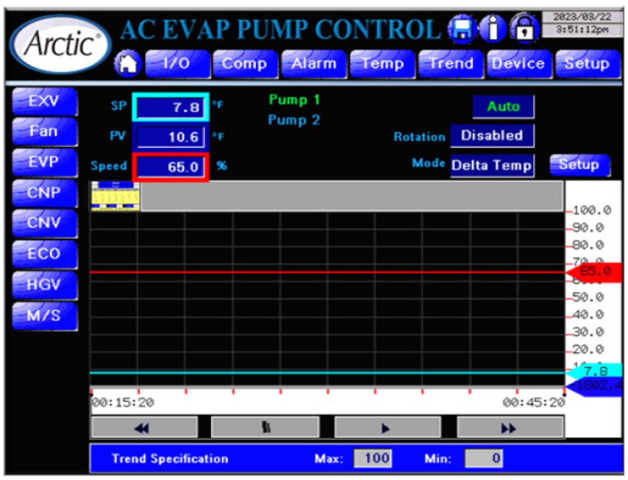
Chiller and Condenser Pump Control

The control system allows for Duty-Standby functionality on both Chiller and Condenser Pumping. The image below shows Rotation and Mode:

Note: *Only available for module dedicated pumps.*

1. Rotation:
   a. Disabled – pump 1 always runs. Pump 2 only runs if Pump 1 fails.
   b. Rotation – each invocation rotates pumps based on Runtime.
   c. Toggle – Switches pump duty.
   d. Pump *X* run selected pump.

Figure 35. Pump control HMI page



2. Mode:
   a. Disabled – no pump function
   b. Differential Pressure Control
   c. Delta Temperature Control
   d. Pass-Through Control
   e. Dual Speed Control
   f. Flow Control

   The following section details the mode functions. The setup screens below look and work similarly and have the following common features:

- Pump Data:
  – Provides available control signals. Extreme values or 0.0 values are likely not signals that can be used.
- HOA – one control for both pumps:
  – Off – no Pump Function
  – Hand – duty pump is enabled and manual speed value.
  – Auto – Duty pump is controlled by controller according to mode and setpoints.
- Pump Count – 1 or 2.
- Rotation time – pumps alternate operations duty at discrete times.
- Flow warning time – when expires, pump is assumed failed and the system switches operation.
- Delay a switch-over – last pump running to let new duty pump get to speed.
- PI controls:
  – Gain – negative value indicates reverse-acting.
  – Integral in seconds.
- Sensor Fail Speed – should control sensor fail, pump runs at this settable speed.

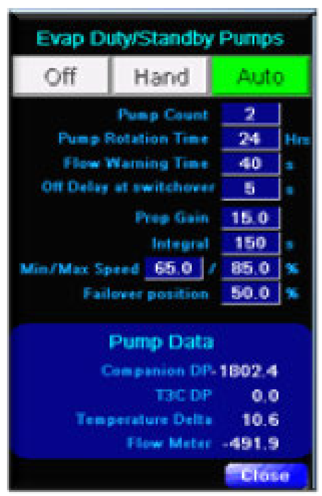
Differential Pressure Control

Pump differential control monitors pressure drop across inlet and outlet to the chiller and drives the pump between max and min speed.

2 sources:

1. T3C DP
2. Companion DP

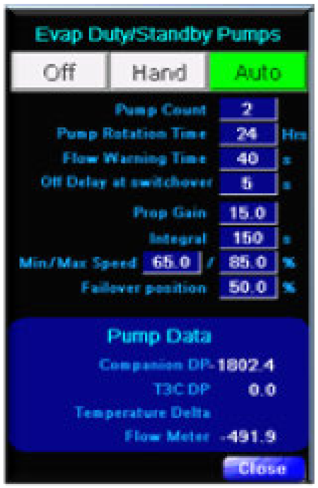
Figure 36. Differential pressure control screen



Delta Temperature Control

Delta temperature pump control monitors the inlet and outlet temperatures to the chiller and maintains a constant Delta-T across by controlling the pump between max and min speeds.

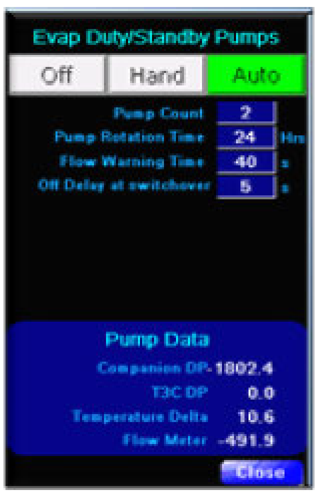
Figure 37. Delta temperature control screen



Pass-Through

Pass-through function takes an external Signal and passes it directly to the pump.

Figure 38. Pass-through screen

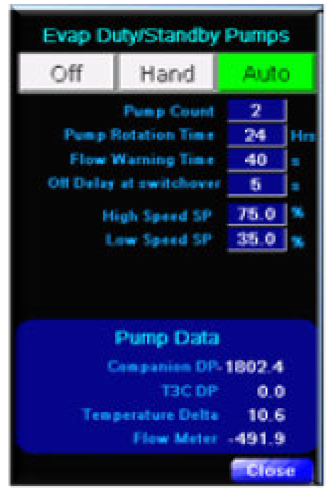


Dual-Speed Control

For use with Free Cooling to increase speed to overcome the additional pressure drop of the inline coils:

- Free Cooling Disabled – send low speed to pumps.
- Free Cooling Enabled – send high speed to pumps.

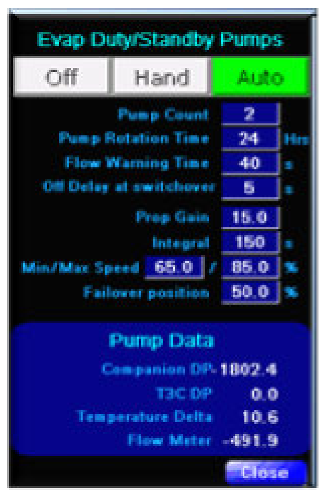
Figure 39. Dual speed control screen



Flow Control

If Flow meter present, pumps are control between max and min speed to maintain constant flow.

Figure 40. Flow control screen



Primary/Secondary Control (Chiller Array)

The Primary/Secondary functionality allows an array on n or n+m chillers to be controlled by one (Primary) controller. Where n is the number of chillers in the array and m is the number of chillers in the array that are designated as "Backup" nodes.

To enable use Manager/Subordinate functionality, click **Chiller Array Control** on the HMI Configuration screen so that it displays Enabled.

Figure 41. Chiller array control disabled screen.

It also exposes the **Chiller Array Screen** via **M/S** button. Access: **Main Menu**>**Devices Menu**>**M/S**:

- The left side of this screen provides the parameters for Primary/Secondary units.
- The right side of this screen provides status information, that details which nodes are requested to run by Primary and their actual running capacity.

Hot Gas Bypass Valves Control

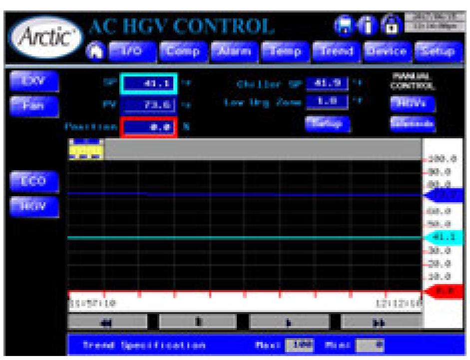
Note: *Not available on Thermafit™ TACW.*

HMI HGV Control option should be changed to Enabled in order to expose Hot Gas Valve control screen under **Devices Menu**.

Figure 42. HMI HGV control enabled screen

Controls accessed on main Hot Gas Bypass valve screen and Setup pop-up screen are common for all Hot Gas Bypass Valves. Controls available on HGVs / Solenoids pop-ups, however are individual for each Hot Gas Bypass Valve.

1. Hot Gas Bypass Valve Control



   a. Displays trend and current values for Setpoint, Process Value and Valve position.

   b. **PV**. Chiller LWT.

   c. **SP**. SP = Chiller SP – low urgency zone (refer to Chiller Control Manual) + SP Offset (described below).

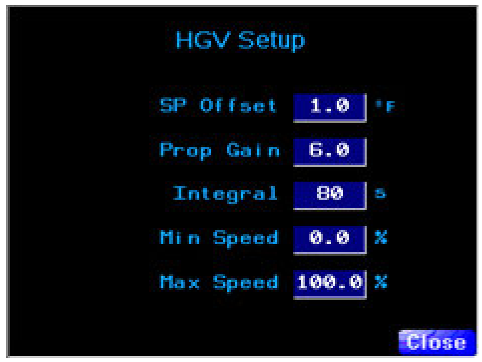
   d. **T3C dP**. Evaporator inlet / outlet pressure delta.

   e. Trend has y-axis zoom capability.

   f. **Access**: **Main Menu** > **Devices Menu** > **HGV** button.

   g. Provides access to other pop-up screens:
      - Setup
      - HGVs
      - Solenoids

2. Hot Gas Bypass Valve Setup



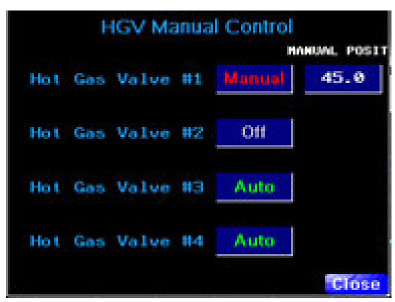
   a. **SP** Offset. Involved in setpoint calculation (see main screen SP description above).

   b. P-Gain and I PID constants.

   c. **Max** and **Min** valve position settings.

   d. **Access**: **Main Menu** > **Devices Menu** > **HGV** button > Setup button.

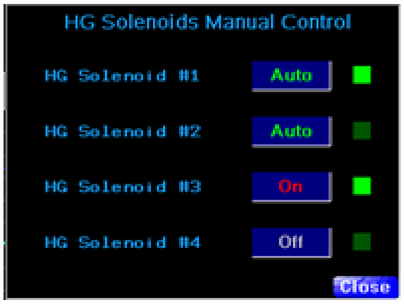
3. Hot Gas Bypass Valves manual control



   a. Each Hot Gas Bypass valve can be in one of the following modes:
      - **Auto**. Valve controlled automatically by Hot Gas Bypass PID controller;
      - **Off**. Valve is always off;
      - **Manual**. Valve position is set up manually.

   b. **Access**: **Main Menu** > **Devices Menu** > **HGV** button > **HGVs** button.

4. Hot Gas Bypass solenoids manual control



a. Each Hot Gas Bypass solenoid can be in one of the following modes:
   - **Auto**. Solenoid controlled automatically;
   - **Off**. Solenoid is always forced off;
   - **Manual**. Solenoid is always forced on.

b. **Access**: **Main Menu** > **Devices Menu** > **HGV** button > **Solenoids** button.

Security Configuration

The **TACW** Chiller control system has 3 levels of security:

1. User:
   a. Automatic Logon.
   b. View all main pages.
   c. Can turn chiller on / off.
   d. Can change user chilled water setpoint.
   e. No access to Settings and Devices screens.
2. Tech:
   a. User is responsible for day-to-day maintenance of the chiller.
   b. Has full access to Devices screens but no access to Settings screens.
3. Admin:
   a. Full Access.

   Both Admin and Tech users must log on using the button on the Main Screen and provide their username and password in the user login screen.

Alarm Handling

There are two alarms lists that can be accessed on the HMI:

- Main alarms list. It includes all the faults that cause compressors and/or chiller to shutdown and have to be handled by the operator.
- Diagnostics alarms list. It displays all the diagnostics messages and is used for preventive/troubleshooting purposes. It can be accessed by Admin user only.

1. Main alarms list:
   a. Lists all the current / acknowledged / reset.
   b. When a fault occurs, a new message appears in RED on the alarm screen.
   c. All entries must be acknowledged with these buttons:

   This turns the entry YELLOW.

   d. Then press and hold the Reset button on the screen for 10 seconds. Any condition that is clear will turn GREEN. Any condition that is still yellow means the condition still exists.
   e. When all entries on the screen are green, press the delete button:

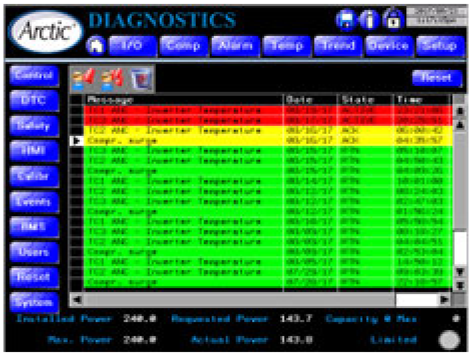
   ***Note:** Do not delete the alarm list if any are Yellow or Red.*

   f. Access: **Main Menu** > Alarm button.

2. Diagnostics alarm list
   a. Diagnostics alarms are handled in the same fashion as main list alarms.
   b. Access: **Main Menu** > **Setup Menu** > HMI button > Alarm button.
   c. Apart from alarms list the screen displays also other chiller diagnostic parameters.

   ***Note:** Do not delete the list if any are Yellow or Red.*



Operator Tasks

Before operating the unit, ensure that all compressor refrigeration service valves are fully back-seated counterclockwise and all valves are in the open position.

Normal Power Up

The following procedure is used for a startup resulting from scheduled seasonal or programmed cold shutdown of the chiller.

⚠ WARNING

Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury.
Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

Important: *This start-up procedure is not to be used for the first-time initial startup for a newly installed chiller.*

1. De-energize the chiller using standard lockout/tagout procedures.
2. Using a known operational voltage meter, test and confirm the chiller is de-energized before proceeding further.
3. Inspect power distribution fuses and overload settings to verify they are correct.
4. Restore power to all modules.
5. Inspect refrigerant pressures for each module using the touchscreen interface panel.
6. Verify pressures correlate using manifold gauges.
7. Verify chilled water flow to condenser and evaporator.
8. Monitor and record temperature and refrigerant pressures registering on the touchscreen interface panel.

Emergency Power Shutdown

The chiller includes a disconnect to turn off the high voltage to the modules. Should an emergency condition arise, the disconnect must be opened to shutdown all voltage to the chiller.

There are several ways to interrupt power to all or part of the chiller:

- Disconnect the primary power source from the building that feeds electricity to the chiller. This occurs in sudden emergencies (usually weather-related) or planned maintenance shutdowns.
- Press the HOA button to access the OFF button. Press the OFF button to disable the module. The HOA button is located on the touchscreen of each module.
- Each module has a toggle switch located on the exterior of the power panel. This switch is used to isolate power in the control panel.

Note: *Pressing the HOA button on the touchscreen interface panel does not de-energize the chiller or the high voltage current into each module's control panel. This action sends a command to the controller in each module's compressors to discontinue electrical current to that component.*

Water Quality Guidelines

Water quality must be maintained periodically by the end user to avoid scaling and corrosion inside the heat exchangers.

NOTICE

Proper Water Treatment Required!

The use of untreated or improperly treated water could result in scaling, erosion, corrosion, algae or slime.
Use the services of a qualified water treatment specialist to determine what water treatment, if any, is required. Trane assumes no responsibility for equipment failures which result from untreated or improperly treated water, or saline or brackish water.

Table 16. Water quality guidelines

Element/Compound/Property	Value/Unit
pH	7.5 - 9.0
Conductivity	< 500 µS/cm
Total Hardness	4.5 - 8.5 dH°

Table 16. Water quality guidelines (continued)

Element/Compound/Property	Value/Unit
Free Chlorine	< 1.0 ppm
Ammonia (NH3)	< 0.5 ppm
Sulphate (SO42–)	< 100 ppm
Hydrogen Carbonate (HCO3–	60 – 200 ppm
(HCO3–) / (SO42–)	> 1.5
(Ca + Mg) / (HCO3–)	> 0.5
Chloride (Cl-)	< 200 ppm

Notes:

1. *Total Hardness/corrosion: Water with high hardness can cause corrosion problems due to its high ion content (Ca+2, Mg+2, Fe+2) which also means a high electrical conductivity and a high total dissolved solid (TDS). For this reason, too high hardness values should be avoided, not only due to higher risk of scaling, but also for corrosion risk. On the other hand, soft water, but not necessarily cation exchange softened water, may in contrast have a low buffering capacity and so be more corrosive. If the hardness values are outside the recommended range, other parameters such as oxygen content, conductivity, and pH values should be considered to evaluate the corrosion risk.*
2. *Fe3+ and Mn4+ are strong oxidants and may increase the risk for localized corrosion on stainless steels in combination with brazing material copper.*

Monitor Water Quality

Maintaining water/glycol mixture quality and cleanliness is critical to chiller health and maintainability. Water/glycol mixture samples should be taken and tested by a professional lab. The results will enable the accurate adjustment of quality thereby increasing the operational life of the chiller.

Note: *Trane will not validate the chiller warranty if the proper water/glycol mixture composition and quality is not maintained.*

Protect the chiller from freezing, particularly if the chiller has a set point that is lower than the freezing point of the water/glycol mixture in the chiller. The chiller is designed to operate with a maximum propylene glycol concentration of 50%. See Table 17, p. 53, for the effects on the chiller when operating with other glycol concentrations.

Table 17, p. 53 shows the capacity reduction and the pressure drop that occurs when higher concentrations of glycol are used.

Maintain Glycol Level

When the chiller has a water set point that is below the freezing point of the water/glycol in use, take precautions against freezing.

The glycol concentration should be based on the lowest fluid design temperature. See Table 18, p. 54 provides guidelines for adding propylene glycol.

Table 17. Glycol performance impact factors

Range Factor	Glycol Concentration Percentages and Performance Impact					
Propylene Glycol Concentration	30%		40%		50%	
Lowest Ambient Temperature	10 °F (-12 °C)		-4 °F (-10 °C)		-20 °F (-29 °C)	
Recommended Minimum Leaving Fluid Temperature	25 °F (-4 °C)		10 °F (-12 °C)		-10 °F (-23 °C)	
Leaving Temperature	Capacity Reduction Factor	Pressure Drop Factor	Capacity Reduction Factor	Pressure Drop Factor	Capacity Reduction Factor	Pressure Drop Factor
70 °F (21 °C)	0.96	1.27	0.93	1.43	0.91	1.63
60 °F (15.6 °C)	0.95	1.31	0.92	1.47	0.90	1.68
55 °F (13 °C)	0.95	1.31	0.92	1.50	0.89	1.73
50 °F (10 °C)	0.94	1.33	0.91	1.51	0.88	1.75

A 10% to 50% solution of glycol should be added to prevent pipe corrosion regardless of the fluid temperature. Propylene glycol has corrosion inhibitors that protect piping and components from corrosion and buildup of rust and other deposits. Trane recommends against using water/ glycol solution in excess of 50% regardless of the ambient temperature conditions.

NOTICE

Equipment Damage!

Failure to follow instructions below could result in permanent damage to pump and internal cooling surfaces.

Do not use automotive antifreeze.

Note: *If glycol-free solutions are mandated at the chiller site, special inhibitors are available for rust prevention, mineral deposit inhibition, and biological suppression. Adding these inhibitors to the water solution is strongly recommended.*

Heaters, heat tracing cable, and closed cell insulation can be installed on any exposed "wet" chiller components for protection against freezing in low ambient temperature and low refrigerant pressure conditions. However, the best freeze prevention is using the appropriate concentration of glycol. Trane does not warranty any component that fails due to freezing.

Prevent Freezing

Many liquids expand in volume upon cooling. This expansion may cause pipes and other enclosed systems containing a liquid to rupture or burst when exposed to low temperature conditions. Burst protection is needed to protect piping and other enclosed systems when they are inactive as they could rupture due to expansion during cold weather or low refrigerant pressure.

In order to maintain a high-quality glycol solution, the water used in the glycol mixture must have very few impurities. Impurities in the water can increase metal corrosion, aggravate pitting of cast iron and steel, reduce the effectiveness of the corrosion inhibitors, and increase the depletion rate of the inhibitor package.

To assure inhibitor effectiveness, the levels of chlorides and sulfates in the water should not exceed 25 ppm each. The total hardness in terms of calcium carbonate should be less than 100 ppm. For best long-term results, de-ionized or distilled water is recommended.

Propylene Glycol

Glycol-based fluids provide such burst protection in water solutions due to their low freezing points. As a glycol-based fluid cools below the solution's freezing point, ice crystals begin to form, and the remaining solution becomes more concentrated in glycol. This ice/water/glycol mixture results in a flowable slush, and remains fluid, even as the temperature continues to cool.

The fluid volume increases as this slush forms and the temperature cools, flowing into available expansion volume in the chiller. If the concentration of glycol is sufficient, no damage to the chiller from fluid expansion should occur within the temperature range indicated in . When liquids are cooled, they eventually either crystallize like ice or become increasingly viscous until they fail to flow and set up like glass. The first type of behavior represents true freezing. The second is known as super-cooling.

Glycols do not have sharp freezing points. Under normal conditions, propylene glycol sets to a glass-like solid, rather than freezing.

The addition of glycol to water yields a solution with a freezing point below that of water. This has led to the extensive use of glycol-water solutions as cooling media at temperatures appreciably below the freezing point of water. Instead of having sharp freezing points, glycol-water solutions become slushy during freezing. As the temperature falls, the slush becomes more and more viscous and finally fails to flow.

Table 18. Freeze and burst protection chart

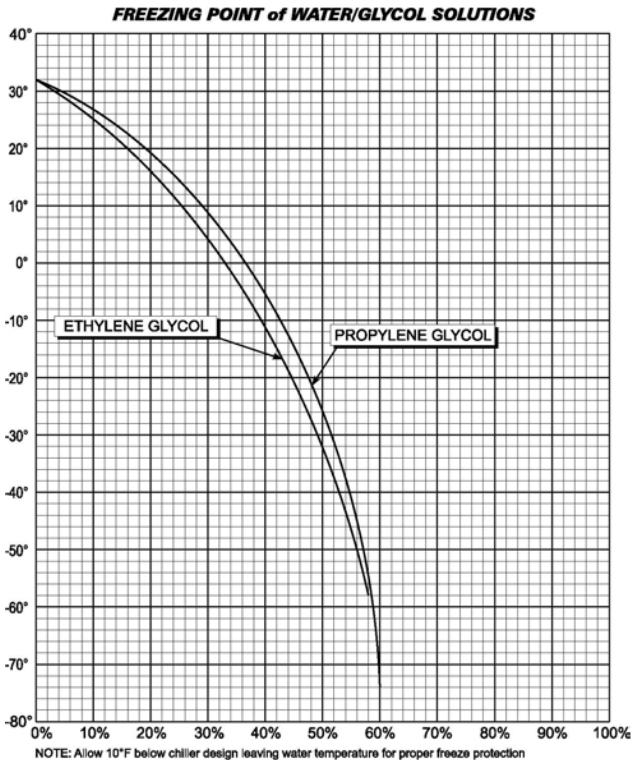
Water/Glycol Temperature	Freeze Protection	Burst Protection
20 °F (-7 °C)	18% glycol mixture	12% glycol mixture
10 °F (-12 °C)	29% glycol mixture	20% glycol mixture
0 °F (-17.8 °C)	36% glycol mixture	24% glycol mixture
-10 °F (-23 °C)	42% glycol mixture	28% glycol mixture
-20 °F (-29 °C)	46% glycol mixture	30% glycol mixture

The precise concentration of glycol for a particular chiller is affected by several key factors such as ambient temperature extremes, entering and leaving water temperatures, and chiller size. A chiller's optimum glycol concentration is modified by these considerations as reflected in Table 17, p. 53. These capacity correction factors are the "best informed estimates" for chiller with copper evaporators. The percentages may vary depending on the materials and alloys of the heat exchangers, total surface area, the amount of present or future fouling, and the brand of glycol used.

Storage Provisions

The chiller controls are designed for storage in ambient temperatures from -20 °F (-29 °C) to 145 °F (63 °C) with relative humidity from 0% to 100%. The glycol should be removed from the chiller if the unit is to be stored for extended periods. Although fluids can be drained via the plug in the bottom of the evaporator, the inhibitors in an approved glycol solution will best protect the surfaces of the evaporator against oxidation if the glycol remains inside the chiller during storage.

Figure 43. Water/Glycol concentration freezing points (in degrees Fahrenheit)



Unit Controls

The control system is comprised of PLC, HMI and BAS interface device. All unit controls and devices have been factory installed and tested prior to shipment. The control circuit incorporates all major safety devices and control features for optimum performance and reliability. Display screen will indicate status of all equipment and parameters. Any fault in the system can be detected without any manual intervention.

Chiller Controller

Mechanical chilling is controlled via T3C and Companion Controller (both are Danfoss MCX products). This Danfoss refrigeration controller is specifically designed to work with the turbocor oil-less compressors in the most efficient manner. All I/O and Setpoints are displayed on a Schneider HMI.

Freeze Protection

The freeze control senses the temperature of the chilled water outlet from the evaporator. It shuts down the module, enables pumps, and opens any isolation valves under the control of the module if abnormally low water temperature is reached (Factory set based on freezing point of chilled or condenser fluid).

Chilled Water Flow Switch

Chilled water flow switch is a safety device which prevents the unit from operating with little or no water flows through the evaporator.

NOTICE

Proof of Flow Switch!

Failure to provide flow switches or jumping-out of switches could result in severe equipment damage. Evaporator and condenser water circuits require proof of flow switches.

- **Failure to include the proof of flow devices and/or jumping out these devices could cause the unit to stop on a secondary level of protection.**
- **Frequent cycling on these higher level diagnostic devices could cause excessive thermal and pressure cycling of unit components (O-rings, gaskets, sensors, motors, controls, etc.) and/or freeze damage, resulting in premature failure of the chiller.**

Temperature Control

The temperature transducers sense the return chilled water temperature, and the controller monitors this signal and cycles the refrigeration system to maintain accurate process water temperature. The set point can be changed using HMI.

Electronic Expansion Valves

The Electronic Expansion Valve (EXV) is a metering device that automatically controls the flow of refrigerant to the evaporator based on superheat/sub-cooling. The EXV allows operation at low condensing pressures/ temperatures and saves energy by increasing the efficiency of the chiller through precise superheat/sub-cooling control.

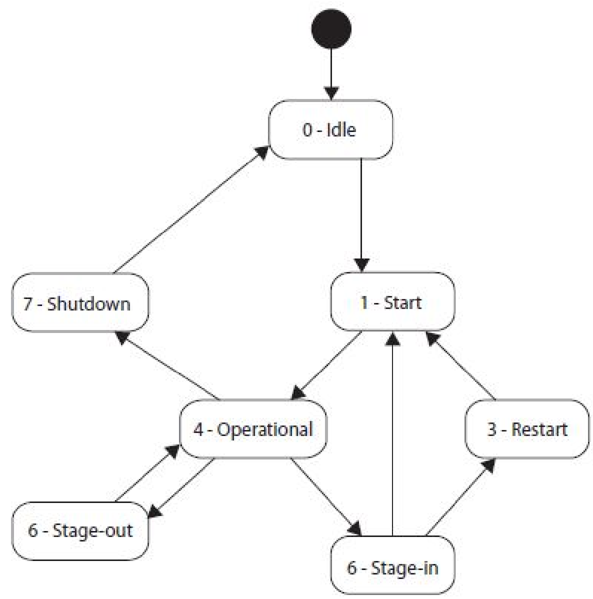
Sequence of Operations

When chiller starts (from 'Idle' state):

1. Enable signal sent from BAS sets digital input on chiller control to true. Chiller controller waits for (adjustable) low urgency zone (LUZ) timer before acting on BAS enable.
2. If the LCHWT is greater or equal than the chiller temperature setpoint plus the "ΔT over set point" and there are compressors available to run, the chiller is set to 'Start' state.
3. If compressor is available, the adjustable Start Demand (default 65%) is sent to the compressor and the compressor starts.
4. This software is capable of staging multiple compressors (up to 6) but Thermafit TACW is a single compressor chiller only. Therefore, this chiller should not go to state 'Stage-in' or 'Stage-out'.
5. Once the compressor state becomes 'Operational' the chiller state also goes to 'Operational', the PID loop takes control supplying demand to the compressors based on the error between the set point and leaving chilled water temperature.
   a. If the chilled water temperature drops below the set point temperature for a period longer than the adjustable stage out timer, the chiller controller will determine if it should shutdown a compressor. Chiller goes in shutdown state.
      - The inlet guide vane must have remained at a position lower than the chiller controller IGV STAGE DOWN, % for the adjustable Stage Out Timer.
        (OR)
      - The chiller demand has reduced to less than the adjustable minimum demand for last compressor.

Chiller Operational States

Figure 44. Chiller Operational States Flow Chart



Idle State

The chiller is standing idle (zero capacity) but is ready for start of the first compressor.

Start State

The pressure ratio must be kept low while one or more compressors are in the process of starting. The start state maintains the low-pressure ratio until all running compressors have reached sufficient speed to operate without risk of surging. At that point, the state is changed into the operational state.

Operational State

The chiller is in normal operation.

Stage-In State

Note: *Not needed on Thermafit™ TACW.*

Starting a compressor when other compressors are already running requires some care because the pressure ratio has to be low enough to start a compressor.

This is the purpose of the stage-in state. The system is instructed to lower the pressure ratio and the rack controller contributes by instructing all running compressors to reduce their capacity (the retreating and hold states of the individual compressor states below. As soon as the pressure ratio has reached the threshold, the new compressor is instructed to start and the state changes into start state.

Restart State

***Note:** Not needed on Thermafit TACW.*

It is assumed in the stage-in state that the pressure ratio will come down below the threshold where another compressor can be started. However, it must be assumed that this is not always the case (although this should not happen in a well-designed system unless it is malfunctioning). In that case, all compressors will be stopped and restarted together with one additional compressor. In the restart state, all compressors are signaled to stop. As soon as they have all reached full stop, the controller signals start to all compressors that need to be started and switches into the start state.

Stage-out State

***Note:** Not needed on Thermafit TACW.*

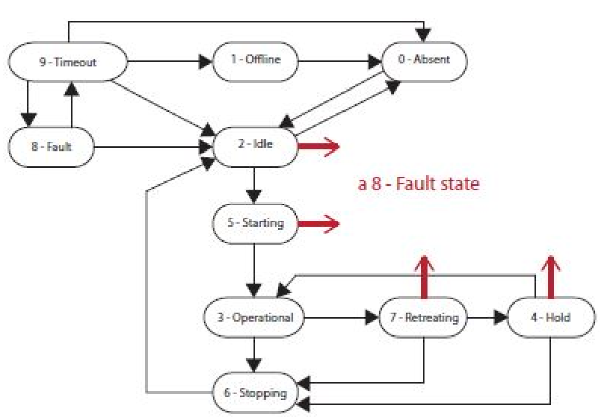
In the stage-out state, one compressor is instructed to stop in order to reduce capacity. When it has reached full stop, the state switches automatically back to the operational state.

Shutdown State

The shutdown state is similar to the stage-out state with the sole exception that in this case the last running compressor is being stopped. The shutdown state therefore switches into the idle stage when this compressor reaches full stop.

Compressor Control States

Figure 45. Compressor Control States Flow Chart



Absent State

A chiller may contain less than the maximum allowed number of compressors. This leaves some of the state machines unused and uninitialized. This is indicated by the absent state.

Offline State

The offline state indicates that the compressor is not to be started. This can be due to three reasons:

1. The operator has taken the compressor offline for maintenance.
2. The compressor encountered a fault state which cannot be recovered by the controller (the operator needs to recycle the power manually).
3. The controller lost its Modbus connection to the compressor.

Idle State

The compressor is currently idle but it is online and ready for use.

Starting State

The compressor has received a start demand and is in the process of speeding up. The state automatically switches into the operational state when the compressor reaches sufficient speed to operate normally without risk of surging.

Operational State

The compressor is in normal operation.

Stopping State

The compressor has received a stop signal (0% demand) and is in the process of slowing down. The state automatically switches into the idle state when the compressor reaches full stop.

Retreating State

***Note:** Not needed on Thermafit™ TACW.*

Compressors cannot be started against a high-pressure ratio. Thus, it is sometimes necessary to bring the pressure ratio down before another compressor can be started.

It is advisable to do this as quickly as possible so that the interruption of the normal operation is reduced to a minimum. This involves the entire chiller (for example utilizing condenser and bypass valves).

The compressors that are already running can help by reducing their power as much as possible. This is implemented as the retreating state, power is reduced as long as the pressure ratio is too high to start another compressor. It automatically switches into the hold state as soon as the threshold is reached.

Hold State

***Note:** Not needed on Thermafit TACW.*

The compressor keeps running at low power after the retreating state has changed into the hold state. It returns to normal operation after the new compressor has been started (i.e. when it has reached its operational state).

Fault State

The compressor has shut itself down after it detected a fault. The controller attempts to clear the fault, with three possible outcomes:

1. The fault is reset, and the compressor is made available for normal use again by switching into the idle state.
2. After overheating faults (motor or electronics have become too hot), the compressor is given some extra time to cool down by changing into the timeout state. This ensures that the compressor cools down well below its alarm threshold before it can be started again.
3. Some faults cannot be reset by the controller, for example when the compressor is damaged. The controller then takes this compressor out of circulation by switching into the offline state.

Timeout State

The compressor has recovered from an overheat fault. It is given some additional time to cool down before it becomes available.

Maintenance Procedures

Maintenance Strategy

The primary goal of preventive maintenance is to avoid the consequences of failure of equipment. This may be by preventing the failure before it actually occurs which preventive maintenance helps to achieve. It is designed to preserve and restore equipment reliability by replacing worn components before they actually fail. In addition, operators can record equipment operating conditions, temperatures, and pressures so they know to replace, or repair worn parts before they cause chiller failure. The ideal maintenance program predicts and prevents unnecessary and costly repairs and chiller down time. Trane chillers are designed for ease of access with a premium placed on locating key components to facilitate visual inspection and hands-on verification.

Maintenance for HVAC equipment and facilities can include a “preventive maintenance checklist” which includes small checks which can significantly extend service life.

Power Disconnect Handle

TACW modular units are equipped with a panel-mounted disconnect handle installed on the outside of the power distribution panel. The disconnect handle must be turned to the off position before the panel can be opened for service. When the panel door is open, power can be reconnected by turning the handle located on the inside of the panel to the ON position.

⚠ WARNING

PPE for Arc/Flash Required!

Failure to wear appropriate PPE could result in death or serious injury.

On this unit, if the handle shield is cracked the circuit breaker could arc/flash when reset. To avoid being injured, technicians MUST put on all necessary Personal Protective Equipment (PPE), in accordance with NFPA70E for arc/flash protection, PRIOR to entering the starter panel cabinet.

NOTICE

Component Damage!

Failure to follow instructions could damage sensitive electronic components beyond repair.

To prevent arcing or surges of electrical current, do not use wires or cables to jump components or bypass the manufacturer's safety systems.

Federal Clean Air Act

Responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be properly certified. The Federal Clean Air Act prescribes procedures for handling, reclaiming, recovering, and recycling of refrigerants and the equipment that must be used in maintenance procedures involving potential leakage of HVAC refrigerants. State and local governments may have additional requirements that must be followed to responsibly handle HVAC refrigerants.

Inspection and Maintenance Schedule

Proactive measures should be taken to prevent potential problems with the chillers. These include maintaining an operational log and conducting weekly, quarterly, and annual inspections of the chiller.

Inspection Methods

Appropriate inspection for modern chillers can be described as “hands on”. Where possible and appropriate, visual inspection should include touching the component or apparatus being inspection. The sense of touch provides additional feedback regarding temperature, texture, tightness, and dryness that “eyes only” inspection cannot match. Habitually touching each item to be inspected also ensures that items are not subconsciously skipped during the inspection process.

Maintenance Checklist

Spring - Major Inspection

- Cleaning condenser tubes using the appropriate equipment designed for tube punching.
- Connect to the compressors using the proper software and perform routine maintenance checks.
- Remove panels from compressors and physically check electrical components for wear and tear.
- Inspect all electrical panels and components for wear and tear.
- Check and verify all safeties.
- Calibrate Temperature sensors.
- Perform proper leak check on chillers and tag.
- Check operation of automatic valves on Chiller.
- Extract logs from chiller and clean SD card (if data logging is enabled).

Spring - Minor Inspection

- Check physical condition of chiller e.g. insulation, compressors, valves, sensors, etc. for damage.
- Check for excessive vibration caused from external sources.
- Insure all electrical connections are secure.
- Verify operation of IGV’s.
- Verify operation of EXV’s.
- Verify operation of level sensors (if chiller has one).

- Verify operation of Staging valves.
- Verify system operation by recording chiller operation e.g. sub- cooling, superheat, water temps, etc.

Winter - Major Inspection

- Cleaning condenser tubes using the appropriate equipment designed for tube punching.
- Connect to the compressors using the proper software and perform routine maintenance checks.
- Remove panels from compressors and physically check electrical components for wear and tear.
- Inspect all electrical panels and components for wear and tear.
- Check and verify all safeties.
- Calibrate temperature sensors.
- Perform proper leak check on chillers and tag.
- Check operation of automatic valves on Chiller.
- Extract logs from chiller and clean SD card.

Maintenance Schedule

⚠ WARNING

Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury.

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/ tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

⚠ WARNING

Refrigerant under High Pressure!

Failure to follow instructions below could result in an explosion which could result in death or serious injury or equipment damage.

System contains refrigerant under high pressure. Recover refrigerant to relieve pressure before opening the system. See unit nameplate for refrigerant type. Do not use non-approved refrigerants, refrigerant substitutes, or refrigerant additives.

Table 19. Maintenance schedule

Task	Daily	Quarterly	Bi-annually	Annually	Other
General Inspection					
Check physical condition of chiller e.g. Insulation, compressors, valves, sensors, etc.		X			
Check Chiller for excessive vibration caused from external sources		X			
Check for oil in the system. Chiller must operate in an oil free environment.[(a)]				X	
Verify external components are in working order e.g. Cooling towers, Pumps, Air handlers, Water valves etc.		X			
Verify chilled/ condenser water pressure gauges and record data	X				
Chiller Inspection					
Clean condenser and/or evaporator using appropriate equipment designed for tube punching (perform as needed) air cooled chillers require condenser cleaning				X	
Check the integrity of the evaporator and condenser tubes once every 5 years or as needed.[(b)]					X
Verify condenser water and chilled water pressure drops to insure proper flow (use flow meter for better accuracy)		X			
Compressor Inspection					
Connect to the compressors using the Service Monitoring Tools software and download event and fault logs, create yenta file recordings. Review and save logs for future reference.[(c)]		X			
Using the proper software, perform bearing calibrations to verify compressor performance (save calibration reports for proof)				X	
Using the proper software, verify all adjustable settings are accurate to your application via air/ water cooled		X			
Check DC bus voltages on compressors				X	

Table 19. Maintenance schedule (continued)

Task	Daily	Quarterly	Bi-annually	Annually	Other
Ensure all communication cables are secure		X			
Ensure all electronic modules are secure.		X			
Check physical condition of all exposed printed circuit boards (PCBs).			X		
Check all exposed PCBs for dust build-up and clean if necessary.			X		
Check discharge and suction pressure/ temperature sensors for accuracy against calibrated pressure/temperature gauges				X	
Re-apply Gel Lanoline to connections suggested by Turbocor once every 2 years to protect against moisture buildup					X
Electrical Inspection					
Verify that all electrical connections on chiller are tight			X		
Check and record main power supply voltage to chiller and each compressor			X		
Check for signs of hot spots/ discoloration on power cables, line reactors, distribution blocks and any other connection point		X			
Check amperages during operation are as per design	X				
Check for damaged/ stripped wires (around panel doors, casings, pinch points)				X	
Check operation of all system safety devices and interlocks			X		
Calibrate temperature sensors			X		
Refrigeration Inspection					
Check system for leaks using an electronic leak detector			X		
Replace relief valves as per your local codes or once every 5 years					X
Verify operation of compressor IGV's, EXV's, Hot Gas Valves, Staging Valves, Level Sensors		X			
Check system and motor-cooling liquid line to ensure sufficient sub-cooling.		X			
Verify discharge check valve operations. If there is backward gas flow immediately after stopping the compressor, replace the check valve.			X		
Inspect/clean motor-cooling strainer (if service has taken place).					X
Communications and Controls Inspection					
Verify communication between HMI, PLC, and BMS via BMS Interface page		X			
Other Inspections					
Verify panel heater is set above 45°F and is in working condition			X		
Verify optional heat trace is operating correctly and is set above 33°F			X		

(a) During motor cooling strainer service or any other service, verify that there is no oil contaminating the refrigeration system.
(b) This verification should be performed by a competent company using nondestructive equipment. If chiller is under factory warranty, reports should be emailed to arctic.warranties@tranetechnologies.com.
(c) Fault and event logs should be emailed to arctic.warranties@tranetechnologies.com if the equipment is under warranty.

Winter Shutdown Preparation

Dry Layup Shutdown

Rooms where chillers have chance of freezing or coming in contact with hot water:

1. Close chilled water and condenser water isolation valves (if available).
2. Drain chilled water and condenser water barrels.
   a. If valves were not available both loops will need to be drained completely.
3. Remove condenser and chilled water bell ends.
   a. If chiller is single or three pass, one pipe end should be removed.
4. Using nitrogen or an air compressor blow out all tubes to ensure no water is left inside.

Wet Layup Shutdown – Unheated Rooms

Rooms where chillers will have chance of freezing but not connected to the boiler loop:

1. Close chilled water and condenser water isolation valves (if available).
   a. If valves are not available, they will need to be installed.
2. Drain chilled and condenser water barrels.
3. Completely fill the barrels with an appropriate amount of ethylene glycol solution for 15˚F (8.3˚C) below the expected low ambient condition.
4. Leave the barrels full of the solution until startup.
5. Mark the barrel stating what was left inside for precautions next season.

Wet Layup Shutdown – Heated Rooms

Rooms that are heated and will not have contact with hot water:

1. Close chilled water and condenser water isolation valves (if available).
   a. If valves are not available, they will need to be installed.
2. Talk to local chemical treatment company for correct chemical treatment for water left in barrel over winter.
   a. If treatment needs to be changed, make proper arrangements.

Maintenance Tasks

The maintenance tasks described herein present the basic, minimal, steps required to successfully complete a task. Local policies and protocols may require more elaborate procedures with additional checks and inspections.

Critical Cleaning Tasks

Flooded Shell and Tube Heat Exchanger Cleaning Tasks:

NOTICE

Proper Water Treatment Required!

The use of untreated or improperly treated water could result in scaling, erosion, corrosion, algae or slime.
Use the services of a qualified water treatment specialist to determine what water treatment, if any, is required. Trane assumes no responsibility for equipment failures which result from untreated or improperly treated water, or saline or brackish water.

Condenser tube fouling is suspect when the approach temperature (i.e., the difference between the refrigerant condensing temperature and the leaving condenser water temperature) is higher than predicted. Standard water applications will operate with less than a 9°F approach. If the approach exceeds 9°F and there is noncondensable in the system, cleaning the condenser tubes is recommended.

Note: *Glycol in the water system typically doubles the standard approach. If the annual condenser tube inspection indicates that the tubes are fouled, 2 cleaning methods can be used to rid the tubes of contaminants.*

Mechanical Cleaning Procedure

This method is used to remove sludge and loose material from smooth-bore evaporator/condenser tubes.

1. Remove the retaining bolts from the water boxes (if equipped) at each end of the evaporator and condenser. Use a hoist to lift the water boxes.
2. Work a round nylon or brass bristled brush (attached to a rod) in and out of each of the water tubes to loosen the sludge.
3. Thoroughly flush the evaporator/condenser water tubes with clean water. (To clean internally enhanced tubes, use a bi-directional brush or consult a qualified service organization for recommendations.).

Chemical Cleaning Procedure

Scale deposits are best removed by chemical means. Consult a qualified water treatment specialist (i.e., one that knows the local water supply chemical/mineral content) for a recommended cleaning solution suitable for the job. (A standard condenser water circuit is composed solely of copper, cast iron and steel.)

Improper chemical cleaning can damage tube walls. All of the materials used in the external circulation system, the quantity of the solution, the duration of the cleaning period, and any required safety precautions should be approved by the company furnishing the materials or performing the cleaning.

Note: *Chemical tube cleaning should always be followed by mechanical tube cleaning.*

Compressor Tasks

Compressor Removal

⚠ WARNING

Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury.
Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

1. Isolate the compressor power.
2. Remove the Mains Input Cover.
3. Remove the AC mains cables from the compressor terminals. Protect/Isolate cable ends.
4. Remove the Mains Input ground wire from the ground post.
5. Remove the cable gland that secures the Mains Input cable conduit to the Mains Input bracket.
6. Remove the Service Side Cover.

   Important: *Ensure that there is no secondary power source connected to the compressor before disconnecting the I/O cable.*
7. Disconnect the I/O cable from the Backplane I/O connector (J7) and remove the cable from the compressor.
8. Reinstall the Service Side Cover.
9. Once the transfer of refrigerant is complete, bring the compressor back to atmospheric pressure according to industry standards using dry nitrogen.
10. Disconnect the compressor from the refrigerant system connections (suction, discharge, economizer and motor cooling line), taking care when removing connections that there is no residual pressure.
11. Reinstall the Mains Input Cover.
12. Remove the four compressor mounting bolts and associated hardware.
13. Connect an appropriate lifting device to the eyebolts provided on each side of the compressor and remove compressor.
14. Using the blanking plates and bolts provided with the new compressor, seal the compressor and charge to 25 psi with inert gas for shipment (this will prevent moisture and foreign material from entering the compressor).

Compressor Installation

⚠ WARNING

Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury.
Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

Note: *Blanking plates should not be removed from the new compressor until you are ready to place the new compressor in position. New compressors are pressurized with inert gas to 50 psi. Pressure should be relieved through the Schrader valve, located next to the motor cooling connection, prior to removing the blanking plates.*

1. Inspect the compressor to ensure all connections and fasteners are correctly installed.
2. Relieve the inert gas pressure through the motor cooling Schrader valve.
3. Remove the suction, discharge and economizer (if applicable) blanking plates from the new compressor.
4. Remove the motor cooling inlet adapter cap.
5. Mount the compressor in position and install the rubber mounts and hardware.
6. Attach all refrigerant line connections to the compressor using the new O-rings supplied with the compressor.
7. Tighten the economizer flange bolts (if applicable).
8. Tighten the discharge flange bolts.
9. Tighten the motor cooling line connection.
10. Tighten the suction flange bolts.
11. Remove the Service Side Cover.
12. Connect the compressor I/O cable to the Backplane.
13. Remove the Mains Input Cover.
14. Connect the cable gland that secures the Mains Input cable conduit to the Mains Input bracket.
15. Install the Mains Input ground wire to the ground post.
16. Attach the AC mains cables to the terminals.
17. Re-install the Mains Input Cover.
18. Leak test the compressor to appropriate pressure and industry accepted standards.
19. Evacuate compressor to appropriate pressure and industry accepted standards.
20. Charge the compressor with refrigerant.
21. Apply power to the compressor.

Chiller Troubleshooting

Abnormal Operation Sequence

Chiller in Alarm Avoidance

The Chiller Management System continuously monitors for abnormal system conditions such as low suction pressure, high discharge pressure, low leaving temperature, high amp draw and others.

The controller implements a three-stage alarm management strategy in order to stay online as long as possible. The alarm management routine operates as follows:

Figure 46. Chiller alarm management routine chart

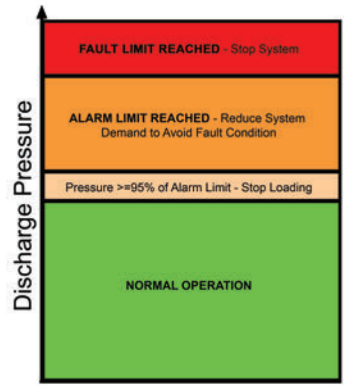


Table 20. Alarm state descriptions

Alarm State	Action Taken by Controller
All monitored values are normal	No action required. Alarm can be deleted from list.
One or more monitored value(s) is within 5% of the alarm setting	If system is loading, the system stops loading.
One or more monitored values is equal to or greater than the alarm setting	System demand is reduced by 0.5% per second until demand reaches 10% or compressors ride to the surge speed. If the alarm is still present and the compressors are at the surge speed, the controller will enter 'Stage-out' state turning compressors off every 2 minutes until the last compressor is left operational.
One or more monitored value(s) is equal to or greater than the trip setting	Chiller is turned off and all compressors are shutdown. The Fault will be automatically reset after the time value is setup in the advanced setting screen (default = 3 minutes). Once the fault has been reset, the system is set back to 'Idle' state.

Alarms

The compressor itself monitors its own internal sensors and employs the same strategy: In Alarm, the compressor reduces its own power to try to keep from hitting Fault limit. Hitting the fault limit shuts down the compressor.

Most compressor faults automatically reset at which time the compressor returns to the 'Idle' state and is ready to start again.

Arbitration for the chiller as a whole is such that alarms and faults should occur first at the compressor level then as a next level, the controller.

All the alarms can be grouped into two main categories:

1. Chiller alarms
2. Compressor alarms

Chiller alarms group comprises chiller control system alarms, for instance sensors faults or equipment communication faults and chiller control devices alarms (other than compressors), for instance flow switches, pumps, condenser fans etc.

Compressor alarms can be non-critical or critical (fault). Compressor non-critical alarm conditions cause the compressor to automatically reduce power so as to avoid fault conditions. Compressor faults, however, always stop compressor from operation and require fault condition to clear before compressor can restart.

Some of the compressor faults are lockout faults. They require a hard reset – power cycle – before compressor can restart.

Compressor Faults

If the fault is resettable such as a suction pressure, bearing displacement or motor over temperature fault, compressor stops and its state changes to 'Fault'. The chiller controller attempts to automatically reset the fault and make the compressor available again. When compressor comes back to available its state changes to "Idle".

If the fault cannot be reset automatically the compressor state is set to 'Offline' and the compressor will need a hard reset (Power-Cycle) to reset the fault. After successful power-cycle, the compressor should return to state 'Idle' and be ready to start again.

A maximum of three compressor identical faults per hour are tolerated. If more than three faults in an hour are generated the compressor is placed in 'Offline' state, the compressor is considered locked out and requires a power-cycle.

Table 21. Chiller / Compressor alarms / Faults listing

Code	Description	Reset[(a)]	Period[(b)]	Start-up[(c)]	Steady[(d)]	Active in Off[(e)]	Alarm Relay[(f)]	Warning Relay[(g)]	Compressors[(h)]
A01	Main switch	-1	0	25	0	X		X	INTERLOCK
A02	Refrigerant NOT selected: Select, Restart	0	60	0	0	X	X		INTERLOCK
A03	Evaporator flow switch alarm	5	60	45	5		X		INTERLOCK
A04	Condenser flow switch alarm	-1	60	10	5		X		OFF
A05	Communication fault	-1	0	0	0		X		INTERLOCK
A07	Entering chilled water sensor alarm	-1	0	0	0	X	X		-
A08	Leaving chilled water sensor alarm	-1	0	0	0	X	X		-
A09	Liquid temperature alarm	-1	0	0	0	X	X		-
A10	Entering water pressure alarm	-1	0	0	0	X	X		-
A11	Leaving water pressure alarm	-1	0	0	0	X	X		-
A13	Outside air sensor alarm	-1	0	0	0	X	X		-
A14	Suction pressure 1 transmitter alarm	-1	0	0	0	X	X		-
A15	Discharge pressure 1 transmitter alarm	-1	0	0	0	X	X		-
A18	LP 1 cutout alarm	-1	0	0	0	X	X		INTERLOCK
A20	HP 1 cutout alarm	-1	0	0	0	X	X		INTERLOCK
A30	Low water temperature	-1	0	10	0	X	X		-
A31	Low To (saturated suction temperature)	-1	0	100	0	X	X		-
A32	High discharge pressure	-1	0	100	0	X	X		-
A33	High pressure ratio	-1	0	100	0	X	X		-
A34	Warning: Low water temperature	-1	0	10	sa9	X		X	-
A35	Warning: Low To (saturated suction temp.)	-1	0	100	sa9	X		X	-
A36	Warning: High discharge pressure	-1	0	100	sa9	X		X	-
A37	Warning: High pressure ratio	-1	0	100	sa9	X		X	-
A53	General DI alarm 1	-1	0	0	20				OFF
A54	General DI alarm 2	-1	0	0	0				-
A55	General DI alarm 3	-1	0	0	0				-
A56	General DI alarm 4	-1	0	0	0				-
A57	General DI alarm 5	-1	0	0	0				-
A58	General DI alarm 6	-1	0	0	0				-
A59	General DI alarm 7	-1	0	0	0				-
A60	General DI alarm 8	-1	0	0	0				-
A61	General DI alarm 9	-1	0	0	0				-
A62	General DI alarm 10	-1	0	0	0				-
A74	Compressor 1 interlock activated	-1	0	0	0			X	-
A75	Compressor 2 interlock activated	-1	0	0	0			X	-

Table 21. Chiller / Compressor alarms / Faults listing (continued)

Code	Description	Reset[(a)]	Period[(b)]	Start-up[(c)]	Steady[(d)]	Active in Off[(e)]	Alarm Relay[(f)]	Warning Relay[(g)]	Compressors[(h)]
A76	Compressor 3 interlock activated	-1	0	0	0			X	-
A77	Compressor 4 interlock activated	-1	0	0	0			X	-
A86	Cooling enable off	-1	0	0	0				-
A90	Capacity limited	-1	0	0	0			X	-
A91	Phase/Sequence alarm	0	0	0	0		X		OFF
aC1	TC1 communication error	-1	0	60	0		X		-
a11	TC1 AC - Inverter Temperature	-1	0	0	0	X	X		-
a12	TC1 AC - Discharge Temp	-1	0	0	0	X	X		-
a13	TC1 AC - Suction Pressure	-1	0	0	0	X	X		-
a14	TC1 AC - Discharge Pressure	-1	0	0	0	X	X		-
a15	TC1 AC - 3 Phase Current Trip	-1	0	0	0	X	X		-
a16	TC1 AC - Shaft Cavity Temperature	-1	0	0	0	X	X		-
a17	TC1 AC - Leaving Air /Water	-1	0	0	0	X	X		-
a18	TC1 AC - Total Compression Ratio Fault	-1	0	0	0	X	X		-
a19	TC1 AC - General Compressor Fault	-1	0	0	0	X	X		-
a1A	TC1 AC - Sensor error	-1	0	0	0	X	X		-
a1B	TC1 AC - SCR Fault	-1	0	0	0	X	X		-
a1C	TC1 AC - Lock out Fault	-1	0	0	0	X	X		-
a1D	TC1 AC - Motor Thermistor	-1	0	0	0	X	X		-
a1E	TC1 AC - Super Heat Fault	-1	0	0	0	X	X		-
a1F	TC1 ANC - Inverter Temperature	-1	0	0	0	X		X	-
a1G	TC1 ANC - Discharge Temp	-1	0	0	0	X		X	-
a1H	TC1 ANC - Suction Pressure	-1	0	0	0			X	-
a1I	TC1 ANC - Discharge Pressure	-1	0	0	0			X	-
a1J	TC1 ANC - 3 Phase Current Trip	-1	0	0	0	X		X	-
a1K	TC1 ANC - Shaft Cavity Temperature	-1	0	0	0	X		X	-
a1L	TC1 ANC - Leaving Water	-1	0	0	0	X		X	-
a1M	TC1 ANC - Total Compression Ratio Fault	-1	0	0	0	X		X	-
a1N	TC1 ANC - SCR Temperature	-1	0	0	0	X		X	-
a1O	TC1 ANC - Super Heat	-1	0	0	0	X		X	-
aC2	TC2 communication error	-1	0	60	0		X		-
a21	TC2 AC - Inverter Temperature	-1	0	0	0	X	X		-
a22	TC2 AC - Discharge Temp	-1	0	0	0	X	X		-
a23	TC2 AC - Suction Pressure	-1	0	0	0	X	X		-
a24	TC2 AC - Discharge Pressure	-1	0	0	0	X	X		-

Table 21. Chiller / Compressor alarms / Faults listing (continued)

Code	Description	Reset[a]	Period[b]	Start-up[c]	Steady[d]	Active in Off[e]	Alarm Relay[f]	Warning Relay[g]	Compressors[h]
a25	TC2 AC - 3 Phase Current Trip	-1	0	0	0	X	X		-
a26	TC2 AC - Shaft Cavity Temperature	-1	0	0	0	X	X		-
a27	TC2 AC - Leaving Air /Water	-1	0	0	0	X	X		-
a28	TC2 AC - Total Compression Ratio Fault	-1	0	0	0	X	X		-
a29	TC2 AC - General Compressor Fault	-1	0	0	0	X	X		-
a2A	TC2 AC - Sensor error	-1	0	0	0	X	X		-
a2B	TC2 AC - SCR Fault	-1	0	0	0	X	X		-
a2C	TC2 AC - Lock out Fault	-1	0	0	0	X	X		-
a2D	TC2 AC - Motor Thermistor	-1	0	0	0	X	X		-
a2E	TC2 AC - Super Heat Fault	-1	0	0	0	X	X		-
a2F	TC2 ANC - Inverter Temperature	-1	0	0	0	X		X	-
a2G	TC2 ANC - Discharge Temp	-1	0	0	0	X		X	-
a2H	TC2 ANC - Suction Pressure	-1	0	0	0			X	-
a2I	TC2 ANC - Discharge Pressure	-1	0	0	0			X	-
a2J	TC2 ANC - 3 Phase Current Trip	-1	0	0	0	X		X	-
a2K	TC2 ANC - Shaft Cavity Temperature	-1	0	0	0	X		X	-
a2L	TC2 ANC - Leaving Water	-1	0	0	0	X		X	-
a2M	TC2 ANC - Total Compression Ratio Fault	-1	0	0	0	X		X	-
a2N	TC2 ANC - SCR Temperature	-1	0	0	0	X		X	-
a2O	TC2 ANC - Super Heat	-1	0	0	0	X		X	-
aC3	TC3 communication error	-1	0	0	0		X		-
a31	TC3 AC - Inverter Temperature	-1	0	0	0	X	X		-
a32	TC3 AC - Discharge Temp	-1	0	0	0	X	X		-
a33	TC3 AC - Suction Pressure	-1	0	0	0	X	X		-
a34	TC3 AC - Discharge Pressure	-1	0	0	0	X	X		-
a35	TC3 AC - 3 Phase Current Trip	-1	0	0	0	X	X		-
a36	TC3 AC - Shaft Cavity Temperature	-1	0	0	0	X	X		-
a37	TC3 AC - Leaving Air /Water	-1	0	0	0	X	X		-
a38	TC3 AC - Total Compression Ratio Fault	-1	0	0	0	X	X		-
a39	TC3 AC - General Compressor Fault	-1	0	0	0	X	X		-
a3A	TC3 AC - Sensor error	-1	0	0	0	X	X		-
a3B	TC3 AC - SCR Fault	-1	0	0	0	X	X		-
a3C	TC3 AC - Lock out Fault	-1	0	0	0	X	X		-
a3D	TC3 AC - Motor Thermistor	-1	0	0	0	X	X		-

Table 21. Chiller / Compressor alarms / Faults listing (continued)

Code	Description	Reset[(a)]	Period[(b)]	Start-up[(c)]	Steady[(d)]	Active in Off[(e)]	Alarm Relay[(f)]	Warning Relay[(g)]	Compressors[(h)]
a3E	TC3 ANC - Super Heat	-1	0	0	0	X	X		-
a3F	TC3 ANC - Inverter Temperature	-1	0	0	0	X		X	-
a3G	TC3 ANC - Discharge Temp	-1	0	0	0	X		X	-
a3H	TC3 ANC - Suction Pressure	-1	0	0	0			X	-
a3I	TC3 ANC - Discharge Pressure	-1	0	0	0			X	-
a3J	TC3 ANC - 3 Phase Current Trip	-1	0	0	0	X		X	-
a3K	TC3 ANC - Shaft Cavity Temperature	-1	0	0	0	X		X	-
a3L	TC3 ANC - Leaving Water	-1	0	0	0	X		X	-
a3M	TC3 ANC - Total Compression Ratio Fault	-1	0	0	0	X		X	-
a3N	TC3 ANC - SCR Temperature	-1	0	0	0	X		X	-
a3O	TC3 ANC - Super Heat	-1	0	0	0	X		X	-
aC4	TC4 communication error	-1	0	0	0		X		-
a41	TC4 AC - Inverter Temperature	-1	0	0	0	X	X		-
a42	TC4 AC - Discharge Temp	-1	0	0	0	X	X		-
a43	TC4 AC - Suction Pressure	-1	0	0	0	X	X		-
a44	TC4 AC - Discharge Pressure	-1	0	0	0	X	X		-
a45	TC4 AC - 3 Phase Current Trip	-1	0	0	0	X	X		-
a46	TC4 AC - Shaft Cavity Temperature	-1	0	0	0	X	X		-
a47	TC4 AC - Leaving Air /Water	-1	0	0	0	X	X		-
a48	TC4 AC - Total Compression Ratio Fault	-1	0	0	0	X	X		-
a49	TC4 AC - General Compressor Fault	-1	0	0	0	X	X		-
a4A	TC4 AC - Sensor error	-1	0	0	0	X	X		-
a4B	TC4 AC - SCR Fault	-1	0	0	0	X	X		-
a4C	TC4 AC - Lock out Fault	-1	0	0	0	X	X		-
a4D	TC4 AC - Motor Thermistor	-1	0	0	0	X	X		-
a4E	TC4 ANC - Super Heat	-1	0	0	0	X	X		-
a4F	TC4 ANC - Inverter Temperature	-1	0	0	0	X		X	-
a4G	TC4 ANC - Discharge Temp	-1	0	0	0	X		X	-
a4H	TC4 ANC - Suction Pressure	-1	0	0	0			X	-
a4I	TC4 ANC - Discharge Pressure	-1	0	0	0			X	-
a4J	TC4 ANC - 3 Phase Current Trip	-1	0	0	0	X		X	-
a4K	TC4 ANC - Shaft Cavity Temperature	-1	0	0	0	X		X	-
a4L	TC4 ANC - Leaving Water	-1	0	0	0	X		X	-
a4M	TC4 ANC - Total Compression Ratio Fault	-1	0	0	0	X		X	-

Table 21. Chiller / Compressor alarms / Faults listing (continued)

Code	Description	Reset(a)	Period(b)	Start-up(c)	Steady(d)	Active in Off(e)	Alarm Relay(f)	Warning Relay(g)	Compressors(h)
a4N	TC4 ANC - SCR Temperature	-1	0	0	0	X		X	-
a4O	TC4 ANC - Super Heat	-1	0	0	0	X		X	-
A92	Evaporator low flow rate alarm	5	60	5	5		X		INTERLOCK
A94	Condenser low flow rate alarm	5	60	5	5		X		-
A95	Master connection lost	-1	0	15	0		X		-
N01	Network Error	-1	90	60	60		X		-
N02	Master Error	-1	90	60	60			X	-
N03	Alarm Node 1	-1	90	60	0	X		X	-
N04	Alarm Node 2	-1	90	60	0	X		X	-
N05	Alarm Node 3	-1	90	60	0	X		X	-
N06	Alarm Node 4	-1	90	60	0	X		X	-
A01	General alarm	-1	60	5	1	X	X		-
S01	Ambient Temp Sensor Fault	-1	60	5	5	X	X		-
S02	Free Cool LW Temp Sensor Fault	-1	60	5	5	X	X		-
S03	Evap DP Sensor Fault	-1	60	5	5	X	X		-
S04	Cond DP Sensor Fault	-1	60	5	5	X	X		-
PF1	Chiller Pump 1 Fault	-1	60	5	1	X	X		-
PF3	Condenser Pump 1 Fault	-1	60	5	1	X	X		-
PA1	Chiller Pump 1 Flow Alarm	-1	60	5	5	X	X		-
PA3	Condenser Pump 1 Flow Alarm	-1	60	5	5	X	X		-
PF2	Chiller Pump 2 Fault	-1	60	5	1	X	X		-
PF4	Condenser Pump 2 Fault	-1	60	5	1	X	X		-
PA2	Chiller Pump 2 Flow Alarm	-1	60	5	5	X	X		-
PA4	Condenser Pump 2 Flow Alarm	-1	60	5	5	X	X		-
TF1	Cooling Tower Fault	-1	60	5	1	X	X		-
S05	Wet Bulb Temp Sensor Fault	-1	60	5	5	X	X		-

(a) **Reset** – type of the alarm / fault reset:

- "– 1". Automatic – when the alarm occurs the reset is done automatically if the alarm conditions no longer persist.
- "0". Manual – when the alarm occurs, the reset has to be done compulsorily by the user (maintainer or service) by pressing a key combination on the user interface.
- ">0". Semiautomatic – alarm is automatically reset for the "Reset" number of attempts in the specified "Period" of time, but if the alarms occur one more time, it becomes Manual.

(b) **Period** – is the period of time where the alarm can occur for "Reset" number of times (minutes) with the automatic reset and without becoming manual.
(c) **Startup** – is the delay (second) in the alarm during the startup phase.
(d) **Steady** – is the delay (second) in the alarm during the steady phase.
(e) **Active in Off** – if this box is checked the alarm will be enabled even if the machine is in OFF condition.
(f) **Alarm Relay** – if this box is checked, when the alarm occurs the corresponding digital output (configured in the "Digital Output" tab as "Alarm") will be activated.
(g) **Warning Relay** – if this box is checked, when the alarm occurs the corresponding digital output (configured in the "Digital Output" tab as "Warning") will be activated.
(h) **Compressors** – with this column there is the possibility to stop/run for security reasons the compressors when the alarm occurs. There are two options:

- OFF – when alarm / fault occurs compressors stop.
- INTERLOCK – when alarm / fault occurs compressors lock out.

Note: *For a complete list of compressor, motor and bearing faults:https://files.danfoss.com/download/Drives/Service%20Manual%20(M-SV-001-EN%20Rev.%20E).pdf*

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