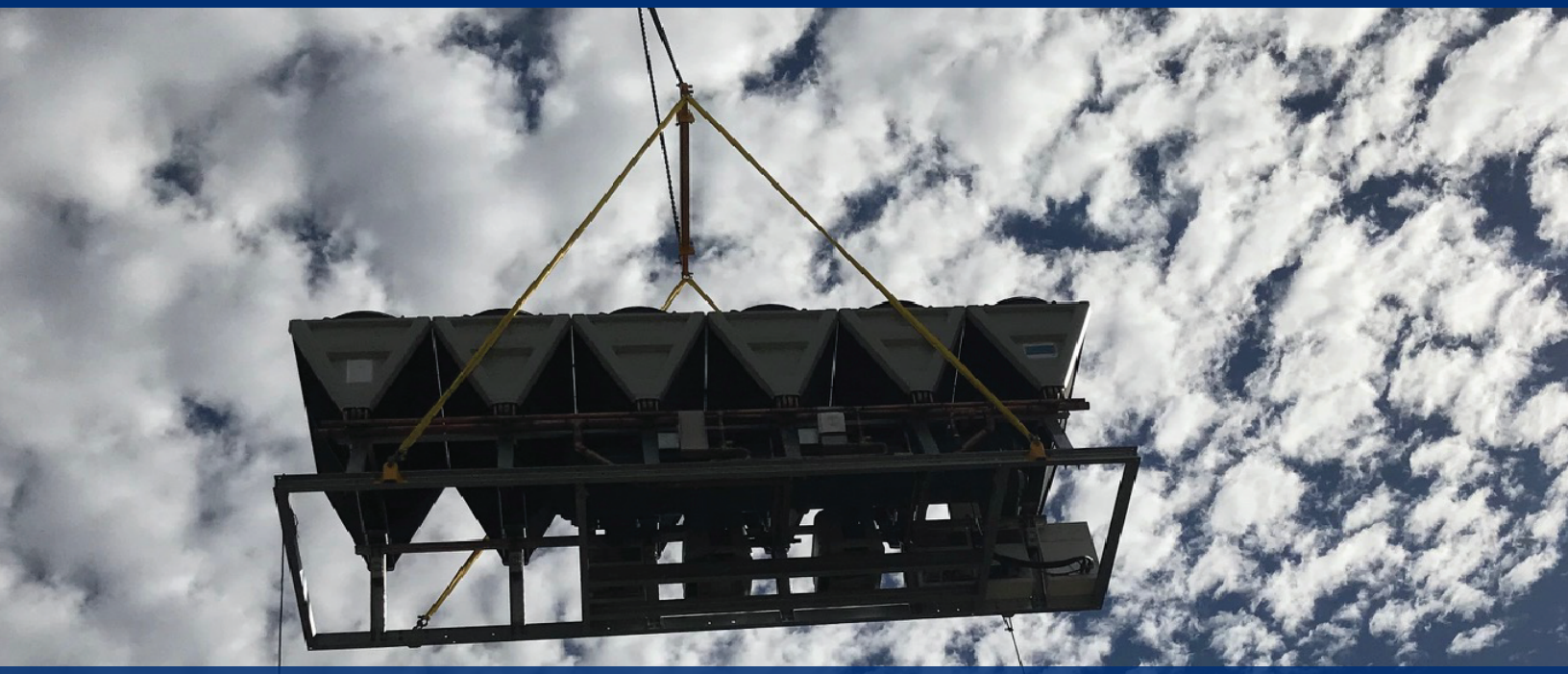


T^A-CLASS AIR-COOLED CHILLERS

Installation, Operation and Maintenance Manual (Kiltech)

SMARDT

SMARDT
T-CLASS CHILLERS

Contents

SMARDT

1 INTRODUCTION

1.1 Proprietary Notice

This publication contains information proprietary and confidential to Smardt Chiller Group Inc. and its subsidiary companies ("Smardt"). Any reproduction, disclosure or unauthorized use of this publication is expressly prohibited without written permission from Smardt.

Smardt reserves the right to make changes to the product or component design as and when warranted and without notice, in line with user needs or evolution in engineering and manufacturing technologies.

Smardt has exercised its best efforts to ensure that the information contained in this manual is correct at the time of printing. However, no warranty, reliability or accuracy is given with respect to the information contained herein, and Smardt shall not be held responsible for any error or omission, or liable for the correctness or suitability of the information given.

All brand names and product names used in this manual are trademarks, registered trademarks, or trade names of their respective holders.

1.2 Document Purpose

This manual covers critical information for contractors, building owners and engineers of the operation and maintenance including technical requirements, commissioning and fault analysis of Smardt's air-cooled series of chillers. It is intended that this manual be used with the applicable installation drawings and wiring diagrams supplied with your chiller. The information provided is general in nature and is subject to change as part of Smardt's commitment to continuous product improvement. For specific application information, contact your nearest Smardt sales representative.

1.3 Smardt Chiller Group

Smardt is "Global Number One" in oil-free centrifugal chillers, with production facilities in Stuttgart, Germany; Melbourne, Australia; Plattsburgh, New York; Guangzhou, China; Thetford, UK; Sao Paulo, Brazil and Montreal, Canada. Smardt Service networks extend across the globe; they monitor and support the world's largest installed base of oil-free high-efficiency chillers (well over 8000 units sold by the end of 2018). Smardt started a global reputation with the first oil-free centrifugal prototype built in 2002 to help refine Turbocor's® compressor technology before its launch in 2003.

Figure 1: Smardt Global Locations

Smardt Chiller Group Inc. Headquarters
1840 Trans Canada Hwy
Dorval, Quebec CANADA H9P 1H7
HQ Office: +1 514 426-8989 **sales@smardt.com**
Support: +1 514 683-5585 **support@smardt.com**
Office, Fax: +1 514 683-6013
www.smardt.com

SMARDT

2 HEALTH AND SAFETY

Smardt centrifugal chillers are designed to provide safe and reliable service when operated within design specifications. When operating this equipment, use good judgement and good safety practices to minimize potential damage to the equipment, property and/or to reduce personal risk.

2.1 Safety Notifications

Safety notifications with ANSI Z535.5 symbols are located throughout this manual to alert service personnel of potential hazards.

Each section is identified by the various headings: DANGER, WARNING, CAUTION and SAFETY INSTRUCTIONS.

⚠ DANGER **A DANGER notification "Indicates a hazardous situation that, if not avoided, will result in death or serious injury."**

⚠ WARNING **A WARNING notification "Indicates a hazardous situation that, if not avoided, could result in death or serious injury. "**

⚠ CAUTION **A CAUTION notification "Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury."**

SAFETY INSTRUCTIONS **SAFETY INSTRUCTIONS provide additional information e.g., tips, comments and/or other useful information.**

2.2 Safety Precautions

Installation, maintenance and service of your Smardt Chiller must only be performed by qualified personnel.

Always ensure that the required safety measures are followed which must include the following:

- Wearing protective clothing,
- Wearing safety glasses,
- Using appropriate tools,
- Employing qualified electricians,
- Employing qualified Smardt trained and certified refrigerant technicians,
- Adhering to all applicable codes and regulations.

2.3 Specific Statements

- Smardt chiller units are not accessible to the general public.
- A Smardt chiller unit is not to be used by persons (including children) with reduced physical, sensory, or mental capabilities, or lack of experience and knowledge.
- Children are prohibited from playing with the unit under any circumstances.
- For appliances located at altitudes exceeding 2000 m (6562 ft) please contact **sales@smardt.com** for details regarding the maximum altitude for safe operation.
- For details of type and rating of fuses or rating of circuit breakers, please refer to the submittal documents.
- For maximum and minimum water or brine operating temperatures, please refer to the submittal documents.

2.4 Refrigerant Safety Guidelines

Smardt believes that responsible refrigerant handling practices are important to the environment and our customers. Any personnel performing any work that carries the risk of refrigerant being emitted must hold a refrigerant handling license mandated in the jurisdiction covering an installation. Refer to relevant MSDS for further handling and safety requirements of the refrigerant in your chiller.

Smardt chillers contain refrigerant under high pressure and are fitted with safety relief valves to relieve excess pressure to atmosphere in the unlikely event of an emergency.

DO NOT VENT refrigerant pressure relief valves within enclosed spaces. Adequate ventilation must be provided, and most building codes require that pressure relief valves be vented to the outside of a building. Refrigerant vapor is heavier than air and within enclosed spaces can displace oxygen leading to asphyxiation.

Refrigerant vapor may cause eye and skin irritation. High concentrations of vapor may cause heart irregularities, unconsciousness and even death in severe cases.

2.5 Electrical Safety

Any voltages in electrical equipment are potentially lethal. Isolate incoming electrical power before attempting installation or service of the equipment. The compressors on this product incorporate capacitors which store enough energy to cause injury.

Do not work on electrical components including control panels, switches, or capacitors, until it is certain that ALL POWER IS OFF and no residual voltage can leak from capacitors. After isolating power allow a minimum of 20 minutes for capacitors to discharge before proceeding.

Any electrical field wiring must be performed by suitably qualified electricians following the electrical codes applicable to the jurisdiction covering the installation.

Improperly installed wiring poses fire and electrocution hazards. Failure to follow National Electrical Code (NEC) requirements and/or any applicable state and local codes could result in death or serious injury.

2.6 Pressure Vessels

All Smardt chillers are constructed with certified pressure vessels manufactured to regulate codes, including AS1210, ASME, GB and PED, to contain high pressure refrigerant. It is essential that each pressure vessel is registered, installed, inspected and maintained in accordance with local code requirements over lifetime of the product

2.7 Welding Information

Smardt vessels are AS1210, ASME, GB and PED certified. Please note that welding should never be performed on the vessels or tube sheet. Such a practice will void the pressure vessel certification.

Do not weld on any part of the chiller under any circumstances as current can travel through the chiller ground if the welder ground is not satisfactory, unnecessarily damaging chiller and/or compressor electronics and voiding the unit's warranty.

Never attempt to modify or repair pressure vessels in any manner without receiving approval from the regulatory body for the jurisdiction in which the pressure vessel is installed. For ASME coded vessels only suitable qualified technicians carrying the "R" stamp from ASME may conduct repairs or modifications.

2.8 Static Magnetic Fields

Smardt chillers feature Danfoss Turbocor® oil-free magnetic bearing compressors. Static magnetic fields generated by the compressor bearings could potentially have an effect on certain medical devices such as pacemakers and defibrillators. The compressor manufacturer advises against personnel with such medical devices from performing any disassembly of the compressor that would expose the shaft and bearings.

Measurements of the Danfoss Turbocor® compressor conducted by the manufacturer show the highest level of static magnetic field is 0.0009 Tesla (9 gauss) within 153 mm (6.03 in) of the compressor body.

3 FUNCTIONAL DESCRIPTION

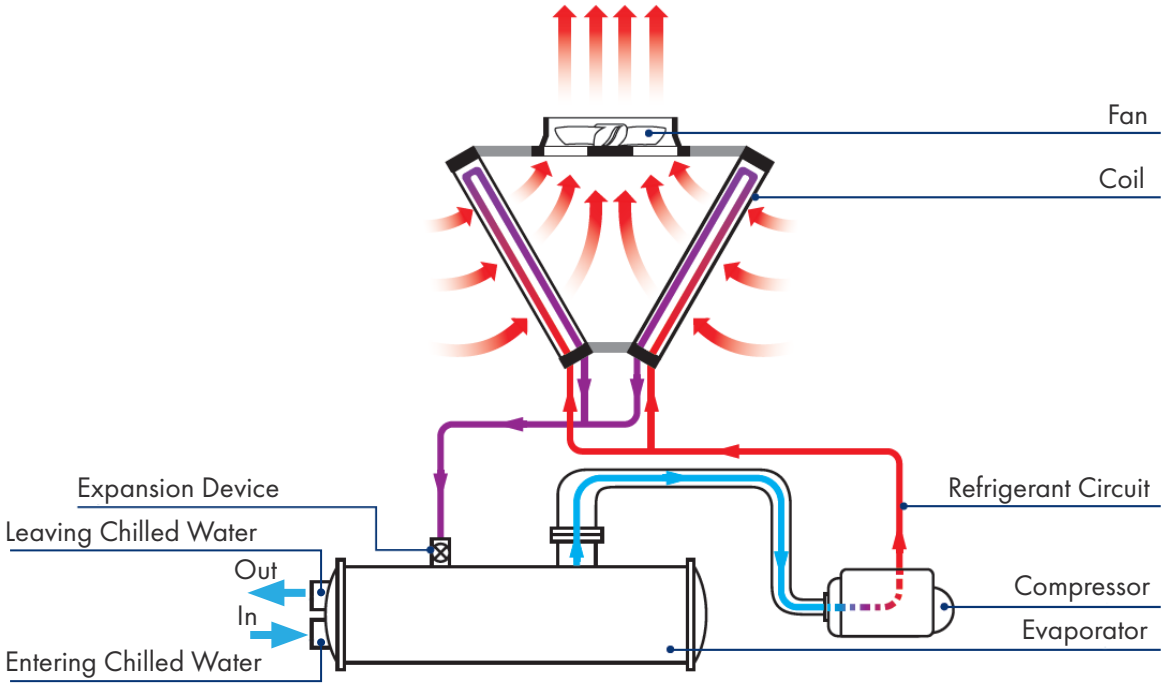


Figure 2: Refrigeration Cycle

Smardt's range of air-cooled chillers combines the experience of having the world's largest installed base of oil-free chillers, with the latest innovations in heat exchanger, electrical and controls software design. As shown in the figure above, all Smardt air-cooled chillers are comprised of a number of systems:

- Flooded shell & tube evaporator,
- Oil-free, magnetic bearing centrifugal compressor,
- Purpose built condenser, which includes:
  - Fin & tube condenser coils
  - Condenser fans
- Electronic expansion device(s),
- Controller.

The first two systems are at the core of all Smardt chillers, where the water flowing through the evaporator is cooled by transferring its heat to the refrigerant causing it to boil. The refrigerant vapor is then compressed in two stages into high-pressure and high-temperature vapor.

The heat absorbed from the chilled water, and the energy added by the compressor must be removed from the cycle: a task that is performed by the air-cooled condenser.

To reject heat effectively, the refrigerant vapor inside the coils must be hotter than the passing air. The hotter the refrigerant, the more power the compressor consumes to keep the cycle running. It stands to reason that significant efficiency gains can be made by reducing the passing air temperature.

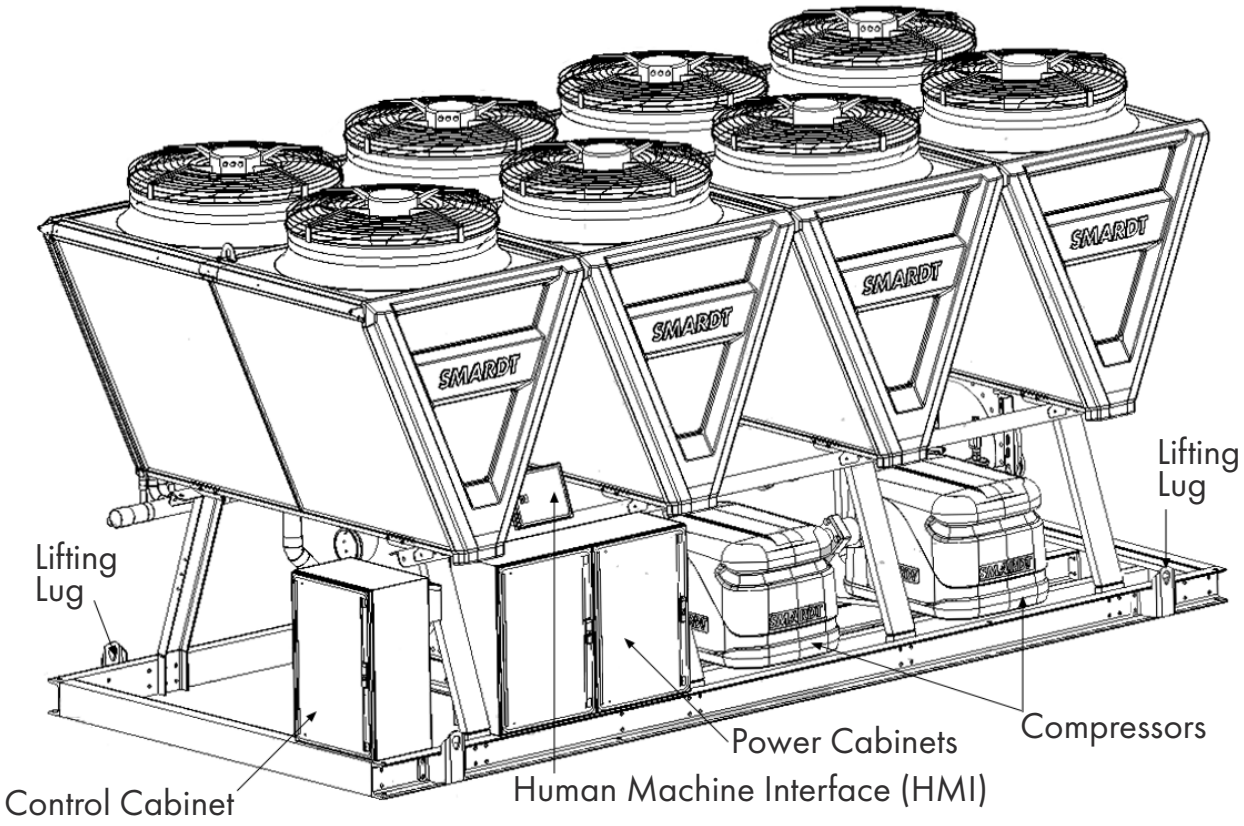
An electrical expansion device then controls the flow of refrigerant back to the evaporator, ensuring both evaporator and condenser are running optimally.

The controller housed in NIP54 (NEMA 3R equivalent) cabinets as-standard contains Smardt's proprietary control algorithms which operate to maximize system efficiency in all conditions.

All Smardt chillers are oil-free, and therefore do not require the components and constraints to ensure oil return and separation. There is also no degradation of heat exchanger performance caused by oil residue, making Smardt chillers more efficient to maintain.

All Smardt chillers include refrigerant isolation valves on both sides of all serviceable components as standard design. This facilitates servicing without the need to pump down the entire unit, and in most cases, can be undertaken while the chiller remains operational.

4 MAIN CHILLER COMPONENTS



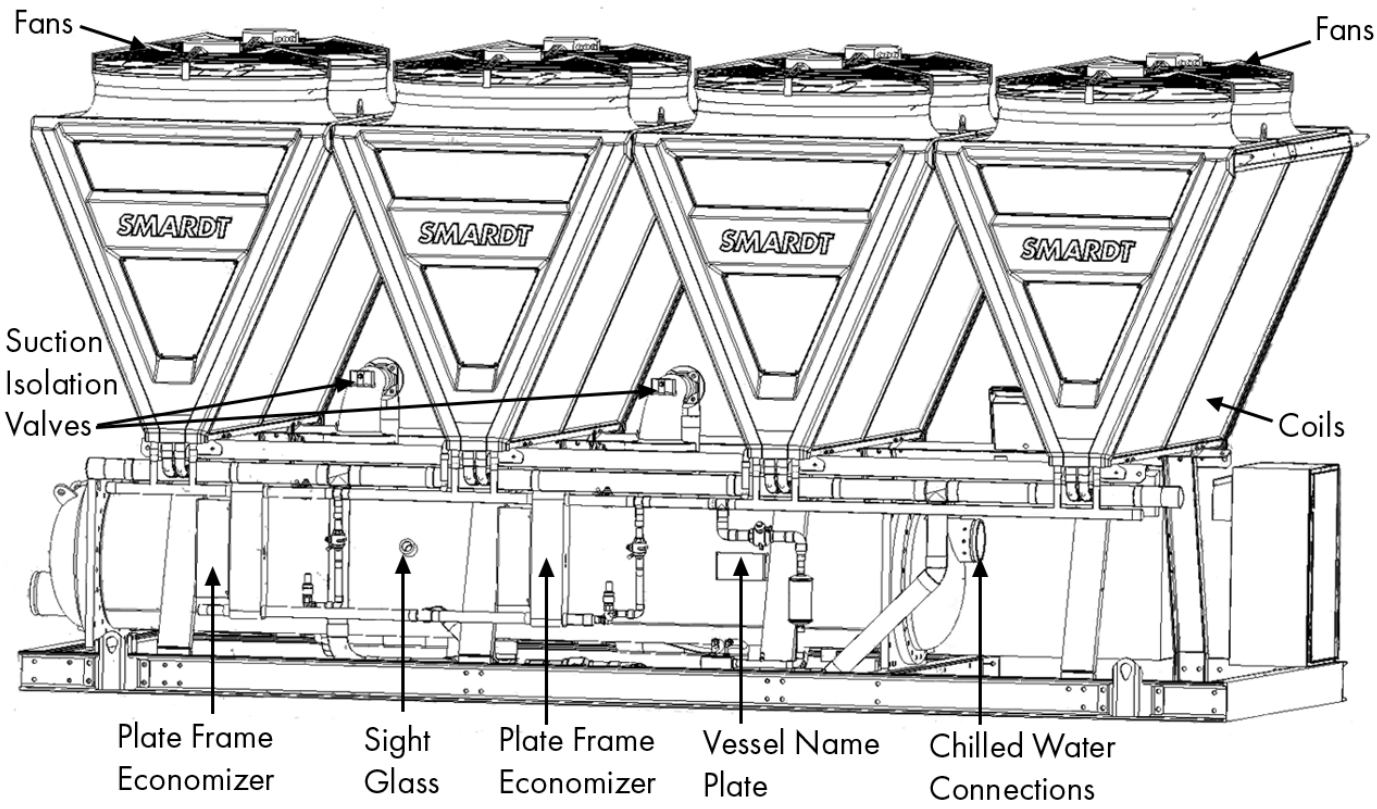


Figure 3: Principle Chiller Components

4.1 Evaporator

The evaporator has a flooded shell and tube design utilizing enhanced surface finned copper tubes. It is constructed in accordance with a variety of international standards including AS1210, ASME, GB and PED for a refrigerant side working pressure of 1320 kPa (190 psi). Standard water side working pressure handling capacity is 1000 kPa (145 psi), with optional 2000 kPa (300 psi) construction.

The evaporator shell is insulated with a minimum of 19 mm (0.75 in) closed-cell foam (max k factor of 0.038W/mK). Optional insulation thickness, types and cladding are also available.

4.2 Evaporator Components

All major piping components are located between shutoff valves. Piping components include all devices and controls used to provide proper water system operation and safe unit operation.

1. All refrigerant piping in/out to evaporator is provided with isolation valves.
2. Complete refrigerant charge for the chiller can be stored in the evaporator.
3. Pressure relief valves are provided on vessel in the event of emergencies.
4. Flow switch is provided on water piping along with a temperature sensor.
5. Connections on water piping are provided as "grooved" as standard or flanged as optimal.

To prevent evaporator damage, do not exceed 1000 kPa (145 psi) evaporator water pressure for standard water boxes. To prevent tube damage, it is recommended that a cleanable 20-mesh strainer be installed in the evaporator water inlet piping.

4.3 Low Pressure Switches

An adjustable pressure switch is most commonly used on the air-cooled units and is installed on the evaporator shell. A low-pressure switch is used to protect the system and proper operating conditions.

4.4 High Pressure Switches

A 1276/1586 kPa (185/230 psi) high pressure switch is used on the air-cooled chiller units. It is commonly located on the Discharge manifold of the chiller unit.

SAFETY INSTRUCTIONS The pressure switch is the last line of defense when it come to starting and running a chiller unit with the required refrigerant pressure inside the unit. The compressor itself has its own pressure/temperature control to protect it from under or over pressure.

4.5 Air-cooled Condenser

The condenser has a fan and coil design. It is constructed in accordance with a variety of international standards including AS1210, ASME, GB and PED for a refrigerant side working pressure of 1320kPa (192psi).

4.6 Refrigerant Economizers

The two-stage magnetic bearing centrifugal compressor technology utilized on all Smardt chillers permits the use of economized operation which lifts the full-load capacity and running efficiency of the chiller. Where required, economizers utilize the secondary compression stage to increase sub-cooling and thereby reduce the necessary refrigerant flow required to deliver a given chiller capacity.

Smardt air-cooled chillers use BPHE (brazed plate heat exchangers) with 210 to 1600 kW (60 to 450 TR) capacity per compressor for air-cooled units.

Consult the Project specific documentation for the option that is included with each chiller.

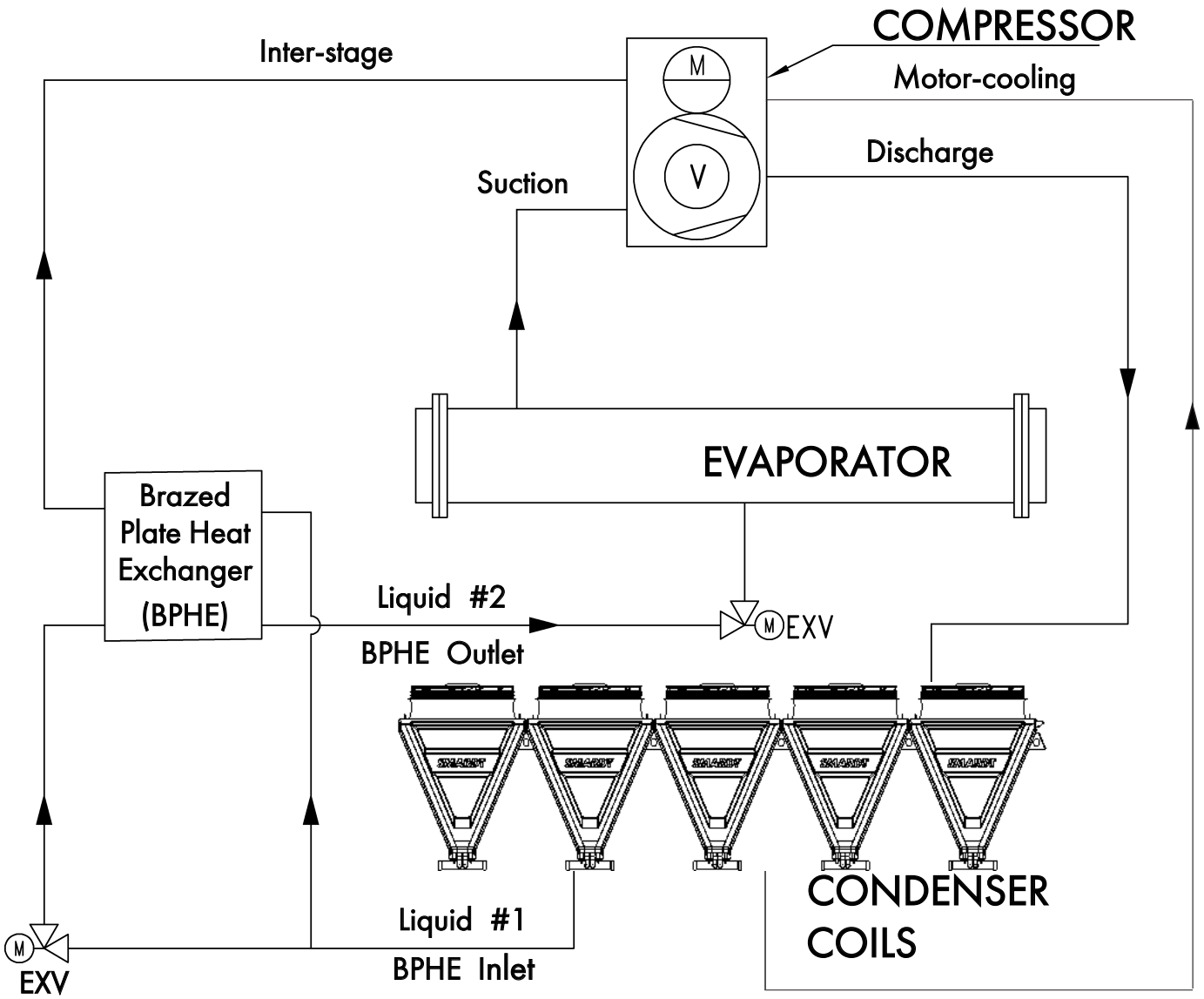


Figure 4: Brazed Plate Heat Exchanger Refrigerant Circuit

4.7 Refrigeration Circuit Components

Refrigerant circuit components include pressure relief valves, combination discharge check and isolation valves, suction line valves, motor cooling line filter drier, liquid line, condenser liquid level sensor chamber, sight glasses, electronic expansion and load balancing valves and motor cooling isolation valves.

No Smardt chiller utilizes oil within the refrigerant circuit.

4.8 Designed for Serviceability

All Smardt air-cooled chillers are supplied with isolation valves on both sides of all serviceable components, this allows for more efficient servicing, and in some cases, allows the chiller to continue operation while servicing specific components. Smardt chiller waterbox hinges provide easy service access. These are a purchased option.

4.9 Controller User Interface

Each Smardt air-cooled chiller comes standard with a 12" (305 mm) touchscreen controller interface.

This panel provides operators with screens displaying a comprehensive overview of the chiller including:

- System overview
- Compressor overview
- Events and faults log
- Trending data
- Evaporator and condenser overviews
- Inputs/outputs.

Figure 5: Control Cabinet with Touch Panel

5 NAMEPLATE INFORMATION

Each Smardt chiller displays important information on nameplates, which you will find in a number of locations on the equipment.

5.1 Chiller Nameplate

The chiller nameplate is located on the outside of the electrical control cabinet and details both the chiller model and unique serial number, both of which should be used to identify the chiller for service, parts and warranty enquiries. The nameplate could appear on the side panel (shown) or on the front panel of the control cabinet. This nameplate also displays the running conditions and refrigerant charge for the chiller design.

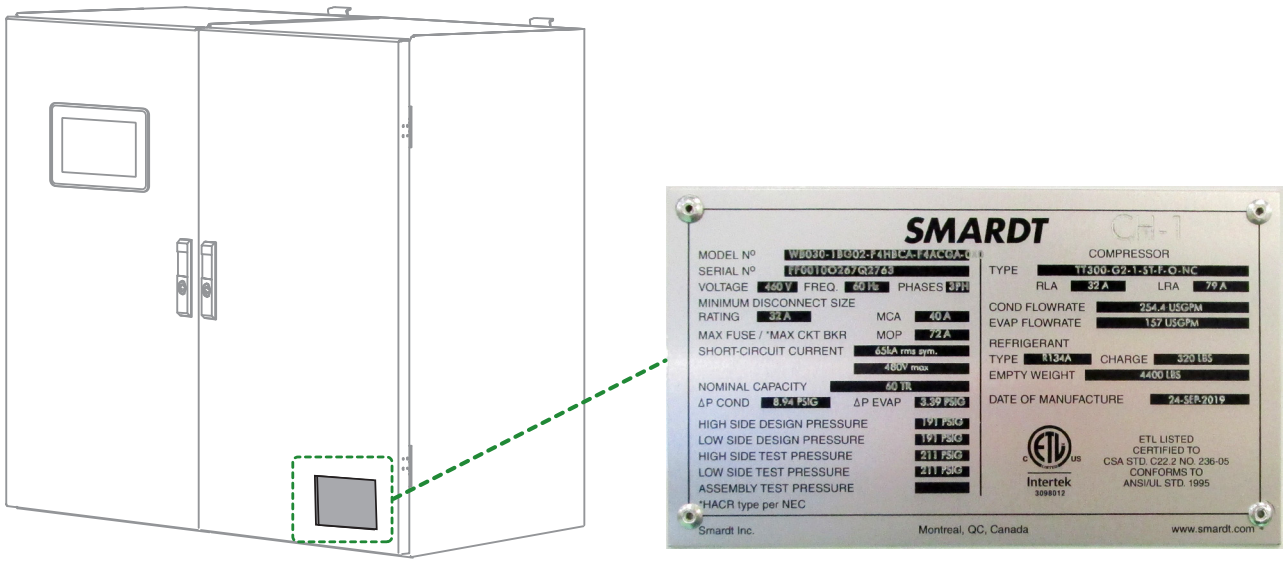


Figure 6: Electrical Cabinet and Chiller Nameplate

5.2 Chiller Nomenclature

The chiller model number code (found on the chiller nameplate) is comprised of numbers and letters that are arranged to provide a detailed summary of the chiller configuration as illustrated below.

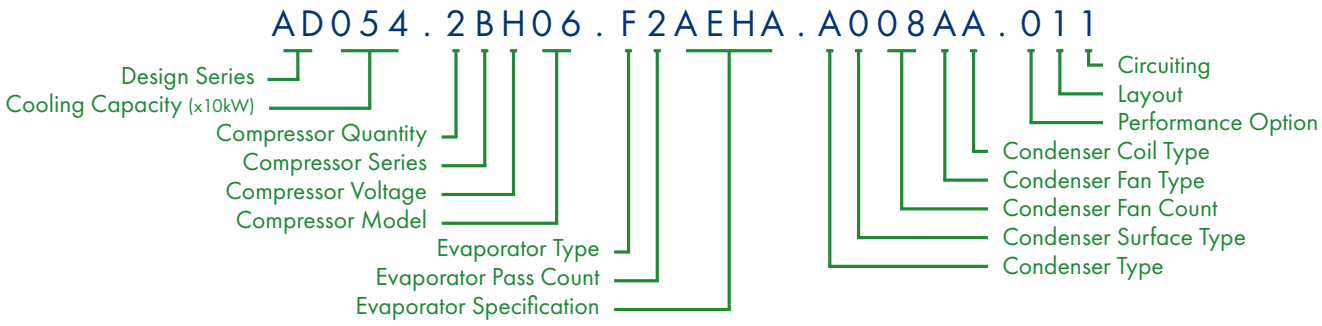


Figure 7: Chiller Nomenclature

5.3 Vessel Nameplates

Each Smardt air-cooled chiller contains one pressure vessel, the evaporator. The evaporator can be identified using a unique serial number which can be found on the vessel nameplate. The nameplate also details the applicable code, year of manufacture, rated pressure and operating temperature range of the vessel.

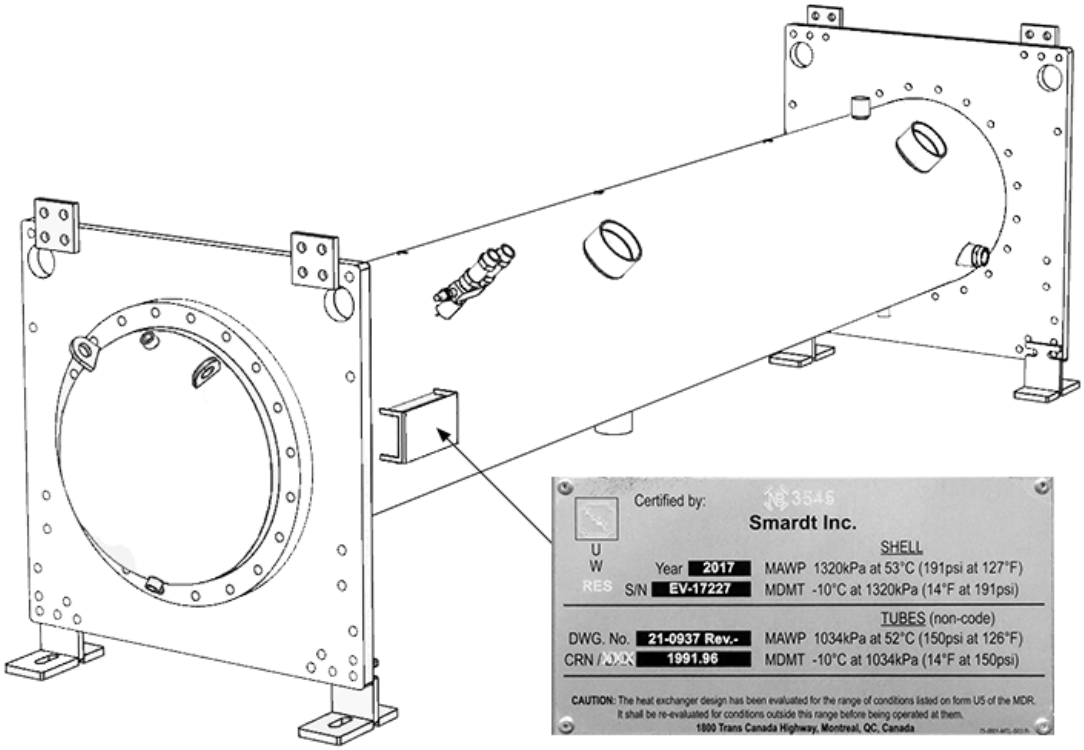


Figure 8: Evaporator Vessel Nameplate

5.4 Compressor Nameplate

Each compressor on the chiller has a unique serial number listed on its nameplate. The serial number should be referenced for any compressor service, parts or warranty enquiries. Critical operational parameters are also shown on this nameplate, including electrical requirements and product certification.

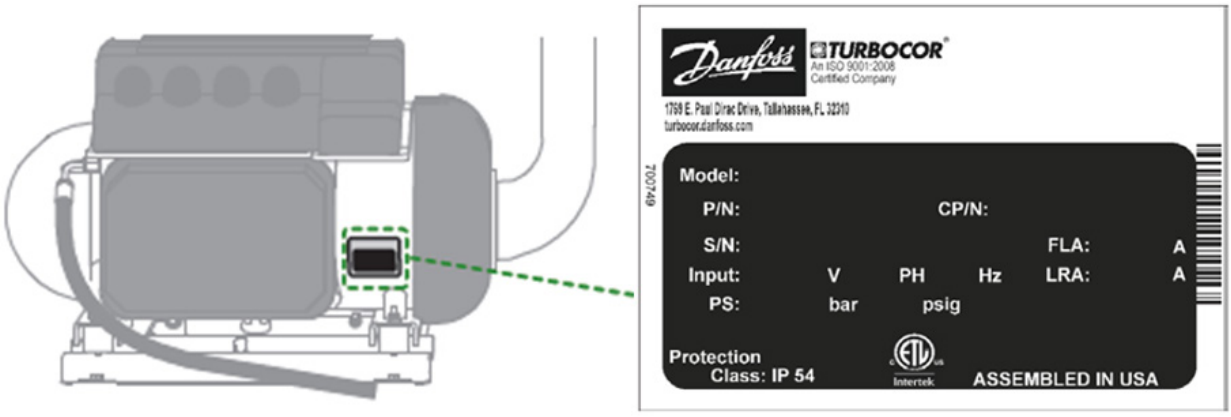


Figure 9: Compressor Nameplate

6 CHILLER ORIENTATIONS

Each Smardt air-cooled chiller may be configured to suit your application. The orientation of each vessel is defined by which side the chilled water enters, when facing the HMI (Human Machine Interface) screen.

NOTE: Chilled water can enter from opposite sides.

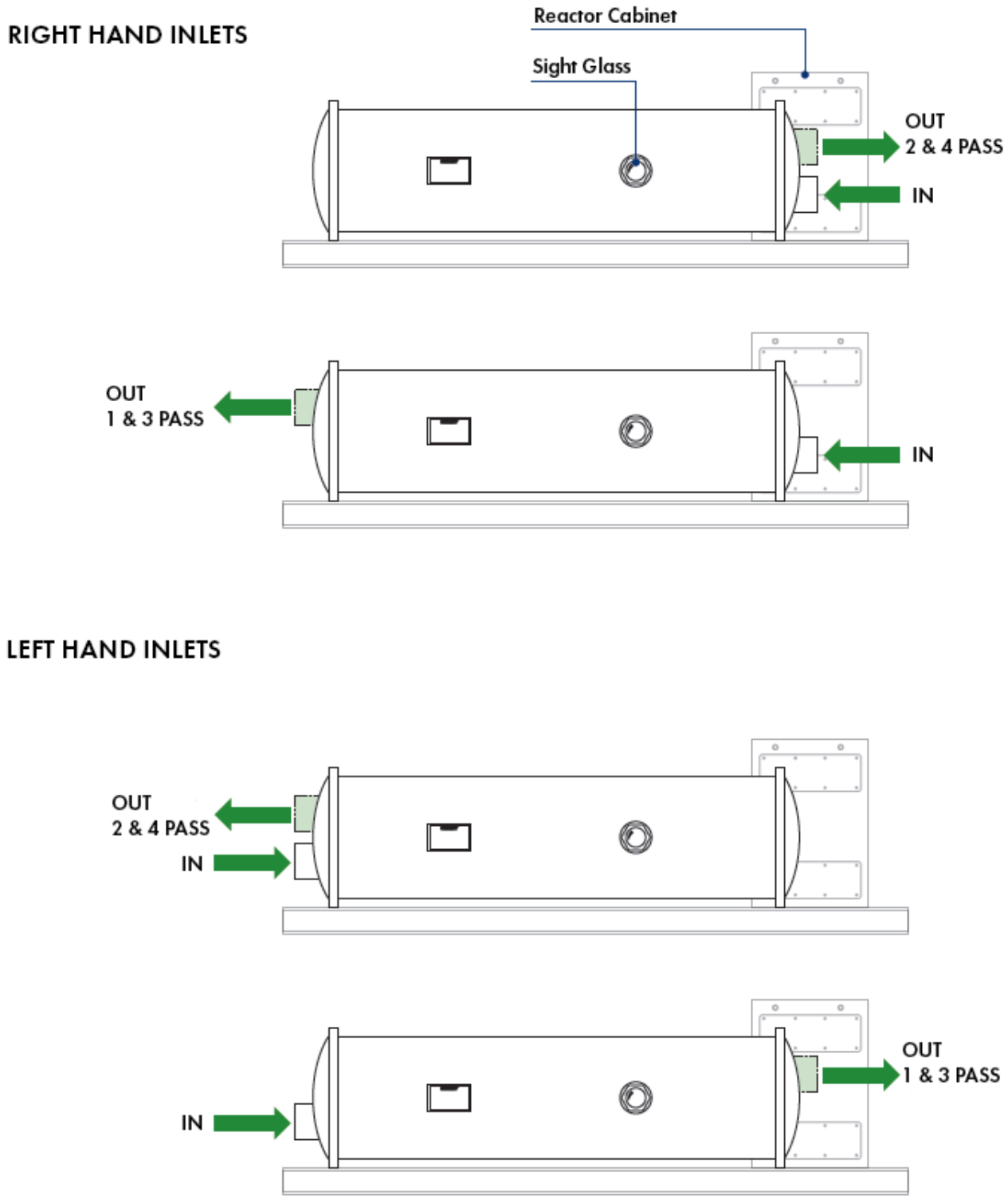


Figure 10: Chiller Orientations

7 CHILLER DIMENSIONS

Smardt prides itself on producing highly customizable products for its clients. Dimensions vary based on clients' cooling and space requirements.

Exact dimensions of your Smardt chiller can be found in your chillers' submittal document. For further dimensioning needs, please contact a Smardt representative at **sales@smardt.com**.

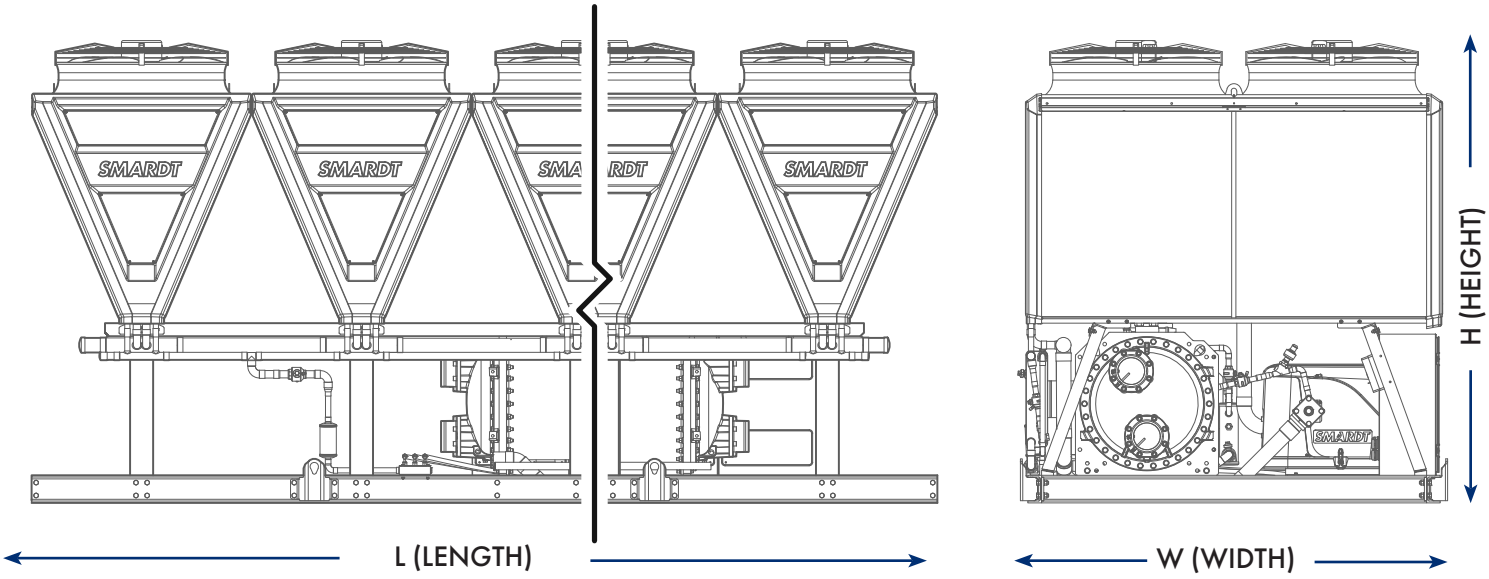


Figure 11: Chiller Dimensions

8 ELECTRICAL ENCLOSURES AND COMPONENTS

Each Smardt air-cooled chiller is fitted with modular electrical enclosures which can be custom configured and may offer many options including (but not limited to) the following:

- Fused/non-fused main disconnect switch
- Active harmonic filter
- EMI filter
- UPS for controls (fast restart)
- Refrigerant pump

All enclosures are NIP54 (NEMA 3R equivalent) rated and contain high quality components, thus providing you with a reliable and safe product. Please note that access to electrical enclosures are restricted to qualified personnel only.

8.1 Electrical Requirements

The unit mains power **MUST** be installed by a certified local contractor. Electrical data (input voltage, rated load amps, full-load amps, etc.) is listed on the chiller nameplate and in the signed submittal. The chiller nameplate will be riveted to the electrical cabinet where the mains are to be landed. Refer to Figure 6.

Failure to follow code could result in death or serious injury. 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 the National Electrical Code (NEC) and your local/state electrical codes.

Depending on the design of the chiller it may have multiple mains entry points, there also could be a separate 120V feed and/or 120V UPS feed.

SAFETY INSTRUCTIONS As you review this manual, along with the wiring instructions presented in this section, keep the following in mind:

- All field-installed wiring must conform to National Electric Code (NEC) guidelines, and/or any applicable state and local codes.
- Be sure to satisfy proper equipment grounding requirements per NEC and/or state and local codes.
- Compressor and unit electrical data (including voltage utilization range, rated load amps, and full load amps) is listed on the chiller nameplate.
- All field-installed wiring must be checked for proper terminations, and for possible shorts or grounds.
- All electrical wiring connecting to the unit shall only be made of copper and shall be grounded.
- Wiring to the unit will require a circuit breaker or fuses to protect the main wiring run from the final distribution sub-board to the unit.
- Three phase mains voltage to the chillers must be within ±10% of nameplate voltage.
- Voltage unbalance between phases must not exceed 2%.
- Minimum required bending space at terminals and means for strain relief of supply conductors shall be provided by the installation contractor in order to prevent leads separating from their terminations or subjecting them to damage from sharp edges.
- Ensure that the position of the field installed conduit does not interfere with the serviceability of any of the unit components, or with structural members and equipment.
- Ensure that the conduit is long enough to simplify any servicing that may be necessary in the future.
- Flexible conduit connections are recommended to enhance serviceability and minimize vibration transmission.
- Avoid modifications or cuts in the enclosure to provide electrical access. If the power supply box must be cut to provide electrical access, exercise care to prevent debris from falling inside the enclosure.
- Ensure that the incoming power wiring is properly phased; each power supply conduit must carry the correct number of conductors to ensure equal phase representation.
- Where the chiller is to be permanently connected to fixed wiring and has leakage current exceeding 10 mA, ensure that a residual current device (RCD) having rated residual operating current not exceeding 30 mA is installed.

NOTE: The Limited Product Warranty does not cover damaged equipment caused by wiring non-compliance, an open fuse resulting from an overload, a short, or a ground. Correct the cause of the open fuse before replacing the fuse and restarting the compressor.

NOTE: Always refer to the actual wiring diagrams shipped with the chiller or the unit submittal for specific as-built electrical schematic and connection information.

Variable speed equipment has a tendency to create EMI noise and proper grounding is crucial for a successful installation. A separate ground conductor that is properly sized for the chiller's rated ampacity is required.

This ground must tie into the main chiller ground in the main chiller breaker panel on one end (ground lugs are located next to field wiring terminals for equipment grounding) and terminate with a ground that is a true reference to earth on the other.

All other grounds on the chiller are linked and designed to travel back to this main ground.

NOTE: Electrical noise cannot be destroyed, it can only be redirected from one path to another.

8.2 Electrical Safety

Before any wiring or service begins, observe the following electrical safety requirements:

- Always wear appropriate personal protective equipment.
- Follow all lockout-tagout procedures prior to performing installation and/or service on unit.
- Wait the required time to allow the compressor capacitor(s) to discharge; minimum 20 minutes and could be up to 30 minutes.

Failure to disconnect power (LOTO) and discharge capacitors before servicing Danfoss Turbocor® compressors could result in death or serious injury.

Failure to follow proper handling guidelines could result in death or serious injury. Always wear appropriate personal protective equipment in accordance with applicable regulations and/or standards to guard against potential electrical shock and flash hazards.

8.3 Electrical Power Supply

The electromagnetic components in the compressors and in the control cabinet require an electric power supply in accordance with the specifications for safe and optimal operation, as per the chiller nameplate. Deviations from this (even short-term deviations) may significantly influence the function and safety of the chiller. Refer to the documentation supplied with the chiller to confirm its power supply requirements.

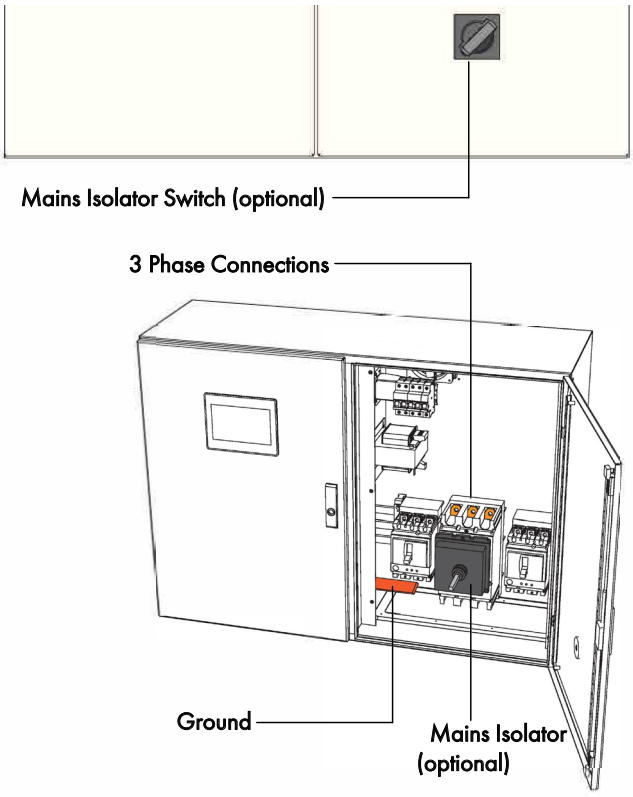


Figure 12: Electrical Cabinet

It is important that the voltage of all Smardt products be within ±10% of the nameplate voltage, and the voltage unbalance between phases must not exceed 2%. Any imbalance between phase voltages of more than 2% or greater than 10% of the current will be considered negligent and void the Smardt chiller warranty. If this occurs, contact your local electricity supplier and ensure that the chiller is turned OFF until this has been rectified.

8.4 Mains Connections and Power Wiring

Mains wiring is brought to a single connection point (unless specified otherwise in the submittal). All power wiring upstream of this point is the responsibility of the installing contractor. Ensure that a qualified electrician is used at all times. The power supply wiring should carry 3 phase and ground.

8.5 Compressor Isolation (Electrical)

The chiller is equipped with a means of electrical isolation for each compressor (circuit breaker or fuses). Isolating a single compressor (or all compressors) does not isolate the incoming power supplied to the chiller. To conduct any work involving accessing the circuit breakers or the incoming power connections to the chiller, the main chiller disconnect must be locked out as per local regulations and safe work practices.

8.6 Wiring Diagrams

Refer to Smardt submittal documents. Copies of wiring diagrams and schematics are located in the control cabinet. Do not remove these documents.

To prevent injury or death, disconnect and isolate all electrical power sources before completing wiring connections to the unit. Wait at least 20 minutes after isolating power before removing compressor access covers. Refer to the location of compressor access covers in the figure below.

The main power supply is brought into the power cabinet from either the top or bottom of the cabinet and is connected to the mains power distribution block (PDB).

A dedicated ground must also be connected to the ground terminal inside the same cabinet.

All wiring must be installed in accordance with appropriate local and national electrical codes and will require a circuit breaker or fuses to protect main wiring from the final distribution sub-board to the unit.

To prevent control malfunctions, do not run low voltage wiring (<30V) in conduit with conductors carrying more than 30 V. It is recommended that the control wiring is run in with screen cable and grounded as it enters the control panel.

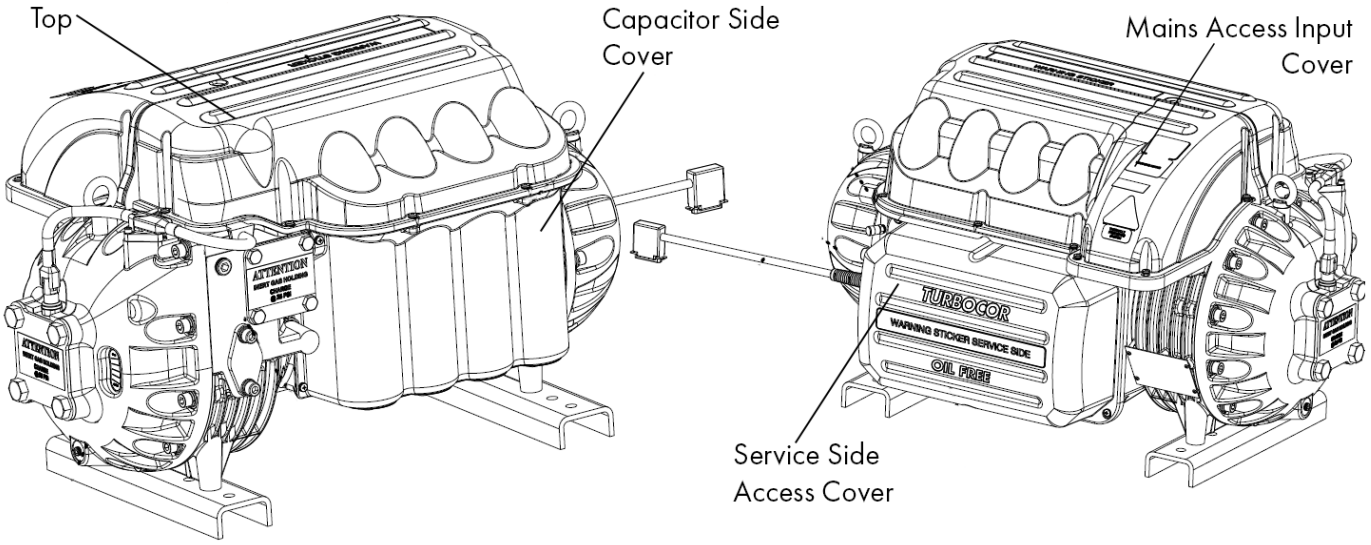


Figure 13: Location of Compressor Access Covers

9 INSTALLATION

The recommendations in this section are general in nature. Please observe local regulations when installing your chiller.

UPON DELIVERY

The chiller must be inspected thoroughly for any damage or defects which may have occurred during transport. Compare chiller nameplate with specifications on the purchase order. Units should be un-tarped for receipt inspection at least and then re-tarped if intended for storage thereafter. Refer to the Storage Requirements section in this document.

Do not remove any packaging materials until the chiller is in its final position, as moving the unit without packaging may result in damage, which will not be covered by Smardt's warranty.

SAFETY INSTRUCTIONS **IMPORTANT: Always use ALL lifting points to lift unit.**

10 START-UP

ARRANGING START-UP

Smardt requires each chiller to be started by a Smardt trained and certified technician.

In order to activate the warranty, the start-up documents must be completed and submitted to Smardt for approval.

- The start-up date should be requested as soon as possible to allow the support team to follow along ensuring scheduling is not a problem.
- The checklist is necessary to ensure a chiller is in fact ready to be turned ON. Optimal performance cannot be guaranteed at the time of start-up.

A level of monitoring must take place thereafter once the application is in its final intended state as settings inside the controller depend on system conditions and dynamics. Please allow 4 weeks for the coordination of start-up from the date the pre-start-up documents are submitted.

Smardt reserves the right to send its own technicians or to engage trained and qualified service provider at its sole discretion.

Forms to be submitted by email to: **support@smardt.com**.

11 STORAGE REQUIREMENTS

11.1 Location Requirements

- Solid foundation
- Vibration and dust free
- Dry ambient
- Temperature range 0 °C to 50 °C (32 °F to 122 °F)
- Equipment should be protected from the elements, including direct sunlight and rain.

11.2 Coverings

- Do not remove any coverings until instructed to by the installing contractor.

11.3 Refrigerant

- Depending on the Smardt offer, the unit can have a complete charge of refrigerant from the factory or a nitrogen charge.
- Smardt is not responsible for the loss of refrigerant due to improper storage.

11.4 Waterboxes and Heat Exchanger Tubes

- Ensure that waterboxes and tube bundles are clean and dry.

11.5 Long-term Storage Requirements

For a storage period exceeding one month, the chiller and/or chiller unit components must be stored in a vibration-free, secure, temperate, dry location indoors and protected from any damage or sources of corrosion. If temperatures of where the chiller is located are expected to exceed 40 °C (104 °F), then the refrigerant must be removed.

- Do not remove protective coverings from chiller unit, chiller components and/or electrical panel(s)
- Attach a gauge at least every 3 months
- Manually check pressure in refrigerant circuit.

Smardt will not be held responsible for any refrigerant loss during the chiller's storage time, and/or for repairs to the unit during the period of storage, and/or while moving the unit from the original location to a storage facility and/or transport to any new installation location. If there is concern about the possibility of damage and/or loss of charge during storage, the customer can have the charge removed and stored in recovery cylinders.

Where a chiller is shipped with glycol, and if temperatures of where the chiller is located are below 0 °C (32 °F) the plugs must be removed and the glycol must be drained. Glycol **MUST** be properly disposed as per local regulations.

11.6 Rigging and Coverings

Care must be exercised at all time when rigging or handling the new chiller to protect it from damage. Where possible, all packaging and protection should be left in place until the chiller is in its final position. Care should be taken to ensure that slings do not crush outer components on the chiller and/or control panel. Only use the supplied lifting points to lift and position the unit.

SAFETY INSTRUCTIONS **Always use all lifting lugs provided or else if unit becomes damaged, the warranty is voided.**

SAFETY INSTRUCTIONS **Do not use a forklift to move the chiller.**

Always refer to the specific chiller outline drawings provided by Smardt to confirm lifting requirements. Smardt is not responsible for the rigging and placement of the unit. Smardt strongly recommends that a specialized company unloads the chiller. Local codes and regulations regarding the lifting of this equipment may apply. Always ensure that any applicable codes and regulations are adhered to.

SAFETY INSTRUCTIONS **Do not drop the unit or allow the unit to absorb shock.**

NOTE: Centre of gravity may vary and therefore do not push or pull the unit. Do not let the unit fall during installation.

11.7 Unit Placement

Before placing the unit, consult the chiller outline drawings supplied by Smardt to confirm that there is adequate room for all connections and clearances to provide service access to the chiller.

Ensure that the supporting floor meets load bearing requirements. When mounting units with feet, as a safeguard, ensure that the feet make full contact with the supporting floor, pads and/or mounts.

Generally, waffle pads are considered suitable as the Smardt chiller is virtually vibration free. The chiller should be protected from excessive ground or pipe borne vibration from external sources such as pumps.

Once installed, remove rigging equipment and check for longitudinal and transverse alignment. Add shims, if necessary, to level the unit along both axes. It is essential that the chiller is installed level to a tolerance of 3 mm/m (0.0365 in/ft).

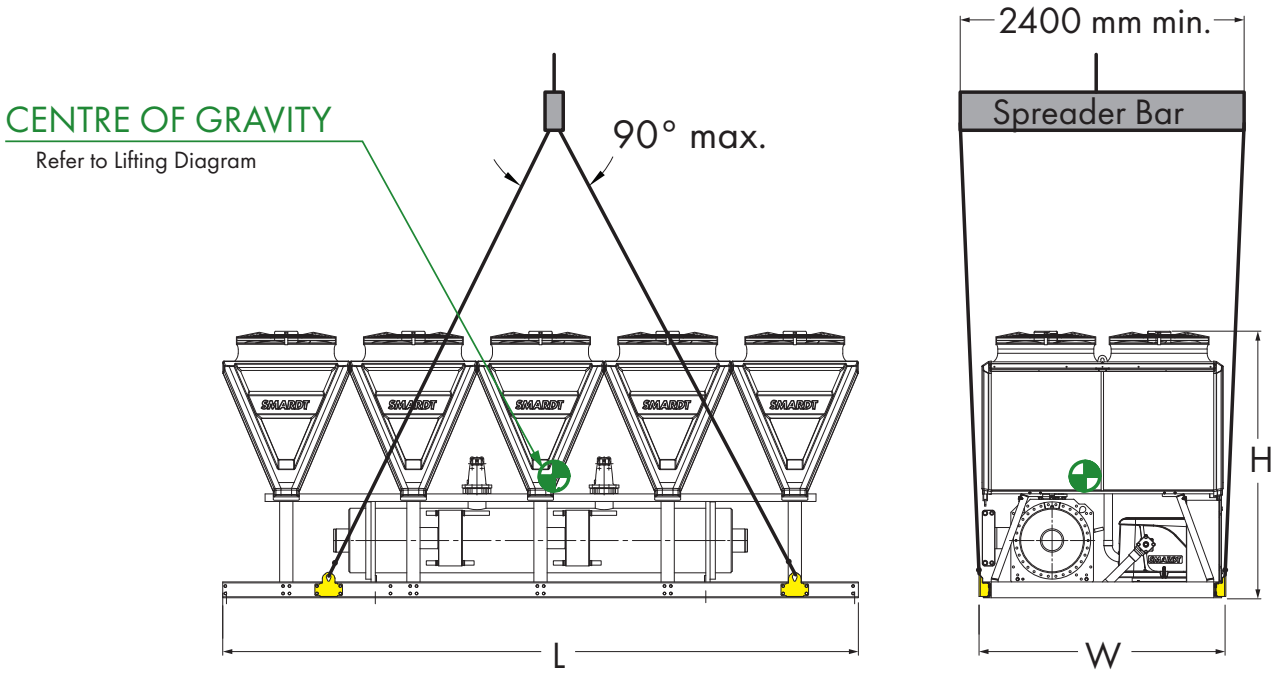


Figure 14: Rigging Diagram

11.8 Side Clearances

A nominal clearance of 2000 mm (78.75 in) around all four sides of the chiller and 3660 mm (144 in) between adjacent chillers is required for Smardt air-cooled chillers. A clearance equal to the length of the evaporator is recommended at either end of the vessel for service access requirements.

Refer to the chiller outline drawing supplied with your chiller. Air discharged from the fans should be unimpeded. Adjacent walls should be no higher than 3000 mm (118.2 in). Contact Smardt for recommendations on restrictive installations.

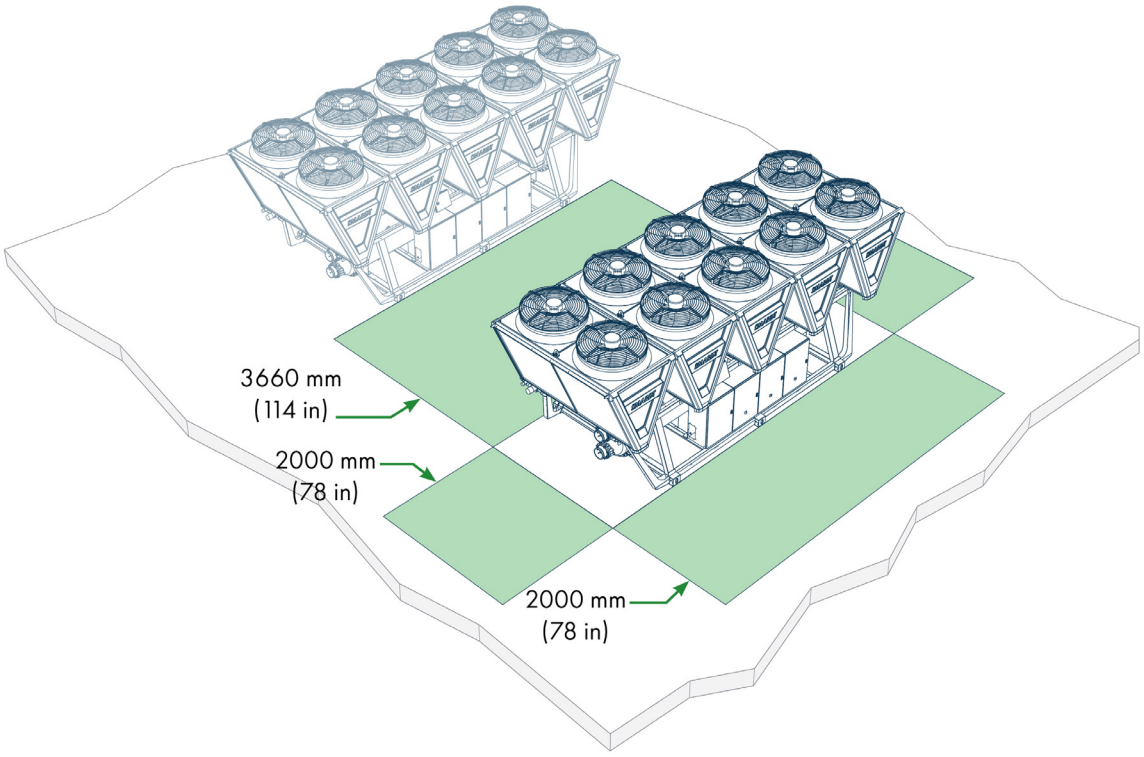


Figure 15: Chiller Side Clearance Requirements

11.9 Flow Safety Interlocks

Flow sensors are fitted as standard on all Smardt air-cooled chillers, protecting the chiller in the event of evaporator flow falling outside working limits. An additional field-supplied chilled water pump interlock, or a VSD interlock signal (I) is required on all installations. If the chiller is intended for an application using variable chilled water flow, please confirm the appropriate cut off point with Smardt. For chillers fitted with refrigerant recovery systems, additional interlocks may be required. Please contact Smardt at **support@smardt.com** to discuss appropriate considerations for your application.

11.10 Chilled Water Pipework Requirements

All external pipework must be self-supported and aligned to prevent strain and distortion on the chiller's headers and couplings. Each water circuit should be arranged so that the pump's discharge is connected to the lower connection of each vessel's waterbox. Consult the supplied chiller outline drawing for connection size and type.

NOTE: For Smardt products with 152.4 mm (6 in) grooved connections, Victaulic fittings to suit 152.4 mm (6 in) DN150 pipe must be used.

11.11 Minimum Water Loop Volumes

As per AHRI 550/590-2011 Standard Conditions Smardt chillers are designed with evaporators with the minimum chilled water volume recommendation of 2.58 lpm/kWR (2.4 gpm/ton) for a temperature differential of 5.6 °C (10 °F).

All non-comfort cooling applications should be checked for recommended loop volume. Please contact Smardt sales at **sales@smardt.com**.

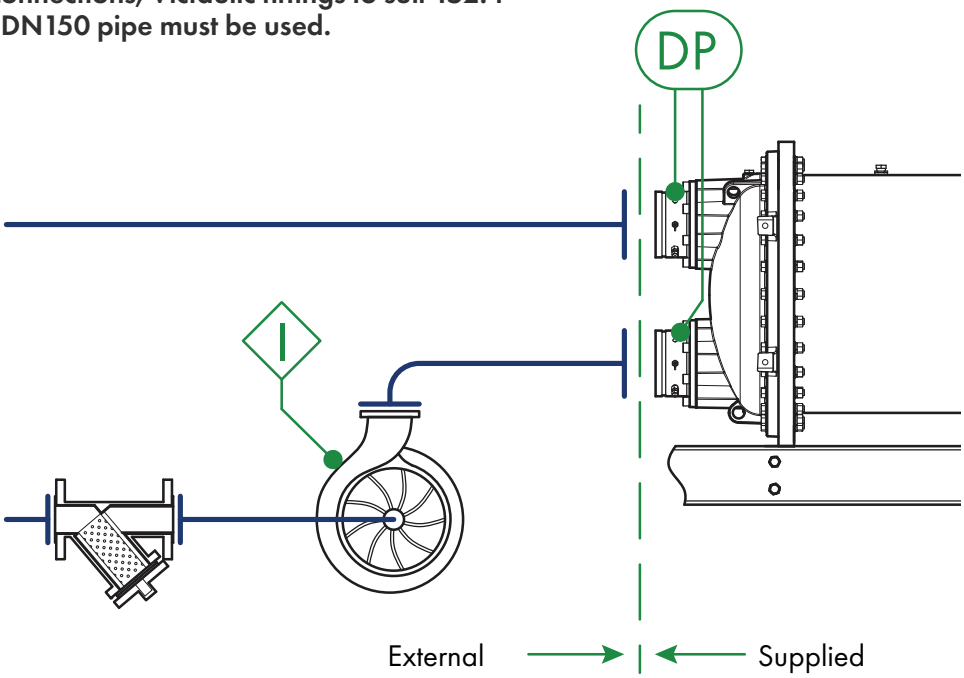


Figure 16: Water Loop Pipework

11.12 Chilled Water Quality

The chiller's performance and efficiency can be adversely affected by contaminants in the water circuit. As such, cleanable 20-mesh strainers should be located on the inlet side of the evaporator. As a rule, all types of suspended matter in the chilled water and cooling water must be avoided.

OPTION: Stainless steel options are available to minimize corrosion, making the water quality as clean as possible.

11.13 Chilled Water Temperature Limits

Smardt air-cooled chillers are optimized for leaving fluid temperatures between 3.3 °C (38 °F) and 22 °C (71.6 °F). For applications outside this range, please consult your local sales representative.

11.14 Operating Limits

The Smardt range of frictionless air-cooled chillers offer a large operating envelope when compared to other centrifugal chillers though there are still application limits that must be observed. Please refer to the chiller's Submittal documents.

11.15 Pressure Relief Valve

Pressure relief valves must be vented in accordance with local codes. It is the responsibility of the installing contractor to ensure venting piping sizes are compliant.

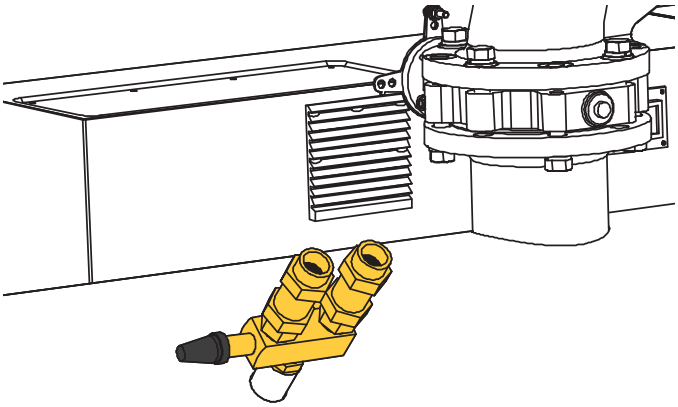


Figure 17: Pressure Relief Valve

11.16 Refrigerant Quality

Smardt air-cooled chillers operate with pure refrigerant only. **NO OIL MAY BE ADDED TO THE REFRIGERANT.**

If oil is present in the cooling circuit, the heat transfer properties in the heat exchangers worsen and the compressor(s) may be damaged and will void your warranty. Different models of Smardt air-cooled chillers require different quantities of refrigerant. The quantity of refrigerant required can be found on the chiller nameplate.

The following items must be observed regarding the refrigerant:

- Only use **oil-free** refrigerant for all Smardt air-cooled chillers.
- Do not add oil to the refrigeration system.
- Do not use recycled refrigerants, as they may contain oil residue.
- When handling the refrigerant and in the event of a leak, observe the safety procedures as described by the refrigerant supplier.
- When handling the refrigerant and in the event of a leak, always wear protective equipment recommended by the refrigerant supplier.

12 SMARDT CUSTOM CONTROLS

12.1 Control Field Wiring

Each air-cooled chiller is controlled via Smardt's proprietary software and equipped with Smardt's custom controller. A number of field connections are made via a terminal strip inside the control cabinet. The following building communication protocols are available as options, including: Modbus, BACnet and LonTalk.

More information can be found in Smardt's custom controller submittal documents.

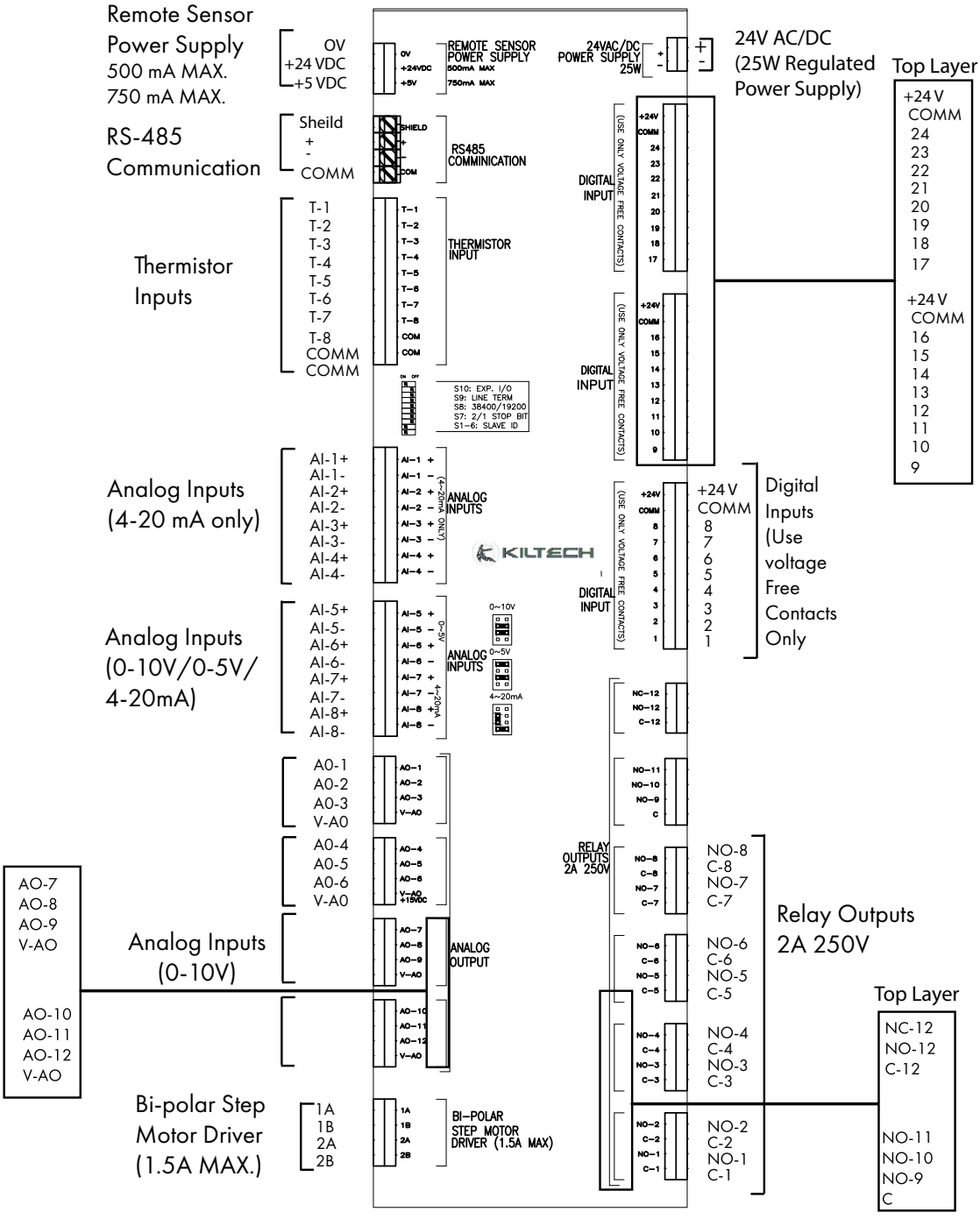


Figure 18: I/O Module (65-point option)

12.2 User Control Interface Specification

KILTECH GEN V CONTROL HARDWARE

The Smardt chiller control solutions are ready to use control interfaces and I/O devices developed specifically for Turbocor® compressor/chiller applications.

FEATURES/BENEFITS

- Enhanced energy efficiency capabilities, utilizing the latest compressor optimization
- Remote monitoring – via web to obtain realtime energy/performance data and system interrogation
- Panel mount 31 cm (12") TFT color touchscreen display
- Modular Input/Output devices – allow simple installation and commissioning
- Live updates/system configuration functionality
- Variable speed condenser fan controls
- Built in stepper motor controls for EXVs
- Continuous data logging – 3 years of data stored on device in easy to use .csv format
- Logging of 32,000 chiller compressor faults & events

CONTROLLER

- Custom DRPC: real time O/S, WiFi-capable
- Intel Atom™ 1.91 Processor System Memory: 1 x 204-pin DDR3L SO-DIMM 4 GB pre-installed (system max: 8GB)
- Solid State Drive: 16GB mSATA
- Hard Drive: 1x2.5" SATA 3GB/s HDD/SSD bay

GRAPHIC TERMINAL

- Advantech FMP-7121T 31 cm (12") Resistive Touchscreen
- Max Resolution: 1024 x 768 pixels
- Brightness: 600 cd/m^2
- Power Requirement: 24VDC

INPUTS AND OUTPUTS

- Thermistor Inputs: (10K NTC) – Qty. 8 Digital Inputs (Voltage Free) - Qty. 24
- Analog Inputs: (4-20mA or 0-10V) fixed – Qty. 4 / adjusted – Qty. 4 (Total Qty. 8)
- Digital Outputs: (Relay) – Qty. 12
- Analog Outputs: (0-10VDC) – Qty. 6
- EXV Output: Bipolar Stepper Motor Drive

BAS PROTOCOLS (WITH ADDITIONAL COMMUNICATIONS MODULES)

- Modbus™, TCP/IP native
- Modbus™, RTU RS485
- LonTalk®, FT-10 module
- BACnet™, MSTP
- BACnet™, IP

PHYSICAL DETAILS OF IP54 CABINET

- Enclosure: 660 x 762 x 152.4 mm^3 (26" x 30" x 6")
- Color: White, enamel (gloss)
- Weight: 27.2 kg (60 lbs)

ENVIRONMENT

- Operating range: -20 to 60 °C (-4 to 140 °F)
- Storage range: -20 to 60 °C (-4 to 140 °F)
- Relative humidity: 5 - 95% RH – non-condensing.

13 USER CONTROL INTERFACE AND SCREENS

Each Smardt Chiller is fitted with a high-resolution touchscreen as a human machine interface (HMI). The following section describes how to access many of the screens and the information displayed.

13.1 Home Page

The Home page offers an overview of the chiller's operating conditions. From this page, the operator can navigate through other pages to obtain specific data related to operation and performance of the chiller system.

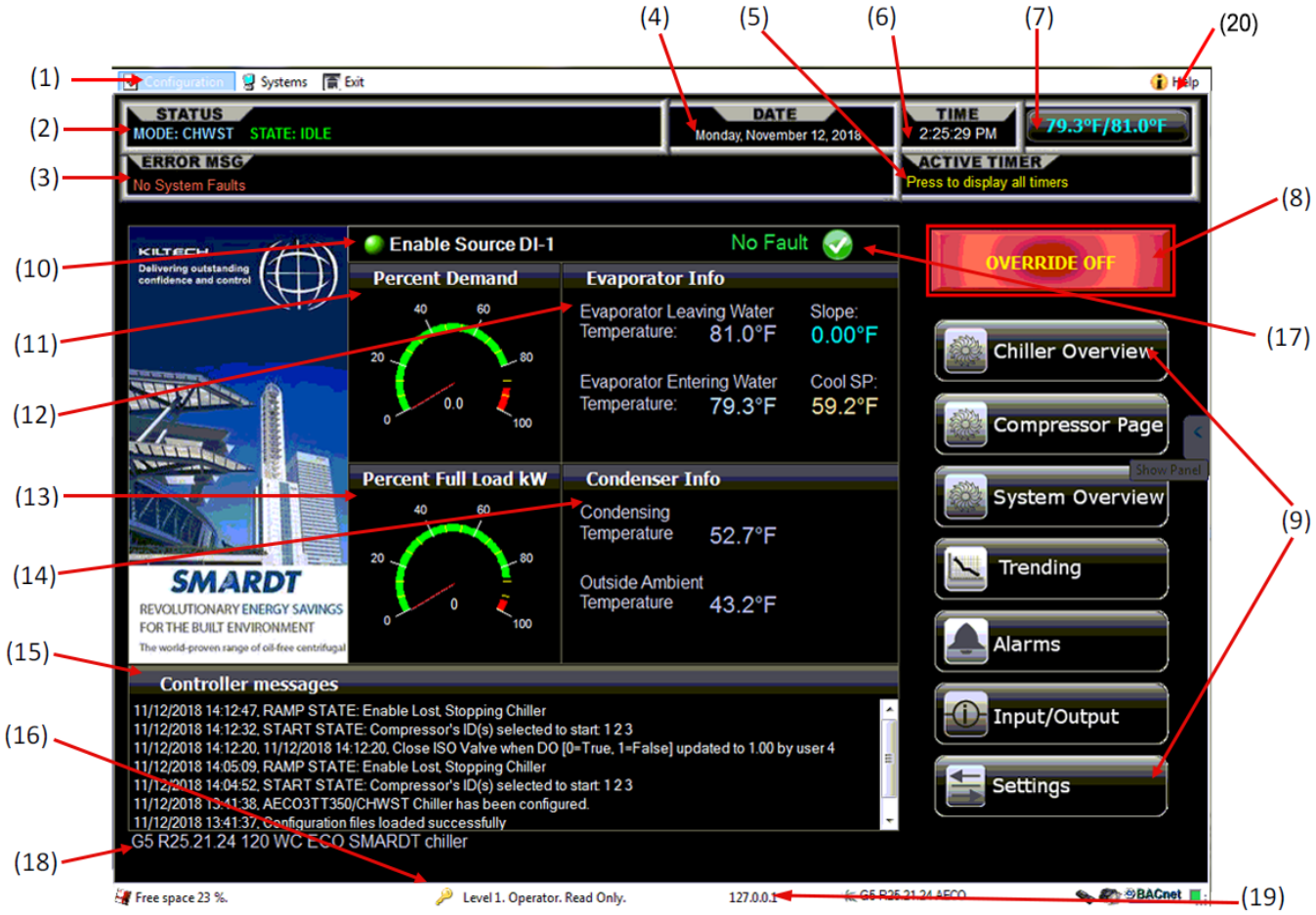


Figure 19: Home Page

BASIC OPERATION

User screens are those available without passcode access and make available all pertinent chiller operating data. Items in the following list can be viewed on the chiller's Home page.
Pressing the Home soft-key  on every page will return the user to Home (main).

1. Menu bar
2. Status messages
3. Error messages
4. Date
5. Active timer drop down menu
6. Time
7. Entering/leaving chiller water temperatures
8. Auto/override soft-keys
9. Page selection soft-keys
10. Enable source status indicator
11. Demand display
12. Evaporator summary information
13. Power display
14. Condenser summary information
15. Controller messages
16. Status line
17. Fault status indicator
18. Interface software release number
19. Control box IP address
20. Help label (access to control documentation).

13.1.1 Control States

On the Home page of the operator interface, the operator will be able to view the state of the chiller. These states can be categorized into two sections: Chiller States and Compressor States.

CHILLER STATES

- RESET
- IDLE
- START
- RAMP
- RUN
- SEQUENCE UP
- SEQUENCE DOWN
- ALARM/AVOIDANCE
- FAULT

RESET STATE

All PID loops are set back to initial values, outputs and counters are cleared. Start requests to compressors are removed and power demand is set to zero for each compressor. All analog and digital outputs are set to "non-active". System timers are reset and the state exits to "IDLE" state. Next start will be executed in 180 seconds as set by the Restart Delay Timer.

IDLE STATE

Controller waits for an enable from the selected source digital input, Modbus, BACnet or Touch panel). When enable is received and the restart delay timer has timed out the controller checks for compressor availability and the evaporator and condenser flow continuous proofs, the leaving chilled water temperature is greater than the set point plus the start offset. If the conditions are met the system is set to the start state.

START STATE

Chilled water pump and condenser water pump outputs are set, there is 45 sec allowed where the lead/ lag pumps may be switched if the lead is turned on and after 30 sec there is no flow feedback (duty standby pump control). The evaporator and condenser flows had been established compressors are selected to run based on user configurable variables such as sequencing mode and number of compressors to start at enable time. A Ready to Run compressor has to have the IGV starting position less than 30%. Once feedback is received from the compressors indicating they are ramping the system is set to the "RAMP" state.

RAMP STATE

In the RAMP state the demand is increased at a slow rate and compressors added until the chilled water temperature is 1 °C of the set point.
Once the chilled water set point temperature is reached the system is set to RUN state.

RUN STATE

In RUN state, the chilled water temperature control is made via the motor power demand PID loop.
Compressors are added and removed as required in order to maintain the chilled water temperature with as many compressors as possible running above surge with fully opened inlet guide vanes.
If the cooling demand is reduced to a point where only a single compressor is left online, the leaving temperature is reduced to less than the set point minus the stop temperature offset then the system is set to the SEQUENCE DOWN state.

SEQUENCE UP STATE (SUB STATE OF RUN AND RAMP)

In SEQUENCE UP state the next lead compressor is selected to run based on the compressor sequencing settings saved in the system.
If the pressure ratio on the active refrigerant circuit is less than the maximum limit the demand to all compressors is reduced slightly and the new lead compressor is enabled via Modbus.
If the pressure ratio on the active refrigerant circuit is greater than the maximum limit the following shall take place in the state prior to enabling the next lead compressor:

- Hot gas valves are driven open.
- Compressor speed is reduced.
- Load reduction timer is started (time limit to avoid holding in a reduced capacity state too long).

Once the pressure ratio is reduced to less than the maximum limit and remains below that value for 15 seconds, the new lead compressor is enabled via Modbus.
If the pressure ratio does not reduce within the sequencing time limit (default 300 sec), the state exits back to RUN or RAMP; however, the sequencing delay timer is tripled in order to provide more operation with less compressors at higher speed.
If the new lead compressor starts correctly the state exits the RUN and RAMP state once the newly added compressor has reached the surge speed of the other compressors operating on the same refrigerant circuit.

SEQUENCE DOWN STATE (SUB STATE OF RUN, RAMP, AND ALARM/AVOIDANCE)

In SEQUENCE DOWN state the operating lag compressor is selected based on the compressor sequencing settings saved in the system. Once the compressor to turn off is selected the enabled is removed via Modbus and then monitored. When feedback is received indicating the compressor has stopped, the state exits back to the initiating state (RUN, RAMP or ALARM).

ALARM/AVOIDANCE STATE (SUB STATE OF RUN AND RAMP)

In ALARM/AVOIDANCE state the chiller's capacity is reduced in an attempt to avoid faulting the entire chiller offline. Demand to all compressors is reduced at a rate of 1% per sec until the alarm condition clears or 45 seconds goes by in which case if there is more than one compressor online, the next compressor is removed from operation. If the alarm condition is caused by high discharge pressure, high lift or high 3 phase amps, the controller's maximum output to the compressors is limited to 80% of the demand value that caused the discharge pressure alarm for a period of 20 minutes. This state may exit to RAMP, RUN or FAULT.

FAULT STATE

In the FAULT state all devices are set inactive. Reset delay timer counts down. When reset delay timer is done the fault status is checked, if the fault has cleared the state is set to IDLE. If the fault condition still exists, the control will remain in FAULT state.

COMPRESSOR STATES

- OFFLINE
- RESETTING
- READY TO RUN
- RAMPING
- RUNNING
- ALARMED
- RESETTING WITH FAULT
- FINISHED RESET WITH FAULT
- CLEARING FAULT
- LOCKED OUT
- LOCKED OUT BY CHILLER

OFFLINE

Communications statistics less than 50%, 50 out of last 100 communications attempts to a specific compressor have failed. If this happens the compressor is deemed unreliable to control or has a power failure, disconnect wires, etc.

RESETTING

Compressor has just been powered up and is going through bearing and drive checks, or compressor has just stopped and is going through IGV reset.

READY TO RUN

Compressor is idle with no faults or alarms and may be started at any time.

RAMPING

Compressor is below its minimum operating speed and ramping up.

RUNNING

Compressor is above its minimum operating speed with no alarms present.

ALARMED

Compressor is above its minimum operating speed with one or more alarms present. In this state the compressor would be unloading itself.

RESETTING WITH FAULT

Compressor is shut down and going through IGV reset with a fault present.

FINISHED RESET WITH FAULT

Compressor is shutdown with a fault present.

CLEARING FAULT

Chiller controller is attempting to clear and reset a fault on one of the compressors.

LOCKED OUT

Compressor has faulted on either high current, high discharge pressure or three motor cooling faults within 30 minutes. Each of these faults require that the compressor is powered down and fully discharge then powered back up in order to reset the fault.

LOCKED OUT BY CHILLER

Compressor has had more than 10 faults in a 12hr period. Compressor must be powered down, fully discharged then powered back up in order to reset the fault.

13.1.2 Turning Chiller ON/OFF

Smardt's Custom Controller does not come with a mechanical ON/OFF switch. However, there is an integrated Auto/Override soft key on the Main system page which can enable/disable the chiller control locally. On the top right-hand side of the Home screen there are three soft keys:

- Auto DI# - 1 (default)
- OVERRIDE ON
- OVERRIDE OFF.

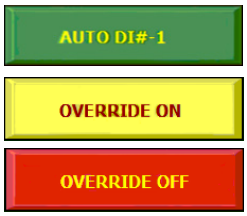


Figure 20: Chiller ON/OFF Soft Keys

The button has different colors depending on the enable mode and communication status. The button frame color depends on the state. When the communication is established the button changes state accordingly.

The different modes are:

AUTO DI#-1 or AUTO BAS

In AUTO DI#-1 the system is controlled by the Digital Input #1 signal. If DI-1is closed=Enable, opened=Disable.

Green frame= Chiller ENABLED

Red frame = Chiller DISABLED

OVERRIDE ON - In this mode the chiller is forced to ENABLE/START and to disregard the state of DI-1.

OVERRIDE OFF - In this mode the chiller is forced to DISABLE/STOP and to disregard the state of DI-1.

13.1.3 Interlocks

For the chiller to be enabled and provide system cooling, it is fitted with external interlocks which are required to be closed.

Interlocks include:

- Chilled Water Flow
- Condenser Water Flow
- Building Management System (BMS) Bypass – Left open circuited unless service is required and the BMS needs to be bypassed for service purposes.

Within the digital inputs, there are other interlocks which are required to be an open circuit during normal operation. If the contacts close, this indicates that a fault has occurred.

These interlocks include:

- External HP Switch
- External LP Switch
- Refrigerant Monitor
- Emergency Stop Button.

13.1.4 Auto Select

Once all of the interlocks are made or closed as per the above description, the chiller will start the cycle to provide cooling. Depending on the configuration, the chiller controller will automatically select the compressor (if a multiple configuration) with the least amount of run hours.

The "auto roll over" compressor select feature allows even run hours for the compressors installed on the chiller platform.

13.1.5 Anti-Recycle Timer

If the Anti-Recycle Timer on the compressor has timed out, the compressor will be called on to run. The compressor will ramp to the required level based on the commissioning settings specific to the application.

NOTE: Some chillers may require either a quick response to increase of load or vice versa. This will typically depend on the chilled water loop, the amount of time it takes to cycle the full amount of water through the system, and the way the AHU and associated valves are controlled in the field.

Part of the control strategy is to look at the load requirements and determine the compressor demand, which is done by the FUZZY PID control loop and the Kiltech compressor optimization loop.

During the operation of the compressor and the control of the chilled water, the chiller controller is processing the necessary data points to target the optimum compressor speed/motor power, to deliver the cooling required.

For multiple compressor applications, the chiller controller will also target the optimum control point for any given condition.

13.2 Chiller Overview Screen

Select the Chiller Overview button to view the overview screen. This screen provides more information including power, water, refrigerant, compressor and additional chiller details.

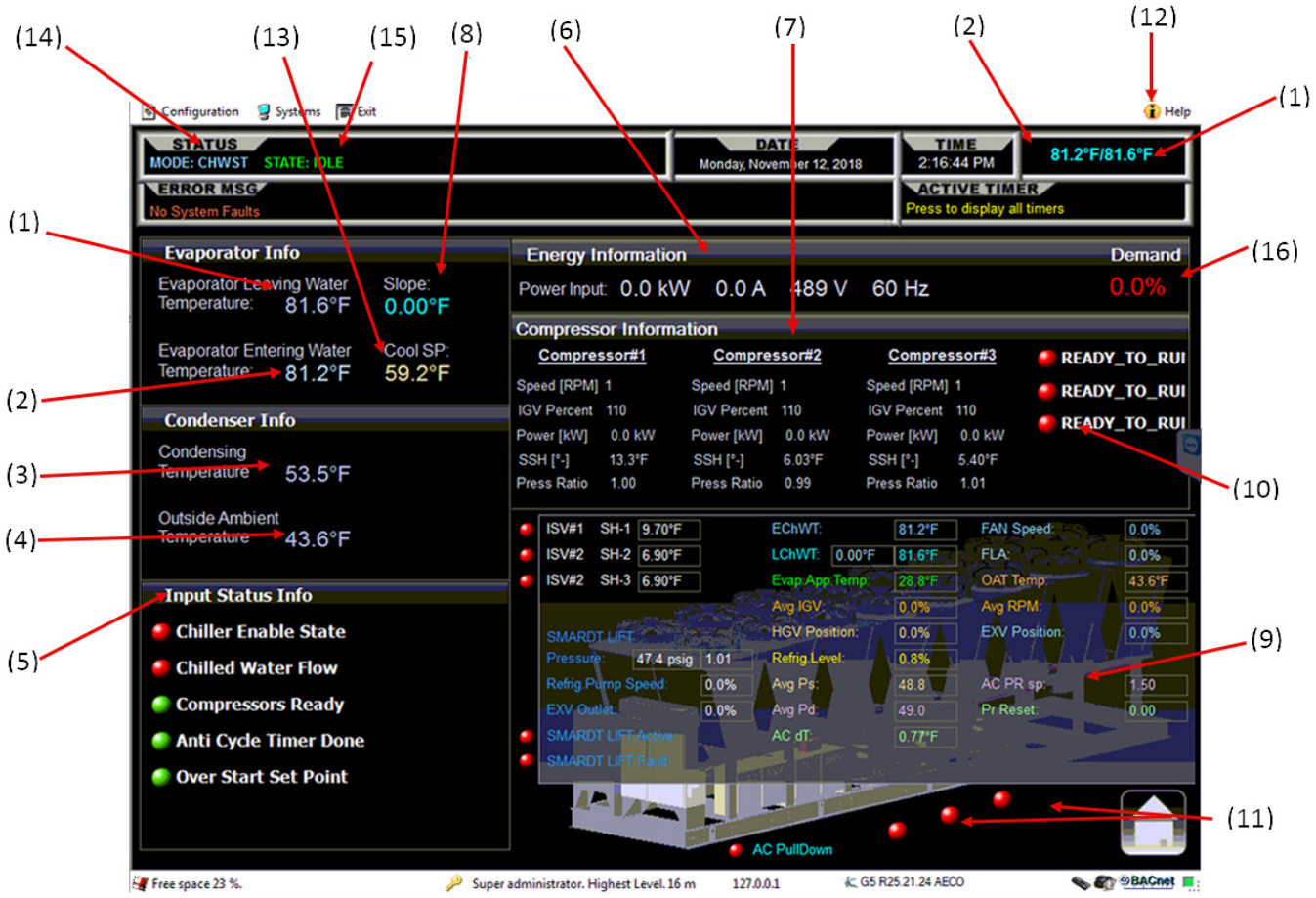


Figure 21: Chiller Overview Screen

1. Evaporator leaving temperature
2. Evaporator entering temperature
3. Condenser leaving temperature
4. Condenser entering temperature
5. Input status info
6. Energy information panel
7. Compressor's information panel
8. Evaporator water leaving temperature statistical dropping average value per minute
9. Chiller running technical points panel
10. Compressor running state label
11. Compressor running status light
12. Help label
13. Chiller cooling set point
14. Chiller operational mode
15. Chiller operational state
16. Compressors demand reference value

13.3 Compressor Data Screen

Select the Compressor Page button to view Compressor Data screen, where it is possible to view the key operating conditions and points of each individual compressor, gathering data directly from the compressor via the Modbus communication network.

Figure 22: Compressor Data Screen

From this screen the operator can view the following data from a single or multiple compressors.

- Alarms code
- Active fault code
- Demand applied to compressor
- Interlock status on compressor
- Compressor speed
- Inlet guide vane position
- Suction pressure
- Suction superheat
- Discharge pressure
- Discharge temperature
- Power input to compressor
- Desired power from chiller Cont.
- 3 phase amps
- Pressure Ratio
- Inverter Temperature
- Surge RPM
- Choke RPM

13.4 Compressor Data Screen (cont'd.)

Depending on the number of compressors the system is controlling, the compressor screen will be populated accordingly. The operator can navigate with the direction arrows to scroll to a specific compressor.

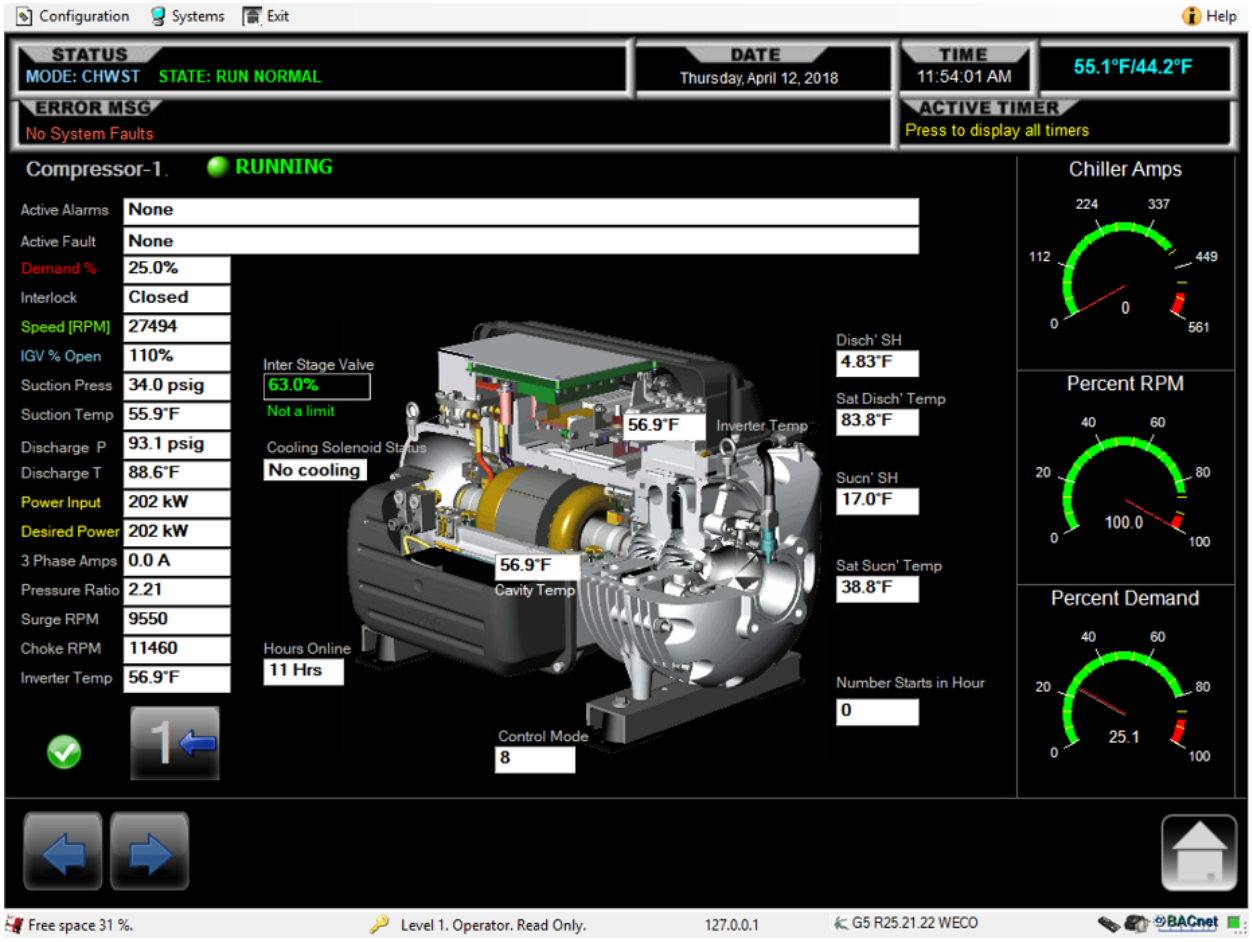


Figure 23: Compressor Data Screen (cont'd)

The operator may also choose to view a graphic representation of a specific compressor by pressing the "SLIDE" arrow next to the compressors number. A compressor graphic will appear with the relevant compressor information.

NOTE: If additional high-level data is required from the compressor, the operator will require an authorized service provider to access this information via the Turbocor® monitoring tool that is accessible via the chiller controller touch panel (password protected).

- Alarms code
- Active fault code
- Demand applied to compressor
- Interlock status on compressor
- Compressor speed
- Inlet guide vane position
- Suction pressure
- Suction temperature
- Suction superheat
- Discharge pressure
- Discharge temperature
- Discharge superheat
- Power input to compressor
- Desired power from chiller Cont.
- 3 phase amps
- Pressure Ratio
- Inverter Temperature
- Surge RPM
- Choke RPM
- Active CC faults and alarms
- Active BMCC fault

13.5 System Overview Screen

Select the 

button to view more detailed information related to shell and tube heat exchanger.

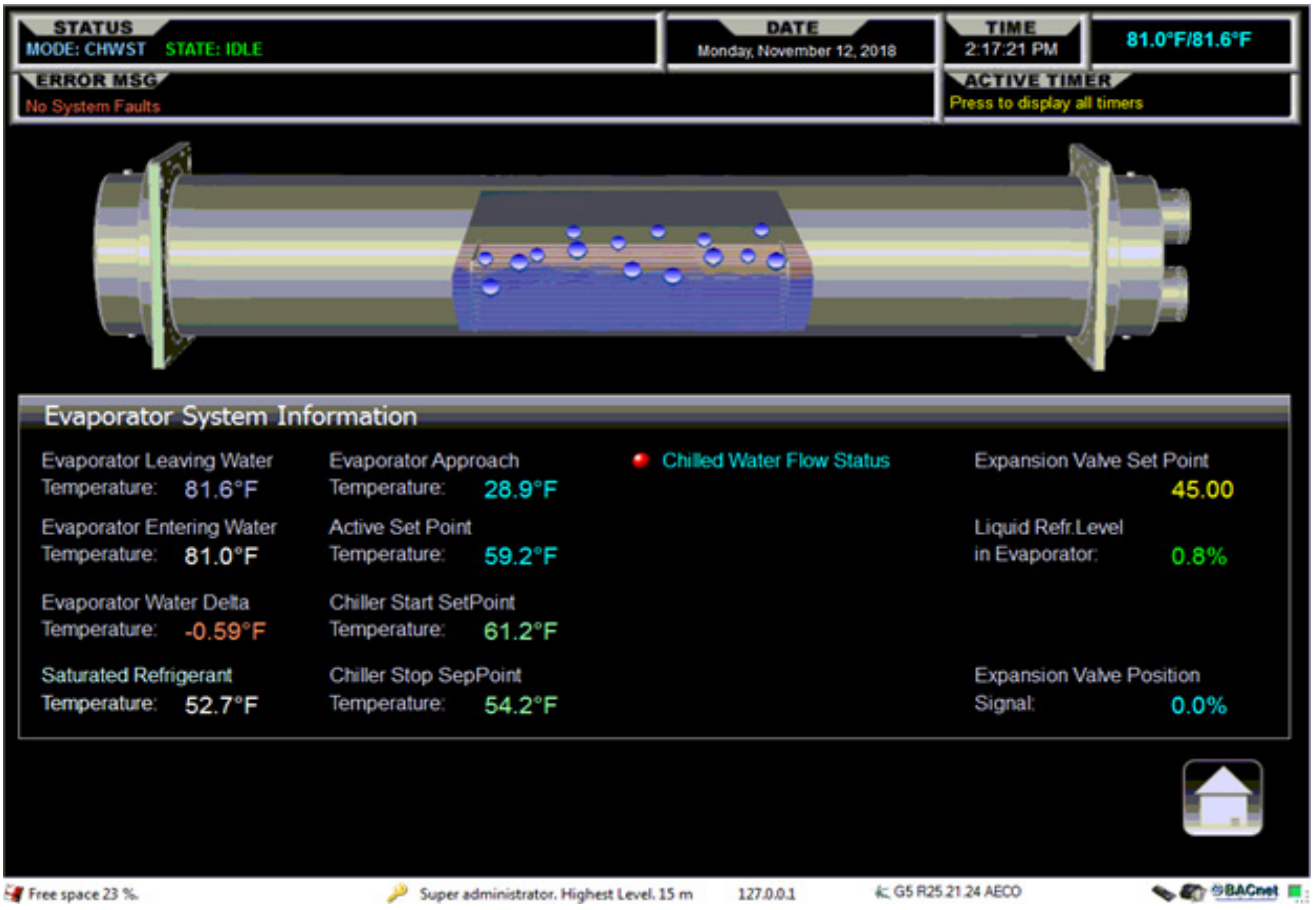


Figure 24: Evaporator Overview Screen

This screen provides additional information on the evaporator regarding:

- Evaporator leaving water temperature
- Evaporator entering water temperature
- Evaporator water temperature difference
- Saturated refrigerant temperature
- Evaporator average approach temperature
- Active set point
- Chiller enable set point temperature
- Chiller stop set point temperature
- Chilled water flow status
- Expansion valve set point
- Liquid refrigerant level in evaporator
- Expansion valve position signal

13.6 System Trending Screen

Select the 

button to display screens.

RUNNING CONTROL TRENDS

The Running Control keeps the trending data maximum for 7 days of the trend period.

STOPPED CONTROL TRENDS

When the control has been stopped, it keeps the last 24 hours of trending history at the file history of the DRPC CPU. It is saved as an .XML file.

Next Start Control will load the last 24 hours of trending history on the interface.

Double-clicking on a trend will change the trend period.

A default trend period value is 6 hours. The dialog also allows tuning the y axis scale to the range of ±10% of the current values.

The trend period settings are kept even when an interface restart occurs.

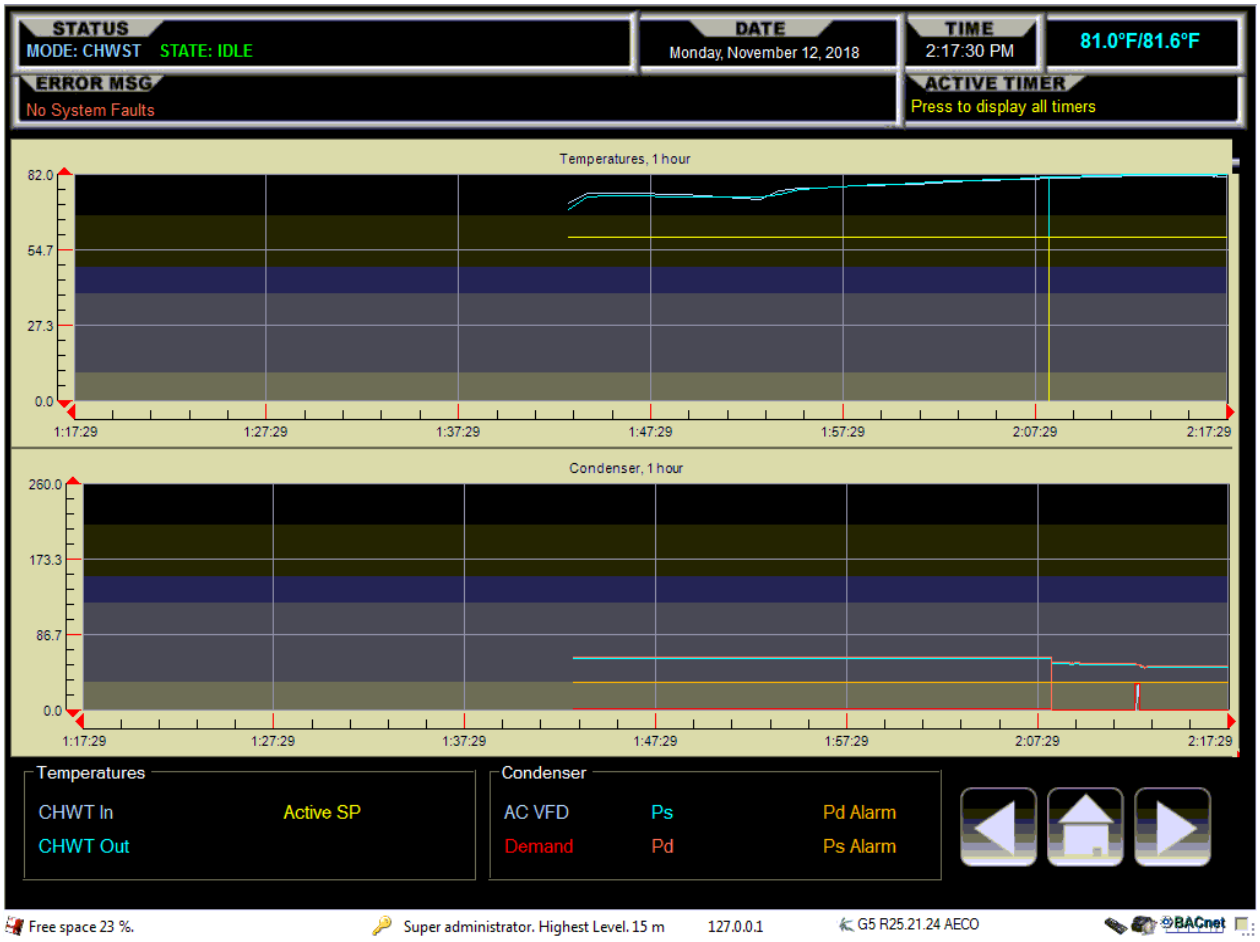


Figure 25: Temperature and Power Trends Screen

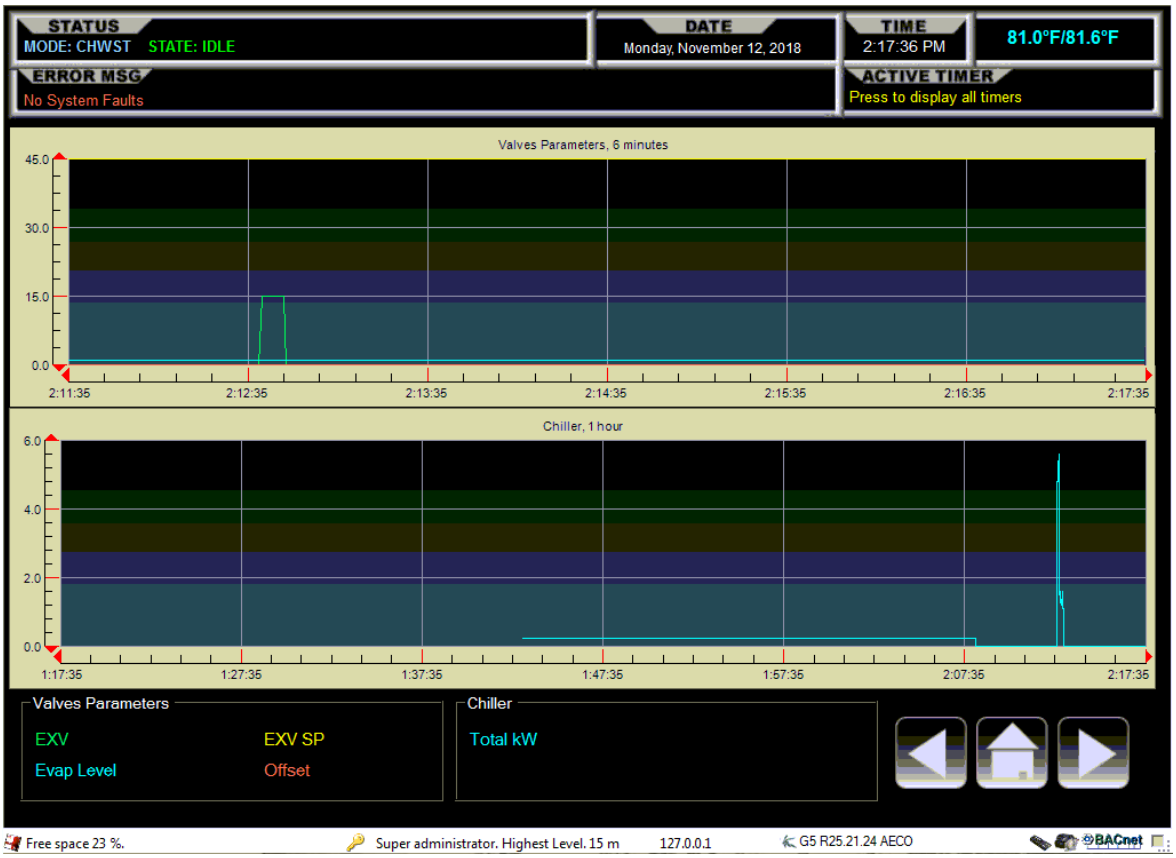


Figure 26: Valve Parameters and Chiller Trends

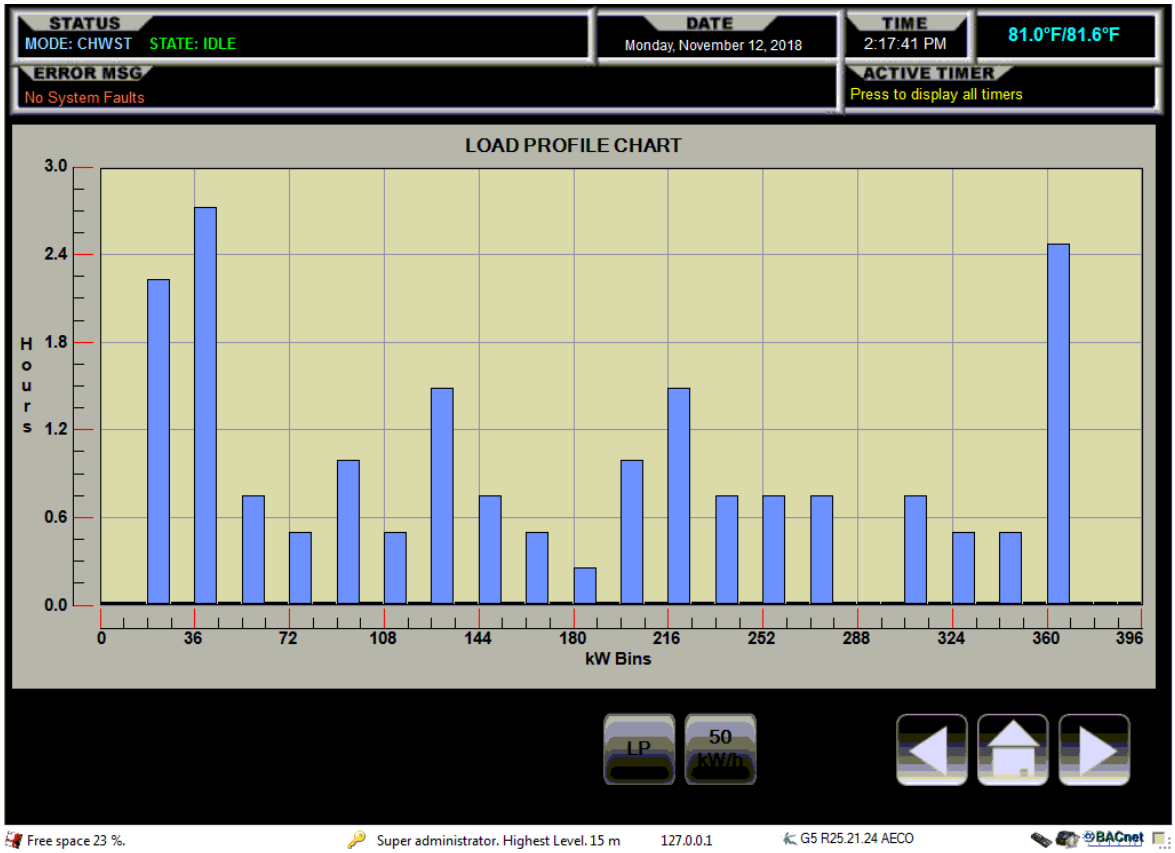


Figure 27: Load Energy Profiles Chart

13.7 Alarms and Faults Screen

Select the Alarms button to display a list of alarms and events that have occurred in the chiller and specific compressors.

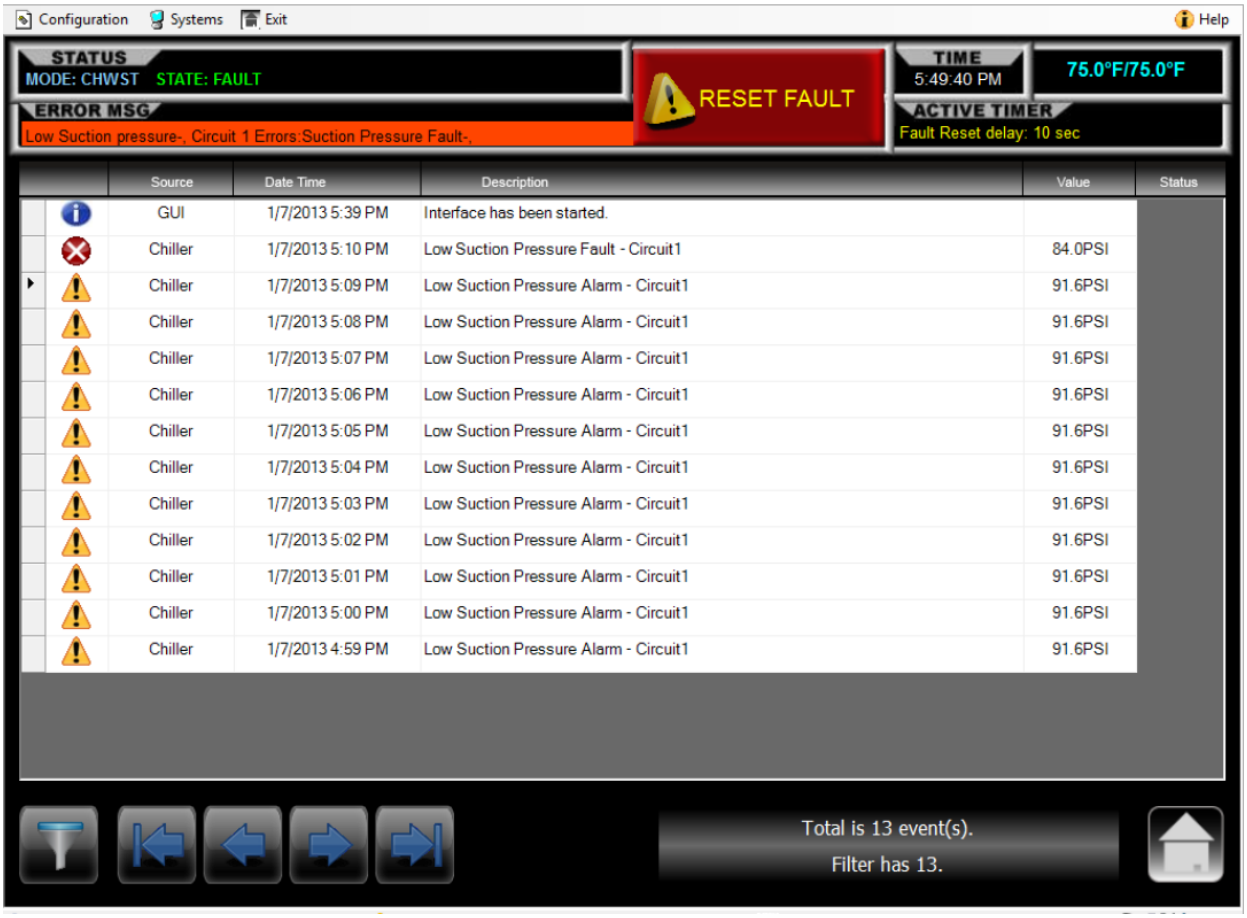


Figure 28: Alarms and Faults Screen

Alarms/faults icons:

- - Fault
- - Event
- - Alarm

Alarms/faults sources:

- Chiller
- Compressor
- GUI Interface

Events or faults can be filtered by pressing the Filter icon .

Filter settings:

- All dates
- Current date
- Selected date
- Chiller control
- GUI
- Compressor

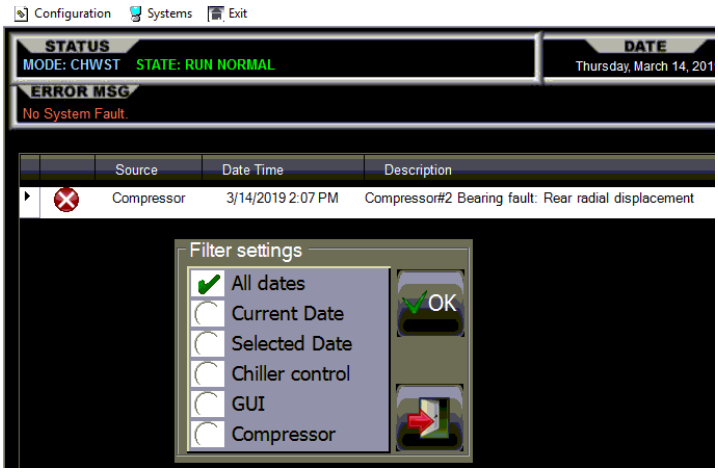


Figure 29: Alarms and Faults Filter

REFRIGERANT CIRCUIT'S FAULTS

- Low suction pressure fault – circuit #
- High discharge pressure fault – circuit #
- LP switch fault – circuit #
- HP switch fault – circuit #
- SSH fault – circuit #
- High evaporator approach fault
- All circuits have had a fault

GENERAL CHILLER FAULTS

- Low leaving CHW temperature fault
- High entering conditions temperature fault
- High 3 phase amps fault
- High 3 phase kW fault
- High evaporator diff temperature fault
- No CHW flow fault
- No CW flow fault
- Emergency switch tripped fault
- Gas leakage fault
- IO board comms has been lost fault
- All compressors comms lost fault

CHILLER ALARMS

- Low suction pressure alarm – circuit #
- High suction pressure alarm on circuit #

CONTROLLER FAULTS AND ALARMS MESSAGES

- Next fault and alarms are shown at the interface main page controller messages window
- Suction pressure alarm on circuit #
- Discharge pressure alarm on circuit #
- Low leaving temp alarm (Only at message center)
- High evaporator diff temperature (Only at message center)
- High 3 phase current alarm (Only at message center)
- Low suction pressure fault – circuit #
- High discharge pressure fault – circuit #
- LP switch fault – circuit #
- HP switch fault – circuit #
- SSH fault – circuit #
- High evaporator approach fault – circuit #
- High condenser approach fault – circuit #
- All refrigerant circuits have an error fault
- Low leaving chilled water fault
- High entering condenser water fault
- High 3 phase amps fault
- High 3 phase kW fault
- High evaporator differential temperature fault
- No chilled water flow fault
- Emergency switch tripped fault
- Gas leak fault
- IO board communication has been lost
- All compressors communication lost

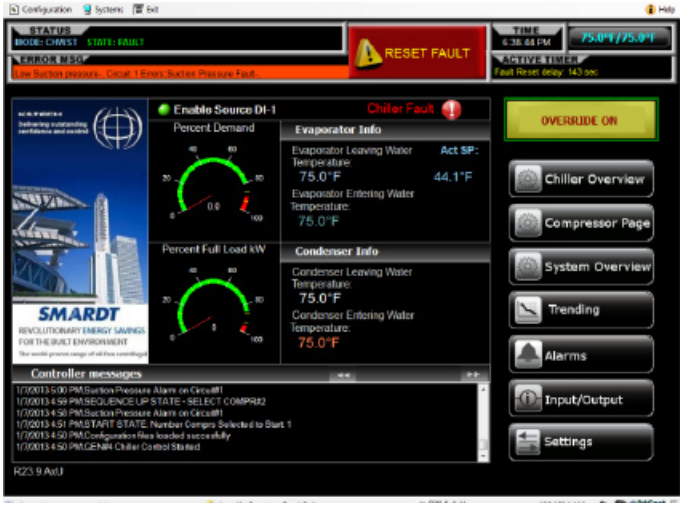


Figure 30: Main Screen with Fault Alarm Warning

13.8 Input & Output Screen

Select the 

button to view one of four I/O screens. Use the left/right arrow buttons to scroll through each screen. Depending on the number of inputs/outputs utilized (application specific) the operator can view the feedback of the current status or value of each input or output. If any I/O has an override applied, it will be shown in red here.

Figure 31: I/O Data Screens

13.9 Settings and Setup Screen

On the touch panel Home screen press 

button to bring up the keypad.

Enter the numeric access code, as provided by Kiltech or an authorized Smardt support representative on the keypad and press the "Accept" button to view the Setup Main Menu screen in read-only mode (Level 1). Depending on the access code entered, the operator shall be able to read most of the parameter settings, however may not be able to change critical commissioning parameters. From this screen select menu buttons only as requested by the Smardt support representative.

Figure 32: Settings and Setup Screen

SETUP SCREEN BUTTONS:

- General Data – chiller parameters and Modbus™.
- Chiller Control Loop – temperature and PID settings are set to define how chiller reacts to control the required set point.
- Valves Settings – user can set stepper motor parameters for EXV and Hot Gas Bypass valve.
- Alarms and Limits – alarms and trip limits for the chiller controller should be set as per manufacturer's recommendations. Failure to do so may void warranty of OEM's equipment.
- Kiltech Field I/O – commissioning agent can manually override inputs from I/O module.
- Activation – user can enter activation code for basic chiller control functions.
- Design Data – set design conditions of chiller / system based on manufacturer's datasheet or as per authorized retrofit contractor.
- Condenser Settings – set condensing control PID loop parameters, cooling tower, and tower bypass control loop parameters (as required).
- Compr. Sequencing - this screen allows a commissioning agent to enter in key sequencing information based on the application.
- I/O Scaling Param. – allows commissioning agent to calibrate chiller or define range of any given input
- Misc. Param Setup – access to additional for commissioning agent.
- Data Log – allows user to login and copy the chiller's data log files to a USB key.

14 MAINTENANCE AND SERVICING

Under NO circumstances shall user maintenance and/or cleaning of the chiller unit be conducted by children (persons under 18 years of age).

14.1 Authorized Maintenance Schedule

Quarterly maintenance of your Smardt chiller must be carried out by an authorized Smardt representative, OTHERWISE THE WARRANTY IS VOIDED. "Quarterly" scheduling is based on typical applications. For special or high-fouling applications, more frequent maintenance may be required. For a local authorized representative, please contact support@smardt.com.

14.1.1 Routine Inspection Schedule

Adhering to a continual inspection routine will ensure the longevity and optimal performance of the Smardt chiller. A list of simple tasks is shown below, and the **T-Class Air-cooled Chiller Maintenance Guidelines** can be found in the following pages. In all procedures Smardt recommends that owner operators:

- Report any damage to the chiller.
- Report any faults that occur with the chiller set.
- Turn OFF the chiller if fault conditions persist.

14.1.2 Routine Cleaning

Each chiller should be cleaned periodically, depending on operational and environmental factors. Use a brush or dry cloth to remove dust and/or other settled debris. If necessary, a solvent-free cleaning product may be used on a slightly damp cloth. Extra care must be taken around compressors, control panel and electrical components.

SAFETY INSTRUCTIONS **NOTE: Do not use a pressure washer to clean a chiller.**

14.1.3 Chiller Logs

Each chiller comes with an 'Events Log' and 'Fault Log' in the HMI. It is recommended that you check these periodically. In the event of a fault, Smardt may require information from these logs to provide you with a solution.

14.1.4 Electrical Enclosures

It is recommended that you check if the electrical enclosure cooling fans are functioning. This can be done by feeling if air is passing through the vents located on the bottom and rear of each enclosure. The vents may be removed to clean the dust filter. This can be done by levering the vents using the tabs on the rear of each vent. Take extra care not to scratch the enclosures.

As part of your routine inspection, it is recommended that you check that the control touchscreen is functioning normally. Further maintenance of the electrical enclosures must be carried out by authorized Smardt service personnel.

14.2 Freeze Protection

Recommendations for Freeze Protection

In locations where the ambient temperature may fall below freezing, appropriate freeze protection of the chilled water circuit is required. Smardt recommends the following to ensure proper system operation and prevent freeze-up of the evaporator:

- Continuous circulation of water through the piping and heat exchanger when the temperatures drop to below freezing.
- Inclusion of glycol solution in the chiller water circuit. Care should be taken to ensure the appropriate concentration of glycol within the system.
- Increasing the thickness of insulation.
- Draining and flushing the chiller water vessel with glycol during freezing weather.

It is the responsibility of the installing contractor or on-site maintenance personnel to insure that these measures are in place.

14.3 Water Treatment

Chiller performance and efficiency can be adversely affected by contaminants in the water circuits, and such contaminants could impede or block the flow of water through the circuit or reduce the performance of the heat exchanger. Smardt strongly recommends using the services of a qualified water treatment specialist to determine necessary water treatment.

The following values can be considered acceptable for Smardt shell and tube heat exchangers:

- pH- greater than 7, less than 9
- Total Dissolved Solids (TDS)- < 2000 ppm
- Hardness as calcium carbonate ($CaCO_3$)- 30-500 ppm
- Alkalinity as calcium carbonate ($CaCO_3$)- 30-500 ppm.

Smardt cannot be responsible for heat exchangers that are damaged as a result of operating chillers in untreated/poorly treated water conditions.

Smardt does not recommend the use of acid to remove scale from heat exchangers.

In the event acid is used to de-scale a heat exchanger, the heat exchanger must be properly flushed and then tested for proper pH levels before being returned to normal operation.

Heat exchangers damaged due to improper acid cleaning are not covered under warranty.

14.4 Corrosion

Corrosion of metals is a complex and on-going problem affecting water-carrying vessels, piping and other components, despite stainless steel being considered corrosion-resistant. Water impurities such as chloride and high pH levels will cause corrosion. To prevent corrosion and erosion of the materials in heat exchangers, additional measures may have to be taken. It may be necessary to use suitable inhibitors for the heat stabilization or anti-corrosion agent.

Consult a water treatment professional before adding chemicals to water. Do not use hydrochloric acid or sulphuric acid.

14.5 Recommended List of Spare Parts

Over the course of a maintenance cycle, certain consumable materials will be required according to the task intervals below. Please contact the Smardt Support department for ordering details and note that additional materials may be appropriate as per application or project specific requirements:

- Dielectric grease
- Antioxidant grease
- Control/power cabinet air filters
- Condenser water box gaskets
- Refrigerant pressure relief valves
- Compressor soft start cooling fans
- Compressor DC capacitor banks.

15 T-CLASS AIR-COOLED CHILLER MAINTENANCE GUIDELINES

Under NO circumstances shall user maintenance and/or cleaning of the chiller unit be conducted by children (persons under 18 years of age).

15.1 General

To ensure performance benefits are sustained over the life of your equipment, having adequate and ongoing maintenance best practices in place is critical. A full inspection should be made roughly one month after substantial completion of new projects and scheduled regularly thereafter.

Smardt offers Planned/Unplanned Maintenance Agreements factory direct and/or through a network of factory trained service providers that can create a worry-free financial situation for the owner while saving substantial operating and maintenance costs over the life of the plan.

With building owners in mind, Smardt maintenance checklists are broken down into three (3) sections: scheduled tasks that can be carried out while 1) the unit is powered ON and in operation and then by tasks that are carried out while the unit is disabled, 2) with power ON and 3) with power OFF so that appropriate down time is planned for. Please refer to **15.3 T-Class Air-cooled Chiller Maintenance Task Index.**

This schedule includes items for both air and water-cooled chillers; therefore, those that do not apply to the type of unit being maintained need not be carried out.

ACRONYMS

- EXV – Electronic eXpansion Valve
- HGBV – Hot Gas Bypass Valve
- CSV – Compressor Staging Valve
- CEV – Compressor Economizer Valve
- IGV – Inlet Guide Vanes
- PCB – Printed Circuit Board
- IFV – IntraFlow Valve

15.2 Safety Instructions

DANGER: Removing covers from powered compressors will expose you to up to 632VAC and 920VDC. Wait 20 minutes from the time power is disconnected before attempting to remove compressor covers and always wear appropriately rated Personal Protective Equipment (PPE).

DANGER: Before performing checks in section three (3) in the Task Index, the chiller mains input power must be disconnected and locked out according to local ordinances.

NOTICE: To prevent premature condenser coil wear, only non-corrosive cleaners are permitted.

NOTICE: All Smardt chillers are 100% oil-free. Any interaction with the refrigerant circuit must be done with oil-free equipment to ensure the charge is not contaminated.

NOTICE: If the unit is expected to operate under freezing conditions, it is the responsibility of the installing contractor and/or the customer to ensure that a pump will start if freezing conditions are detected. Only the proper concentration of freeze inhibitor or complete drainage of the water circuit can ensure the unit is undamaged in the event of a power failure.

Smardt Inc. reserves the right, at its sole discretion, to amend this publication without prior notification and is under no obligation to present such modifications. This document may be reproduced and redistributed provided no fee is charged, the content is not modified, and the copyright notice is included. Smardt Inc. makes no warranty or representation, neither expressed nor implied, with respect to this publication, including its quality, performance, or fitness for a particular use. The user agrees that the information contained herein will be used solely for operating equipment from Smardt.

In no event shall Smardt be liable for any incidental, consequential or special damages of any kind or nature whatsoever, including but not limited to lost profits arising from or in any way connected with items sold to the buyer by Smardt, whether alleged to arise from breach of contract, express or implied warranty, or in tort, including without limitation, negligence, failure to warn, or strict liability. Smardt Inc.

CHILLER POWERED ON, ENABLED

This section of checks consists primarily of note taking on various aspects of the unit with no effect of any kind towards its operation. A note may contain such things as words, figures, models, and/or pictures necessary to communicate clearly and concisely anything that has been altered from its original state or from the state it was last in.

CHILLER POWERED ON, DISABLED

These are checks that require power to be carried out and that doing so will adversely affect the performance of the chiller such as removing sensors for calibration or ensuring electronically actuated valves stroke fully and freely.

Such checks may require the use of a laptop computer and it being in direct communication with the chiller controller or the compressor(s).

CHILLER POWERED OFF, DISABLED

Wherever possible, sensors must be calibrated against known accurate standards such as regularly calibrated gauges, the melting point of ice or the boiling point of water at sea level and standard atmospheric pressure. This segment of checks includes checks that pose a threat to the health and safety of those carrying them out; therefore, the mains input power must be locked out as per local ordinances.

15.3 T-Class Air-cooled Chiller Maintenance Task Index

		Quarterly	Semi annually	Annually	As required by performance	During seasonal shutdown	During seasonal startup
1.	**CHILLER POWERED ON, ENABLED**						
1.1.	Note anything related to physical condition that has changed from its original state and/or the last state it was known to be in.	X	X	X		X	X
1.2.	Note any leaks around water box connections.	X	X	X		X	X
1.3.	Note any sources of significant vibration.	X	X	X		X	X
1.4.	Note any compressor sweating while idle.	X	X	X		X	X
1.5.	Note any significant discrepancy between IGV ball indicator and the position shown on the chiller controller.	X	X	X		X	X
1.6.	Note any indication of moisture in the refrigerant circuit.	X	X	X		X	X
1.7.	Note any significant source of control/power cabinet dust/debris ingress.	X	X	X		X	X
1.8.	Note any inoperable control/power cabinet cooling fan.	X	X	X		X	X
2.	**CHILLER POWERED ON, DISABLED**						
2.1.	Download full chiller controller data logs for record.	X	X	X		X	X
2.2.	Download full compressor fault AND event logs for record.	X	X	X		X	X
2.3.	Note compressor date/time stamp before synchronizing with a laptop computer.			X			X
2.4.	Ensure compressor IGVs fully open/close.		X	X			X
2.5.	Ensure EXVs fully open/close.		X	X			X
2.6.	Ensure HGBVs fully open/close.			X			X
2.7.	Ensure CSVs fully open/close.			X			X
2.8.	Ensure CEVs fully open/close.			X			X
2.9.	Ensure actuated ball valves fully open/close.		X	X			X
2.10.	Calibrate temperature sensors (water/air).	X	X	X		X	X
2.11.	Calibrate water flow safety devices (switch/transmitter).		X	X			X
2.12.	Calibrate liquid refrigerant level sensors.			X			X
2.13.	Ensure evaporator heat trace is functional.		X	X			X
2.14.	Ensure compressor heat trace is functional.			X			X
2.15.	Note mains input voltage phase to phase.		X	X			X
3.	**CHILLER POWERED OFF, DISABLED**						
3.1.	Note any signs of discoloration on medium/high power terminals.		X	X		X	X
3.2.	Ensure medium/high power terminals are tight/secure.		X	X		X	X
3.3.	Inspect/clean exposed PCBs with compressed/dry air.			X	X		
3.4.	Apply compressor dielectric grease.		X	X	X	X	X
3.5.	Apply antioxidant grease.		X	X	X	X	X
3.6.	Ensure discharge stop check valves fully open/close.			X			
3.7.	Replace control/power cabinet air filters.		X	X	X	X	X
3.8.	Check all refrigerant seals for leaks including relief valves.		X	X		X	X
3.9.	Clean water flow safety devices.			X	X		
3.10.	Clean condenser tubes.			X	X		
3.11.	Conduct Eddy Current testing of condenser and evaporator tubes.						
3.12.	Replace the compressor Soft Start fan every five (5) years.						
3.13.	Replace the pressure relief valves every five (5) years.						
3.14.	Replace the compressor DC capacitors every ten (10) years.						

16 TROUBLESHOOTING AND FAULTS

For Technical Assistance on these or any other issues contact Smardt Product Support: **+1 514 683-5585** **support@smardt.com**.

FAULTS	POSSIBLE CAUSE	ACTION
Chiller does not turn ON	No electric power	Check supply of electricity on client's side Check power supply to Chiller (see wiring diagram)
	A safety device prevents start	A client-side safety feature is preventing start and must be checked
	External release is missing (e.g. process control, master-slave control or chilled water pump)	Check process control, master slave control or chilled water pump for proper functionality
		Check for proper communication
Chiller components do not power up when chiller energized	Open control fuse transformer	Check all control fuses Check in/out voltages at XFRMR's Confirm incoming voltages on all 3 phases
Chiller will not start when placed in Override On	Tripped high or low press switch	Check system refrigerant pressure & that safeties are open (N/O)
	Flow switch(s) not closed	Check for proper flow and minimum flow switch settings are correct
	No compressor communication	Ensure compressors are powered up, cables are tight at comp IO board
	Entering chilled water above start temp	Check that entering chilled water start temp is reached (chilled water setpoint + offset in Settings)
	Compressors not "Ready to Run"	Determine cause of compressor issue using SMT if properly trained
Chiller will not start when placed in Auto	Safeties or entering chilled water start temp	See above
	DI-1 not closed	Check that DI-1 is closed to 24V (if DI-1 start is selected in controller)
	BAS not enabling chiller	Check that BAS is sending enable via HLI
Touch panel does not turn on (remains dark)	Touch panel defective	Contact Smardt Support department
Increased energy demand of the compressor	Chiller overloaded	Reduce the thermal load
	Thermal load too high	Check technical parameters
	Compressor defective	Contact Smardt Support department
Unusual sounds from compressor	Compressor defective	Contact Smardt Support department
Compressor(s) with excessive temperature	Refrigeration of compressor interrupted or defective	Verify compressor cooling circuit
Compressor doesn't work even though no fault message displayed	Loose electric connection to motor or in control cabinet	Contact Smardt Support department
Discharge check valve chatters excessively when compressor(s) running	Compressor may be in surge condition	Verify chilled water & condenser water flows are at design as detailed on chiller ID tag
	High pressure ratio	Check entering condenser water temperature is within design
	Low suction pressure	Check refrigerant level sensor & EXV(s) are working correctly; check for refrigerant leaks
Frost protection	Set point temperature of frost protection is set incorrectly	Check set point temperature of frost protection
	PLC or sensor defective	Check function of PLC Measure resistance of sensor

TROUBLESHOOTING AND FAULTS (CONT'D.)

FAULTS	POSSIBLE CAUSE	ACTION
Sensor faults	A connected sensor or switch is defective	Replace sensor or switch
Broken wire in a sensor	Signal from a connected sensor or switch is defective	Replace sensor or switch cable
High pressure fault	Dirty condenser	Clean condenser
	High entering condenser water temp	Confirm cooling tower operating properly
	Low condenser water flow	Confirm condenser water pump operating properly and all valves are open
Low pressure fault	Refrigerant level sensor out of calibration	Check/calibrate sensor
	EXV(s) not operating properly	Check open/close position of EXV(s) at sight glass
	Low chilled water flow	Confirm chilled water pump operating properly & all chilled water valves are open
	Dirty evaporator	Clean evaporator
	Chiller low on refrigerant	Perform leak check on machine
High inverter temp or high cavity temp	No liquid refrigerant available for compressor cooling	Check calibration of refrigerant level sensor
	Cold condenser water temperature	Confirm liquid refrigerant available for compressor cooling via sight glass
	Compressor cooling components have an issue	Warm up condenser water via chilled water bypass or reduced flow
		Check that cooling solenoids & serial driver functioning properly (Certified technician using SMT)
High pressure in the condenser	Dirty condenser	Clean condenser
		Contact Smardt Support department
	Volume flow of cooling water too high	Check function and performance of cooling water pumps
		Check barriers, flaps, valves and filters of cooling water
		Check regulation of cooling water cycle
	Temperature of the cooling water too high	Check function of water cooling circuit components (cooling tower, water pumps, etc.)
		Check piping of water cooling circuit for proper functionality
		Check regulation of cooling water cycle
	Refrigeration system overloaded	Reduce the thermal load
	Thermal load too high	Check the Chiller's technical parameters
	Pressure Limiter defective or set incorrectly	Check settings on device
		Contact Smardt Support department
	Inert gas in refrigerant circuit	Contact Smardt Support department
	Pressure transmitter on condenser defective	Replace pressure transmitter
Low pressure in the evaporator	Dirty Evaporator	Clean evaporator
		Contact Smardt Support department
	Frozen Evaporator	Check evaporator for damage
		Contact Smardt Support department
	Volume flow of cooling water too low	Check function and performance of chilled water pumps
		Check barriers, flaps, valves and filters of chilled water
		Check regulation of chilled water circuit
	Expansion valve defective	Contact Smardt Support department
	Not enough refrigerant in chiller	Check the entire refrigerant cycle for leakage

FAULTS	POSSIBLE CAUSE	ACTION
Low pressure in the evaporator (cont'd.)	Condensing pressure too low	Check function & performance of cooling water pumps
		Check all components of cooling water loop (filters, piping. etc.)
		Check regulation of cooling water cycle
Reduction of cooling capacity	The technical parameters are outside the operating conditions of the chiller	Check the chiller's operating limits
	The quality of the chilled water and cooling water is outside the operation conditions of the chiller	Verify the correct parameters for the quality of the chilled water and cooling water in the chiller's submittal documents and adjust appropriately
	Dirty condenser and/or dirty evaporator	Clean heat exchangers
	Volume flow of the chilled water too low	Check function and performance of the chilled water pump
		Check all components of the chilled water loop (filters, piping, etc.)
		Check regulation of the chilled water circuit
	Volume of air flow is too low	Check function and performance of the fans
		Check for possible obstructions to airflow
	Inert gas inclusion on the water side of the heat exchanger	Purge the inert gas (air) form the water side of the heat exchangers on the chiller
		Purge the circuits of the chilled water and cooling water at suitable locations
	Inert gas in the refrigerant circuit	Purge the non-condensable from the refrigerant side of heat exchangers on the Chiller
	Not enough refrigerant in the chiller	Check the entire refrigerant cycle for leakage
		Add refrigerant (after fixing the refrigerant leak)
	Expansion valve defective	Contact Smardt Support department
Communication between two or more components is failing	Connection to another chiller, master-slave control or process control is failing	Check process control, master-slave control or chilled water pump for proper functionality
		Check wiring and communication cables for proper functionality
		Contact Smardt Support department
Chilled water or cooling water pump not working)	Electric connection or signal in the motor of the pump or in the control cabinet is loose	Check wiring and communication cables for proper functionality
		Contact Smardt Support department.

17 REPLACEMENT PARTS

RECOMMENDED LIST OF REPLACEMENT PARTS

As per Smardt's operating guidelines, Smardt's consistent use of oil-free compressor technology requires minimal maintenance. However, routine maintenance and checks are recommended to ensure proper functioning of your Smardt chiller. To ensure minimal down time, Smardt recommends having additional critical components onsite. In applications where time-sensitivity is critical a replacement part inventory should be kept, to ensure minimal operating down-times.

Smardt provides a list of common replacement components upon request. These components should be kept in an easy-to-locate environment that can be accessed by a Smardt trained technician at any time.

NOTE: In the event that a replacement part, that has been purchased, is still under warranty, Smardt will adhere to its Warranty policy and will credit the customer the price of said part, provided it has been replaced in accordance with Smardt Terms and Conditions and Warranty policy. Specific Warranty guidelines can be found in the Terms and Conditions section of this manual.

18 SMARDT SUPPORT

The Smardt product support team assists existing and new chiller installations and resolves other support issues.

Factory direct phone and e-mail support for the US is divided into two regions, east and west. All emails can be sent to **support@smardt.com**. Phone: 514 683-5585.

In addition to our factory direct product support, Smardt has recently launched a program of Smardt Authorized Service Contractors.

These Smardt-trained contractors are assigned by state and are the recommended companies by Smardt to perform independent after market maintenance, start up and commissioning.

Zendesk is Smardt's service portal, which generates digital service tickets. Each request is assigned a unique 5-digit number. Your digital request will be sent to a pool of agents and technicians who will respond in a timely manner to assist with your installation issue(s).

Each ticket is assigned a priority - Low, Normal, High, and Urgent and is used throughout the help desk to generate views and reports.

19 TECHNICAL TRAINING

The Smardt Technical Training Course is a four-day program designed to equip technicians with the skills and tools necessary to service and maintain Smardt products.

To request training session, application forms are available from the Smardt corporate website. Please complete and submit the online form or complete and return the PDF to the attention of the Support Department via fax 514 683-6013 or email: **support@smardt.com**.

20 TERMS & CONDITIONS OF SALE

The Terms and Conditions of Sale stated below are incorporated into and shall constitute part of Sales Order Acknowledgment ("Sales and Order Acknowledgment") between you ("The Buyer") and Smardt Chiller Group Inc., ("The Seller"). These Terms and Conditions shall be binding upon The Buyer unless otherwise stated in writing on the Sales Order Acknowledgement.

ACCEPTANCE AND BINDING

All purchase orders are subject to acceptance at The Seller's factory, and The Seller shall have no liability until and unless they are so accepted. Sales representatives are not authorized to bind The Seller. Clerical errors are subject to correction. The Seller shall not be bound by any representations or warranties which are not expressly set forth in writing and signed by an authorized employee of The Seller.

PRICES AND TAXES

Unless otherwise acknowledged by The Seller in writing: (i) all prices are subject to change without notice; (ii) goods will be billed at the prices in effect at the time of shipment; (iii) prices are quoted F.O.B. at The Seller's factory; (iv) prices on the items set forth in the Sales Order Acknowledgment are exclusive of all city, state, provincial and federal excise taxes, including, without limitations, taxes on manufacture, sales, receipts, occupation, use and similar taxes. Whenever applicable, any taxes will be added to the Sales Order Acknowledgment as a separate charge to be paid by The Buyer.

The acknowledged purchase price is firm if the product is shipped within 180 days of the purchase order date. Thereafter, the purchase price is subject to a 1% increase for each month or part thereof that shipment is delayed beyond the initial 180-day period. Any purchase order not released for immediate manufacture and shipment by the customer within 180 days of purchase order receipt, may be cancelled by The Seller and/or subject to re-quotation.

TERMS OF PAYMENT

Terms of Payment shall be as stated in the Sales Order Acknowledgement, or, unless otherwise stated, payment is due in full 30 days after the shipping date from The Seller, with no retention. All "Pay when Paid" or "Pay if Paid" provisions contained in The Buyer's Terms are expressly rejected. No payment due to The Seller shall be withheld or subject to retainage for any reason without The Sellers consent, including back-charges. Any back-charges made by The Buyer prior to The Seller's written approval will be the sole responsibility of The Buyer. In the event that payment is not made promptly when due, The Buyer agrees to pay a penalty at the rate of 1.5% per month, or as limited by state, federal or other applicable laws, from the due date. Partial shipments on quality orders shall be deemed a separate and independent contract for billing.

CREDIT APPROVAL

Shipment of the items set forth in the Sales Order Acknowledgement shall at all times be subject to the approval of The Seller's credit department. The Seller may at any time decline to make any shipment except upon receipt of payment or security or upon Terms and Conditions satisfactory to The Seller.

SUBMITTALS

The Seller manufactures its products based on a customer approved submittal. When discrepancies exist between a customer approved submittal and the corresponding project plans & specifications, customer approved submittals shall take precedence. For purposes of this contract, customer approved submittals are those technical drawings and related documentation, prepared by The Seller and sent to the customer, whose primary purpose is to define the equipment that the Seller proposes to manufacture on behalf of the customer.

SHIPMENT

Shipping dates are approximate and may be contingent upon the prompt receipt from The Buyer, of drawings, access, or approvals of release, for procurement of materials and manufacturing. The Seller shall have no liability for delays in delivery. All shipments are made at The Buyer's risk. Method and route of shipment are at The Seller's discretion, unless The Buyer supplies written instructions that are accepted by The Seller. Regardless of the method of delivery, however, risk of loss shall pass to The Buyer upon the seller's delivery to a carrier. If The Seller is prepared to make a shipment, but the Buyer delays delivery, terms of payment shall apply as though delivery had been affected as the date that The Seller was prepared to make shipment. All costs associated with handling, care and custody of the material shall be to the account of the Buyer. The acceptance of the material by The Buyer shall constitute a waiver of all claims for losses due to delay.

CANCELLATION AND CHANGES

Orders shall not be subject to cancellation unless cancellation charges (including recovery of lost profit) are paid by The Buyer of all work done by The Seller and for any obligations incurred by The Seller in connection with the order. Requests to change an order by The Buyer after acceptance by The Seller may result in changes to design, delivery lead time, cost and/or terms of payment. The Buyer agrees that such changes may require renegotiation of the order.

INDEMNITY

The Buyer agrees to hold The Seller harmless from any and all liability, and to pay all costs and attorney's fees for injury or damage to persons or property caused in any manner, by material covered by the Sales Order Acknowledgement while in possession or under the control of The Buyer or The Buyer's successor in interest.

INDEMNITY FOR INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS

The Seller shall have no liability for infringement of any patents, trademarks copyrights, trade dress, trade secrets or similar rights except as provided in SMARDT's Terms & Conditions of Sale. The Seller will defend and indemnity The Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets (hereinafter collectively referred to as "Intellectual Property Rights"). The Seller will defend at its expense and will pay the cost of any action brought against The Buyer based on an allegation that an item sold to The Buyer that is listed in Sales Order Acknowledgement ("Item") infringes upon the Intellectual Property Rights of a third party. The Seller's obligation to defend and indemnify The Buyer is contingent upon The Buyer notifying The Seller within ten (10) days after The Buyer becomes aware of such allegations of infringement, and The Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item is subject to a claim that it infringes the intellectual property rights of a third party, The Seller may, at its sole discretion, procure for The Buyer, the right to continue using the item, replace or modify the item so as to make it non-infringing, or to offer to accept return of the item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, The Seller shall have no liability for claims of infringement based on information provided by The Buyer, or directed to items for which the designs are specified in whole or in part by The Buyer, or infringements resulting from the modification, combination, or use in a system of the items. The foregoing provisions of SMARDT's Terms & Conditions of Sale, shall constitute The Seller's sole and exclusive liability and The Buyer's sole and exclusive intellectual property rights.

If a claim is based on information provided by The Buyer or if the design for an item is specified in whole or in part by The Buyer, The Buyer shall defend and indemnity The Seller of all costs, expenses, or judgments resulting from any claim that such an item infringes any patent, trademark copyright, trade dress, trade secret or similar right.

INSTALLATION, INITIAL OPERATION AND SERVICE

All material provided by The Seller Shall be installed by and at the expense of The Buyer, unless otherwise arranged in writing. Should The Buyer request the services of The Seller, such service shall be rendered and charged at the established rate at the time of performing and said service, plus other expenses including travel, hotel bills and living expenses.

TOOLING

Any tooling designed or produced by The Seller in the manufacture of any product or material sold to The Buyer, shall remain the sole and exclusive property of The Seller, unless the cost of designing and producing the tooling is paid by The Buyer and shall be provided to the Buyer upon completion of the work.

LIMITED WARRANTY

The Seller warrants that upon shipment, the products sold to The Buyer shall be as described in the SMARDT submittal document and shall be free from defects in material and workmanship for a period of 12 months from start-up or 18 months from the date of shipment, whichever is shorter. Standard warranty includes the labor necessary to replace or repair the defective component but does not include crane rigging, specialty tools, refrigerant, equipment rental, special unit access, or overtime or holiday premiums. Warranty applies only to equipment that has been started by SMARDT direct employees or SMARDT Authorized Service Contractors (SASC).

Optional extended labor, refrigerant and parts warranties may be quoted under a separate agreement. Please consult SMARDT. It is the customer's responsibility to advise The Seller of any and all changes required to affect warranty repairs. Prior to affecting repairs, approval must be obtained from The Seller before proceeding with any work. If warranty is in effect and The Seller ascertains that the damage was due to an accident, abuse, or misapplication, and the seller has incurred costs in this regard, these charges will be billed to the customer at cost.

This warranty applies only to equipment that is properly installed, maintained and operated under normal conditions and in the presence of competent supervision. In addition, equipment must be installed, maintained and operated in accordance with the equipment Installation, Operation & Maintenance Manual. Company recommendations, if any, made in submittal document of the said equipment, does not cover physical damage resulting from corrosion, excessive heat or degradation in performance as a result of dirt, dust or other foreign materials.

At its option, The Seller's obligation under this warranty is limited to repair or replacement of any returned part prepaid, and which upon examination, shall prove to be defective. Freight charges incurred for shipment of warranty repair or replaced parts will be responsibility of the purchaser.

This warranty shall be void in the case of any equipment which has been disassembled, repaired or tampered with any way, except when such work has been done with Company written approval.

This warranty comprises the sole entire warranty pertaining to items sold to The Buyer by The Seller. The Seller makes no other warranty, guarantee, or representation of any kind whatsoever. All other warranties, including but not limited to merchantability and fitness for a particular purpose, whether express, implied, or arising by operation of law, trade usage, or course of dealing, are hereby disclaimed. Notwithstanding the foregoing, there are no warranties whatsoever on items built or acquired wholly or partially, to the buyer's designs of specifications.

LIMITATIONS OF REMEDY

The Seller's liability arising from or in any way connected with the items sold to the buyer by the seller, at The Seller's sole option, shall be limited exclusively to repair or replacement of the items sold, or refund of the purchase price paid by the buyer. In no event shall the seller be liable for any incidental, consequential or special damages of any kind or nature whatsoever, including but not limited to lost profits arising from or in any way connected with items sold to The Buyer by The Seller, whether alleged to arise from breach of contract, express or implied warranty, or in tort, including without limitation, negligence, failure to warn, or strict liability.

SOFTWARE PROGRAMS

Computer Software Programs that may be included in material or products sold to The Buyer, have been designed to perform a stranded sequence of operations as defined in the documentation provided, and are offered AS IS. It is The Buyer's responsibility to determine if the features of the software programs are suitable for The Buyer's requirements. In the event The Buyer desires site specific modifications, The Buyer is responsible for commissioning, final validation, and cost of upgrades that may be required to conform to future software generations provided by Smardt. To obtain assistance under this limited warranty, please contact the selling agency. To obtain information or to gain factory assistance, contact Smardt Chiller Group Inc.

SELLER'S RIGHT OF POSSESSION

The Seller shall have the right, in addition to all others it may possess, at any time, for credit reasons or because of The Buyer's default, to withhold shipments in whole or in part, and to recall goods in transit, retake the same, and repossess all goods which may be stored with The Seller for The Buyer's account, without the necessity of taking any other proceedings, and The Buyer consents that all goods so withheld, recalled, retaken or repossessed, shall become The Seller's absolute property, provided that The Buyer is given full credit thereof. The foregoing shall not be construed as limiting in any manner, any of the rights or remedies available to The Seller because of any default by The Buyer.

CONTROLLING PROVISIONS

If the Sales Order Acknowledgment is accepted and The Buyer's purchase order is used for any purpose, it is expressly understood and agreed that the Terms and Conditions set forth in the Sales Order Acknowledgment and these Terms and Conditions of Sale, shall prevail in so far as the same may in any way conflict with the terms and conditions set forth in The Buyer's order form, and the issuance of such an order by The Buyer, shall be deemed to note The Buyer's assent to the foregoing. Provisions in The Buyer's purchase orders contrary to these terms and conditions, are not binding upon The Seller, unless accepted in writing by an authorized agent or representative of The Seller. Acceptance of the material or products covered by The Sales Order Acknowledgment shall in all events constitute such acceptance and assent, and the Terms and Conditions of the Sales Order Acknowledgement shall herein supersede any provisions, terms and conditions contained in any confirmation, order, or other writing that The Buyer may give or receive, and the parties shall be governed exclusively by the provisions, Terms and Conditions hereof. The Seller makes no representations or warranties concerning the Sales Order Acknowledgement and these Terms and Conditions of Sale, which may not be changed or modified orally.

FORCE MAJEURE

The Seller shall not be liable for any delay in the performance of the Sales Order Acknowledgment in the delivery or shipment of goods, or for any damages suffered by The Buyer or its customers by reason of such delay, if such delay is directly or indirectly caused by or in any manner arises from, fires, floods, accidents, civil unrest, acts of God, war, governmental interference or embargoes, strikes, labor difficulties, shortage of labor, fuel, power, materials or supplies, computer issues, transportation delays, or for any other cause (whether or not similar in nature to any of the-aforementioned) and that are beyond its control.

CONDITIONS

The Sales Order Acknowledgement is accepted with the understanding that it is subject to The Seller's ability to obtain the necessary raw materials, and the Sales Order Acknowledgement and all shipments applicable thereto are subject to The Seller's current manufacturing schedules, governmental regulations, orders, directives, and restrictions, that may be in effect from time to time.

ASSIGNMENT

The Buyer shall not assign, subcontract, delegate or transfer in any way whatsoever, the Sales Order Acknowledgement, in whole or in part, without the prior written consent of The Seller. Any such assignment, subcontract, delegation or transfer, without the prior written consent, shall become void. The Buyer shall not be relieved of any of its obligations under the Sales Order Acknowledgement, notwithstanding any such written consent by The Seller.

NON-WAIVER BY SELLER

Waiver by The Seller of a breach of any of the Terms and Conditions of the Sales Order Acknowledgement or the Terms and Conditions of Sale, shall not be construed as a waiver of any other breach.

GOVERNING LAW

The Sales Order Acknowledgment and these Terms and Conditions of Sale, shall be governed by and construed in accordance with internal laws of the province or state of The Sellers location. The Convention on Contracts for International Sale of Goods shall be applicable to the Sales Order Acknowledgement or these Terms and Conditions of Sale. No actions arising out of the sale of material or products covered by the Sales Order Acknowledgement, other than an action by The Seller to recover the purchase price of such material or products, may be brought by either party more than two (2) years after the cause of the accrued action.

Details shown in this IOM regarding quarterly and annual maintenance requirements for both first year and extended warranties must be adhered to for the warranty to remain valid. A warranty certificate will be sent to you. It is important that you become familiar with the terms and conditions. It is the responsibility of the representatives and/or contractors to make you aware of these conditions.

This page is intentionally left blank

AMERICAS

CANADA

1800 Trans Canada Highway
Dorval Quebec H9P1H7
T +1 514 426 8989
E sales.na@smardt.com

USA

22 Colorado Street Bldg 2815
Plattsburgh NY 12903
T +1 518 324 5741
E sales.na@smardt.com

BRAZIL

Smardt-Transcalor
Av. Eldorado, 187 – Jardim Ruyce – Diadema
SP – Brasil – CEP: 09961-470
T +55 11 4351-4089 / 4351-3803
E contato@transcalor.com.br

EUROPE, MIDDLE EAST, AFRICA

GERMANY

Bahnhofstraße 74 D73240 Wendlingen
T +49 7024 79429 0
E sales.eu@smardt.com

UNITED KINGDOM

10A Burrell Way,
Thetford, Norfolk IP24 3RW
T +44 1842 824830
E sales.uk@smardt.com

ASIA PACIFIC

AUSTRALIA

144 Colchester Road
Bayswater North VIC 3153
T +61 3 9761 7905
E sales.au@smardt.com

CHINA

Mei Xing Industrial Park
No. 30 Dong Zhong Road ETDD Guangzhou
T +86 20 8205 7161
E sales.cn@smardt.com

SINGAPORE

438A Alexandra Road #08-11
Alexandra Technopark 119967
T +65 6273 1120
E sales.as@smardt.com

12/19 NA Dual E02283-12