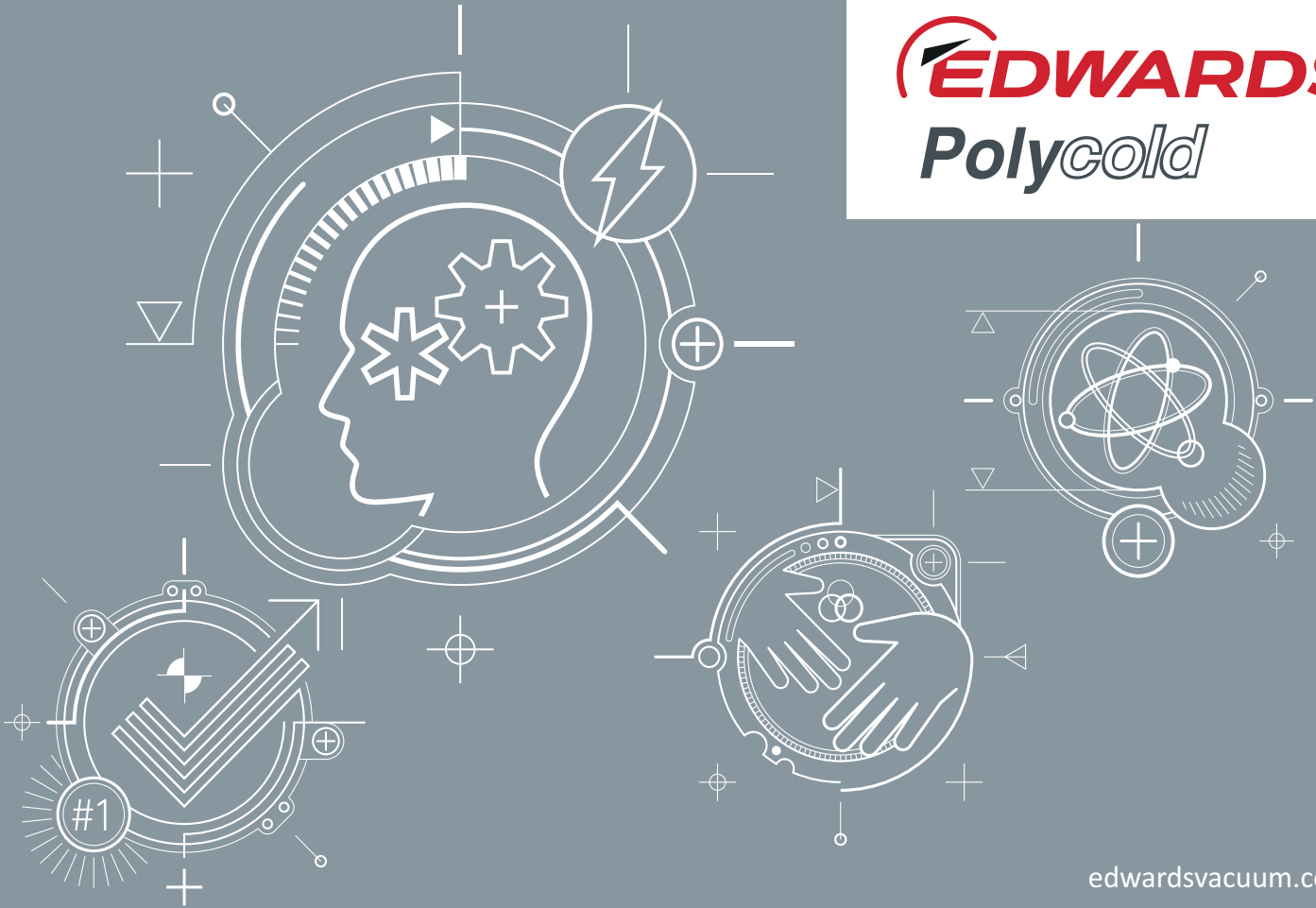




edwardsvacuum.com

Polycold® Cryochiller Service and Maintenance Manual

185303 Revision E

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You must use this products as described in this manual. Read the manual before you install, operate, or maintain the product.

Customer support information

You can reach our global customer operations teams around the world at the times and phone numbers below.

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Note:

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1

Introduction

Using this Manual

	 WARNING
	General Hazards The Polycold Cryochiller contains high voltages and other hazards which, if not properly handled, may result in serious injury or death. • Only trained and qualified personnel should work on the Polycold Cryochiller. • Do not perform installation, operation, or maintenance procedures on the Polycold Cryochiller unless you have read and understand the information in the Safety chapter of this manual.

The Polycold Cryochiller is intended for use by industrial customers and should be serviced only by Edwards or Edwards trained representatives. The manuals and related materials are provided in English at no charge and are intended for use by experienced technicians. It is the responsibility of the user to obtain and assure the accuracy of any needed translations of manuals. If you require assistance please contact Edwards service department. Contact information can be found at www.edwardsvacuum.com.

This manual is one part of a documentation kit, either on CD or printed, which includes additional manuals and procedures. All documents referenced in this manual refer to documents of the latest revision as of the publication date of this manual.

This manual provides information for a wide variety of Polycold Cryochiller configurations and options. Some features mentioned in this manual may be optional or may not be installed on your system. Refer to Edwards Vacuum sales literature to determine the standard and optional items.

Pressure values are stated as gauge (i.e., psig) not absolute values.

- **Psig** is pounds per square inch gauge
- **kPag** is Kilopascals gauge. $\text{kPag} = 6.895 \times \text{Psig}$ $\text{bar} = \text{Psig} \div 14.5$

Before making adjustments or changes to Polycold Cryochiller, consult all appropriate system documentation.

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2

Safety

	 WARNING
	Failure to review the Safety chapter and follow the safety warnings can result in death or serious injury. • Do not perform installation, operation, or maintenance procedures until you have read and understand the safety information. • Follow all applicable facility safety codes • Read and understand each procedure before performing it.

If additional safety related upgrades or newly identified hazards associated with the Polycold Cryochiller are identified, Edwards Vacuum Technical Support notifies the owner of record with a Technical Support Bulletin (TSB).

Explanation of Hazard Alerts

This manual and this product use industry standard hazard alerts to notify the user of personal or equipment safety hazards. Hazard alerts contain Safety Text, Safety Icons, Signal Words, and Color.

Safety Text

Hazard alert text follows a standard, fixed-order, three-part format.

- Identify the hazard,
- State the consequences if the hazard is not avoided,
- State how to avoid the hazard.

Safety Icons

- Hazard alerts contain Safety Icons that graphically identify the hazard.
- The safety icons in this manual conform to ISO 3864 and ANSI Z535 standards.

Signal Words and Color

Signal Words inform of the level of hazard.

	Danger indicates a hazardous situation which, if not avoided, will result in death or serious injury. Danger signal word is white on a red background with an iconic exclamation point inside a yellow triangle with black border.
	Warning indicates a hazardous situation which, if not avoided, could result in death or serious injury. Warning signal word is black on an orange background with an iconic exclamation point inside a yellow triangle with black border.
	Caution indicates a hazardous situation or unsafe practice which, if not avoided, may result in minor or moderate personal injury. Caution signal word is black on a yellow background with an iconic exclamation point inside a yellow triangle with black border.
	Indicates a situation or unsafe practice which, if not avoided, may result in equipment damage. Notice signal word is white on blue background with no icon.

Alert Example

The following is an example of a WARNING hazard alert.

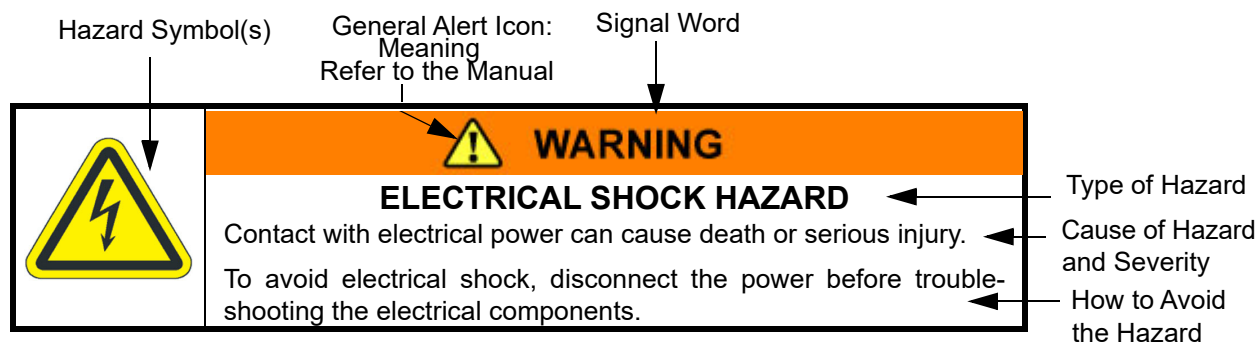


Figure 2-1: Components of a Safety Alert

Use of Notes

This manual uses notes to make the reader aware of additional information. Information in notes is not related to human or equipment safety. A note does not use icons. The following is an example of a Note.

NOTE: *Save all shipping materials for future use. If the Polycold Cryochiller is shipped, the original shipping crate must be used.*

General Safety Guidelines

	 CAUTION
	Unauthorized Service Personal injury or damage to equipment may result if this product is operated or serviced by unauthorized personnel. Only qualified personnel are allowed to transport, assemble, operate, or maintain the Polycold Cryochiller. Properly qualified personnel are those who have received certified training and have the proper qualifications for their jobs.

	 CAUTION
	Proper Operation Improper use of the Polycold Cryochiller may cause personal injury. Do not operate the Polycold Cryochiller before it is properly installed. Do not modify connectors or cables. Do not operate the unit without all guards and safety devices in place. Do not install or operate the Polycold Cryochiller if it has been dropped, damaged, or is malfunctioning. Do not use the Polycold Cryochiller for any purpose other than as a Cryochiller or damage to the Polycold Cryochiller or the equipment to which it is connected may occur.

	 CAUTION
	Seismic Restraint Use of the Polycold Cryochiller in an earthquake prone environment may cause equipment damage or personal injury. User is responsible for determining if the unit is used in an earthquake prone environment and for installing the appropriate seismic restraint in accordance with local regulations.

Safety Labels and Safety Label Identification

Safety labels are placed on the Polycold Cryochiller to identify hazards. Identification labels provide information about the product. This section describes each label and identifies its location.

NOTICE

Do not change or remove the safety labels or equipment identification labels.

Label Identification and Location

Table 2-1 lists the labels that are affixed to the Polycold Cryochiller. These labels alert personnel to hazards on or within the product and provide information about the product.

Figure 2-2 shows the location of each label. To replace a lost or damaged label call Edwards Vacuum Technical Support.

Table 2-1: Labels Used on the Polycold Cryochiller

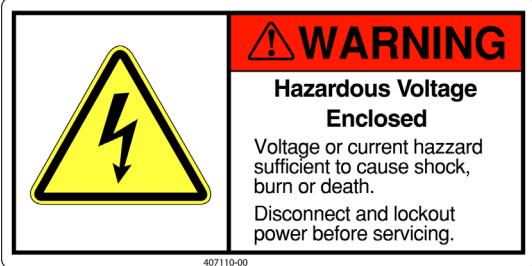
	Hazard: Hazardous Voltage Part Number: 407110-00 Qty: 2 Location: (1) On inside and (1) on outside of inner control unit cover below circuit breaker view port. Possible injuries: Electrical Shock or burn How to avoid the hazard: Turn off power and lock out before servicing.
	Hazard: Heavy Object Part Number: 407112-00 Qty: 1 Location: On compressor body Possible injuries: Muscle strain or back injury How to avoid the hazard: Use lifting aids and proper lifting techniques

Table 2-1: Labels Used on the Polycold Cryochiller

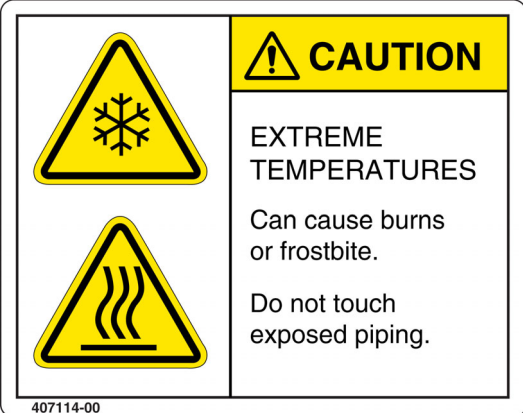
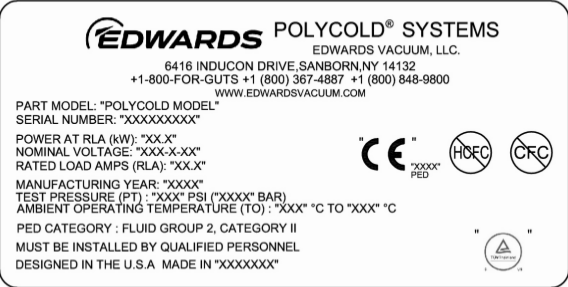
 ©Clarion Safety Systems, LLC clarionsafety.com 12031 Reorder No. 182740	Hazard: Tip (On units with Caster option installed) Part Number: 184193 Qty: 2 Location: Front and back lower panels. Only on units with caster option Possible injuries: Crush How to avoid the hazard: Push from below the midpoint of the height. Lock casters when not moving. Move only on level surfaces. Do not use casters to move up and down ramps. Move at slow speed with slow acceleration/deceleration Move on smooth floors free of gaps, grooves, or debris
 407114-00	Hazard: (Hot and Cold) Extreme Temperatures Part Number: 407114-00 Qty: 3 Locations: (1) Lower right front cover. (1) Lower rear cover, (1) Inner valve cover panel on inside of unit. Possible injuries: Burns or Frost Bite injuries How to avoid the hazard: Do not touch exposed piping. Allow to come to ambient temperature before servicing.
	Unit Name Plate Label, Abbreviated Part Number: 179924 Qty: 1 Location: Outside Lower Right Front Cover Contains part number, serial number

Table 2-1: Labels Used on the Polycold Cryochiller

EDWARDS POLYCOLD® SYSTEMS
EDWARDS VACUUM, LLC.

6416 INDUCON DRIVE, SANBORN, NY 14132
+1 800-FOR-GUTS +1 (800) 367-4887 +1 (800) 848-9800
WWW.EDWARDSVACUUM.COM

TEMPERATURE DESIGNATION
CRYOCHILLER UNIT
PART NUMBER: "POLYCOLD MODEL PART NUMBER"
DESCRIPTION: "POLYCOLD MODEL DESCRIPTION FROM ORACLE"
SERIAL #: "XXXXXXXXXX"
MANUFACTURING DATE: "DAY MONTH YEAR"

DESIGN PRESSURES (PS)
"COMPRESSOR LOW (SUCTION) SIDE: XXX psi (XXX BAR)"
SYSTEM LOW (SUCTION) SIDE: "XXX psi (XXX BAR)"
SYSTEM HIGH (DISCHARGE) SIDE: "XXX psi (XXX BAR)"
"SECONDARY COOLANT CIRCUIT: XXX psi (XXX BAR)"

"TEST PRESSURES (PT)"
"COMPRESSOR LOW (SUCTION) SIDE: XXX psi (XXX BAR)"
SYSTEM LOW (SUCTION) SIDE: "XXX psi (XXX BAR)"
SYSTEM HIGH (DISCHARGE) SIDE: "XXX psi (XXX BAR)"

AMBIENT OPERATING TEMPERATURE (TO)
MINIMUM: "XXX °F (XX °C)"
MAXIMUM: "XXX °F (XX °C)"

"PED 2014/68/EU"
CATEGORY "XXX"

ELECTRICAL
NOMINAL VOLTAGE: "XXX-V-XX"
LOCKED ROTOR AMPS: (LRA): "XXX"
MAXIMUM CONTINUOUS CURRENT (MCC, Amps): "XXX,X"
POWER AT MCC (kW): "XX,X"
RATED LOAD AMPS (RLA): "XX,X"
POWER AT RLA (kW): "XX,X"
MAXIMUM FUSE SIZE (Amps): "XX"
"PROTECTION CLASS (IP): XX"
"SHORT CIRCUIT CURRENT RATING (kA): "XX"

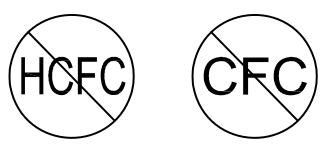
MUST BE INSTALLED AND SERVICED BY QUALIFIED ELECTRICAL PERSONNEL.

"THIS UNIT CAN OPERATE SAFELY AT THE CONDITIONS BELOW WITH PROPER SETTINGS OF THE TRANSFORMER TAPS."

NOMINAL VOLTAGE-PHASE-FREQUENCY	ACCEPTABLE VOLTAGE RANGE
*Nominal Voltage 1"	*Acceptable Voltage 1"
*Nominal Voltage 2"	*Acceptable Voltage 2"
*Nominal Voltage 3"	*Acceptable Voltage 3"
*Nominal Voltage 4"	*Acceptable Voltage 4"
*Nominal Voltage 5"	*Acceptable Voltage 5"

Name Plate Label
Part Number: 407168-00 (left or top section)
Qty: 1 (2 label set)
Location: Inside on lower left frame of compressor area
Contains part number, serial number, and specification information.

Table 2-1: Labels Used on the Polycold Cryochiller

 POLYCOLD® SYSTEMS EDWARDS VACUUM, LLC. 6416 INDUCON DRIVE, SANBORN, NY 14132 +1 800-FOR-GUTS +1 (800) 367-4887 +1 (800) 848-9800 WWW.EDWARDSVACUUM.COM REFRIGERANT INFORMATION TYPE: "Refrigerant Type" FACTORY CHARGE: "XXXXXX-XX"; EDWARDS REPLACEMENT CHARGE: "XXXXXX-XX" COMPONENTS: "R-XXXX, R-XXX, R-XXX, R-XXX, XXXX" TOTAL REFRIGERANT WEIGHT: "XXX.XX lb (XXX.XX kg)" SAFETY INFORMATION MSDS #: "XXXXXX" ASHRAE SAFETY CLASSIFICATION: "XX/XX" "EN378 SAFETY CLASSIFICATION: XX/XX" MINIMUM ROOM VOLUME ASHRAE: "XX.XX X ft³ (XX.X m³)" "EN378: XX.XXX ft³ (XX.X m³)"   CAUTION USE ONLY SPECIFIED POLYCOLD® REFRIGERANT MIXTURE IN THIS UNIT. USE OF OTHER REFRIGERANTS MAY DAMAGE THE UNIT AND WILL VOID YOUR WARRANTY. MUST BE INSTALLED AND SERVICED BY QUALIFIED REFRIGERANT PERSONNEL. SEE CUSTOMER INSTRUCTION MANUAL. THIS UNIT AND ITS REFRIGERANT MIXTURE ARE COVERED BY THE FOLLOWING U.S. PATENTS AND THEIR FOREIGN EQUIVALENTS. "XXXXXXXX; XXXXXXXX; XXXXXXXX; XXXXXXXX; XXXXXXXX; XXXXXXXX; XXXXXXXX" "AND PATENTS PENDING" DESIGNED IN THE USA (COUNTRY OF ORIGIN)	Name Plate Label Part Number: 407168-00 (right or bottom section) Qty: 1 (2 label set) Location: Inside on lower left frame of compressor area Contains specification information
--	---

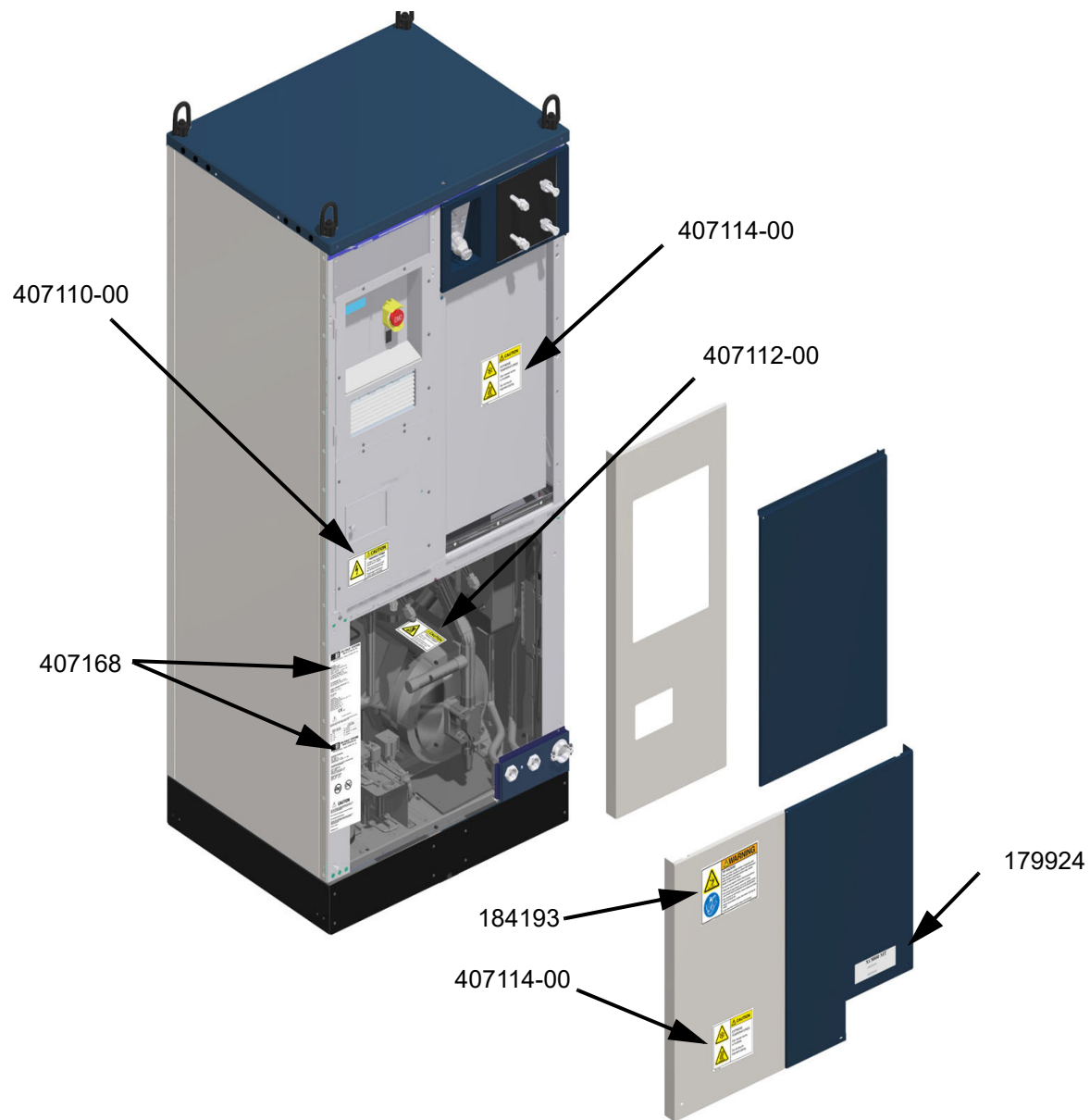


Figure 2-2: Locations of Labels on the front side of the MaxCool

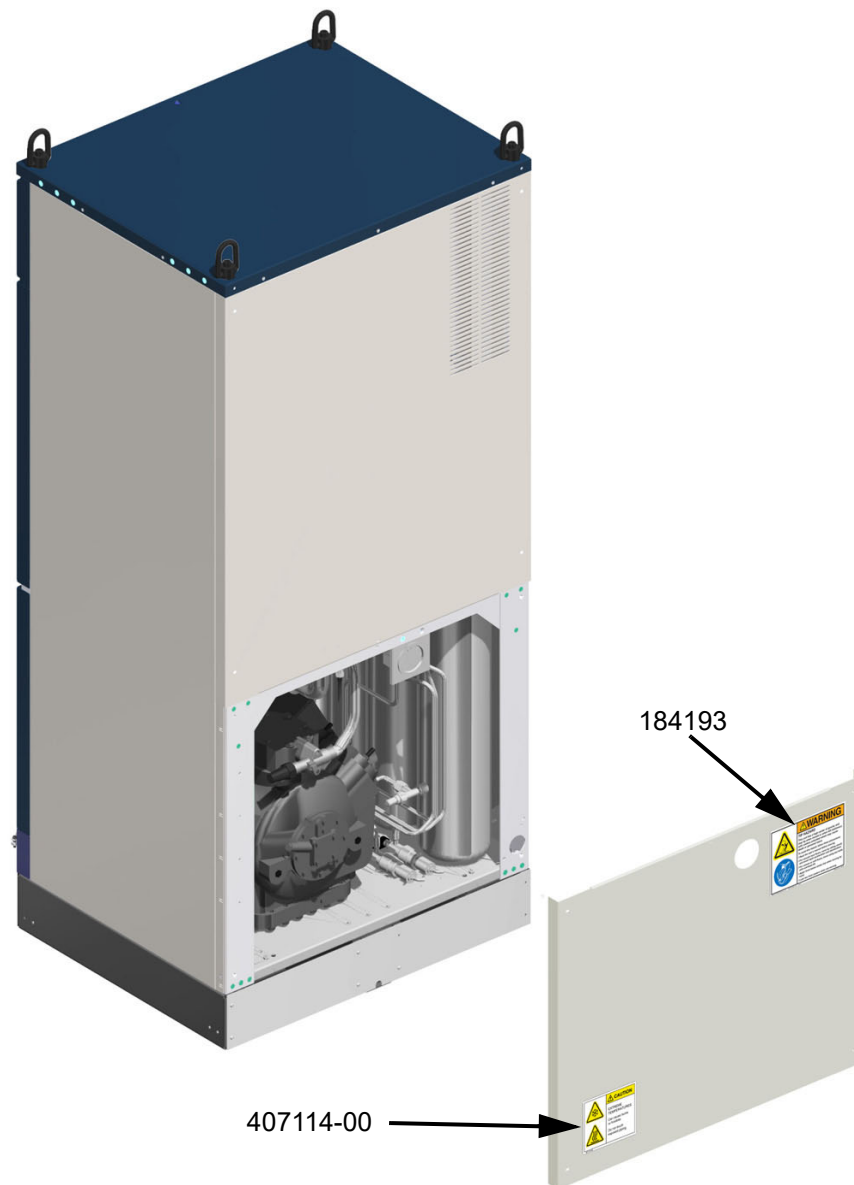


Figure 2-3: Locations of Labels on the back side of the MaxCool

Safety and Operational Interlocks

Safety interlocks protect personal safety. Operational interlocks protect the Polycold Cryochiller. Additional interlocks may be added to the Polycold Cryochiller by the user.

The Polycold Cryochiller contains the interlocks listed in [Table 2-2](#) and shown in [Figure 2-4](#).

Table 2-2: Interlocks on the Polycold Cryochiller

Interlock	Function
Circuit Breakers	Protective devices that prevent current overload of the compressor motor or control system. Circuit breakers require manual reset.
High Voltage Interlock	The Lockout/Tagout slide bar must be moved to the lockout/tagout position with the primary circuit breaker in the OFF position in order to remove the cover to the high voltage box and access the interior of the high voltage assembly.
Over Pressure Relief Valve	A pressure relief valve vents refrigerant gas when the refrigerant circuit pressure exceeds the set point of the valve. Causes a controlled-release of excess pressure for the refrigerant in a manner that avoids an over pressure event. Valve closes when pressure is reduced to the valve set point.
Compressor Motor Thermostat	Detects when the temperature of the compressor on the Polycold Cryochiller exceeds a safe temperature and shuts off power to the compressor motor. The thermostat automatically resets when the temperature of the compressor motor thermostat falls to a safe level.

	 DANGER
	Hazardous Voltage
	Overriding interlocks can cause electrical hazards. Direct contact with hazardous voltage will cause death or serious injury. Do not defeat, modify, or disable any of the unit's safety interlocks.

NOTICE
The user may choose to add an Emergency Off (EMO) circuit to the Polycold Cryochiller and is accountable for that EMO circuit.

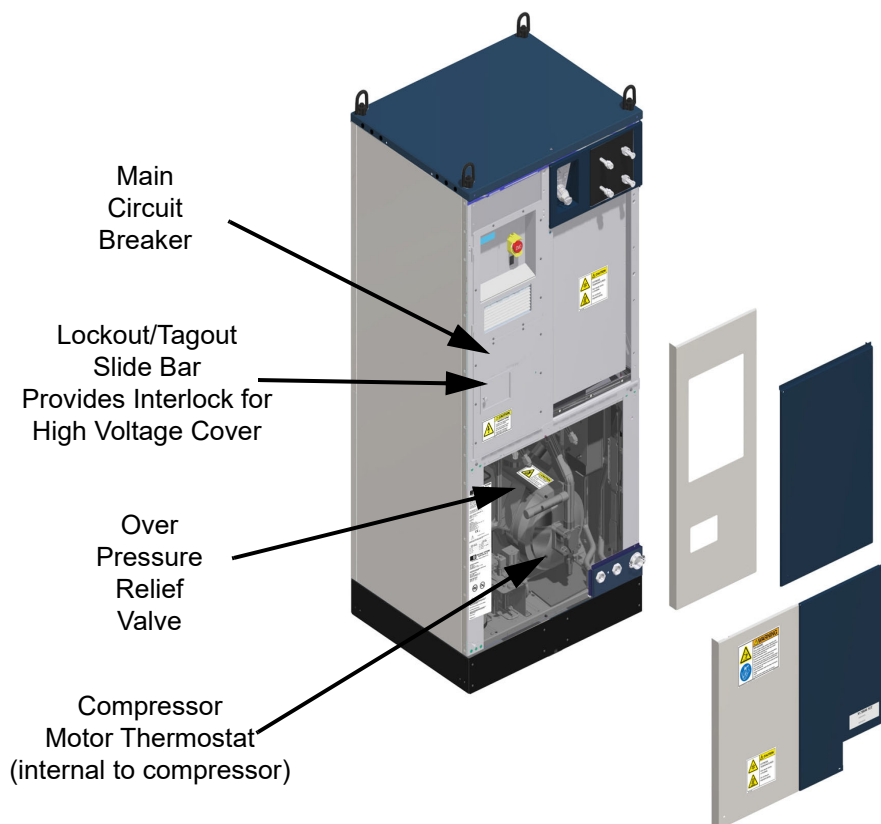


Figure 2-4: Location of Safety Interlocks on the MaxCool

Lockout/Tagout

A slide bar that is attached to the high voltage box cover is provided as the Lockout/Tagout device.

When the high voltage box cover is removed, the Lockout/Tagout device is also removed, and Lockout/Tagout procedures must be performed on the input power to the Polycold Cryochiller.

To use the Lockout/Tagout device:

1. Turn off the main circuit breaker.
2. Slide the Lockout/Tagout bar across the circuit breaker to prohibit the circuit breaker from being turned on.
3. Apply the Lockout/Tagout device to hold the slide bar in place.

To remove the high voltage box cover:

1. Apply Lockout/Tagout procedures at the source of the input power.
2. Turn off the main circuit breaker and move the Lockout/Tagout slide bar to the Lockout/Tagout position.
3. Remove the high voltage box cover.

Mechanical Hazards

	 CAUTION
	Heavy Object The Polycold Cryochiller weighs a minimum of 533 kg (1175 lb) up to a maximum of 544 kg (1200 lb). Failure to take the proper precautions before moving this unit could result in personal injury. Follow appropriate methods for moving heavy equipment.

 	 WARNING
	Tip Hazard This unit has a high center of gravity and may tip when moved improperly or when left stationary with casters unlocked which may cause death or personal injury. To avoid this hazard, follow these precautions: • Read the user's manual before moving. • For smooth hard floors, move by rolling slowly and avoid rapid acceleration and deceleration. • Move only on smooth level surfaces that are free of gaps, grooves, or debris. • For uneven or soft floors, move using optional hoist rings with overhead lift • Do not use casters to move up and down ramps. • Apply force below center line when moving by hand. • Lock two front casters when not moving.

	 CAUTION
	Trip Hazard Trip hazard which may cause personal injury exists if the facilities connections such as power and communications cables, gas and vacuum lines, for the compressor are not properly routed. Route facilities connections and communication cables out of the way where there is no travel and they do not cause trip hazards

	 WARNING
	Lifting Ring Hazard This unit is equipped with lift rings that when used improperly may fail and cause death or serious personal injury. To avoid this hazard, follow these precautions: • Lift with 4 straps that each have a minimum strength as required by local regulations but not less than the weight of the item being lifted. • Length for each strap between the lift ring bolt and the lifting point must be greater than 736mm (29 inches). • The angle between the sling strap and horizontal at each lift ring must be greater than 45° • Strength of lift device must be greater than 4 times weight of unit being lifted.

Electrical Hazards

The Edwards Vacuum Polycold Systems Polycold Cryochiller is a hazardous voltage device. It requires a user installed slow blow circuit breaker that meets, or exceeds, the minimum SCCR rating specified by SEMI S2.

The proper precautions for operating and servicing electrical equipment must be observed.

	 WARNING
	Electrical Installation Hazard Improper electrical connection or improper handling of the power can cause electrical shock resulting in death or serious injury and can cause fire and damage to the equipment. • Ensure that a proper ground is provided from the power connection and confirm the equipment is properly grounded. • Do not allow cables to be walked on or become wet. • Turn off power before connecting or disconnecting cables. • Allow only a qualified electrical installer to perform electrical work on the Polycold Cryochiller in accordance with local codes.

 	WARNING Electrical Hazard Contact with energized equipment can cause electric shock and result in death or serious injury. • All electrical energy supplied to the Polycold Cryochiller must be disconnected from the system according to the facility's lockout/tagout procedure before performing service or maintenance. • Lockout/Tagout device is provided for use when high voltage box cover is in place. • Lockout/Tagout must be provided at the input power source if high voltage box cover is removed, • Only a qualified electrician or electrical technician is allowed to open the Polycold Cryochiller and troubleshoot electrical problems.
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Thermal Hazards

The condenser and compressor inside the Polycold Cryochiller present thermal hazards.

  	WARNING Extreme Temperature Hazard Contact with hot or cold surfaces can cause death or serious injury from burns or frost bite. Do not operate the Polycold Cryochiller without all covers in place. Wait 90 minutes after performing appropriate Lockout/Tagout procedures before removing covers. Allow cryocoil, cold chuck, or cryobaffle to come to +10° C (50° F). Wait until signs of frost have gone before servicing. Use appropriate Personal Protective Equipment if handling cold devices. Do not touch any uninsulated part of the refrigerant circuit when the unit is operating. This includes the: • Solenoid • Hand valves • Uninsulated parts of the refrigerant line • Uninsulated parts of the feedthrough • Cryosurface
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	 CAUTION
	Cold Thermal Hazard Moving or repositioning the refrigerant line when cold may result in crimping of the gas lines and insulation may crack and cause minor or moderate injury along with hazardous refrigerant discharge. Do not attempt to move or position the refrigerant line.

Chemical Hazards

The Polycold Cryochiller is supplied with two Overpressure Relief Valves. In the unlikely event that the relief valves release refrigerant gas, the gas must vent to atmosphere in a well vented area that meets the minimum room size requirements as specified in ASHRAE-15 and EN-378.

	 WARNING
	Chemical Hazard The blend of refrigerant used in the Polycold Cryochiller is non flammable and non toxic. However, as with any gas, asphyxiation could occur if concentrated refrigerant gas is inhaled which may cause death or serious injury. Service the Polycold Cryochiller in a well ventilated area as specified by ASHRAE-15 and EN-378.

	 CAUTION
	Chemical Hazard Opening the refrigerant circuit or changing valve settings without following the instructions in this manual could result in release of refrigerant gas which is considered a green house gas. • Avoid releasing refrigerant gas to the atmosphere. • Keep the gas line couplings aligned when making or breaking coupling connections to prevent leaks due to a sharp bends. • Review this manual before performing any procedure including routine operation.

Notice

United States federal law requires a certified refrigeration technician (Type 2, High Pressure) perform any procedure that could release refrigerant to the atmosphere.

This includes:

- Installing the Polycold Cryochiller
- Inspecting procedures
- Disconnecting the refrigerant lines
- Troubleshooting procedures
- Repairing
- Disposing of the unit or charged components

High Pressure Gas Hazard

	 CAUTION
	High Pressure Gas The use of high pressure gas or compressed air during cleaning may cause flying debris. Wear personal protection equipment such as safety glasses if using high pressure gas for cleaning, Follow safety guidelines for cleaning with high pressure gas as specified by the facility.

Fire and Explosion Hazard

The Polycold Cryochiller does not have any direct fire or explosion hazard.

	 WARNING
	Fire Hazard Cleaning fluids such as isopropyl alcohol may cause fire if used on hot parts. Allow the Polycold Cryochiller to cool before using cleaning fluids.

	 CAUTION
	High Pressure Refrigerant In the unlikely event that the Polycold Cryochiller develops a refrigerant leak inside an enclosed chamber, it is possible that a high pressure event could occur which may result in equipment damage or personal injury. The vacuum chamber must have a pressure-relief valve to avoid an over-pressure condition.

Environmental Information

NOTICE
The Polycold Cryochiller contains fluorinated green house gases covered by the Kyoto Protocol.

Refrigerant Gas Recycling and Disposal

	 CAUTION
	Refrigerant Gas A qualified refrigeration technician is required to remove the refrigerant from the Polycold Cryochiller. When working with refrigerant gas, follow all facility and local regulatory environmental procedures regarding the storage, handling, and disposal of the gases. Refer to the Material Safety Data Sheets, SDS, for each refrigerant.

Hazardous Materials

Ensure the product has been properly decontaminated before performing any service. Follow the facility's decontamination procedures.

Follow all facility and local regulatory procedures for the disposal of hazardous materials. If the components are charged with refrigerant, refer to the Material Safety Data Sheets, SDS, for each refrigerant.

Material Safety Data Sheets - SDS

The Polycold Cryochiller contains refrigerants that are a proprietary mixture of different gasses. The actual blend may vary depending on the application. All of the blends of refrigerant gases are non-flammable and non-toxic.

A single Material Safety Data Sheet set for the different blends of gasses is located in [Appendix B: SDS on page 7-3](#) and in the Appendix of the Installation and Operation Manual, p/n 825161-00.

3 Polycold Cryochiller Overview

System Summary

Definitions:

Refrigeration Unit: The enclosure that cools, compresses, and pumps the refrigerant through the refrigerant line and cryosurface.

Refrigerant Line: The insulated bundle that contains feed and return hoses that transfer refrigerant between the Polycold Cryochiller refrigeration unit and the cryosurface.

Cryosurface: The cooling unit that is installed in the customer's vacuum chamber. The Cryosurface consists of tubing that the refrigerant flows through and either a coil or a series of baffles that become cold and freeze the molecules to the surface. Cryosurfaces are usually shaped as a coil to capture water vapor or as a ring of baffles to capture backstreaming oil.

About the Cryochiller

The Polycold Cryochiller is a closed loop cryogenic refrigeration system with many applications. It is frequently used to capture water vapor and other condensable substances by freezing them onto a cold surface such as a cryocoil (Meissner trap) or chevron baffle. The Polycold Cryochiller is also used to cool and heat objects such as electrostatic chucks used in semiconductor wafer processing.

The Polycold Cryochiller consists of a refrigeration unit, refrigerant line set, and a cryosurface with cryogenic feedthrough. The refrigeration unit can pump cold or hot refrigerant in a continuous loop through the refrigerant lines and cryosurface. The innovative cryogenic refrigeration process in the Cryochiller uses patented refrigerant mixtures and patented control processes made by Edwards Polycold Systems.

Some configurations include advanced electronic controls that can anticipate problems and reduce unexpected down time, control the refrigerant temperature, and reduce power consumption. Models are available that control two independent circuits, providing greater design flexibility for vacuum systems such as two cryocoils or one cryocoil and one cryobaffle. All models include both local and remote operation.

Refer to the Polycold Cryochiller User's Manual for information regarding the use of the Polycold Cryochiller for water vapor removal, minimizing backstreaming with diffusion pumps, and heat removal and temperature control.

Polycold Cryochiller Versions

The Polycold Cryochiller is manufactured in different models, configurations, and options to fit a variety of applications. [Table 3-1](#) shows the currently manufactured Polycold Cryochiller model numbers and their description.

Table 3-1: Polycold Cryochiller Models and Descriptions

Configuration	Description
MaxCool 4000H	High Capacity
MaxCool 2500L	Medium Temperature

Theory of Operation

Refrigeration Process

The Polycold Cryochiller employs an HCFC-free refrigerant mixture in an auto-refrigerating cycle (ARC) cooling process to provide operating temperatures from -80°C to -150°C. This process, which is thermodynamically more efficient than a multistage cascade process, combines all of its refrigerants into a single multi-component stream circulated by one compressor. The advantages of the mixed refrigerant ARC cooling process are reduced system complexity, more favorable operating conditions, lower maintenance and greater reliability.

The non-flammable refrigerant mixture contains a series of chlorine free halocarbons with a wide range of boiling points plus a very low boiling point inert gas. This refrigerant mixture boils and condenses over a wide temperature range, allowing the partial condensation and distillation needed for proper and efficient operation.

After compression by the compressor motor, a water-cooled condenser cools the refrigerant stream to partially condense most of the higher boiling components of the mixture. A first-stage heat exchanger further cools the vapor stream using the returning low-pressure refrigerant. Then a separator divides the liquid and vapor streams. The liquid stream is throttled and expanded into the low-pressure returning refrigerant stream to provide the refrigeration necessary to partially condense the separated vapor stream.

This process is repeated in several stages of heat exchange, with each successive liquid fraction consisting of lower boiling components as the temperature decreases. The final liquid stream is throttled to suction pressure and fed into the final evaporator (i.e., “the customer’s application”) where it boils to remove heat at very low temperatures.

Operating Sequence

1. First, the compressor motor compresses the refrigerant; creating the high pressure necessary for the refrigeration process. The compression process causes the refrigerant to become hot and also to pick up some unwanted compressor lubricant at the same time. The excess oil is later reduced to an acceptable level and the exiting hot gas can be used for defrosting cryosurfaces or heating customer applications.
2. The refrigerant then passes through the oil separators whose elements collect oil mist from the refrigerant, agglomerate the oil, and return it to the compressor. Oil collected in the separators flows back to the compressor through the oil return tube.
3. Next, the hot refrigerant flows through a condenser where the refrigerant is chilled by the customer-supplied cooling water. A portion of the gaseous refrigerant mixture cools enough to liquefy at this point, and the other portion of the mixture remains as a gas.
4. After the oil separators, the refrigerant passes through a filter-dryer that removes excess moisture from the refrigerant stream and then the refrigerant goes to the "Polycold Stack".
5. The "Polycold Stack" is the nonspecific name for a complex network of heat exchangers, phase separators and throttling/expansion devices. In the stack, the refrigeration process exploits the differences in the boiling points of the different refrigerants; repeating a cycle of cooling and vapor separation; extracting the low boiling point refrigerants by liquification; and expanding these liquids to produce extremely low temperatures down to -160°C.
6. Expansion tanks connected to the stack enable very rapid and severe changes in the Polycold Cryochiller refrigeration process.
7. After the stack, the coldest refrigerant is transferred by the feed lines to the customer's cooling application such as cryocoil, cold chuck, etc. The customer's heat load is absorbed by the refrigerant and this removal of heat causes some of the refrigerant to evaporate and raises the refrigerant temperature slightly. The warmed refrigerant is returned to the compressor via the return line.

The refrigerant feed and return lines are often bundled together as a single refrigerant line set. Refrigerant line sets and custom-designed cryocoils are both available from Edwards Polycold.

Electronic or manual valves isolate the feed and return refrigerant lines from the Cryochiller when necessary. Optional dual circuit Polycold Cryochillers split the refrigerant flow exiting the stack and share it with two parallel applications.

8. The pressure gauge located on the rear panel of the Polycold Cryochiller indicates equalization (charge) pressure when the system is not running. The gauge is included primarily for inspection during shipping. When the system is running, this analog pressure gauge also reads the refrigerant suction pressure, but it is better to utilize the electronic pressure transducers for both the suction and discharge pressures while running.
9. Pressure-relief valves inside the Cryochiller prevent operation at unsafe pressures.
10. Various optional lines and valves may bypass this fundamental refrigeration process in both the feed and return directions. These optional lines and valves enable a host of optional features, including temperature control, ramp control, application heating and rapid cooling cycle turnaround.

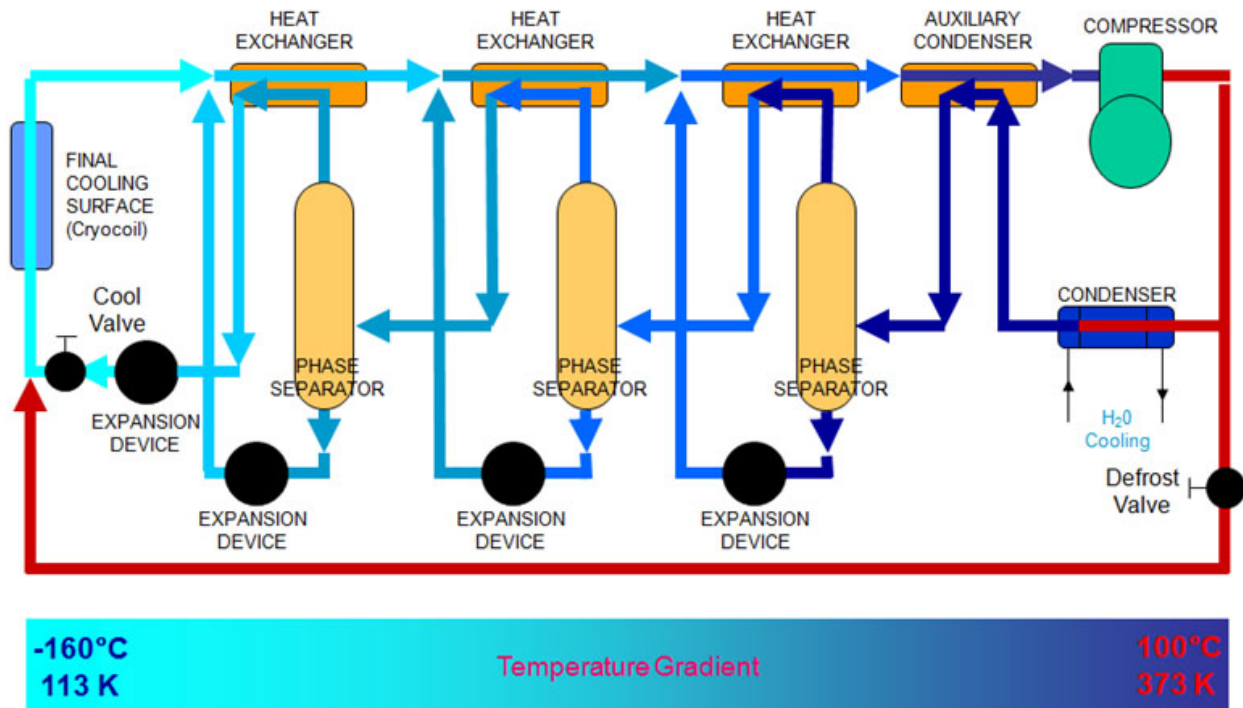


Figure 3-1: Refrigeration Flow Diagram

Refrigerant Circuit Diagram

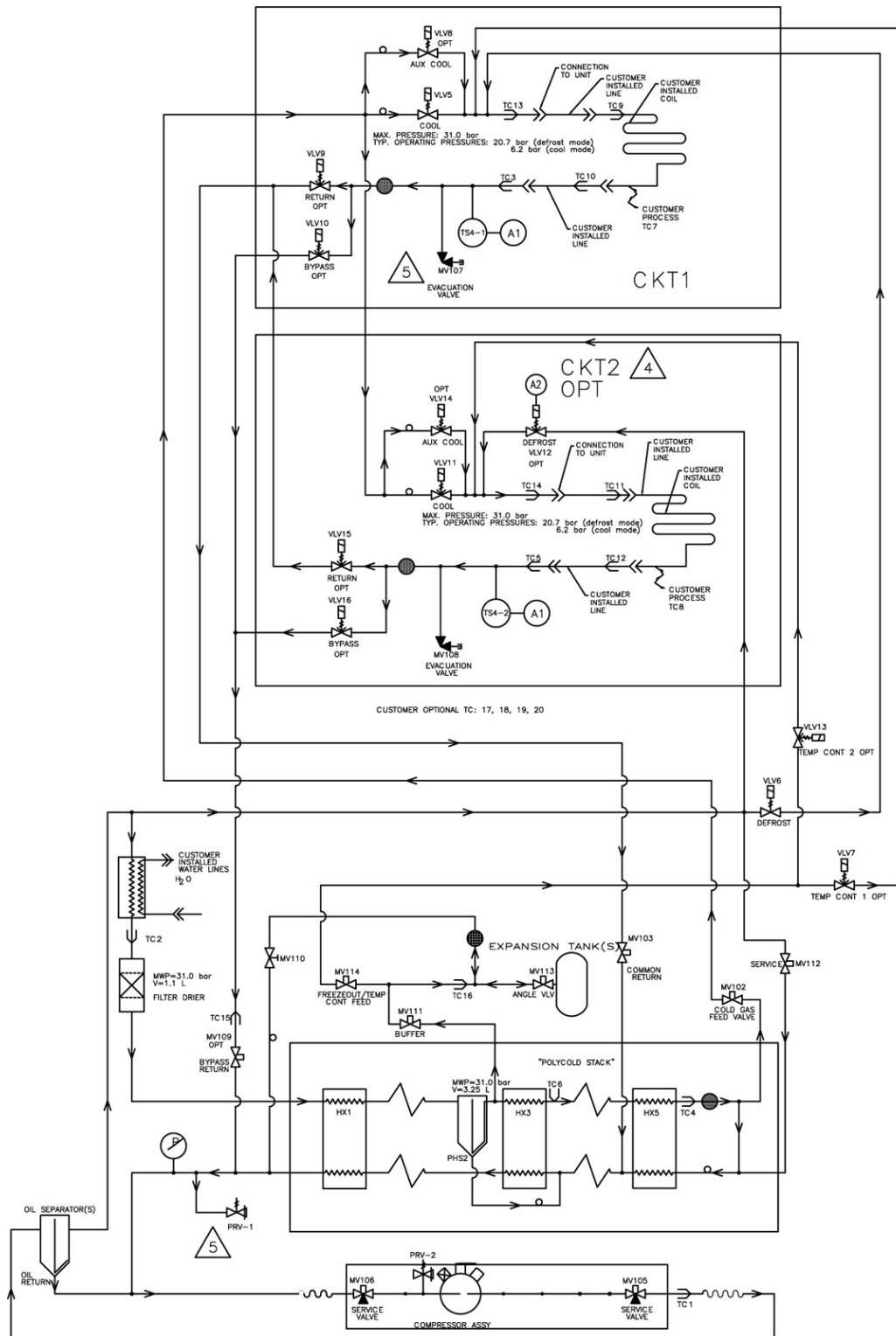


Figure 3-1: Refrigerant Circuit Diagram

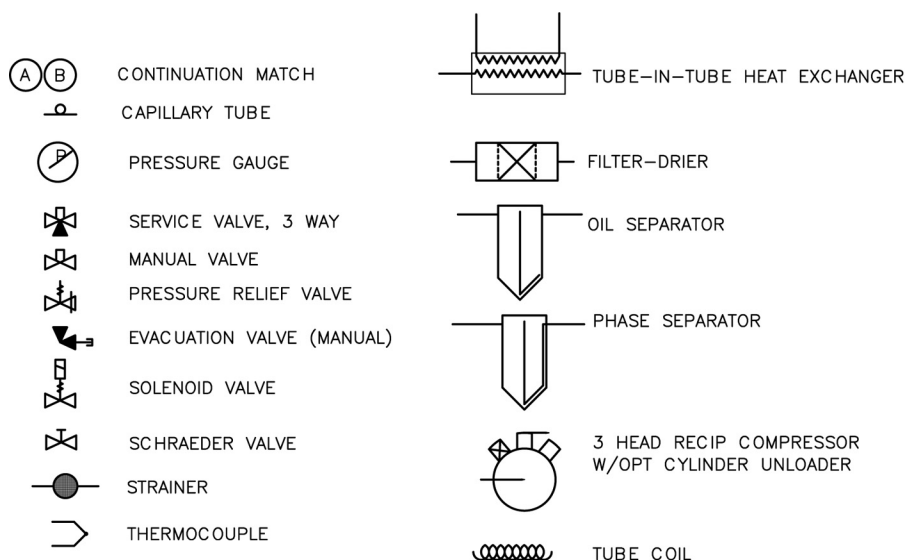


Figure 3-2: Legend for Refrigerant Circuit Diagram

Electrical Circuit Overview

The System Electrical Block Diagram shown in [Figure 3-3](#) provides an overview of the electrical routing. The 3 phase power enters at the main circuit breaker and connects to the compressor through the circuit controlled contactor. A single phase circuit breaker feeds a small transformer which supplies 24VAC to the Controller PC Board.

The Controller uses 2 processors: an ARM9 and a Digital Signal Processor, DSP.

The ARM9 runs Windows CE and the Application Software stored in memory. The software displays a User Interface at the Front Panel and responds to commands entered at the user keypad. The ARM9 also handles remote communications through a serial port in the Basic configuration. Additional user interfaces are available in the Technology Package configuration, including Ethernet, Profibus, and DeviceNet.

The DSP handles the I/O, including front panel display and keypad, thermocouple and pressure transducer inputs, solenoid and proportional valve control outputs, 24V DI/DO I/O isolated and non-isolated interface, safety logic, and contactor control.

A multiplexer is used to expand the analog thermocouple inputs and the I²C GPIO Expander handles the digital I/O.

Solenoid valves are driven by triacs directly from the 24VAC input. These triac switches are optically triggered to isolate the control circuits from the AC power path.

The Front Panel includes a Compressor On/Off switch to allow an operator to force the compressor off. An optional Emergency Off button is available. The safety logic monitors temperature and pressure and turns off the compressor upon a fault.

Electrical Block Diagram

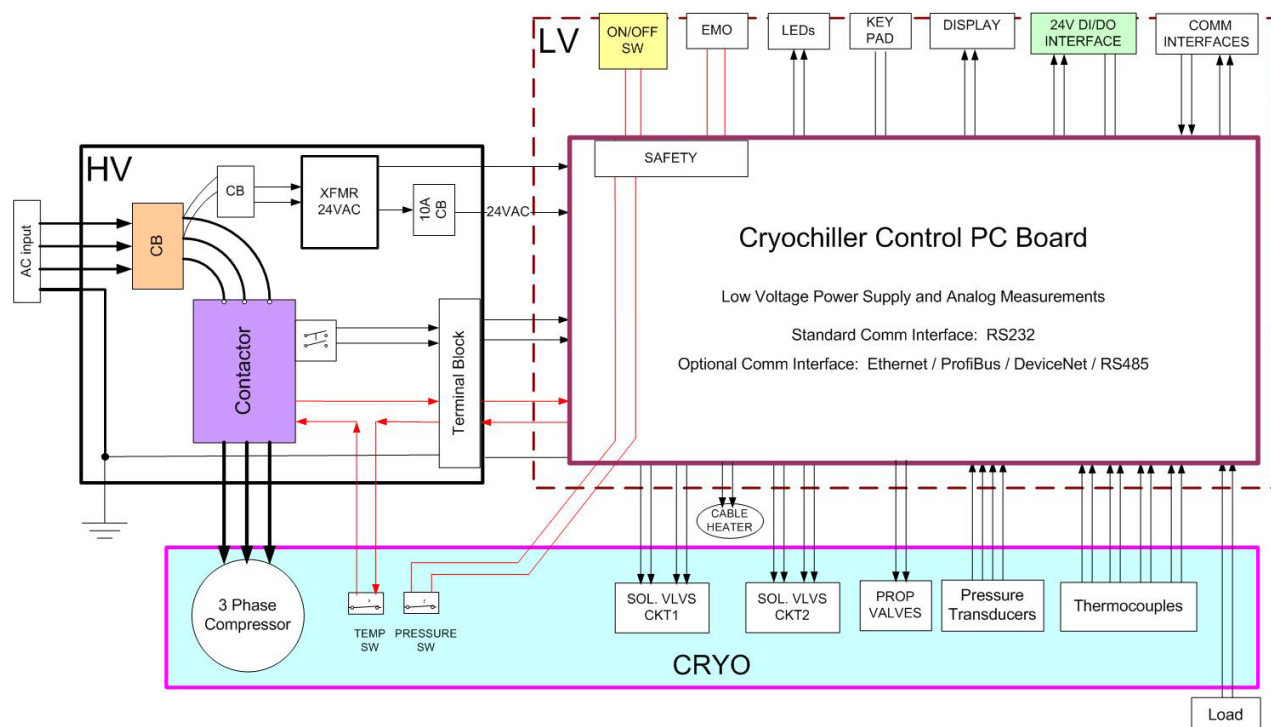


Figure 3-3: Cryo System Electrical Block Diagram

Overload Detection Circuit

The PolycolD Cryochiller incorporates a physical circuit breaker (CB1) located behind the sliding door on the front panel.

If tripped, this circuit breaker interrupts all incoming power to the unit and prevent the unit from restarting. It must be manually reset to restart the unit.

The Cryochiller also includes a thermal overload switch built into the compressor motor. If the motor gets too hot, the thermal switch trips which is detected by software. Software reports a fault and prevents the unit from restarting until the fault is cleared. Note that when the motor thermostat or the circuit breaker trips, damage may have already occurred.

Units with the technology package have performance monitoring software algorithms that increase the likelihood that a change in performance is detected and then shut down the compressor before damage becomes severe. Whether or not software detects the performance change depends on the amount that the reed valve is damaged. In general, the system will “know” the normal discharge temperature for the unit and detect when the temperature deviates significantly. This is designed to improve the chance of detecting a compressor problem before the damage becomes non-repairable.

Compressor Safety Chain

The compressor safety chain consists of several hardware/software interlocks that will cause the compressor to stop or prevent the compressor from starting.

Table 3-2: Compressor Safety Chain

Safety Chain Item	Description
Compressor ON/OFF switch (SW1)	Switch on HMI panel controls compressor contactor. Must be manually turned on for contactor to close and compressor to run.
Circuit breaker 1 (CB1)	CB1 controls input power for entire compressor unit Must be manually turned on or manually reset.
Circuit breaker 2 (CB2)	CB2 controls power to the low voltage transformers Must be manually turned on or manually reset.
Circuit breaker 3 (CB3)	CB3 controls low voltage power to the control PC Board. If off, the main control PC Board loses power and contactor opens and all electrical valves close Must be manually turned on or manually reset.
Emergency Off Button (EMO) (if equipped on unit)	EMO provides emergency control for compressor contactor. If the EMO button is pressed in, compressor contactor opens. EMO button must be manually disengaged to enable contactor
Compressor Over Temp Switch	Over Temp switch is a thermal cut out switch located inside the compressor motor and wired in series with the compressor power. Opens when compressor motor temperature is above the rated value. Closes when compressor motor temperature is below rated value.
Pressure switch (PS1)	Pressure switch is mounted in compressor discharge line. Wired in series with EMO and SW1. Trigger pressure is preset. Switch opens if discharge pressure is above the rated value. Switch closes when pressure is below rated value.
Software "Thermal Overload" Fault	Software monitors system performance comparing suction and discharge pressures. Generates "Thermal Overload" fault when conditions are met. Fault condition opens the compressor contactor. Fault resets after a 30 minute wait period.

System Components

The illustrations and tables in this section show the location and explain the function of the system refrigeration components.

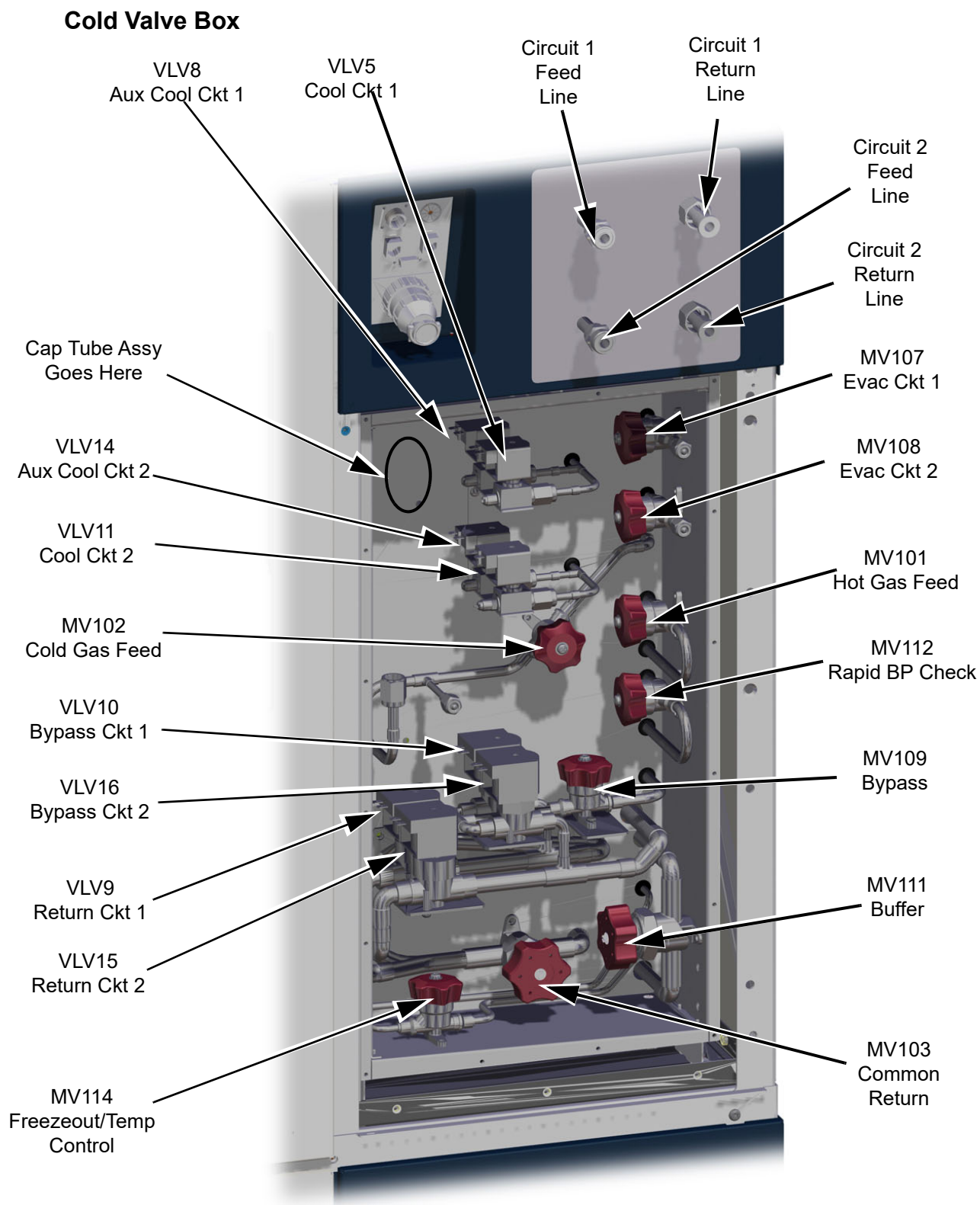


Figure 3-4: Illustration of Cold Valve Box

Warm Valve Assembly

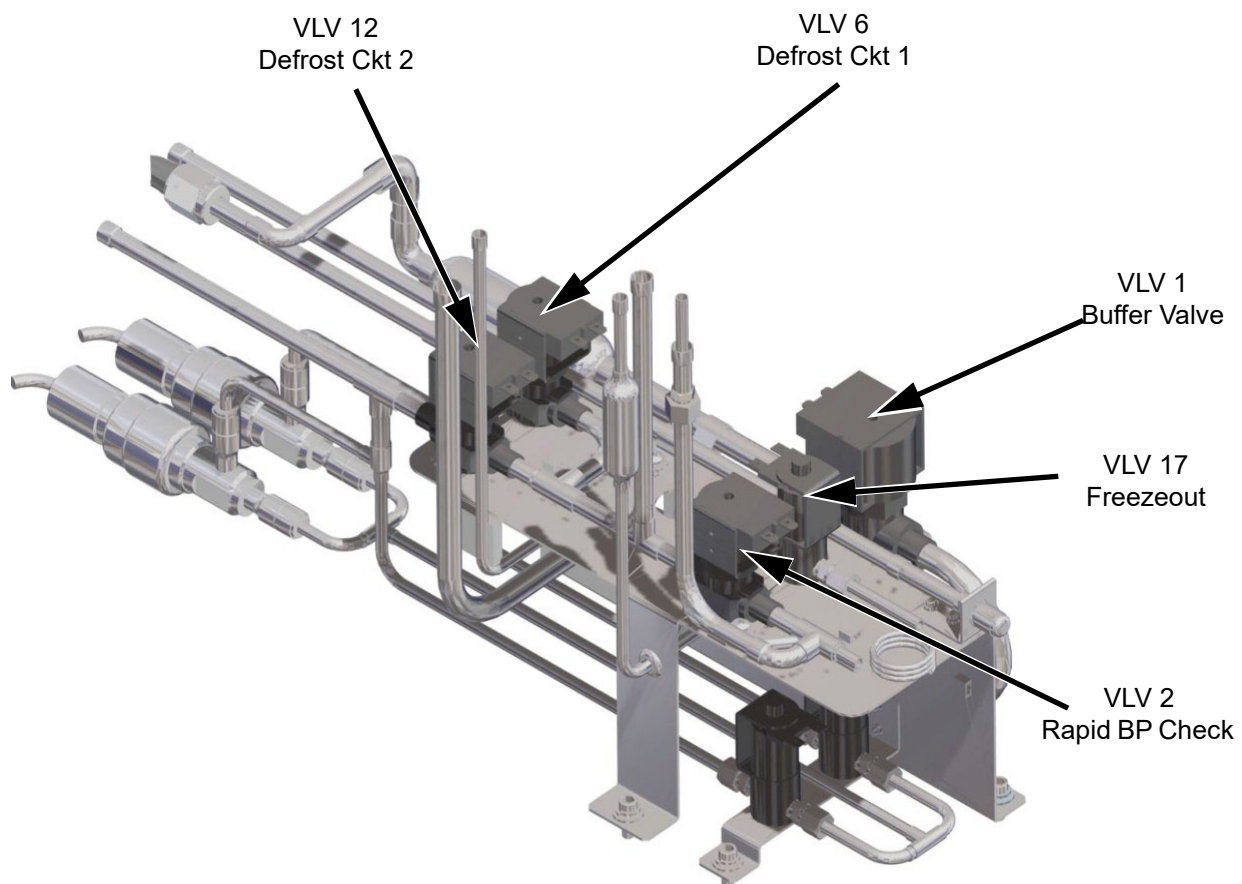


Figure 3-5: Illustration of Warm Valve Assembly
(see also [Figure 3-6](#))

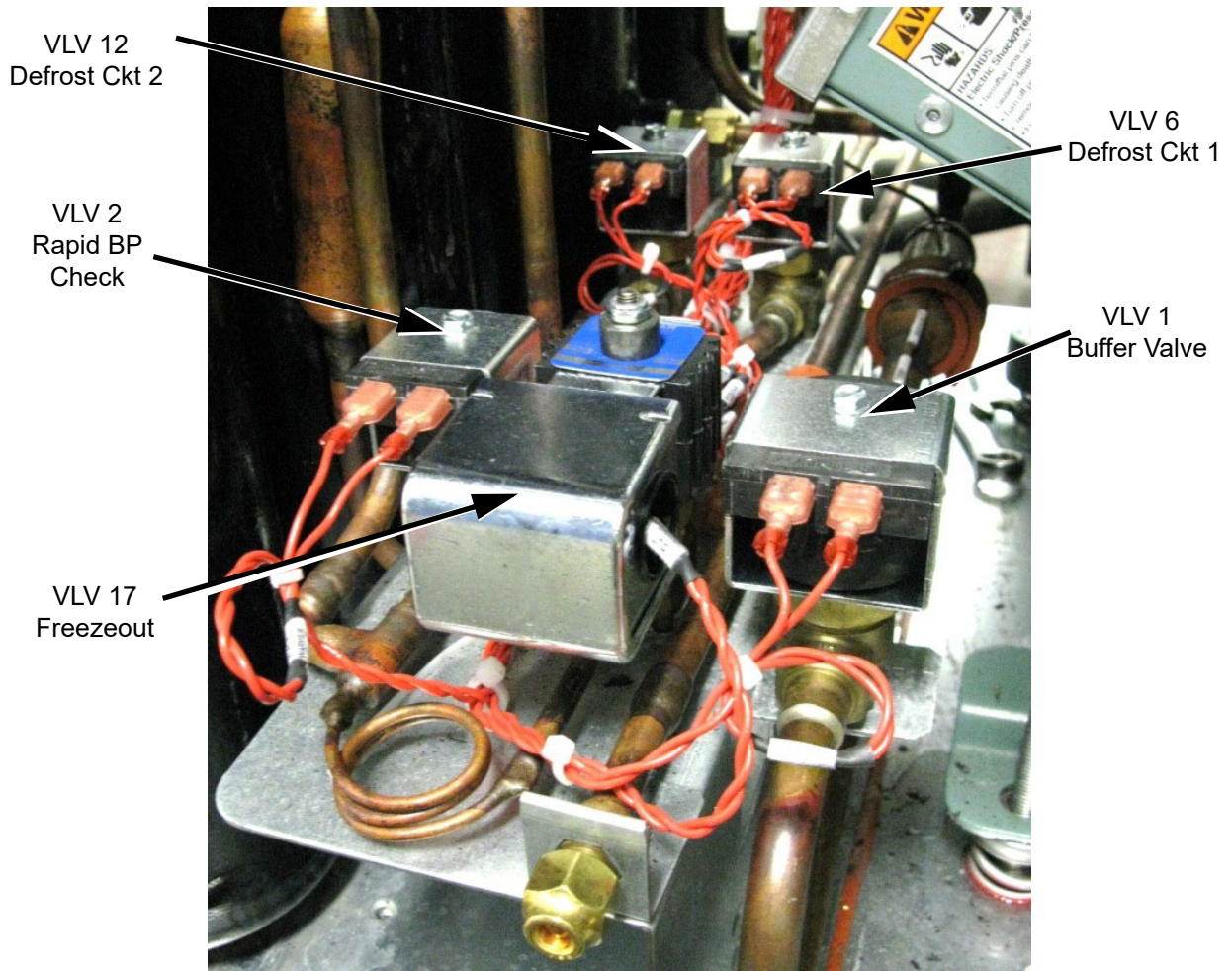


Figure 3-6: Physical View of Warm Valve Assembly from front of unit
(see also [Figure 3-5](#))

Compressor Compartment

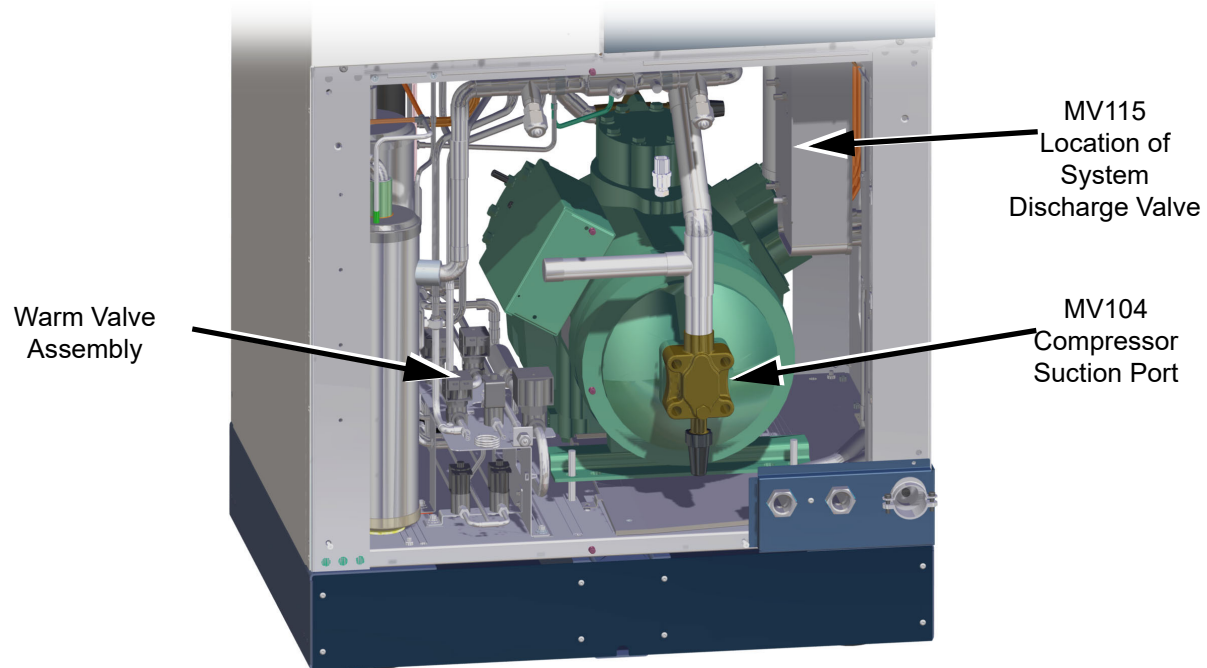


Figure 3-7: Front View of Warm Valve Assy and Compressor

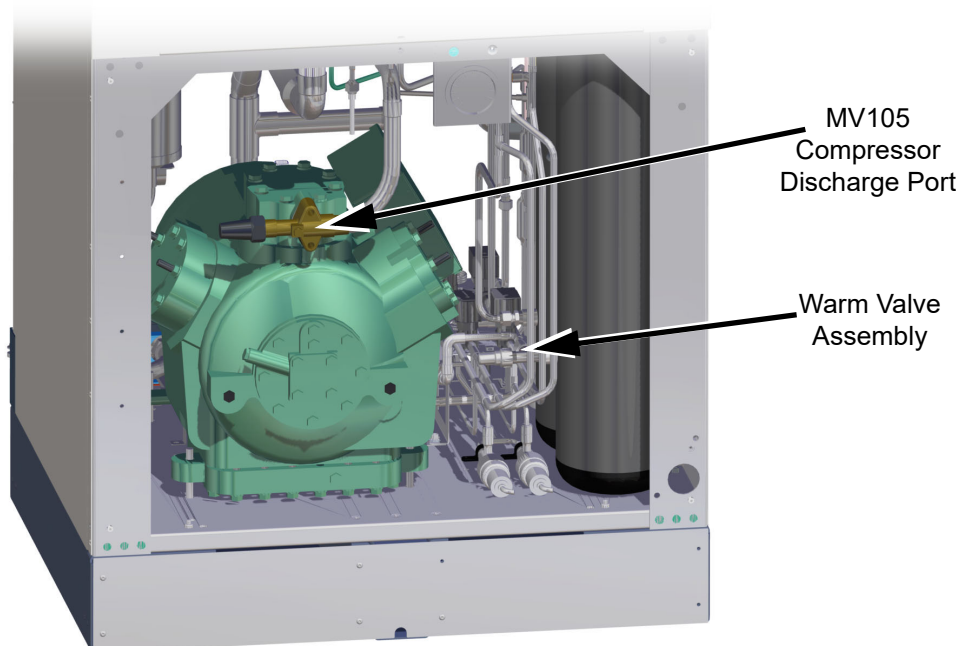


Figure 3-8: Rear View of Warm Valve Assy and Compressor

System Valves

Table 3-3: TSystem Valve Alignment During Operation

Mode	Return Temp (see notes)	System Valve Alignments							
		* Aux Valve 8/14	* Return Valve 9/15	* Bypass Valve 10/16	Cool Valve 5/11	Defrost Valve 6/12	Buffer Valve 1	Freeze-out Valve 17	Adv Rapid BP Check Valve 2
Power Off		Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
Power On		Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed
Comp On Standby	Steady State	Closed	Open	Closed	Closed	Closed	Modulates	Modulates Closed $\geq -80^{\circ}\text{C}$	Closed
Cool	$\geq -80^{\circ}\text{C}$	Closed	Open	Closed	Open	Closed	Closed	Modulates Closed $\geq -80^{\circ}\text{C}$	Closed
Cool	$\leq 0^{\circ}\text{C}$	Open	Closed	Open	Open	Closed	Closed	Modulates Closed $\geq -80^{\circ}\text{C}$	Closed
Defrost	$\leq -20^{\circ}\text{C}$	Closed	Open	Closed	Closed	Open	Closed	Modulates Closed $\geq -80^{\circ}\text{C}$	Closed
Defrost	$\geq -20^{\circ}\text{C}$	Closed	Closed	Open	Closed	Open	Closed	Modulates Closed $\geq -80^{\circ}\text{C}$	Closed
Rapid BP Check		Closed	Closed	Closed	Closed	Closed	Open	Closed	Open

- Return Temperature values are typical. Actual values are user configurable in software.
- Manual valves for Hot Gas (MV101), Cold Gas Feed (MV102), Common Return (MV103), and Compressor Service Valves (MV104 and MV105) are normally open.
- Buffer Valve (VLV1) is open during startup and other high pressure events.
- When VLV5/11, VLV6/12, VLV1 are de-energized, forward flow is not possible. Reverse flow is possible.
- Some units with optional features have additional control modes that impact the use of Aux Cool Valves during Cool Down and Defrost.
- Proportional valves are driven to the closed position at power up
- Cylinder Unloader will fluctuate as programmed.
- When compressor power is turned on, system defaults to Standby mode.
- * Denotes optional valve

Hand Valves

Polycold Cryochillers have up to 14 manually operated hand valves, depending on system configuration.

Table 3-4: Hand Valve List

Valve	Description	Type	Location
MV101	Hot Gas Feed Valve	3/8 Superior	Cold Assy
MV102	Cold Gas Feed Valve	3/8 Superior	Cold Assy
MV103	Common Return Valve	5/8 Henry	Cold Assy
MV104	Compressor Suction Service Valve	5/8 Henry	Compressor
MV105	Compressor Discharge Service Valve	5/8 Henry	Compressor
MV106	Expansion Tank Service Valve	5/8 Henry	Expansion Tank
MV107	Ckt 1 Evacuation Valve (optional)	3/8 Superior	Cold Assy
MV108	Ckt 2 Evacuation Valve (optional)	3/8 Superior	Cold Assy
MV109	Bypass Return Service Valve (optional)	3/8 Superior	Cold Assy
MV110	Expansion Tank Cap Tube HV	5/8 Henry	Warm Assy
MV111	Buffer Line	5/8 Henry	Cold Assy
MV112	Rapid Balance Pressure Check Valve	3/8 Superior	Cold Assy
MV113	Expansion Tank Angle Valve	5/8 Henry	Expansion Tank
MV114	Freezeout/Temp Cont Feed	3/8 Superior	Cold Assy
MV115	Discharge	3/8 Superior	Warm Assy

Automatic Valves

Polycold Cryochillers may have up to 17 system controlled solenoid operated valves, depending on system configuration. See system flow documentation p/n 690065-00.

Table 3-5: Automatic Valve List

Valve	Description	Type	Location
PVLV1	Ckt 1 Proportional	Stepper Motor Valve	Warm Assy
PVLV2	Ckt 2 Proportional	Stepper Motor Valve	Warm Assy
VLV1	Buffer	B9 Solenoid	Warm Assy
VLV2	Rapid Balance Pressure Check	B6 Solenoid	Warm Assy
VLV3	(not populated)		
VLV4	Cylinder Unloader	Solenoid	Compressor
VLV5	Ckt 1 Cool	XUJ Solenoid	Cold Assy
VLV6	Ckt 1 Defrost Rapid Cool (Plus pkg)	B6 Solenoid	Warm Assy
VLV7	(not populated)		
VLV8	Ckt 1 Aux Cool (optional)	XUJ Solenoid	Cold Assy
VLV9	Ckt 1 Return (optional)	B14 Solenoid	Cold Assy
VLV10	Ckt 1 Return Bypass (optional)	B9 Solenoid	Cold Assy
VLV11	Ckt 2 Cool	XUJ Solenoid	Cold Assy
VLV12	Ckt 2 Defrost Rapid Cool (Plus pkg)	B6 Solenoid	Warm Assy
VLV13	(not populated)		
VLV14	Ckt 2 Aux Cool (optional)	XUJ Solenoid	Cold Assy
VLV15	Ckt 2 Return (optional)	B14 Solenoid	Cold Assy
VLV16	Ckt 2 Return Bypass (optional)	B9 Solenoid	Cold Assy
VLV17	Freezeout Prevention	B6 High Cycle (early) Peter Paul Solenoid	Warm Assy

NOTE: Solenoid valves do not provide open/closed state feedback to software. The valve state displayed by the `SENSOR_SNAPSHOT` command is the state commanded by software.

All solenoid valves are closed when in Standby mode with the exception of the following:

- Freezeout Prevention valve logic
- Logic associated with compressor startup or other normal high pressure conditions where the Buffer valve may be opened to manage high pressure.
- Logic for the Cylinder Unload for power management

Pressure Sensing / Relief Components

Table 3-6: Pressure Transducer List

Transducer	Description	Location	Setpoint
PS1	High Pressure Switch		$P > 3.10 \text{ bar}$
PT1	Low Pressure Transducer (Suction / Return)		$-1 < P < 34.5 \text{ bar}$
PT2	High Pressure Transducer (Discharge / Feed)		$-1 < P < 34.5 \text{ bar}$
PRV-1	System Suction Side Pressure Relief Valve		$P > 27.6 \text{ bar}$
PRV-2	Compression Suction Side Pressure Relief Valve		$P > 20.7 \text{ bar}$

Pressure transducer readings are part of the SENSOR_SNAPSHOT Host command and are associated with Alarm/Faults which can turn off the compressor due to high or low system pressure.

Host commands are available to read the individual pressure transducers COMP_SUCTION_PRESS and COMP_DISCHARGE_PRESS.

UNIT_BALANCE_PRESS can be used to read balance pressure $((\text{feed} + \text{return}) / 2)$ if these two values are close). COMP_DP can be used to read the differential pressure $(\text{feed} - \text{return})$.

Thermocouples

Each Polycold Cryochiller may have up to 20 type T thermocouples as listed below, depending on configuration.

Thermocouple	Description	Note
TC1	Compressor Discharge Temperature	
TC2	Refrigerant Liquid Line Temperature	
TC3	Ckt 1 Return Temperature	
TC4	Coldest Liquid Temperature	
TC5	Ckt 2 Return Temperature	
TC6	Rapid Balance Pressure Check Control Temperature	
TC7	Ckt 1 Process Control ¹ Temperature	Optional
TC8	Ckt 2 Process Control ¹ Temperature	Optional
TC9	Ckt 1 Coil Inlet Temperature	
TC10	Ckt 1 Coil Outlet Temperature	
TC11	Ckt 2 Coil Inlet Temperature	
TC12	Ckt 2 Coil Outlet Temperature	
TC13	Ckt 1 Feed Temperature	
TC14	Ckt 2 Feed Temperature	
TC15	Bypass Temperature	Optional
TC16	Buffer Line Temperature	
TC17	Custom 1 (extra for customer use, no control functions)	Optional
TC18	Custom 2 (extra for customer use, no control functions)	Optional
TC19	Custom 3 (extra for customer use, no control functions)	Optional
TC20	Custom 4 (extra for customer use, no control functions)	Optional

1: TC7 and TC8 are used as customer installed temperature control thermocouples for Cool and Defrost modes using Host command EXT_TC_ENABLE

Some Thermocouples are used for the control functions of the system.

Example TC3 is used by the COOL_SETPT for PID temperature control Cool mode

Commands are available to get the individual thermocouple values by name. See [Chapter 5: Software Command Set](#).

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Troubleshooting

	 WARNING
	General Hazard Failure to review the Safety section and follow the safety warnings can result in death or serious injury. Do not attempt to perform installation, operation, or maintenance procedures on the Polycold Cryochiller until you have read and understand the information in the Safety chapter. Read and understand each procedure before performing the procedure.

Replaceable Parts

Edwards Vacuum provides Field Replaceable Unit Kits, FRU Kits, for repair or replacement of common parts. Contact Edwards Vacuum for a listing of the FRU kits for your system.

Troubleshooting Techniques

Successful troubleshooting involves gathering enough information and asking enough questions to define the problem using a single statement of how the system is supposed to operate and how the system is operating improperly.

Create a simple problem statement using the steps below

- Observe and list the symptoms of the problem
- Determine what is happening that is different from what should happen
- Determine the items that have the problem and those that do not
- Determine when the problem first occurred and how often it occurs
- Determine the state of the system when the problem occurred or occurs
- Reduce the list of symptoms to the primary symptom.
- List the possible causes of the symptom
- Reduce the list of causes based on what is happening and what is supposed to happen.
- Troubleshoot the probable causes.

HMI Service Menus

HMI Service Menu allows access to service functions once the access code is entered. These menu selections are not included in the Installation and Operation Manual. See [Figure 4-1](#) and [Figure 4-2](#).

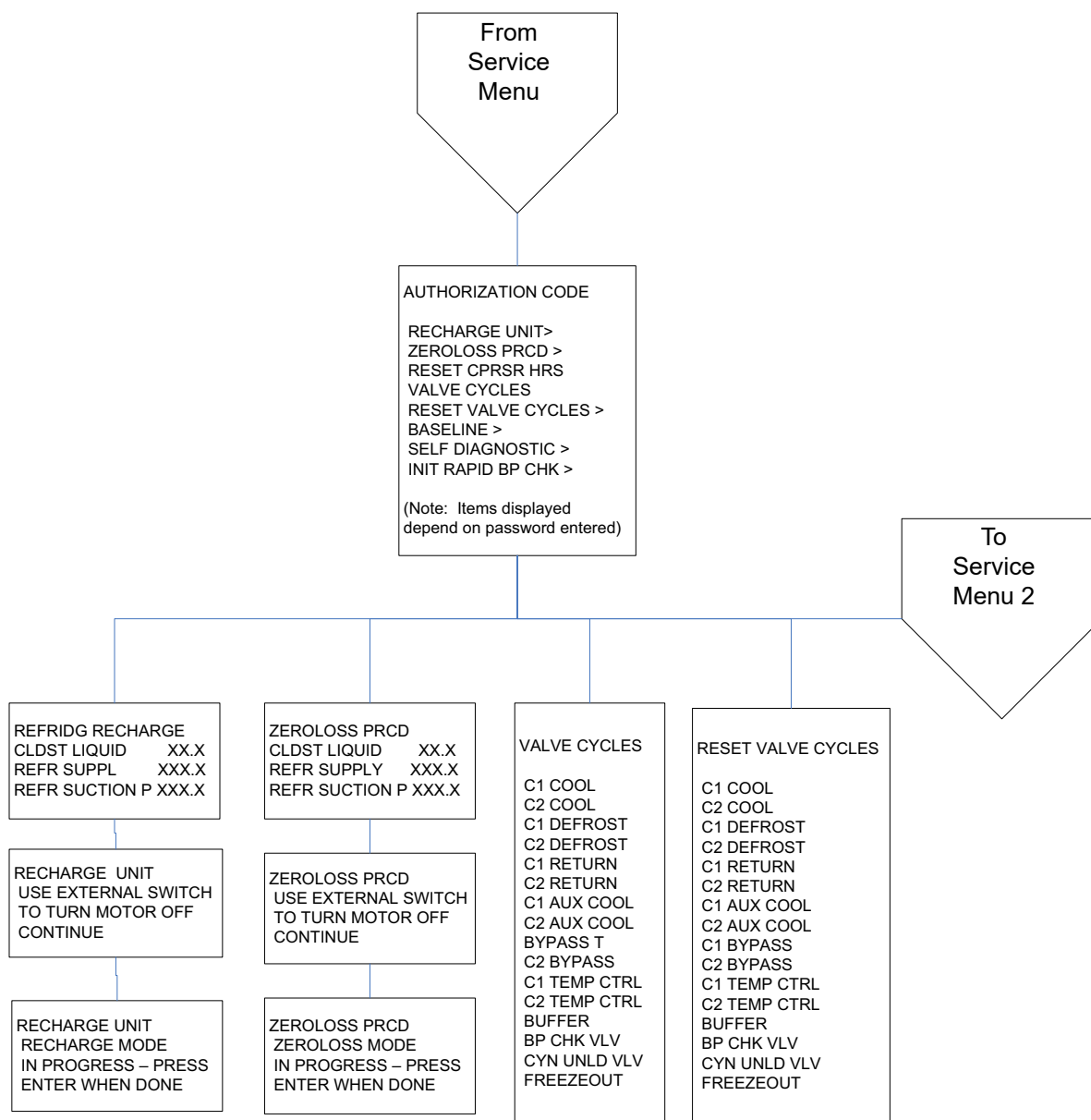


Figure 4-1: Service Menu 1

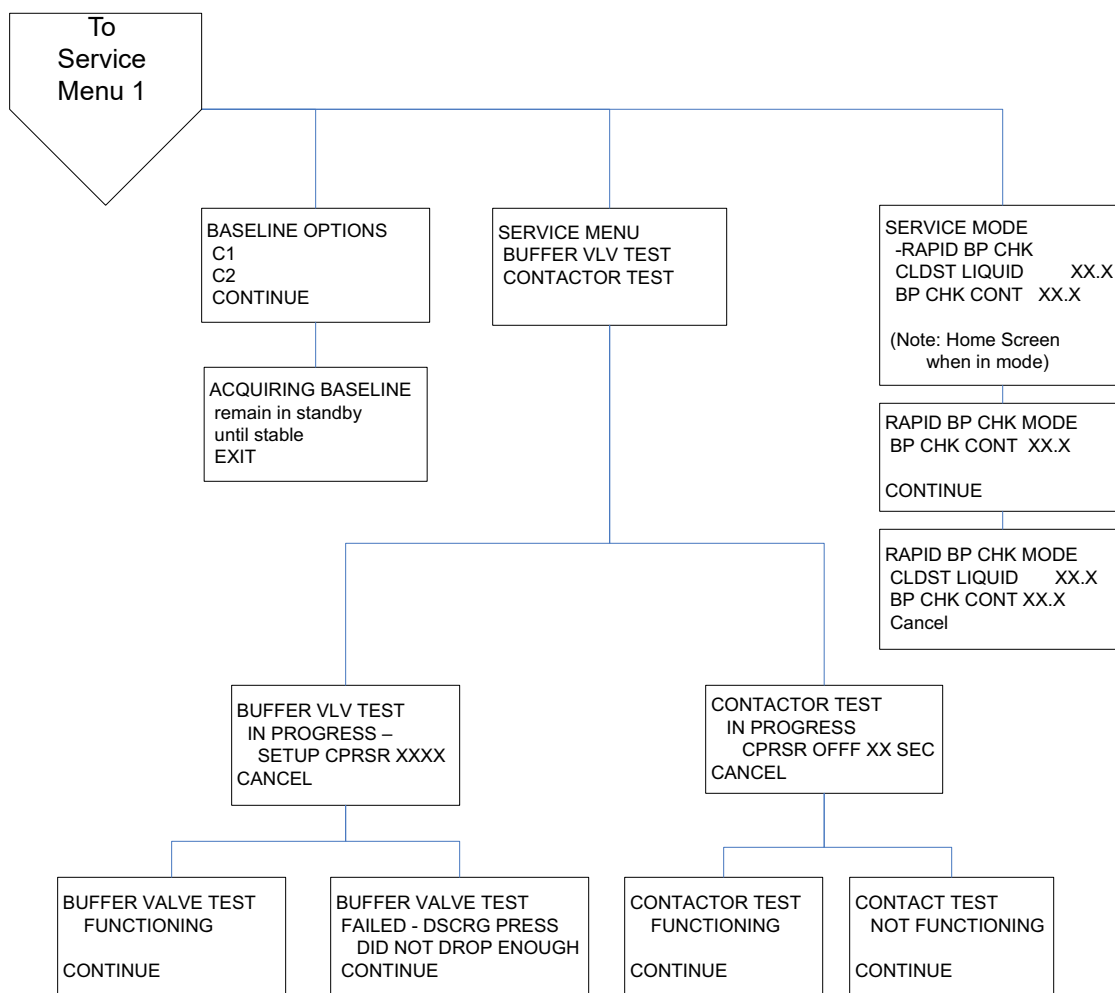


Figure 4-2: Service Menu 2

Troubleshooting Table Format

Troubleshooting issues are listed in two groups: **HMI and Observed Errors** and **Remote Monitor Troubleshooting**. Troubleshooting tables use a 3-column format.

Problem column shows the messages in **BOLD UPPER CASE** and the status of the Fault LED.

- If the system recognizes a fault, the HMI screen may display a fault message and a recommended action and the Fault LED may be lit.
- If the system does not recognize a fault, the display may not provide any fault information and the Fault LED may not be lit and the user must determine the problem.

Possible Cause column lists the probable causes of the problem.

Corrective Action column lists recommended actions to correct the problem.

HMI and Observed Errors

Power Troubleshooting

Troubleshooting power requires that CB1 and CB2 are turned on.

Problem / HMI Display	Possible Cause	Corrective Action
POWER FAILURE NO RECOMMENDATION Fault LED is Amber	Control voltage is outside of acceptable limits.	Check the transformer tap settings and ensure they are correct for your supply voltage
		Check supply voltage for deviations beyond the allowable voltage range for this tap setting.
(No HMI message) No LED indicators CB1 or CB2 trip and cannot be reset.	Faulty component in the power or control circuit.	Contact authorized service
(No HMI message) No LED indicators CB1 occasionally trips	Power consumption too close to CB1 maximum rated value.	Refer to CB2 Excepted Wiring in the Appendix B of the Installation and Operation Manual. Have a qualified electrician rewire CB2 to Excepted Wiring
(No HMI message) No LED indicators System does not boot up. CB1 stays ON	No input power	Check power source. Check fuses, circuit breakers, and wiring Contact authorized service to repair as needed
(No HMI message) Fault LED not lit System boots up Compressor will not turn on	Motor on/off switch fault	Contact authorized service to check the switch and replace if required.

Communication Troubleshooting

Problem / HMI Display	Possible Cause	Corrective Action
System does not communicate on RS232, Ethernet, Profibus, or DeviceNet	System electronics is "confused"	Power cycle the system.
		Contact authorized Service

Compressor Motor Troubleshooting

Troubleshooting the compressor motor requires that the Polycold Cryochiller is fully booted up.

Problem / HMI Display	Possible Cause	Corrective Action
Compressor will not start No LEDs lit Compressor switch is off	Compressor switch must be on for compressor to run.	Set compressor switch to ON.
Compressor will not start No LEDs lit Compressor switch is on.	Compressor contactor circuit needs to be reset after power up.	Turn compressor switch OFF and then ON
	Remote EMO connector or J11 bypass is disconnected	Connect remote EMO cable or install J11 EMO Jumper
	Remote EMO signal open at remote device	Check continuity on pins 3 and 4 on remote EMO connector. Correct remote EMO condition.
	Remote EMO wiring insufficient Must be 16AWG and less than 15M (50 feet).	Check EMO wiring for 16AWG Correct wiring as required.
	Supply voltage too low	Check voltage and correct
Compressor will not start Fault LED flashing	Compressor contactor circuit needs resetting	Press Reset switch
	A Fault that opens the compressor contactor is active	Determine what fault is active. Resolve the issue creating the fault. Contact authorized service if fault continues

Problem / HMI Display	Possible Cause	Corrective Action
Compressor will not start Fault LED flashing	Compressor pressure switch PS1 is open indicating high discharge pressure	Wait for pressure to come down below the threshold level. Contact authorized service if high pressure continues
	Compressor thermal cutout switch is open	Wait for compressor motor to cool. Contact authorized service if over heating continues
EMO SWITCH ALARM CHECK EMO SWITCH Fault LED Amber	EMO switch is pressed in and activated	Turn EMO switch clockwise to disengage the switch
	Remote EMO is active - open	Correct remote EMO condition
	Remote EMO bypass J11 disconnected	Connect J11
CONTACTOR CHATTERING CHECK POWER LINE Fault LED not lit	Motor contactor is rapidly opening and closing	Verify power supply meets all requirements
		Verify control transformer tap settings are correct for supply voltage
		Verify transformer output voltage is in the correct range
		If all voltages are in spec. contact authorized service.
ABUSIVE COMP ON ALARM WAIT 60 SECONDS Fault LED Amber	The compressor has been reset too frequently.	Review cause for multiple resets. If due to faults, investigate root cause of the faults and correct. Contact authorized service if problem cannot be resolved

Fan Fault

Problem / HMI Display	Possible Cause	Corrective Action
FAN FAULT WARNING CHECK COOLING FAN Fault LED not lit	One or more electrical box cooling fans are not operating.	Check power and cable. Check fan operation Replace both cooling fans
		Contact authorized service if problem cannot be resolved

Pressure Related Troubleshooting

Problem / HMI Display	Possible Cause	Corrective Action
DIFFERENTIAL PRESSURE Alarm L1	PT1 > PT2 Differential 20psi PT1 = Suction Pressure Transducer PT2 = Discharge Pressure Transducer Alarm L1	Pressure Sensor Fault Contact Authorized Service
HIGH SUCTION PRESSURE Alarm L1	PT1 > 270 psi PT1 = Suction Pressure Transducer Alarm L1	Excessive Suction Pressure Contact Authorized Service
REF PRESSURE SWITCH NO RECOMMENDATION Fault LED is Red	Refrigerant Discharge Pressure Switch has activated.	Contact authorized Service
LOW SUCTION PRESS REFRIGERANT LEAK CHECK BALANCE PRESSURE Fault LED is Amber	A low suction pressure condition has occurred.	Check system balance pressure.
		If balance pressure has dropped, check for leak
		Contact authorized service

Problem / HMI Display	Possible Cause	Corrective Action
HIGH DISCHRG PRESS EXCESSIVE HEAT LOAD Fault LED Red	Discharge pressure is too high	Review application to ensure it is within the capability of the unit.
		Check for excessive heat load.
		Make sure all thermal radiation shields are in place.
		If the unit is equipped with the rapid recovery feature, ensure that the return/bypass valve transition temperature is set between -20 C and -40 C. See BYAPSS_TEMP_SETPT
		If the unit is not equipped with the rapid recovery feature, ensure that the unit has a minimum of 5 minutes in standby before switching to cool.

Temperature Related Troubleshooting

Problem / HMI Display	Possible Cause	Corrective Action
FREEZOUT PREVENTION Fault LED not lit	Freeze out prevention sensor is experiencing a temperature colder than expected.	Check refrigerant
		Check freezeout prevention valve and thermocouple
		Contact authorized service
C1 CUST TC FAILED C2 CUST TC FAILED Fault LED is Amber	Thermocouple not proper type	Verify that a type T (copper - constant an thermocouple sensor is being used.
	Thermocouple not properly installed	Check installed polarity of customer installed thermocouple
		Check TC terminal connection tightness Torque Spec is 0.34 N-m (3 lb-in)
		Check thermal bonding of sensor to tube.
HIGH DISCHRG TEMP REFRIGERANT LEAK CHECK BALANCE PRES-SURE Fault LED Amber	Compressor discharge temperature is too high	Check cooling water flow
		Contact authorized service
REF LQD LINE TEMP Fault LED is Amber	Cooling water flow and / or temperature are outside of acceptable limits. The system turns off due to excessively low cooling water temperature, excessively high cooling water temperature or insufficient flow.	Check your temperature and flow to ensure it is within acceptable limits.

Problem / HMI Display	Possible Cause	Corrective Action
LQD LINE START TEMP NO RECOMMENDATION Fault LED is Amber	Cooling water flow and / or temperature are outside of acceptable limits during system start This fault will occur during start up if the system coolant sensor fails to reach a temperature below 42 C within 14 seconds.	Check your temperature and flow to ensure it is within acceptable limits.
THERMAL OVERLOAD NO RECOMMENDATION Fault LED is Amber	Motor thermostat has tripped	Contact authorized service.
	CB1 has tripped	Check for cause of excessive thermal load on the cryocoil,
		Check if supply voltage is below nominal conditions.
		If application has a combination of high load, near max rating and supply voltage is below 93% nominal, have a qualified electrician rewire CB2 to "Excepted Wiring". Refer to CB2 Excepted Wiring in the Appendix B of the Installation and Operation Manual.
C1 COOL TEMP SETPT C2 COOL TEMP SETPT NO RECOMMENDATION Fault LED is Amber	Temperature control is operating outside of deadband	Check control set point algorithms. Review procedure for setting control parameters.
C1 DEFR TEMP SETPT C2 DEFR TEMP SETPT NO RECOMMENDATION Fault LED is Amber	Temperature control is operating outside of deadband	Check control set point algorithms. Review procedure for setting control parameters

Problem / HMI Display	Possible Cause	Corrective Action
C1 COOL VALVE CYCLE C2 COOL VALVE CYCLE NO RECOMMENDATION Fault LED is Amber	Cool valve requires replacement	Contact authorized service
C1 DEFR VALVE CYCLE C2 DEFR VALVE CYCLE NO RECOMMENDATION Fault LED is Amber	Defrost valve requires replacement	Contact authorized service
C1 AUX VALVE CYCLE C2 AUX VALVE CYCLE NO RECOMMENDATION Fault LED is Amber	Auxiliary valve requires replacement	Contact authorized service
C1 RET VALVE CYCLE C2 RET VALVE CYCLE NO RECOMMENDATION Fault LED is Amber	Return solenoid valve requires replacement	Contact authorized service
C1 BYPASS VLVE CYCLE C2 BYPASS VLVE CYCLE NO RECOMMENDATION Fault LED is Amber	Bypass solenoid valve requires replacement	Contact authorized service

Performance Related Troubleshooting

Problem / HMI Display	Possible Cause	Corrective Action
Too slow to go to cool	Cryosurface full and requires defrosting.	Defrost the cryosurface
Fault LED not lit		Contact authorized Service
Date and Time rolled back		

Date or Time Error

Problem / HMI Display	Possible Cause	Corrective Action
(No HMI Message)	Internal battery is dead and real time clock has reset to default after recent power cycle	Reset the real time clock to correct time using remote interface
Fault LED not lit		
Date and Time rolled back		Contact authorized Service to have battery replaced

Remote Monitor Troubleshooting (optional)

This section is for the convenience of Remote Monitor troubleshooting. The tables below are the same faults as previously listed in this chapter but are listed in numerical order of the bitmask value.

This section lists faults in numeric order of the bit mask value as received from the command **ACTIVE_ALARMS**. See [ACTIVE_ALARMS Current Active Alarms on page 5-20](#).

For information on decoding the hexadecimal bitmask value to find the decimal bit values, refer to [32 Bit Numbered Bitfield on page 5-3](#).

Bit Mask Value Listing

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 0 Customer Installed TC is out of range Fault LED Amber Compressor ON	Difference between system TC 3/5 and customer installed TC 7/8 greater than value of EXT_TC_ALARM when EXT_TC_ENABLE is set to 1 for the circuit Absolute difference between TC3 and TC7 > EXT_TC_ALARM or Absolute difference between TC5 and TC8 > EXT_TC_ALARM Fault sets EXT_TC_ENABLE to 0 for affected Ckt Alarm L1	Check customer installed TC for proper installation and proper operation Press Reset to clear alarm
Bit 1 Not used	N/A	N/A

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 2 Freeze out prevention active Fault LED Amber Compressor ON	Coldest Liquid Temperature (TC4) (6C low-side dead band in effect when FRZ_RREVENT_SETPT > -158C) When FRZ_PREVENT_SETPT > -158C, then Alarm when TC4 is lower than 6C below FRZ_PREVENT_SETPT When FRZ_PREVENT_SETPT < -158C, then... Alarm when TC4 is lower than FRZ_PREVENT_SETPT Warning L2	Check freezeout prevention valve. Check freezeout TC installation and operation.
Bit 3 Not used	N/A	N/A
Bit 4 Differential Pressure Fault LED Amber Compressor OFF	PT1 > PT2 Differential 20psi PT1 = Suction Pressure Transducer PT2 = Discharge Pressure Transducer Alarm L1	Pressure Sensor Fault Contact Authorized Service
Bit 5 High Suction Pressure Fault LED Amber Compressor ON	Suction Pressure Transducer (PT1) PT1 > 270 psi Alarm L1	Excessive Suction Pressure Contact Authorized Service
Bit 6 Not used	N/A	N/A
Bit 7 High discharge pressure Fault LED Red Compressor OFF	Pressure Transducer PT2 shows high discharge pressure which indicates excessive heat load PT2 > 3102.6kpa (450 psi) Alarm L1	Check system load and performance

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 8 High discharge temperature LED Amber Warning: Compressor ON Alarm: Compressor OFF	Compressor Discharge Temperature (TC1) too high TC1 $\geq 135^{\circ}\text{C}$ for 30min Warning L2 TC1 $\geq 135^{\circ}\text{C}$ for 40min Alarm L1 TC1 $\geq 145^{\circ}\text{C}$ for 2min Warning L2 TC1 $\geq 145^{\circ}\text{C}$ for 40min Alarm L1 TC1 $\geq 149^{\circ}\text{C}$ immediate Alarm L1	Contact authorized service
Bit 9 Rapid BP Check Valve Cycle Count Fault LED Amber Compressor ON	Rapid BP Check Valve Cycle Count has exceeded limit CRYO_VALV_OPEN_CNT for Rapid BP Check Valve > VALVE_CYCLE_WARN Alarm L1	Contact authorized service
Bit 10 Input power out of range Fault LED Amber Warning: Compressor ON Alarm: Compressor OFF	Input voltage out of range of PWR_WARN_BAND Voltage outside of range of PWR_WARN_BAND for 10sec Warning L2 - Comp On (10 sec to restart compressor) Voltage outside of range of PWR_WARN_BAND for 30min Alarm L1 - Comp Off (10 min to restart compressor) Voltage above 33.2V for 1min Alarm L1 -Comp Off (10 sec to restart compressor)	Check and correct the input voltage

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 11 Refrigerant liquid line temp Fault LED Amber Warning: Compressor ON Alarm: Compressor OFF	Refrigerant Liquid Line Temperature (TC2) multiple conditions TC2 is between 9C and 12C for 1 min. Warning L1 TC2 < 9C for 15 min Alarm L1 TC2 > LINE_TEMP_FAULT_LIMIT for 2 min Alarm L1 TC2 > 50C for 1 min Alarm L1 TC2 > 60C for 30 sec Alarm L1	Check cooling water flow and temperature
Bit 12 Refrigerant Liquid Line Temp (TC2) before and during operation Fault LED Amber Compressor OFF	Cooling water is poor Before Comp start TC2 > 85C Comp will not start After Comp start TC2 > 85C for 14 seconds, then Alarm L1 Comp OFF	Water temperature too high. Check cooling water flow and temperature
Bit 13 Refrigerant Pressure Switch Fault LED Red Compressor OFF	Pressure switch is open Pressure switch fault Alarm L1	Check refrigerant pressure Contact authorized service
Bit 14 Low Refrigerant Suction Pressure Fault LED Amber Compressor OFF	PT1 < -17.9kpa (-2.6psi) Alarm L1 PT1 < -4.13kpa (-0.6psi) for 5 min Alarm L1	Low refrigerant pressure Possible refrigerant leak Contact authorized service

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 15 Thermal Overload Fault LED Amber Compressor OFF	Absolute difference between PT2 and PT1 < 137.9kpa (20 psi) for 20 seconds Alarm 1 30 min to restart compressor OR “Aux” contact pair on the Contactor is 1 (open), and contactor is programmed to be 0 (closed) Alarm L1	Wait 30 minutes to clear Check input power and load. Check for cause of thermal overload Check the contactor operation. Check the “Aux” contact set on the Contactor
Bit 16 Cool Temp Setpoint Fault LED Amber Compressor ON	During Cool Mode with Temp Control mode only TC3 or TC5 greater than COOL_MODE_ALARM_DEADBAND from COOL_SETPT Alarm L1	Check system for cause of C1 or C2 outside of cool temp setpoint Rerun AutoTune or make Deadband wider See manual
Bit 17 Defrost Temp Setpoint Fault LED Amber Compressor ON	During Defrost with Temp Control modes only TC3 or TC5 greater than +/- 30% outside of DEFR_SETPT Warning L1 TC3 or TC5 greater than EXT_DEFR_ALARM_DEADBAND from DEFR_SETPT Alarm 1 Ckt goes to Standby	Check system for cause of C1 or C2 outside of defrost temp setpoint Setpoint may be out of range Deadband may need to be wider. Contact Service
Bit 18 Not used	N/A	N/A
Bit 19 Not used	N/A	N/A
Bit 20 Buffer Valve Cycle Count Fault LED Amber Compressor ON	Buffer Valve cycle count has exceeded limit CRYO_VALV_OPEN_CNT for Buffer Valve > VALVE_CYCLE_WARN. Alarm L1	Contact authorized service

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 21 Cylinder Unloader Valve Cycle Fault LED Amber Compressor ON	Cylinder Unloader Valve Cycle Count has exceeded limit CRYO_VALV_OPEN_CNT for Cylinder Unloader valve > VALVE_CYCLE_WARN Alarm L1	Contact authorized service
Bit 22 Cool Valve Cycle Fault LED Amber Compressor ON	Cool Valve Cycle Count has exceeded limit CIRC_VALV_OPEN_CNT for Cool valve > VALVE_CYCLE_WARN Alarm L1	Contact authorized service
Bit 23 Defrost Valve Cycle Fault LED Amber Compressor ON	Defrost Valve Cycle Count has exceeded limit CIRC_VALV_OPEN_CNT for Defrost valve > VALVE_CYCLE_WARN Alarm L1	Contact authorized service
Bit 24 Freezeout Valve Cycle Fault LED Amber Compressor ON	Freezeout Valve Cycle Count has exceeded limit CRYO_VALV_OPEN_CNT for Freezeout valve > VALVE_CYCLE_WARN Alarm L1	Contact authorized service
Bit 25 Aux Valve Cycle Fault LED Amber Compressor ON	Auxiliary valve open count has exceeded limit. CIRC_VALV_OPEN_CNT for Aux Valve > VALVE_CYCLE_WARN Alarm L1	Contact authorized service
Bit 26 Return Valve Cycle Fault LED Amber Compressor ON	Return Valve Cycle Count has exceeded limit CIRC_VALV_OPEN_CNT for Return valve > VALVE_CYCLE_WARN Alarm L1	Contact authorized service

Bit Mask Value / Problem	Possible Cause	Corrective Action
Bit 27 Bypass Valve Cycle Fault LED Amber Compressor ON	Bypass valve cycle count has exceeded limit CIRC_VALV_OPEN_CNT for Bypass valve > VALVE_CYCLE_WARN Alarm L1	Contact authorized service
Bit 28 EMO Switch Fault LED Amber Compressor OFF	EMO switch is open Alarm L1	Check EMO switch Twist EMO switch CW to reset
Bit 29 Cooling Fan Fault LED not lit Compressor ON	One or both of the (2) E-Box cooling fans is disconnected or has stopped Warning L2	Check cooling fans Fix or replace fan(s)
Bit 30 Contactor Chatter Fault LED not lit Compressor ON	Compressor Contactor is chattering ON/OFF due to low voltage or power issues Warning L2	Check input power Check Transformer tap setting
Bit 31 Abusive Comp On/OFF Fault LED Amber Compressor ON	Compressor has been turned ON/OFF 3 times within 1 minute Alarm L1	Wait one minute to clear before compressor allowed to start

WEB GUI

A web based Graphical User Interface, WEB GUI, is a planned future option. When implemented, the WEB GUI can allow a remote computer to view the operation and parameters of the Polycold Cryochiller at any time.

The WEB GUI may be used to take control of the unit when the unit is in remote and remote is set to WEB GUI. Control requires signing in at the desired security level using the appropriate security level password. See [Security Levels on page 5-6](#).

Once signed in, the mouse may be used to control the unit using the WEB GUI virtual keypad. The stored parameters may be accessed using tabs that allow access to active server web pages.

Access WEB GUI

A remote computer with a supported web browser such as Internet Explorer 5, 6, or 7 that is connected to the Polycold Cryochiller Ethernet port is required for logging onto the Polycold Cryochiller LAN.

Enter the address of the system in the browser address bar to log on, as shown in the sample below:
"http://10.20.243.241/polycold_system_home.asp" (sample only)

When logged on, you are at the basic log on level and the parameters and data may be viewed. The parameter data appears as gray and cannot be changed at this basic level.

To gain access to control the unit and change the data, you must "sign in". The "sign in" option is available only if the unit has WEB GUI set as the default remote mode and the unit is set to remote either by using the HMI Remote key or using a remote command from the current control interface.

To gain control of the unit using the WEB GUI, follow these steps.

- Press the **Remote** key on the HMI keypad when the Default Remote Mode is set to WEB GUI.
To set the Default Remote Mode to WEB GUI:
 - Select Control Config
 - Select Local/Remote
 - Select Def Remote Mode.
 - Select WEB GUI.
- Click the **"sign-in"** field on the Home page,
- Select the desired security level.
- Enter the password for the security level. Click **"Sign In"** button.
- If sign-in is successful, a success message appears. Click **OK**.

You may also gain control using **CONTROL_MODE** or **CONTROL_MODE_DEF** commands.

To change configuration values, follow these steps:

- Click the **Configuration** tab. Click the **Param Config** tab. Click **Edit**. The parameter fields become editable.
- Enter the new values.
- Click **Save Changes**.
- If the changes are not valid, an **Invalid Parameters** error message occurs and the invalid field turns yellow.
- If the changes are valid, the changes are loaded.

- When the changes are loaded, an acceptance message appears.

WEB GUI Home Page

The Home page allows for control of the Polycold Cryochiller using a mouse to actuate virtual switches that function the same as the HMI keypad.

The Home page also allows access to the other windows of the GUI.

Sign In

Click on the “sign in” and enter the selection allows for access to the GUI functions based on the level of access used when signing in.

If “sign in” is not present, then WEB GUI has not been set as the control mode.



Figure 4-3: WEB GUI Home Page

WEB GUI Sign In Page

The “sign in” selection is available on most WEB GUI pages. It allows for access to the GUI functions based on the security level used during sign in.

- Click on the “sign in” selection on the WEB GUI page.
- Click the drop down arrow and select the security level. See [Security Levels on page 5-6](#).
- Enter the password for the desired security level.
 - Level 1 - Limited Operator Access
 - Level 2 - Default Operator Access
 - Level 3 - Configuration / Maintenance (manager access)
- Click on the “Sign In” button.

Window selections that are appropriate for the security level are now available for editing.

When changes are made on the WEB GUI page, click on the “Save Changes” button.

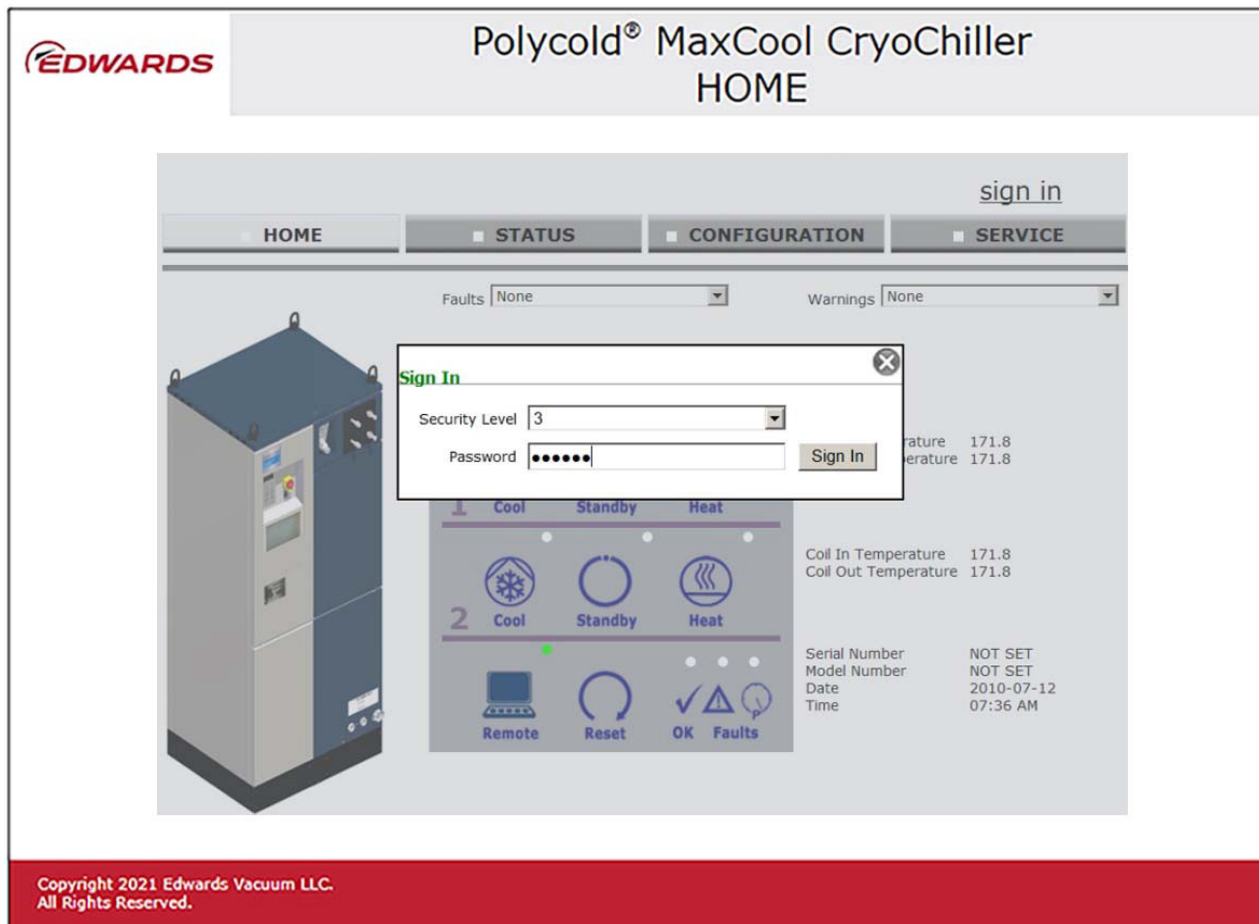


Figure 4-4: WEB GUI Sign In Selection

WEB GUI Status Page

The Status page allows viewing the status of the system components.



Polycold® MaxCool CryoChiller

STATUS

[sign in](#)

HOME

STATUS

CONFIGURATION

SERVICE

CIRCUIT 1 STATUS

MODE COOL STANDARD

Coil In Temperature	-135.1
Coil Out Temperature	-134.4
Feed Temperature	-137.1
Return Temperature	-132.5
Process Temperature	171.8

CRYOCOOLER

Compressor Discharge Temperature	88.7
Liquid Line Temperature	25.7
Coldest Liquid Temperature	-131.7
Stack Warm Control Temperature	-39.4
Bypass Temperature	14.4
Buffer Line Temperature	27.4
Relay 1 Setpoint	0.0
Relay 2 Setpoint	0.0
Compressor ON/OFF	ON
Compressor Suction Pressure	22.0
Compressor Discharge Pressure	187.3

CIRCUIT 2 STATUS

MODE COOL STANDARD

Coil In Temperature	-134.4
Coil Out Temperature	-136.3
Feed Temperature	-136.6
Return Temperature	-131.9
Process Temperature	171.8

GENERAL

Fault Description	None
Warning Description	None
Serial Number	POC 9
Model Number	XC-8800 HC
Date	2012-05-21
Time	10:37 AM

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Figure 4-5: WEB GUI Status Page

WEB GUI Configuration Page

Configuration is the first of three configuration pages. It allows for general system access and communication parameters.

EDWARDS Polycold® MaxCool CryoChiller
CONFIGURATION

[sign in](#)

■ HOME ■ **CONFIGURATION** ■ CONTROL CONFIG ■ PARAM CONFIG

ETHERNET HOST

IP Address: 0.0.0.0
Default Gateway: 0.0.0.0
Netmask: 255.255.0.0

LANGUAGE
English

PRESSURE UNITS
PSI: ☐
BAR: ☐
KPA: ☒

GENERAL
Date: 2000-01-25
Time: 11:25 PM

DEFAULT REMOTE MODE
LEGACY REMOTE: ☐
RS 232: ☐
ETHERNET: ☐
DEVICENET: ☐
PROFIBUS: ☐
WEB GUI: ☒

DeviceNET Communication Speed
125 K: ☒
250 K: ☐
500 K: ☐
MAC ID: 63

Profibus Communication Speed
9.6 K: ☐
19.2 K: ☐
45.45 K: ☐
93.75 K: ☐
187.5 K: ☐
500 K: ☐
1.5 M: ☐
Slave Address:

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Figure 4-6: WEB GUI Configuration Page

WEB GUI Control Configuration Page

Control configuration is the second of three configuration pages. It allows for setting modes and types of operation.

EDWARDS Polycold® MaxCool CryoChiller
CONTROL CONFIGURATION

[sign in](#)

■ **HOME** ■ **CONFIGURATION** ■ **CONTROL CONFIG** ■ **PARAM CONFIG**

CIRCUIT 1 COOL TYPE

STANDARD	☒
RAMP	☐
PID	☐
PID & RAMP	☐

CIRCUIT 1 DEFROST TYPE

STANDARD	☒
DEADBAND	☐
RAMP	☐
DEADBAND & RAMP	☐
NO STANDBY	☐

CIRCUIT 2 COOL TYPE

STANDARD	☒
RAMP	☐
PID	☐
PID & RAMP	☐

CIRCUIT 2 DEFROST TYPE

STANDARD	☒
DEADBAND	☐
RAMP	☐
DEADBAND & RAMP	☐
NO STANDBY	☐

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Figure 4-7: WEB GUI Control Configuration Page

WEB GUI Parameter Configuration Page

Parameter Configuration is the third of three configuration pages.

Param Config page allows for each parameter to be configured.

- Scroll to the parameter
- Enter the value
- Click **SAVE** to save the values.

Polycold® MaxCool CryoChiller

PARAMETER CONFIGURATION

[sign in](#)

HOME

CONFIGURATION

CONTROL CONFIG

PARAM CONFIG

CIRCUIT 1 PARAMETERS

COLDEST LIQUID TEMPERATURE	-200.0
EXTENDED DEFROST DEADBAND	5.0 5.0
COOL SETPOINT	-112.0
AUX COOL OPEN	-40.0
AUX COOL SHUT	-41.0
DEFROST COMPLETE	100.0
BYPASS TEMPERATURE	-40.0
COOL RAMP LIMIT	300.0
DEFROST RAMP LIMIT	2.0

CRYOCOOLER PARAMETERS

FREEZE OUT	-148.0
BUFFER VALVE START	350.0

CIRCUIT 2 PARAMETERS

COLDEST LIQUID TEMPERATURE	-200.0
EXTENDED DEFROST DEADBAND	5.0 5.0
COOL SETPOINT	-112.0
AUX COOL OPEN	-40.0
AUX COOL SHUT	-41.0
DEFROST COMPLETE	20.0
BYPASS TEMPERATURE	-40.0
COOL RAMP LIMIT	300.0
DEFROST RAMP LIMIT	2.0

SERVICE MODE PARAMETERS

STACK WARM SET POINT	-15.0
BUFFER MIN OPEN	-80.0

EDIT

SAVE CHANGES

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Figure 4-8: WEB GUI Parameter Configuration Page

WEB GUI Service Password Page

The Service Page allows access after the system service password is entered.



The screenshot displays the 'SERVICE' page of the Polycold MaxCool CryoChiller web interface. At the top left is the Edwards logo. The main title is 'Polycold® MaxCool CryoChiller SERVICE'. Below the title is a navigation bar with four tabs: 'HOME', 'STATUS', 'CONFIGURATION', and 'SERVICE'. The 'SERVICE' tab is currently selected. On the left side of the page is a 3D image of the cryochiller unit. On the right side, there is a text prompt 'Please enter the System Service Password' above a text input field. To the right of the input field are two buttons: 'Cancel' and 'Submit'. At the bottom of the page, a red banner contains the text 'Copyright 2021 Edwards Vacuum LLC. All Rights Reserved.'

Figure 4-9: WEB GUI Service Page - Password Entry

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5 Software Command Set

This chapter contains the full published command set including commands with a Get or Set level above 3 that are not in the Installation and Operations Manual.

The commands are used by RS-232 or Ethernet from a host or service computer. The commands are not used by Profibus or DeviceNet which each have their own communication protocols.

Command categories are listed below in the chapter Contents. To view a full listing of all commands, go to the Table of Contents in the beginning of this manual.

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Command Format

Commands are either **GET** or **SET** commands based on comma separated parameters following the command name. Use **GET** to check a value or status. Use **SET** to change a value or setting.

Host commands use the following protocol

- Must be sent by RS-232 or Ethernet connection
- Ethernet port for Host commands is port 5000.
- Must begin with the \$ character followed by the specific command with associated parameters.
- Parameters are separated with a comma.
- Command must end with a single character checksum.
- The Checksum is a single character that follows the parameters and is not separated by a comma. Software interprets the last character in a string as the command checksum.
- Checksum is calculated by the 8 bit sum of all characters sent following \$ calculated by the equation in [Checksum Calculation. on page 5-4](#).
- Must be terminated with an ASCII Carriage Return (CR) (Hex 0D).
- Must be sent complete to Polycold Cryochiller under 10 seconds from the \$ to the <CR> for the unit to recognize data sent as a complete command
- Must be sent as uppercase ASCII characters

Get Example:

Get software version "\$**SW_VER**,?P(CR)".

Set Example:

Set cooling termination set point "\$**COOL_SETPT**,1,-199D(CR)".

Response Format

The first character of the response from the Polycold system to the external device provides information about the specific command received along with information about whether the command succeeded.

Command Terms

The following are used to represent the format of command and reply parameters.

[n] = a numeric value (0 thru 9)

[nnnn] or [nnn.n] = a multi-numeric value which may contain a decimal place
(Example: 1234 or 567.8)

[nnnnnnnn] = 32 bit number bitfield. This is a Hex encoded 8 byte value. See [Table 5-2](#).

[c] = a character value such as an alphabetic character

[cccc] = a multi-character value which may contain alphabetic characters and/or numeric values

[A] = the command reply code. First character of the response. Provides information about the specific command received along with information about whether the command succeeded. Refer to Command Reply Codes [Table 5-1](#).

Table 5-1: Command Reply Codes

Letter	Meaning
'A'	Command understood. Reply (if any) follows.
'F'	Invalid command or invalid data argument for the given command such as SET command value is out of range.
'C'	Proper command, which currently cannot be acted upon for some reason which, may be temporary or correctable. Typically incorrect security level.

32 Bit Numbered Bitfield

Bitfields are hexadecimal data that contain parameter data that is interpreted using the decimal value. Follow the steps below to find the decimal values in the hexadecimal bitfield value.

- Convert the hexadecimal value to binary.
- Determine the value of each set bit by counting the binary bits starting from the least significant bit as zero.
- Record the decimal value of all of the bits that are set.
- Look up the decimal values of each set bit in the parameter listing for the command.

Example of Remote Monitor Usage Use with [Table 5-2](#).

1. Send the command "ACTIVE_ALARMS, 1,?"
2. Receive the response ACTIVE_ALARMS \$A 00002000, 0, 0.
00002000 is the Hexadecimal response.
3. Translate the hexadecimal value of 00002000 to binary.
 - The first three hex digits are 0 and the 4th hex digit is 2.
 - The 4th hex digit value of 2 decodes to 0010 in binary.
4. Find the decimal value of each set bit by counting from the LSB with the LSB being 0.
 - The table shows that hex 00002000 is decimal value 13.
5. Look up the decimal value in the parameter list. This example shows that alarm bit 13 is set.

Table 5-2: Hexadecimal Bit Field Decoding

Hex Bit	Hex Digit 4				Hex Digit 3				Hex Digit 2				Hex Digit 1			
Hex Value	2				0				0				0			
Binary Value	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Decimal Value	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Hex Bit	Hex Digit 8				Hex Digit 7				Hex Digit 6				Hex Digit 5			
Hex Value	0				0				0				5			
Binary Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decimal Value	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16

Checksum Calculation.

The checksum algorithm is defined as follows: Perform the 8 bit sum of all the ASCII characters sent in the data field (with the most significant bit cleared to 0, ignore parity). This is performed on the first character following the '\$' up to the last data character before the checksum and Carriage Return (CR)

C Language example for checksum calculation:

```

////////////////////////////////////
// Function:  CtiChkSum
// Purpose:   Calculate the checksum for a given NULL terminated
//            command.
unsigned char CtiChkSum (unsigned char * pCommand)
{
    unsigned char checkSum = 0;
    unsigned char charNum = 0;
    do
    {
        checkSum = checkSum + ( pCommand[charNum] & 0x7f);
        charNum++;
    } while (pCommand[charNum] != 0);
    checkSum = 0x3f & (checkSum ^ (checkSum >> 6));
    checkSum = (0x30 + checkSum) & 0x7f;

    return checkSum;
}
// End Function CtiChkSum

```

Example of Interface Usage:

User has Polycold Cryochiller with connections for both the RS-232 port and Ethernet Port.

The user wants to set a parameter value for AUX_COOL_SETPT using the RS-232 connection.

In the RS-232 terminal, the user must

- Send a command to set **SYSTEM_CONTROL_MODE** to **2** (RS-232 port)
- Send a command to set **AUX_COOL_SETPT** along with the value to be set

If the interface sends a Set command and the interface does not have control, the host will respond with “C” which means that the command is OK but cannot be executed.

Example of a Get Host Command

\$SW_VER,?P command to get current installed software version

\$ then command **SW_VER** then **?** (get parameter) then **P** (command checksum)

\$AQF0.1.0.32I response to command to get current installed software version

\$ then response code **A** (accepted) then response value **QF0.1.0.32** then **I** (response checksum)

Example of a Set Host Command

\$SYSTEM_CONTROL_MODE,14 command to Set System Control Mode

\$ then command **SYSTEM_CONTROL_MODE** then **0** (set to 0 local mode) then **4** (checksum)

\$A0 is the response for Set System Control Mode

\$ then response code **A** (accepted) then **0** (checksum)

Set Command Information

Most Set values for parameter Host commands are stored to non-volatile flash memory when the SET is executed.

However, some configuration Set command values are not stored and must be set again after a power cycle or CPU reset.

Example SECURITY_LEVEL, SYSTEM_CONTROL_MODE

Set commands have min and max values associated with each command. If a set command uses a value outside the min/max range, F is the response.

Set values will take affect immediately and do not require a system restart or power cycle to take effect.

Security Levels

Polycold Cryochiller command functions are security protected and require that the security level be set to a specific level in order to perform the Get or Set command functions.

- Security Level 1 - Limited Operator Access Password: 102030A (where all 0s are zeros)
- Security Level 2 - Default Operator Access Password: 102030B (where all 0s are zeros)
- Security Level 3 - Configuration / Maintenance (manager access) Contact Edwards Polycold. for password

Security levels follow these rules.

- “Get” and “Set” functions for each command require specific security levels and the functions cannot be performed unless the security level is set to the required level or higher.
- Security level for Get and Set functions for each command are hard coded and cannot be changed.
- The default system security level is 2 and cannot be changed.
- Current security level can be temporarily changed by Host command SECURITY_LEVEL.
- Security level set to 1 will stay at 1 until changed by the SECURITY_LEVEL command or the system is power cycled.
- Security level set above level 2 will change back to default level 2 after 5 minutes of inactivity.
- Time to change back to default can be set using the SERVICE_INTERVAL command.
- Security level does not affect HMI access.
- HMI access to Service Mode requires a service password and temporarily sets the system to the highest security level until it goes back to default.

Example of Security Level

User wants to set AUX_COOL_SETPT value. AUX_COOL_SETPT command has a Get security level of 1 and a Set level of 3. System security level is 2 by default.

- User can use a **Get** command for **AUX_COOL_SETPT** since get is level 1.
- User cannot use **Set** command since the set level is 3. User must change the security level to 3 or above to use **Set** command for **AUX_COOL_SETPT**.
- If a command is not accepted for security reasons, the response is “C”.

Command Listing Format

The commands are listed in this chapter using the title block and table format below.

ABC_DEF Description of the Command

Purpose:	Describes the purpose of the command	
Parameter(s):	List of parameters	
Return Value:	Lists information the system returns for this command [A][nn.nn.nn]	
Default Value:	Default command value, if applicable	
Security Level:	Security required to Get the value	Security required to Set the value
Example:	Sample of command with exact syntax	
Interface	Interface options available for this command	

Commonly Used Host Commands

Table 5-3: Commonly Used Host Software Commands

Command	Description
SENSOR_SNAPSHOT	Returns value of all current system thermocouple and state of all system commanded valves Return value: 1e70ff7f,0,23.5,23.5,23.5,171.8,171.8,171.8,121.1,0.0,171.8,171.8,171.8,171.8,171.8,171.8,171.8,0.0,0.0,0.0,0.0,23.9,25.2, 0.0,0.0,0.0,0.0,0.0,180.6,92.0,0.0,0.0,0.0,0.0
SYSTEM_CONTROL_MODE	Get/Set the current "Control" interface of the system (ie. RS-232, Ethernet etc.)
SYSTEM_CONTROL_MODE_DEF	Get/Set the current default "Control" interface of the system (ie. RS-232, Ethernet etc.)
SECURITY_LEVEL	Get / Set the security level for processing Host commands Values are 1 (lowest) thru 6 (highest)
COMP_MOTOR_STATE	Get / Set the current state of the Compressor Motor ON/OFF
ACTIVE_ALARMS	Get current alarms/warning pending on the system. The return value is a Hex encoded bitfield corresponding to the current alarms
RESET_ALARMS	Acknowledge Alarms. Clears alarms if the condition causing the alarm is resolved
OPERATING_MODE	Get/Set the system Cool/Defrost modes and Standby mode

Command	Description
SW_VER	Get the currently running system software/firmware version
UNIT_BALANCE_PRESSURE	Get the system balance pressure (static charge)
COOL_SETPT	Get/Set the system setpoint for the temperature controlled Cool modes
DEFR_SETPT	Get/Set the system setpoint for the temperature controlled Defrost modes

System Configuration Commands

SW_VER Software Version & Build Number

Purpose:	Returns identifier strings for the current software version and build number.	
Published:	Yes	
Return Value:	[A][nn.nn.nn.nn] (major.minor.patch.build)	
Default Value:	N/A	
Security Level:	Get: 1	Set (none)
Example:	"SW_VER,?" Get application software revision	
Interface	RS-232, Ethernet	

VENDOR_ID Get the DeviceNet Vendor ID

Purpose:	Returns identifier string indicating the vendor ID. Only returns a value if DeviceNet config is installed	
Published:	Yes	
Return Value:	[A][cccccccc]	
Default Value:	N/A	
Security Level:	Get: 1	Set: N/A
Example:	"VENDOR_ID,?"	
Interface	RS-232, Ethernet	

PRESSURE_UNITS Set the pressure display units

Purpose:	Get/set the pressure display units on the local HMI (4-line LCD Display)	
Parameter(s):	? or [n] 0 = PSI 1 = kPa 2 = Bar	
Return Value:	[A] or [A] [n]	
Default Value:	0 (PSI)	
Security Level:	Get: 1	Set: 2
Example:	"PRESSURE_UNITS,?" Get the pressure units	
Interface	RS-232, Ethernet	

DATE_TIME Date & Time

Purpose:	Get/set the system date/time.	
Parameter(s):	? or [year],[month],[day],[hour],[min],[sec] all parameters are specified as integers	
Return Value:	[A] or [A] [year],[month],[day],[hour],[min],[sec]	
Default Value:	N/A	
Security Level:	Get: 1	Set: 5
Example:	"DATE_TIME,?" Get the date/time	
Interface	RS-232, Ethernet	

IP_ADDR IP Address

Purpose:	Get/set the IP Address for the system.	
Parameter(s):	? or [nnn.nnn.nnn.nnn] [nnn.nnn.nnn.nnn] is the IP address	
Return Value:	[A] or [A][nnn.nnn.nnn.nnn]	
Default Value:	0.0.0.0	
Security Level:	Get: 1	Set: 3
Example:	"IP_ADDR,192.168.1.100" Set the IP Address for host port	
Interface:	RS-232, Ethernet	

DEFAULT_GATEWAY Default Gateway

Purpose:	Get/set the default network gateway for the system.	
Parameter(s):	? or [nnn.nnn.nnn.nnn] [nnn.nnn.nnn.nnn] is the Gateway address	
Return Value:	[A] or [A][nnn.nnn.nnn.nnn]	
Default Value:	0.0.0.0	
Security Level:	Get: 1	Set: 3
Example:	"DEFAULT_GATEWAY,192.168.1.1" Set the default gateway for host port	
Interface	RS-232, Ethernet	

NETWORK_MASK Network Mask

Purpose:	Get/set the subnet mask for the system.	
Parameter(s):	? or [nnn.nnn.nnn.nnn] [nnn.nnn.nnn.nnn] is the Network Mask address	
Return Value:	[A] or [A][nnn.nnn.nnn.nnn]	
Default Value:	0.0.0.0	
Security Level:	Get: 1	Set: 3
Example:	"NETWORK_MASK,255.255.255.0" Set the subnet mask for host port	
Interface	RS-232, Ethernet	

DEVICENET_PARAMS DeviceNet parameters

Purpose:	Set / Get the DeviceNet speed and mac id	
Parameter(s):	? or [speed],[Mac ID] [speed] is - 0 = 125k - 1 = 250k - 2 = 500k [Mac ID] is 0 - 63	
Return Value:	[A] or [A][speed],[Mac ID]	
Default Value:	A,63	
Min: [speed] = 0 [Mac ID] = 0	Max: [speed] = 2 [Mac ID] = 63	
Security Level	Get: 1	Set: 3
Example:	"DEVICENET_PARAMS,?"	
Interface	RS-232, Ethernet	

PROFIBUS_PARAMS Profibus parameters

Purpose:	Set the profibus speed and Get/Set Profibus	
Parameter(s):	SPEED,? or, ADDRESS,? or, ADDRESS, [address] [speed] is READ ONLY - 0 = 9.6k - 1 = 19.2k - 2 = 45.45k - 3 = 93.75k - 4 = 187.5k - 5 = 500k - 6 = 1.5M - 7 = 3M - 8 = 6M - 9 = 12M [address] is 1 - 125.	
Return Value:	[A] or [A][speed] or [A][address]	
Default Value:	[speed] = 0 [address] = 7	
Min: [speed] = 0 Read Only [address] = 1	Max: [speed] = 9 Read Only [address] = 125	
Security Level	Get: 1	Set: 3
Example:	"PROFIBUS_PARAMS,SPEED,?" Get the Profibus speed	
Interface	RS-232, Ethernet	

UNIT_SERIAL_NUM Unit serial number

Purpose:	Get/Set identifier string indicating the unit serial number, up to 14 characters.	
Parameter(s):	? or [nnnnnnnnnnnnnnnn]	
Return Value:	[A] or [A][nnnnnnnnnnnnnnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: 5
Example:	"UNIT_SERIAL_NUM,?"	
Interface	RS-232, Ethernet	

UNIT_MODEL_NUM Get the Unit Model Number

Purpose:	Get/Set identifier string indicating the unit model number, up to 14 characters.	
Parameter(s):	? or [nnnnnnnnnnnnnnnn]	
Return Value:	[A] or [A][nnnnnnnnnnnnnnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: 5
Example:	"UNIT_MODEL_NUM,?"	
Interface	RS-232, Ethernet	

HMI_TIMEOUT HMI Timeout

Purpose:	Get/Set the timeout of the HMI menu to previous menu	
Parameter(s):	? or [nnnn] [nnnn] is HMI timeout in seconds	
Return Value:	[A] or [A][nnnn]	
Default Value:	300	
Min: 30	Max: 1800	
Security Level:	Get: 1	Set: 3
Example:	"HMI_TIMEOUT,?" get the current HMI timeout setting	
Interface	RS-232, Ethernet	

LEGACY_REMOTE,COMP_SIGNAL_LOGIC Compressor Input Signal Logic

Purpose:	Get/Set the Legacy Remote compressor input signal logic. Default setting is equivalent to jumper “J11” being placed on PFC system control board. The compressor will not be controlled by Legacy Remote compressor on/off input signal.	
Monitor Data:	N/A	
Parameter(s):	? or [n] [n] 0 = Compressor controlled by Legacy Remote compressor input signal Equivalent to “J11” jumper being removed from PFC system control board 1 = Compressor not controlled by Legacy Remote compressor input signal. Equivalent to “J11” jumper being placed on PFC system control board	
Return Value:	[A] or [A][n]	
Data Type:	[n]: Integer	
Default Value:	[n] = 1	
Min: [n] = 0	Max: [n] = 1	
Units:	N/A	
Security Level	Get: 1	Set: 3
Example:	“LEGACY_REMOTE,COMP_SIGNAL_LOGIC,0” Set the Legacy Remote interface to use the state of the compressor on/off input signal to control the compressor.	
Interface	RS-232, Ethernet	

LEGACY_REMOTE,RMT_SIGNAL_LOGIC Legacy Remote Output Signal Logic

Purpose:	Get/Set the Legacy Remote, remote output signal logic. Default setting is to remain compatible with remote signal functionality on PFC. The remote output signal will be Low when the Compressor is off regardless of unit being in Local or Remote control.	
Monitor Data:	N/A	
Parameter(s):	? or [n] [n] 0 = Remote output signal will be: Low when compressor is Off in Local Control High when compressor is Off in Remote Control Original MaxCool remote signal logic 1 = Remote output signal will be: Low when compressor is Off in Local Control Low when compressor is Off in Remote Control Original PFC remote signal logic	
Return Value:	[A] or [A][n]	
Data Type:	[n]: Integer	
Default Value:	[n] = 1	
Min: [n] = 0	Max: [n] = 1	
Units:	N/A	
Security Level	Get: 1	Set: 3
Example:	"LEGACY_REMOTE,RMT_SIGNAL_LOGIC,0" Set the Legacy Remote, remote signal logic to the original MaxCool logic.	
Interface	RS-232, Ethernet	

LEGACY_REMOTE,OP_MODE_LOGIC Legacy Remote Operating Mode Logic

Purpose:	Get/Set the Legacy Remote, operating mode logic when cool and defrost signals are both High. Default setting is to remain compatible with operating mode functionality on PFC. When the Cool and Defrost input signals are both High, the unit will switch to Cool operating mode.	
Monitor Data:	N/A	
Parameter(s):	? or [n] [n] 0 = When both Cool and Defrost input signals are High, system will switch to Standby Mode Original MaxCool mode signal logic 1 = When both Cool and Defrost input signals are High, system will switch to Cool Mode Original PFC mode signal logic	
Return Value:	[A] or [A][n]	
Data Type:	[N]: Integer	
Default Value:	[n] = 1	
Min: [n] = 0	Max: [n] = 1	
Units:	N/A	
Security Level	Get: 1	Set: 3
Example:	“LEGACY_REMOTE,OP_MODE_LOGIC,0” Set the Legacy Remote, operating mode logic to the original MaxCool operating mode logic.	
Interface	RS-232, Ethernet	

System Operational State Commands

SYSTEM_CONTROL_MODE_DEF Default System Control Mode

Purpose:	Get/set the default system control mode on startup. This command does not actually change the mode.	
Parameter(s):	? or [mode] [mode] is 0 = local mode 1 = remote Ethernet 2 = remote RS232 3 = remote RS485 (Not supported) 4 = remote Legacy 5 = remote DeviceNet 6 = remote Profibus 7 = remote Web GUI	
Return Value:	[A] or [A][n]	
Default Value:	Basic Units: 2 Technology Package Units: 1	
Security Level	Get: 1	Set: 2
Example:	"SYSTEM_CONTROL_MODE_DEF,0" Set the system default control mode to local mode.	
Interface	RS-232, Ethernet	

SYSTEM_CONTROL_MODE System Control Mode

Purpose:	Get/set the system control mode.	
Parameter(s):	? or [mode] [mode] is 0 = local mode 1 = remote Ethernet 2 = remote RS232 3 = remote RS485 4 = remote Legacy 5 = remote DeviceNet 6 = remote Profibus 7 = remote Web GUI 8 = Default Control Mode (SYSTEM_CONTROL_MODE_DEF)	
Return Value:	[A] or [A][n]	
Default Value:	Determined by command SYSTEM_CONTROL_MODE_DEF	
Security Level	Get: 1	Set: 2

Example:	"SYSTEM_CONTROL_MODE,0" Set the system to local mode.
Interface	RS-232, Ethernet

FAULT_STATUS Current Fault Status

Purpose:	Get the current fault status.
Parameter(s):	?
Return Value	[A] or [A][nnnnnnnn],[nnnnnnnn] parameter 1: Equipment operation faults : 32 bit number / bitfield hex encoded bit 0: HIGH DISCHRG PRESS bit 1: EXCESS SUCT PRESS bit 2: VOLT OUT OF RANGE bit 3: THERMAL OVERLOAD bit 4: PRESSURE SWITCH bit 5: WATER TEMP or WATER TEMP HIGH bit 6: DISCHARGE TEMP bit 7: PRESS SENSOR FAULT bit 8: Not Used bit 9: LOW SUCT PRESSURE bit 10: Not Used bit 11: C1/C2 COOL TEMP SETPT bit 12: C1/C2 DFR TEMP SETPT bit 13: SYSTEM DATE (Not supported) bit 14: C1/C2 COOL VLV CYCLE bit 15: C1/C2 DFR VALVE CYCLE bit 16-27: Not Used bit 28: EMO SW ACTIVATED bit 29: FAN WARNING bit 30: CONTACTOR CHATTER bit 31: EXCESS COMPRESS ON parameter 2: Sensor value range faults : 32 bit number / bitfield hex encoded bit 0: DSCHRG TEMP SENSOR (TC1) bit 1: LQD LN TEMP SENSOR (TC2) bit 2: C1 INLET SENSOR (TC9) bit 3: C1 OUTLET SENSOR (TC10) bit 4: C2 INLET SENSORTC (TC11) bit 5: C2 OUTLET SENSOR (TC12) bit 6: C1 FEED SENSOR (TC13) bit 7: C1 RETURN SENSOR (TC3) bit 8: CLDST LQD TEMP (TC4) bit 9: C2 FEED SENSOR (TC14) bit 10: C2 RETURN SENSOR (TC5)

Return Value (continued)	bit 11: C2 OUTLET SENSOR (TC12) bit 12: C1 PROC CTRL SENSOR (TC7) bit 13: C2 PROC CTRL SENSOR (TC8) bit 14: BYPASS SENSOR (TC15) bit 15: BUFFER LINE TC FAULT (TC16) bit 16: OPTION1 TC FAULT (TC17) bit 17: OPTION2 TC FAULT (TC18) bit 18: OPTION3 TC FAULT (TC19) bit 19: BP CHK CTRL (TC6) bit 20: CLD JUNCTION SENSOR (TC21) bit 21: Not Used bit 22: Not Used bit 23: OPTION4 TC FAULT (TC20)	
Return Value	bit 24: Not Used bit 25: Not Used bit 26: DSCHRG PRESS SENSOR (PT2) bit 27: SUCT PRESS SENSOR (PT1) bit 28: Not Used bit 29: Not Used bit 30: Not Used bit 31: Not Used	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"FAULT_STATUS,?"	
Interface	RS-232, Ethernet	

ALARM_STATUS Current Alarm Status

Purpose:	Get the current alarm or warning status.
Parameter(s):	[n], [nnnnnnnn],? [n] is 0 = Equipment operation alarms 1 = Sensor range alarms 2 = Performance Monitor alarms [nnnnnnnn] is a 32 bit number / bitfield that represents the state of the alarm. Displays the hex number that represents the state of the 6 bits of one of the bitfields returned by ACTIVE_ALARMS command

Return Value:	[A] or [A],[alarm status bits] or [A], [circuit 1 alarm status bits], [circuit 2 alarm status bits] The alarm name and status. “alarm name” is the name used to refer to the alarm “alarm status bits” is a bit field with the following values: bit 0: 0 = warning, 1 = alarm bit 1-4: alarm or warning level as an integer. bit 5: alarm clear state (0 = not cleared, 1 = cleared) bit 6: alarm acknowledge state (0 = not acknowledged, 1 = acknowledged)	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	“ALARM_STATUS,0,40000,?” returns the alarm status of the cool temperature ramp monitor alarm	
Interface	RS-232, Ethernet	

ACTIVE_ALARMS Current Active Alarms

Purpose:	Get the current active alarms and warnings
Parameter(s):	[n],? [n] is 0 = Warnings 1 = Alarms 2 = Both
Return Value	[A],[nnnnnnnn], [nnnnnnnn], [nnnnnnnn] parameter 1: Equipment operation alarms: 32 bit number / bitfield (different from parameter 1 from FAULT_STATUS) hex encoded • bit 0: C1/C2 USER TC FAILED • bit 1: Not Used • bit 2: LOW REFRIG TEMP • bit 3: Not Used • bit 4: PRESS SENSOR FAULT • bit 5: EXCESSS SUCT PRESS • bit 6: SYSTEM DATE (Not Supported) • bit 7: HIGH DISCHRG PRESS • bit 8: DISCHARGE TEMP • bit 9: Not Used • bit 10: VOLT OUT OF RANGE • bit 11: COOLING WATER • bit 12: WATER TEMP HIGH • bit 13: PRESSURE SWITCH • bit 14: LOW SUCT PRESSURE • bit 15: THERMAL OVERLOAD

Return Value	• bit 16: C1/C2 COOL TEMP SETPT • bit 17: C1/C2 DFR TEMP SETPT • bit 18: C1/C2 COOL TEMP RAMP • bit 19: C1/C2 DFR TEMP RAMP • bit 20: Not Used • bit 21: Not Used • bit 22: C1/C2 COOL VLV CYCLE • bit 23: C1/C2 DFR VALVE CYCLE • bit 24: FREEZEOUT VLV CYCLE • bit 25: C1/C2 AUX VALVE CYCLE • bit 26: C1/C2 RTN VALVE CYCLE • bit 27: C1/C2 BYPAS VLV CYCLE • bit 28: EMO SW ACTIVATED • bit 29: FAN WARNING • bit 30: CONTACTOR CHATTER • bit 31: EXCESS COMPRESS ON parameter 2: Sensor value range alarms : 32 bit number / bitfield (different from parameter 2 from FAULT_STATUS) hex encoded • bit 0: DSCHRG TEMP SENSOR • bit 1: LQD LN TEMP SENSOR • bit 2: CLD JUNCTION SENSOR • bit 3: Not Used • bit 4: Not Used • bit 5: Not Used • bit 6: DSCHRG PRESS SENSOR • bit 7: SUCT PRESS SENSOR • bit 8: Not Used • bit 9: Not Used • bit 10: CLDST LQD TEMP • bit 11: BP CHK CTRL • bit 12: C1 INLET SENSOR • bit 13: C2 INLET SENSOR • bit 14: C1 OUTLET SENSOR • bit 15: C2 OUTLET SENSOR • bit 16: C1 FEED SENSOR • bit 17: C2 FEED SENSOR • bit 18: C1 RETURN SENSOR • bit 19: C2 RETURN SENSOR • bit 20: C1 PROC CTRL SENSOR • bit 21: C2 PROC CTRL SENSOR • bit 22: BYPASS SENSOR • bit 23: BUFFER LINE TC FAULT • bit 24: Not Used • bit 25: Not Used • bit 26: OPTION1 TC FAULT • bit 27: OPTION2 TC FAULT • bit 28: OPTION3 TC FAULT • bit 29: OPTION4 TC FAULT • bit 30: Not Used • bit 31: Not Used •
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Return Value	parameter 3: Performance Monitor alarms: 32 bit number / bitfield • bit 0: Balance Pressure • bit 1: Cool Performance • bit 2: Trend Cool • bit 3: Cool Deviation • bit 4: Not Used • bit 5: Trend Cool Deviation • bit 6: Not Used • bit 7: Defrost Performance • bit 8: Trend Defrost • bit 9: Not Used • bit 10: Not Used • bit 11: Not Used • bit 12: Not Used • bit 13: Cooling Under • bit 14: Defrost End • bit 15: Cool Down Time • bit 16: Cool Down Asymptote • bit 17: Defrost time • bit 18: Cool Steady	
Security Level	Get: 1	Set: N/A
Example:	"ACTIVE_ALARMS,1,?" Get current active alarms	
Interface	RS-232, Ethernet	

SERVICE_INTERVAL Security Level Expiration Interval

Purpose:	Get/Set the interval after which the security level will be reset to the default level of 2	
Monitor Data:	Time	
Parameter(s):	? or [nnn] [nnn] is interval in seconds	
Return Value:	[A] or [A][nnn]	
Data Type:	Integer	
Default Value:	300	
Min: 60	Max: 7200	
Units:	Seconds	
Security Level:	Get: 4	Set: 5
Example:	"SERVICE_INTERVAL,60" Set the security level expiration interval to 60 seconds.	
Interface	RS-232, Ethernet	

CAPACITY_TARGET_TEMP Cooling Capacity Target Temperature

Purpose:	Get/Set the cooling capacity target temperature used to define normal capacity for non-temperature controlled cooling modes to engage power management mode	
Monitor Data:	Refrigerant return temperature	
Parameter(s):	? or [nnnn] [nnnn] is target temperature	
Return Value:	[A] or [A][nnnn]	
Data Type:	Integer	
Default Value:	-120	
Min: -190	Max: -70	
Units:	Degrees Celsius (signed)	
Security Level:	Get: 1	Set: 3
Example:	"CAPACITY_TARGET_TEMP,?" Get the normal cooling capacity target temperature.	
Interface	RS-232, Ethernet	

EXCESS_CAP_TEMP_DELTA Excess Capacity Temperature difference

Purpose:	Get/Set the cooling capacity temperature delta that determines when to engage power management due to excess cooling capacity. Delta is from CAPACITY_TARGET_TEMP value	
Monitor Data:	Refrigerant return temperature	
Parameter(s):	? or [nnnn] [nnnn] is temperature delta	
Return Value:	[A] or [A][nnnn]	
Data Type:	Integer	
Default Value:	10	
Min: 2	Max: 30	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"EXCESS_CAP_TEMP_DELTA,?" Get the excess capacity temperature delta.	
Interface	RS-232, Ethernet	

POWER_MGMT_STANDBY_DELAY Excess Capacity Temperature difference

Purpose:	Get/Set Power Management Standby Mode delay time	
Monitor Data:	Time	
Parameter(s):	? or [nnnn] [nnnn] is delay in seconds	
Return Value:	[A] or [A][nnnn]	
Data Type:	Integer	
Default Value:	1200	
Min: 1	Max: 36000	
Units:	Seconds	
Security Level	Get: 1	Set: 3
Example:	"POWER_MGMT_STANDBY_DELAY,?" Get the power management delay	
Interface	RS-232, Ethernet	

FRZ_PREVENT_SETPT Freezeout Prevention Set Point

Purpose:	Get/Set the freezeout prevention set point for the freezeout prevention valve.	
Monitor Data:	Coldest liquid temperature	
Parameter(s):	? or [nnn.n] [nnn.n] is freezeout prevention setpoint	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Double	
Default Value:	-148	
Min: -165	Max: -120	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 5
Example:	"FRZ_PREVENT_SETPT,?" Get the freezeout prevention set point.	
Interface	RS-232, Ethernet	

FRZ_PREVENT_SETPT_OFFSET Freezeout Prevention Set Point Offset

Purpose:	Get/Set the freezeout prevention set point offset for the freezeout prevention valve to be used during specified operating modes. When applied, the control point is increased (warmed) by the number of degrees specified by this offset from the FRZ_PREVENT_SETPT	
Monitor Data:	Coldest liquid temperature	
Parameter(s):	? or [n],[nnn.n] [n] = modes that the offset will be applied to FRZ_PREVENT_SETPT 0 = offset disabled 1 = either circuit in any defrost mode 2 = both circuits in Standby mode 3 = either circuit in any defrost mode OR both circuits in Standby mode [nnn.n] is freezeout prevention setpoint offset	
Return Value:	[A] or [A][n],[nnn.n]	
Data Type:	[n]: Integer, [nnn.n]: Double	
Default Value:	[n] = 1 [nnn.n] = 5	
Min: [n] = 0 [nnn.n] = 0	Max: [n] = 3 [nnn.n] = 25	
Units:	Degrees Celsius	
Security Level:	Get: 1	Set: 5
Example:	"FRZ_PREVENT_SETPT_OFFSET,?" Get the freezeout prevention set point offset.	
Interface	RS-232, Ethernet	

FRZ_PREVENT_STPR_MTR_ENABLE Freezeout Prevention Stepper Motor Enable

Purpose:	Enable/Disable the freezeout prevention function of the stepper motor, cool valve, return valve when in Standby or Cool modes on dual circuit units	
Monitor Data:	Coldest liquid temperature	
Parameter(s):	? or [n] [n] = modes for stepper motor and cool/return valve for freezeout prevention 0 = FOP Stepper Motor/Cool/Return valve function is disabled for all circuit modes 1 = FOP Stepper Motor/Return valve function is enabled for a circuit in Standby and the other circuit is in Cool, OR when both circuits are in Cool (circuits in cool will follow minimized stepper motor rules) 2 = Stepper Motor/Cool valve function enabled only when both circuits are in Standby OR when both circuits are in cool (circuits in cool will follow minimized stepper motor rules)	
Published:	Yes	
Return Value:	[A] or [A][n]	
Data Type:	[n]: Integer	
Default Value:	[n] = 0	
Min: [n] = 0	Max: [n] = 2	
Units:	N/A	
Security Level:	Get: 1	Set: 5
Example:	“FRZ_PREVENT_STPR_MTR_ENABLE,?” Get the freezeout prevention stepper motor enable state.	
Interface	RS-232, Ethernet	

FOP_VALVE_DUTY_CYCLE Freezeout Prevention Valve Duty Cycle

Purpose:	Get/Set the minimum close time and maximum open duration time for the FOP valve.	
Monitor Data:	Time	
Parameter(s):	[n],? or [n],[nnn] [n] is FOV Open/Close 0 = Min Closed Time 1 = Max Open Time [nnn] is the duration in seconds	
Published:	Yes	
Return Value:	[A] or [A][n],[nnn]	
Data Type:	[n]: Integer, [nnn]: Integer	
Default Value:	[nnnn] = 30	
Min: [n] = 0 [nnn] = 1	Max: [n] = 1 [nnn] = 180	
Units:	Degrees Celsius	
Security Level:	Get: 1	Set: 5
Example:	“FOP_VALVE_DUTY_CYCLE,0,?” Get the freezeout valve duty cycle duration for Open	
Interface	RS-232, Ethernet	

VALVE_CYCLE_WARN Valve Cycle Warning Count

Purpose:	Get/set the valve cycle count at which a warning will be issued concerning valve lifetime.
Monitor Data:	valve cycle count
Parameter(s)	n],? or [n],[nnnn] [n] is valve ID: 0 = Cool 1 = Temp Control 2 = Defrost 3 = Auxiliary

Parameter(s):	4 = Return 5 = Bypass 6 = Buffer 7 = Rapid BP Check 8 = Cylinder Unloader 9 = Freezeout Prevention [nnnn] is warning count	
Return Value:	[A] or [A][nnnn]	
Data Type:	Integer	
Default Value:	500000 Freezeout 10000000	
Min: 250000 Freezeout 5000000	Max: 10000000 Freezeout: 30000000	
Units:	Count	
Security Level	Get: 1	Set: 6
Example:	"VALVE_CYCLE_WARN,0,?" Get the cooling valve cycle warning count.	
Interface	RS-232, Ethernet	

BUFFVALVE_STARTUP_SETPT Buffer Valve Startup Pressure Set Point

Purpose:	Get/Set the buffer valve startup pressure close set point.	
Monitor Data:	Compressor discharge pressure	
Parameter(s):	? or [nnn] [nnn] is startup setpoint	
Return Value:	[A] or [A][nnn]	
Data Type:	Double	
Default Value:	350	
Min: 300	Max: 425	
Units:	PSI	
Security Level	Get: 1	Set: 3
Example:	"BUFFVALVE_STARTUP_SETPT,400" Set the buffer valve startup close set point to 400 psi.	
Interface	RS-232, Ethernet	

BUFFVALVE_MIN_OPEN_TEMP Buffer Valve Minimum Open Temp.

Purpose:	Get/Set the minimum temperature at which the buffer valve may open when the unit is starting.	
Monitor Data:	Coldest liquid temperature	
Parameter(s):	? or [nnn.n] [nnn.n] is open temperature	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Double	
Default Value:	-80	
Min: -180	Max: 5	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 4
Example:	"BUFFVALVE_MIN_OPEN_TEMP,?" Get the minimum buffer valve open temperature.	
Interface	RS-232, Ethernet	

BUFFVALVE_PRESSURE_LIMIT Buffer Valve Pressure Limits

Purpose:	Get/set the high pressure limits for opening and closing the buffer valve.	
Monitor Data:	Compressor discharge pressure	
Parameter(s):	? or [nnn1],[nnn2] [nnn1] is open pressure [nnn2] is close pressure Constraint ([nnn1] – [nnn2]) >=2.5 psi [nnn1 > [nnn2]	
Return Value:	[A] or [A][nnn]	
Data Type:	Double	
Default Value:	param1 = 410 Param2 = 400	
Min: param 1 = 300 Min: param 2 = 290	Max: param 1 = 425 Max: param 2 = 420	
Units:	PSI	
Security Level	Get: 1	Set: 3
Example:	"BUFFVALVE_PRESSURE_LIMIT,378,370" Set the buffer valve pressure limits to 378 and 370 psi.	
Interface	RS-232, Ethernet	

BUFFVALVE_ENABLE Buffer Valve Enable

Purpose:	Get/set whether the buffer valve is enabled.		
Monitor Data:			
Parameter(s):	? or [n] [n] is 1 = enabled 0 = disabled		
Return Value:	[A] or [A][n]		
Data Type:	Integer		
Default Value:	1		
Min: 0		Max: 1	
Units:	N/A		
Security Level	Get: 1		Set: 3
Example:	“BUFFVALVE_ENABLE,?” Get the enable state of the buffer valve		
Interface	RS-232, Ethernet		

E_MGMT_ENABLE Energy Management Enable

Purpose:	Get/set the enable state of energy management. (also referred to as power management)		
Monitor Data:			
Parameter(s):	? or [n] [n] is 1 = enabled 0 = disabled		
Return Value:	[A] or [A][n]		
Data Type:	Integer		
Default Value:	1		
Min: 0		Max: 1	
Units:	N/A		
Security Level:	Get: 1		Set: 3
Example:	“E_MGMT_ENABLE,?” Get the enable state of energy management		
Interface	RS-232, Ethernet		

System Sensor Readings

SENSOR_SNAPSHOT Sensor Data Snapshot

Purpose:	Get a snapshot of the current sensor data.
Parameter(s):	?
Return Value	[A][nnnnnnnn1],[nnnnnnnn2],[nnn.n].... Param 1 is bit field for if sensors values are valid (valid = 1) hex encoded • bit 0 – 20: T1 – T21 • bit 21: Voltage transformer • bit 22: Not Used (0) • bit 23: Not Used (0) • bit 24: Not Used (0) • bit 25: Not Used (0) • bit 26: Not Used (0) • bit 27: Discharge Pressure Transducer • bit 28: Suction Pressure Transducer • bit 29: Not Used (0) • bit 30: Not Used (0) • bit 31: Not Used (0) Param 2 is bit field for if sensors are faulted • same bit mapping as above (faulted = 1) hex encoded Param 3-23 TC1-TC21 temperature values Param 24 Voltage transformer value Param 25 Not Used (0) Param 26 Not Used (0) Param 27 Not Used (0) Param 28 Not Used (0) Param 29 Not Used (0) Param 30 Discharge Pressure Transducer value Param 31 Suction Pressure Transducer value Param 32 Not Used (0) Param 33 Not Used (0) Param 34 Not Used (0) Param 35 Not Used (0) Param 36 is bit field for Valve states, hex encoded (1=valve open) • bit 0: Fault Relay • bit 1: Buffer Valve • bit 2: Rapid Bp Chk Valve • bit 3: Not used (0) • bit 4: Cylinder Unloader Valve • bit 5: Ckt1 Cool Valve • bit 6: Ckt1 Defrost Valve • bit 7: Ckt1 Temperature Control Valve • bit 8: Ckt1 Auxiliary Cool Valve

Return Value	• bit 9: Ckt1 Return Valve • bit 10: Ckt1 Bypass Valve • bit 11: Ckt2 Cool Valve • bit 12: Ckt2 Defrost Valve • bit 13: Ckt2 Temperature Control Valve • bit 14: Ckt2 Auxiliary Cool Valve • bit 15: Ckt2 Return Valve • bit 16: Ckt2 Bypass Valve • bit 17: Freezeout Prevention Valve	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"SENSOR_SNAPSHOT,?" Get the sensor snapshot	
Interface	RS-232, Ethernet	

SYSTEM_VALVE_STATE Valve Open/Closed State for system valves

Purpose:	Get the open/closed state of a system valve. A value of 1 indicates the valve is open. A value of 0 indicates the valve is closed.	
Parameter(s):	[n],? [n] is Valve identifier: 0 = Buffer 1 = Rapid Bp Chk 2 = Not Used 3 = Cylinder Unloader 4 = Freeze Out Prevention	
Return Value:	[A] [n]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"SYSTEM_VALVE_STATE,0,?"	
Interface	RS-232, Ethernet	

CLDST_LQD_TEMP Unit Coldest Liquid Temperature

Purpose:	Get the unit coldest liquid temperature sensor value. (TC4)
Parameter(s):	?
Return Value:	[A][nnnn]
Default Value:	N/A

Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: N/A
Example:	"CLDST_LQD_TEMP,?"	
Interface	RS-232, Ethernet	

COLD_JUNCT_TEMP Cold Junction Temperature

Purpose:	Get the cold junction temperature. (TC21)	
Parameter(s):	?	
Return Value:	[A][nnn.n]	
Default Value:	N/A	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: N/A
Example:	"COLD_JUNCT_TEMP,?"	
Interface	RS-232, Ethernet	

BUFFER_LINE_TEMP Buffer Line Temperature

Purpose:	Get the buffer line temperature. (TC16)	
Parameter(s):	?	
Return Value:	[A][nnn.n]	
Default Value:	N/A	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: N/A
Example:	"BUFFER_LINE_TEMP,?"	
Interface	RS-232, Ethernet	

BUFFER_PULSE_DELAY Buffer Pulse Delay Value

Purpose:	Get/set the enable and delay of the buffer valve to pulse open/closed after the buffer valve has been closed by normal system operation. Buffer valve pulse open time is a fixed 1.5 seconds (open/close).	
Monitor Data:	Time	
Parameter(s):	? or [n],[d] [n] is 0 = Disable buffer valve pulse open/close 1 = Enable buffer valve pulse open/close [d] is Delay time after the buffer valve has been closed during normal system operation that the buffer valve will pulse open/closed	
Return Value:	[A] or [A][n],[d]	
Data Type:	Integer	
Default Value:	[n] = 0 [d] = 1200	
Min: [n] = 0 [d] = 1	Max: [n] = 1 [d] = 3600	
Units:	[d] seconds	
Security Level	Get: 2	Set: 5
Example:	"BUFFER_PULSE_DELAY,1,600" Set the buffer valve pulse to enabled, after the buffer valve is closed by normal system operation the buffer valve will pulse open then close after 600 seconds. (Buffer valve pulse time open/close is a fixed 1.5 seconds)	
Interface	RS-232, Ethernet	

BUFFER_RECOVERY Buffer Recovery Value

Purpose:	Get/set the enable, delay and temperature of the buffer valve to periodically pulse open. Buffer valve pulse open time is a fixed 1.5 seconds (open/close).	
Monitor Data:	Time and Temperature (Buffer Line TC16)	
Parameter(s):	? or [n],[d],[ttt.t] [n] is 0 = Disable buffer valve pulse open/close logic 1 = Enable buffer valve pulse open/close logic [d] is Delay time between opening the buffer valve periodically when temperature [ttt.t] is met [ttt.t] is Temperature that the buffer thermocouple (TC16) must remain below during the time delay [d] for the buffer valve open/close pulse	
Return Value:	[A] or [A][n],[d],[ttt.t]	
Data Type:	Integer, Double	
Default Value:	[n] = 0 [d] = 1200 [ttt.t] = 5.0	
Min: [n] = 0 [d] = 5 [ttt.t] = -160.0	Max: [n] = 1 [d] = 7200 [ttt.t] = 80.0	
Units:	[d] seconds, [ttt.t] degrees C	
Security Level	Get: 2	Set: 5
Example:	"BUFFER_RECOVERY,1,600,-135" Set the buffer valve recovery periodic pulsing to enabled, the buffer valve will open then close every 600 seconds if the temperature of buffer thermocouple TC16 is less than -135C. (Buffer valve pulse time open/close is a fixed 1.5 seconds)	
Interface	RS-232, Ethernet	

WARM_CTL_TEMP Rapid BP Check - Stack Warmer Control Temperature

Rapid Balance Pressure Check is previously referred to as Stack Warm.

Purpose:	Get the rapid BP check control temperature sensor value. (TC6)	
Parameter(s):	?	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: N/A
Example:	"WARM_CTL_TEMP,?"	
Interface	RS-232, Ethernet	

STK_WARM_SETPT Rapid BP Check - Stack Warming Setpoint

Rapid Balance Pressure Check is previously referred to as Stack Warm.

Purpose:	Set / Get the end point temperature for the rapid BP check service mode.	
Monitor Data:	Rapid BP Check Control Temperature	
Parameter(s):	? or [nnnn] [nnnn] is Rapid BP Check setpoint	
Return Value:	[A][nnnn] or [A]	
Default Value:	-15	
Min: -40	Max: 20	
Units:	Degrees Celsius (signed)	
Security Level:	Get: 1	Set: 5
Example:	"STK_WARM_SETPT,20" Set the rapid BP check set point to 20 C.	
Interface	RS-232, Ethernet	

System Actions Commands

RESET_ALARMS Reset alarms

Purpose:	Acknowledge all outstanding alarms.	
Parameter(s):	N/A	
Return Value:	[A]	
Default Value:	N/A	
Security Level	Get: N/A	Set: 2
Example:	"RESET_ALARMS"	
Interface	RS-232, Ethernet	

SECURITY_LEVEL Security Level

Purpose:	Get/set the system security level.	
Parameter(s):	? or [n],[cccccc],[userID] [n] is security level 1-6 [cccccc] is password [userID] is userID string	
Return Value:	[A] or [A][n]	
Default Value:	2	
Security Level	Get: 1	Set 6
Example:	"SECURITY_LEVEL,?" Get the current security level.	
Interface	RS-232, Ethernet	

CPU_RESET CPU Reset

Purpose:	Reset the CPU.	
Parameter(s):	N/A	
Return Value:	(CPU is reset without response)	
Default Value:	N/A	
Security Level	Get: N/A	Set: 4
Example:	"CPU_RESET"	
Interface	RS-232, Ethernet	

DSP_RESET DSP Reset

Purpose:	Reset the DSP.	
Parameter(s):	N/A	
Return Value:	[A]	
Default Value:	N/A	
Security Level	Get: N/A	Set: 4
Example:	"DSP_RESET"	
Interface	RS-232, Ethernet	

NV_RESET NV Reset

Purpose:	Reset non-volatile storage parameters to their default values.	
Parameter(s):	N/A.	
Return Value:	[A]	
Default Value:	N/A	
Security Level	Get: N/A	Set: 5
Example:	"NV_RESET"	
Interface	RS-232, Ethernet	

DELETE_BASELINE Delete a Baseline

Purpose:	Delete predictive diagnostic baseline data	
Parameter(s):	[baseline] [baseline] is: ALL USER_INITIATED_BASELINES COOL_BASELINES DEFROST_BASELINES STEADY_COOL_BASELINES STANDBY_BASELINES AFTER_DEFROST_BASELINES BALANCE_PRESSURE_BASELINES	
Return Value:	[A]	
Default Value:	N/A	

Security Level:	Get: N/A	Set: 6
Example:	"DELETE_BASELINE,COOL_BASELINES" deletes the cool mode baselines	
Interface	RS-232, Ethernet	

Service Commands

SERVICE_MODE Enter the specified service mode

Purpose:	Get/Set the service mode	
Monitor Data:		
Parameter(s):	? or [n],[cccccccc] [n] is the mode 0 = normal operation 1 = autotune calibration (requires 1 or 2 for service code text for ckt1 or ckt2 autotune) 2 = refrigerant recharge 3 = Rapid Balance Pressure Check (previously Stack Warm) 4 = ZeroLoss Procedure 5 = collect baseline information [cccccccc] is a service code text string or for autotune must be "1" or "2" for ckt to autotune	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Integer	
Default Value:	0	
Min: 0		Max: 4
Units:	N/A	
Security Level	Get: 1	Set: 3
Example:	"SERVICE_MODE,?" Get the current service mode	
Interface	RS-232, Ethernet	

SERVICE_MODE_SELF_DIAGNOSTICS Enter self diagnostics check service mode

Purpose:	Get/Set the self diagnostics check service mode	
Parameter(s):	? or [n] [n] is the test to run 0 = Normal Operating Mode 1 = Buffer Valve Test 2 = Contactor Test	
Return Value:	[A] or [A][n]	
Data Type:	Integer	
Default Value:	0	
Security Level:	Get: 1	Set: 3
Example:	"SERVICE_MODE_SELF_DIAGNOSTICS,1" Set the self diagnostics service mode to Buffer Valve Test	
Interface	RS-232, Ethernet	

ALARM_DESCR Alarm description

Purpose:	Get a description for the specified alarm.	
Parameter(s):	[n],[alarm bit field],? [n] is 0 = Equipment Operation alarms 1 = Sensor value range alarms 2 = Performance Monitor alarms [alarm bit field] is bitfield returned by ACTIVE_ALARMS	
Return Value:	[A][cccccc]	
Default Value:	N/A	
Security Level	Get: 5	Set: N/A
Example:	"ALARM_DESCR,0,40000,?" Get a description and service recommendations for Cool Ramp Monitor alarm	
Interface	RS-232, Ethernet	

SERVICE_HISTORY Service Access History

Purpose:	Get the service access history	
Parameter(s):	[n],? [n] is the number of days to display from current day	
Return Value:	[A][ccccccc]	
Default Value:	N/A	
Security Level:	Get: 4	Set: N/A
Example:	"SERVICE_HISTORY,5,?" Get 5 days worth of the Service Access log	
Interface	RS-232, Ethernet	

RECHARGE_HISTORY Recharge Event History

Purpose:	Get the recharge event history.	
Parameter(s):	[n],? [n] is the number of days to display from current day	
Return Value:	[A][ccccccc]	
Default Value:	N/A	
Security Level:	Get: 4	Set: N/A
Example:	"RECHARGE _HISTORY,7,?" Get 5 days worth of the Recharge Event history	
Interface	RS-232, Ethernet	

Compressor Configuration Commands

COMP_SERIAL_NUM Compressor Serial Number

Purpose:	Get / Set identifier string representing the serial number of the specified Compressor Module.	
Parameter(s):	[n], ? or [cccccccc] [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor [cccccccc] is serial number string (32 character max)	
Return Value:	[A] or [A][cccccccc]	
Default Value:	N/A	
Security Level	Get: 1	Set: 6
Example:	"COMP_SERIAL_NUM,0,?"	
Interface	RS-232, Ethernet	

COMP_MOTOR_HOURS Refrigerant Motor Operating Hours

Purpose:	Get / Set the total number of hours that the specified compressor motor has run in its lifetime.	
Parameter(s):	[n], ? or [nnnn] [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor [nnnn] is motor hours	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Range	Min: 0	Max: 2000000
Security Level	Get: 1	Set: 5
Example:	"COMP_MOTOR_HOURS,0,?"	
Interface	RS-232, Ethernet	

Compressor Operational State Commands

COMP_MOTOR_STATE Refrigerant Compressor On/Off State

Purpose:	Get/Set the refrigerant compressor motor on/off state.	
Parameter(s):	[n],? or [n1] [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor [n1] is motor state 0 = motor off (contactor open) 1 = motor on (contactor closed)	
Return Value:	[A] or [A][n1]	
Default Value:	N/A	
Security Level	Get: 1	
Example:	"COMP_MOTOR_STATE,0,?" Get the motor state.	
Interface	RS-232, Ethernet	

PT_CALIBRATE Refrigerant Compressor Pressure Sensor Calibration Value

Purpose:	Get/Set the compressor pressure transducer calibration value.	
Monitor Data:	N/A	
Parameter(s):	[n],? or [n],[nominator],[denominator],[offset] [n] is * = PT1 and PT2 Pressure sensor 1 = PT1 Suction Pressure sensor 2 = PT2 Discharge Pressure sensor	
Return Value:	[A] or [A][nominator/denominator+(offset)] or [A][nominator/denominator+(offset)],[nominator/denominator+(offset)]	
Data Type:	Integer	
Default Value:	2146/20000+(-790) default value read from DSP until modified	
Min: N/A		Max: N/A
Units:	N/A	
Security Level	Get: 1	Set: 3
Example:	"PT_CALIBRATE,1,300,400,-500" Set refrigerant compressor return pressure PT1 calibration value to 300/400+(-500)	
Interface	RS-232, Ethernet	

COMP_PRESS_SW_DET Compressor Suction Pressure Switch Detection

Purpose:	Get/set whether compressor suction pressure switch detection is enabled or disabled. The enable state specifies whether a fault is reported when the pressure switch opens.	
Parameter(s):	[n], ? or [n],[state] [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor [state] is 0 = disabled 1 = enabled	
Return Value:	[A] or [A][state]	
Default Value:	1 [state]	
Security Level:	Get: 1	Set: 2
Example:	"COMP_PRESS_SW_DET,0,?" Get enabled state of Refrigerant suction pressure switch detection.	
Interface	RS-232, Ethernet	

Compressor Sensor Readings

COMP_LINE_VOLT Compressor Line Voltage

Purpose:	Read the compressor line voltage.	
Parameter(s):	[n], ? [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Units:	volts	
Security Level:	Get: 1	Set: N/A
Example:	"COMP_LINE_VOLT,0,?"	
Interface	RS-232, Ethernet	

COMP_DP Compressor Differential Pressure

Purpose:	Read the compressor differential pressure. (Supply pressure minus Return Pressure)	
Parameter(s):	[n], ? [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Units:	PSI	
Security Level	Get: 1	Set: N/A
Example:	"COMP_DP,0,?"	
Interface	RS-232, Ethernet	

UNIT_BALANCE_PRESS Compressor Static Charge Pressure

Purpose:	Get the unit balance (static charge) pressure.	
Parameter(s):	[n], ? [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor	
Return Value:	[A] [nnnn]	
Default Value:	N/A	
Units:	PSI	
Security Level	Get: 1	Set: N/A
Example:	"UNIT_BALANCE_PRESS,0,?"	
Interface	RS-232, Ethernet	

COMP_DISCHRG_TEMP Compressor Discharge Temp

Purpose:	Read the compressor discharge temperature sensor value. (TC1)	
Parameter(s):	[n], ? [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor	
Return Value:	[A][nnnn]	
Default Value:	N/A	

Security Level	Get: 1	Set: N/A
Example:	"COMP_DISCHRG_TEMP,0,?"	
Interface	RS-232, Ethernet	

COMP_LINE_TEMP Compressor Liquid Line Temperature

Purpose:	Read the compressor liquid line temperature sensor value. (TC2)	
Parameter(s):	[n],? [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"COMP_LINE_TEMP,0,?"	
Interface	RS-232, Ethernet	

COMP_SUCT_PRESS Compressor Suction Pressure

Purpose:	Read the compressor suction pressure sensor value.	
Parameter(s):	[n],? [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	
Example:	"COMP_SUCT_PRESS,0,?"	
Interface	RS-232, Ethernet	

COMP_DSCHRG_PRESS Compressor Discharge Pressure

Purpose:	Read the compressor discharge pressure sensor value.	
Parameter(s):	[n],? [n] is 0 = Refrigerant compressor 1 = Nitrogen compressor	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"COMP_DSCHRG_PRESS,0,?"	
Interface	RS-232, Ethernet	

Circuit Configuration Commands

CLDST_LQD_SETPT Coldest Liquid Temperature Set Point

Purpose:	Get/set the temperature set point at which to transition from standby to cool mode.	
Monitor Data:	Coldest liquid temperature	
Parameter(s):	[n],? or [n],[nnnn] [n] is circuit number or * for all circuits [nnnn] is the set point	
Return Value:	[A] or [A][nnnn]	
Data Type:	Double	
Default Value:	-200	
Min: -200	Max: -80	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"CLDST_LQD_SETPT,1,?" Get the coldest liquid temp. set point for circuit 1	
Interface	RS-232, Ethernet	

SETPOINT_RELAY External Vacuum Device Vacuum Level Set Point

Purpose:	Get/set the External Relay 1 or Relay 2, Relay open parameters
Monitor Data:	Setpoint Type
Parameter(s)	SETPOINT_RELAY,[1.2],? SETPOINT_RELAY,[1.2],[Setpoint Type],[Relay Logic],[Setpoint],[Deadband] Parameters: - Relay [1.2] = Setpoint Relay 1 or Relay 2 - Setpoint Type: Sensor to monitor - None = 0, - Circuit1_FeedTemp = 1, - Circuit1_ReturnTemp = 2, - Circuit1_CoilInTemp = 3, - Circuit1_CoilOutTemp = 4, - Circuit1_ProcessCtrlTemp = 5, - Circuit1_Avg_FeedReturn = 6, - Circuit1_Avg_CoilInOut = 7, - Circuit2_FeedTemp = 8, - Circuit2_ReturnTemp = 9, - Circuit2_CoilInTemp = 10, - Circuit2_CoilOutTemp = 11, - Circuit2_ProcessCtrlTemp = 12, - Circuit2_Avg_FeedReturn = 13, - Circuit2_Avg_CoilInOut = 14, - Compressor_DischargeTemp = 15, - Customer_Option1 = 16, - Customer_Option2 = 17, - Customer_Option3 = 18, - Customer_Option4 = 19, - Discharge_Pressure = 20, - Suction_Pressure = 21 - Coldest_LiquidTemp = 22, - RefrigerantLiquid_LineTemp = 23, - BypassTemp = 24, - Stack_WarmerTemp = 25, - Buffer_LineTemp = 26, - Relay Logic: Relay will open above or open below Setpoint value - Open_Above = 0, - Open_Below = 1 - Setpoint: Setpoint of selected sensor to initiate relay logic - Deadband: deadband value from setpoint to close relay
Return Value:	[A] or [A][nn],[nnnn]
Data Type:	Integer
Default Value:	0,0,0,0

Min: Setpoint Type: 0 Relay Logic: 0 Setpoint: -200 Deadband: 0	Max: Setpoint Type: 21 Relay Logic Setpoint: 600 Deadband: 600
Units:	
Security Level:	Get: 1 Set: 3
Example:	"SETPOINT_RELAY,1,?" Get the external vacuum device set point for Relay 1 "SETPOINT_RELAY,2,3,1,-30,5" Set the external relay set point for Relay 2, to monitor sensor Circuit1_CoilInTemp, and open relay below -30c with a closure of the relay at -25c (5 degree deadband)
Interface	RS-232, Ethernet

EXT_VAC_CONTACT External Vacuum Device Contact Closure Monitor

Purpose:	Get/set the enable/disable state for using the gauge relay input to change the mode of the circuit.	
Monitor Data:	External vacuum contact	
Parameter(s):	[n],? or [n],[nn] [n] is circuit number or * for all circuits [n] is the enable state of the external vacuum contact 0 = Disabled 1 = Enabled	
Return Value:	[A] or [A][nn]	
Data Type:	Integer	
Default Value:	0	
Min: 0		Max: 1
Units:		
Security Level	Get: 1	Set: 3
Example:	"EXT_VAC_CONTACT,1,?" Get the external vacuum device enable state for circuit 1	
Interface	RS-232, Ethernet	

COOL_SETPT Cooling Termination Set Point

Purpose:	Get/set the cooling termination set point (target) for temperature controlled cooling mode.	
Monitor Data:	Refrigerant return temperature.	
Parameter(s):	[n],? or [n],[nnn.n] [n] is circuit number or * for all circuits [nnn.n] is the set point	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Double	
Default Value:	-15	
Min: -199	Max: 100	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"COOL_SETPT,1,?" Get the cooling termination set point for circuit 1	
Interface	RS-232, Ethernet	

COOL_MODE_ALARM_DEADBAND Cooling Mode Alarm Deadband

Purpose:	Get/Set the Cool mode alarm deadband around the temperature control setpoint, COOL_SETPT.	
Monitor Data:	Refrigerant return temperature	
Parameter(s):	[n],? or [n],[nnn.n1],[nnn.n2] [n] is circuit number (1.4) [nnn.n1] is the deadband low [nnn.n2] is the deadband high	
Return Value:	[A] or [A][nnn.n1],[nnn.n2]	
Data Type:	Double	
Default Value:	5,5	
Min: 0.1	Max: 15	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"COOL_MODE_ALARM_DEADBAND,1,?" Get Circuit 1's cooling alarm set point.	
Interface	RS-232, Ethernet	

COOL_RAMP_LIMIT Cooling Ramp Limit

Purpose:	Get/set the cooling ramp limit for temperature ramp controlled cooling.	
Monitor Data:	Refrigerant return temperature change per minute	
Parameter(s):	[n], ? or [n],[nnn.n] [n] is circuit number or * for all circuits [nnn.n] is the ramp limit	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Double	
Default Value:	300	
Min: 1		Max: 600
Units:	Degrees Celsius, change per minute	
Security Level	Get: 1	Set: 3
Example:	"COOL_RAMP_LIMIT,1,10" Set the cooling ramp limit for circuit 1 to 10 degrees Celsius per min.	
Interface	RS-232, Ethernet	

COOL_RAMP_MON_INT Cooling Ramp Monitor Interval

Purpose:	Get/set the monitor interval for temperature ramp controlled cooling.	
Monitor Data:	Time	
Parameter(s):	[n], ? or [n],[nnnn] [n] is circuit number or * for all circuits [nnnn] is the interval	
Return Value:	[A] or [A][nnnn]	
Data Type:	Integer	
Default Value:	5	
Min: 0.1		Max: 60
Units:	Seconds	
Security Level	Get: 1	Set: 3
Example:	"COOL_RAMP_MON_INT,1,30" Set the cooling ramp monitor interval for circuit 1 to 30 seconds.	
Interface	RS-232, Ethernet	

COOL_RAMP_SAMPLE_CNT Cooling Ramp Sample Count

Purpose:	Get/set the number of samples to use for computing the cooling average in temperature ramp controlled cooling mode.	
Monitor Data:	None.	
Parameter(s):	[n],? or [n],[nnn] [n] is circuit number or * for all circuits [nnn] is the sample count	
Return Value:	[A] or [A][nnn]	
Data Type:	Integer	
Default Value:	5	
Min: 3		Max: 100
Units:	Samples	
Security Level	Get: 1	Set: 3
Example:	"COOL_RAMP_SAMPLE_CNT,1,?" Get the sample count for circuit 1	
Interface	RS-232, Ethernet	

BYPASS_TEMP_SETPT Bypass Temperature Set Point

Purpose:	Get/Set the bypass temperature set point. If Bypass valve is open, Bypass valve will close and Return valve will open. If Return valve is open, Return valve will close and Bypass valve will open.	
Monitor Data:	Refrigerant return temperature	
Parameter(s):	[n],? or [n],[nnn.n] [n] is circuit number [nnn.n] is the setpoint	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Double	
Default Value:	-40	
Min: -40		Max: 100
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"BYPASS_TEMP_SETPT,1,?" Get the bypass temperature setpoint for circuit 1	
Interface	RS-232, Ethernet	

AUX_COOL_SETPT Auxiliary Cool Set Points

Purpose:	Get/Set the auxiliary cool temperature set points for rapid cooldown.	
Monitor Data:	Refrigerant return temperature	
Parameter(s):	[n],? or [n],[nnn.n1],[nnn.n2] [n] is circuit number or * for all circuits [nnn.n1] is the open temp [nnn.n2] is the close temp	
Return Value:	[A] or [A][nnn.n1],[nnn.n2]	
Data Type:	Double	
Default Value:	param 2 = +20 param 3 = -80	
Min: param 2 = -40 param 3 = -145	Max: param 2 = +100 param 3 = +10	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"AUX_COOL_SETPT,1,-30,-50" Set the auxiliary cool open temperature for circuit 1 to -30 degrees and close temp to -50	
Interface	RS-232, Ethernet	

XTALK_FORTIFY_LIMIT Thermal Cross-talk Fortify Limit

Purpose:	Get/set the temperature above which the thermal crosstalk protection opens the auxiliary cool valve.	
Monitor Data:	Refrigerant Return Temp	
Parameter(s):	[n],? or [n],[nnnn] [n] is circuit number or * for all circuits [nnnn] is limit temperature	
Return Value:	[A] or [A][nnnn]	
Data Type:	Double	
Default Value:	-80	
Min: -155	Max: -40	
Units:	Degrees Celsius (signed)	
Security Level:	Get: 1	

Example:	"XTALK_FORTIFY_LIMIT,1,?" Get the temp limit for circuit 1
Interface	RS-232, Ethernet

XTALK_AUX_VALVE Thermal Cross-talk Aux Valve Functionality

Purpose:	Get/Set the Enable state of Thermal Cross-talk aux. cool valve for the circuit being Guarded		
Monitor Data:	N/A		
Parameter(s):	[n],? or [n],[n1] [n] is circuit number or * for all circuits [n1] defines when the auxiliary valve for circuit A is enabled within the XTALK GUARD mode 0 = disabled 1 = enabled for any condition supported per the original SRS 2= enabled only when circuit B is entering into any cool mode 3 = enabled only when circuit B is entering into any defrost mode		
Return Value:	[A] or [A][n]		
Data Type:	Integer		
Default Value:	0		
Min: 0			Max: 3
Units:	N/A		
Security Level:	Get: 1		Set: 3
Example:	"XTALK_AUX_VALVE,1,?" Get the enable state of the aux. valve for circuit 1 when being guarded		
Interface	RS-232, Ethernet		

XTALK_GUARD Thermal Cross-talk Guard On/Off

Purpose:	Get/Set the Enable state of Thermal Cross-talk circuit Guarding		
Monitor Data:	N/A		
Parameter(s):	? or [n] [n] is the enabled state of Guarding 0 - Disabled 1 - Enabled		
Return Value:	[A] or [A][n]		
Data Type:	Integer		
Default Value:	0		
Min: 0			Max: 1
Units:	Seconds		
Security Level:	Get: 1		Security Level: 3
Example:	"XTALK_GUARD,?" Get the enable state of Guarding		
Interface	RS-232, Ethernet		
Note:			

XTALK_GUARD_DELAY Thermal Cross-talk Guard Delay

Purpose:	Get/Set the minimum delay after which thermal crosstalk protection can begin		
Monitor Data:	time		
Parameter(s):	? or [nnn] [nnn] is the delay		
Return Value:	[A] or [A][nnn]		
Data Type:	Double		
Default Value:	1800		
Min: 0			Max: 7200
Units:	Seconds		
Security Level	Get: 1		Set 3
Example:	"XTALK_GUARD_DELAY,?" Get the minimum thermal crosstalk protection delay		
Interface	RS-232, Ethernet		

XTALK_GUARD_TEMP Thermal Cross-talk Guard Temperature

Purpose:	Get/set the temperature below which thermal crosstalk guarding kicks in	
Monitor Data:	Refrigerant Return Temp	
Parameter(s):	[n],? or [n],[nnnn] [n] is circuit number or * for all circuits [nnnn] is the guard temperature	
Return Value:	[A] or [A][nnnn]	
Data Type:	Double	
Default Value:	-80	
Min: -155	Max: -80	
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	
Example:	"XTALK_GUARD_TEMP,1,?" Get the temp limit for circuit 1	
Interface	RS-232, Ethernet	

XTALK_GUARD_SETPT_ENABLE Thermal Cross-talk Setpoint Enable

Purpose:	Get/Set the Enable state of Thermal Cross-talk circuit Guarding Setpoint	
Monitor Data:	N/A	
Parameter(s):	? or [n] [n] defines which temperature to use as the set point around which circuit A's temperature is guarded. Selection will apply to both circuit 1 and 2. 0 = use the temperature of circuit A observed at the time of circuit B mode transition 1 = use the temperature defined by XTALK_GUARD_SETPT_A	
Return Value:	[A] or [A][n]	
Data Type:	Integer	
Default Value:	0	
Min: 0	Max: 1	
Units:	N/A	
Security Level:	Get: 1	Set: 3

Example:	"XTALK_GUARD_SETPT_ENABLE,?" Get the enable state of Guarding Setpoint
Interface	RS-232, Ethernet

'XTALK_GUARD_SETPT_A Thermal Cross-talk Guard Setpoint

Purpose:	Get/set the temperature of circuit A for thermal crosstalk protection. XTALK_GUARD_SETPT_ENABLE must be 1 to use setpoint. XTALK_ABOVE_LIMIT and XTALK_BELOW_LIMIT will reference this temperature.		
Monitor Data:	Refrigerant Return Temp		
Parameter(s):	[n],? or [n],[nnnn] [n] is circuit number or * for all circuits [nnnn] is the setpoint temperature		
Return Value:	[A] or [A][nnnn]		
Data Type:	Double		
Default Value:	-90		
Min: -145		Max: -80	
Units:	Degrees Celsius (signed)		
Security Level:	Get: 1	Set: 3	
Example:	“XTALK_GUARD,SETPT_A,1,?” Get the Guard setpoint		
Interface	RS-232, Ethernet		

XTALK_ABOVE_LIMIT Thermal Cross-talk Above Limit

Purpose:	Get/set the temperature above which the thermal crosstalk protection adjusts the circuit cool/defrost		
Monitor Data:	Refrigerant Return Temp		
Parameter(s):	[n],? or [n],[nnnn] [n] is circuit number or * for all circuits [nnnn] is the limit temperature		
Return Value:	[A] or [A][nnnn]		
Data Type:	Double		

Default Value:	5	
Min: 0		Max:20
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"XTALK_ABOVE_LIMIT,1,?" Get temp limit for circuit 1	
Interface	RS-232, Ethernet	

XTALK_BELOW_LIMIT Thermal Cross-talk Unpause Below Limit

Purpose:	Get/set the temperature below which the thermal crosstalk protection resets the circuit cool/defrost	
Monitor Data:	Refrigerant Return Temp	
Parameter(s):	[n], ? or [n],[nnnn] [n] is circuit number or * for all circuits [nnnn] is the limit temperature	
Return Value:	[A] or [A][nnnn]	
Data Type:	Double	
Default Value:	3	
Min: 0		Max: 20
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"XTALK_BELOW_LIMIT,1,?" Get the temp limit for circuit 1	
Interface	RS-232, Ethernet	

AVG_TEMP_ENABLE Average Temperature Enable

Purpose:	Get/Set control based on the average of the circuit feed and return temperatures for thermal xtalk. When disabled will used the return temperature only	
Monitor Data:	Refrigerant Return Temp, Refrigerant Feed Temperature	
Parameter(s):	[n],? or [n],[state] [n] is circuit number [state] is 0 = disabled – use Return Temperature 1 = enabled – use Avg. Feed and Return Temperature	
Return Value:	[A] or [A][state]	
Data Type:	Integer	
Default Value:	0	
Min: 0		Max: 1
Units:	N/A	
Security Level	Get: 1	Set: 3
Example:	“AVG_TEMP_ENABLE,?” Get the Avg temp enable state	
Interface	RS-232, Ethernet	

DEFR_SETPT Defrost Complete Set Point

Purpose:	Get/Set the defrost complete temperature set point.	
Monitor Data:	Refrigerant return temperature.	
Parameter(s):	[n],? or [n],[nnn.n] [n] is circuit number or * for all circuits [nnn.n] is the setpoint	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Double	
Default Value:	+20	
Min: -40		Max: 100
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	“DEFR_SETPT,1,?” Get the defrost compete set point for circuit 1.	
Interface	RS-232, Ethernet	

DEFR_RAMP_LIMIT Defrost Ramp Limit

Purpose:	Get/set the defrost ramp limit for temperature ramp controlled defrost.	
Monitor Data:	Return temperature change per minute	
Parameter(s):	[n],? or [n],[nnn.n] [n] is circuit number or * for all circuits [nnn.n] is the ramp limit	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Double	
Default Value:	2	
Min: 1		Max: 600
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"DEFR_RAMP_LIMIT,1,10" Set the defrost ramp limit for circuit 1 to 10 degrees Celsius per min.	
Interface	RS-232, Ethernet	

DEFR_RAMP_MON_INT Defrost Ramp Monitor Interval

Purpose:	Get/set the monitor interval for temperature ramp controlled defrost.	
Monitor Data:	Time	
Parameter(s):	[n],? or [n],[nnn] [n] is circuit number or * for all circuits [nnn] is the interval	
Return Value:	[A] or [A][nnnn]	
Data Type:	Integer	
Default Value:	5	
Min: 0.1		Max: 60
Units:	Seconds	
Security Level	Get: 1	Set: 3
Example:	"DEFR_RAMP_MON_INT,1,30" Set the defrost ramp monitor interval for circuit 1 to 30 seconds.	
Interface	RS-232, Ethernet	

DEFR_RAMP_SAMPLE_CNT Defrost Ramp Sample Count

Purpose:	Get/set the number of samples to use for computing the defrost average in temperature ramp controlled defrost mode.	
Monitor Data:	None	
Parameter(s):	[n],? or [n],[nnn] [n] is circuit number or * for all circuits [nnn] is the count	
Return Value:	[A] or [A][nnn]	
Data Type:	Integer	
Default Value:	5	
Min: 3		Max: 100
Units:	Samples	
Security Level	Get: 1	Set: 3
Example:	"DEFR_RAMP_SAMPLE_CNT,1,?" Get the sample count for circuit 1	
Interface	RS-232, Ethernet	

EXT_DEFROST_DEADBAND Extended Defrost Deadband

Purpose:	Get/set the deadband limits for maintaining the temperature in extended defrost.	
Monitor Data:	Refrigerant return temperature.	
Parameter(s):	[n],? or [n],[nnn.n1],[nnn.n2] [n] is circuit number or * for all circuits [nnn.n1] is the low limit [nnn.n2] is the high limit	
Return Value:	[A] or [A][nnn.n1],[nnn.n2]	
Data Type:	Double	
Default Value:	5,5	
Min: 0.1		Max: 20
Units:	Degrees Celsius (signed)	
Security Level	Get: 1	Set: 3
Example:	"EXT_DEFROST_DEADBAND,1,?" Get the low/high temperature limits for the circuit 1 temperature controlled cooling deadband.	
Interface	RS-232, Ethernet	

EXT_DEFROST_ALARM_DEADBAND Extended Defrost Alarm Deadband

Purpose:	Get/Set the extended defrost alarm deadband around the temperature control deadband. It is expected that the alarm (fault) deadband will be larger than the defrost deadband.	
Monitor Data:	Refrigerant return temperature	
Parameter(s):	[n],? or [n],[nnn.n1],[nnn.n2] [n] is circuit number (1..4) [nnn.n1] is the deadband low [nnn.n2] is the deadband high	
Return Value:	[A] or [A][nnn.n1],[nnn.n2]	
Data Type:	Double	
Default Value:	10,10	
Min: 0.1	Max: 40	
Units:	Degrees Celsius (signed)	
Security Level:	Get: 1	Set: 3
Example:	"EXT_DEFROST_ALARM_DEADBAND,1,?" Get Circuit 1's extended defrost alarm set point.	
Interface	RS-232, Ethernet	

PID_CONTROL_PARAMS PID control parameters

Purpose:	Get/set the control parameters used for PID control of the circuit. These are the parameters computed during autotune.	
Parameter(s):	[n],[n],? or [n],[n],[nnn.n],[nnn.n],[nnn.n] Param 1 = circuit number (1..4) Param 2 = monitoring thermocouple (0 = internal, 1 = external) Param 3 = Proportional band constant (Kp) Param 4 = Integral time constant (Ki) Param 5 = Derivative time constant (Kd)	
Return Value:	[A] or [A][nnn.n],[nnn.n],[nnn.n]	
Data Type:	Double	
Default Value:	0.020632, 0.000124, 0	
Min: 0	Max: 10	
Security Level	Get: 1	Set: 3
Example:	"PID_CONTROL_PARAMS,1,0,?" Get the PID control parameters for circuit 1 with internal thermocouple monitoring	

Interface	RS-232, Ethernet
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PID_MONITOR_PARAMS PID monitor parameters

Purpose:	Get/set the monitoring parameters used for PID control of the circuit.		
Parameter(s):	[n],? or [n],[n],[n] Param 1 = circuit number (1..2) Param 2 = PID Control Rate in seconds Param 3 = Temperature Control Valve (0 = On/Off Valve, 1 = Stepper Motor Valve)		
Return Value:	A] or [A][n],[n]		
Data Type:	Integer		
Default Value:	30,0		
Min:5		Max: 60	
Security Level	Get: 1		Set: 3
Example:	PID_MONITOR_PARAMS,1,?" Get the PID control monitoring parameters for circuit 1 "PID_MONITOR_PARAMS,1,30,1" Set the PID control monitoring parameters for circuit 1 to use Stepper Motor Valve with 30 seconds control rate. "PID_MONITOR_PARAMS,1,30,0" Set the PID control monitoring parameters for circuit 1 to use On/Off Valve with 30 seconds control rate.		
Interface	RS-232, Ethernet		

EXT_TC_ENABLE Enable external thermocouple

Purpose:	Get/set the enable state of the external thermocouple on the circuit. If enabled, the external Thermocouple is used to monitor the temperature, else the internal Return temperature Thermocouple is used.
Parameter(s):	[n],? or [n],[state] [n] is circuit number (1..4) [state] is enable state 1 = Enabled 0 = Not Enabled
Return Value:	[A] or [A][0 or 1]
Data Type:	Integer
Default Value:	0

Security Level:	Get: 1	Set: 3
Example:	"EXT_TC_ENABLE,1,?" Get the enable state of the circuit 1 external thermocouple	
Interface	RS-232, Ethernet	

EXT_TC_ALARM External thermocouple alarm

Purpose:	Get/set the alarm setpoint for the External Thermocouple if enabled. Alarm is raised if difference between External TC temperature and Return temperature of circuit is greater than setpoint	
Parameter(s):	[nnn.n] or ? [nnn.n] is temperature difference	
Return Value:	[A] or [A][nnn.n]	
Data Type:	Double	
Default Value:	20	
Min: 0	Max: 200	
Units:	Deg C	
Security Level:	Get: 1	Set: 3
Example:	"EXT_TC_ALARM,?" Get the setpoint for external thermocouple alarm	
Interface	RS-232, Ethernet	

Circuit Operational State Commands

OPERATING_MODE_DEF_COOL Cool operating mode default state

Purpose:	Get/set the operating mode's default cool state.	
Parameter(s):	[n],? or [n],[mode] [n] is the circuit number (1..4) [mode] is 0 = COOL 1 = Not Used 2 = COOL TEMP CONTROL 3 = COOL RAMP CONTROL 4 = Not Used 5 = COOL RMP+TMP CNTL	
Return Value:	[A][mode]	
Default Value:	N/A	
Security Level	Get: 1	Set: 2
Example:	"OPERATING_MODE_DEF_COOL,1,?" Get the current default cool mode.	
Interface	RS-232, Ethernet	

OPERATING_MODE_DEF_DEFROST Defrost operating mode default state

Purpose:	Get/set the operating mode's default defrost state.	
Parameter(s):	[n],? or [n],[mode] [n] is the circuit number (1..4) [mode] is 0= DEFROST 1 = DEFROST RAMP CNTL 2 = DFR RMP+TEMP CNTL 3 = Not Used 4 = HEAT 5 = HEAT TEMP CONTROL	
Return Value:	[A][mode]	
Default Value:	N/A	
Security Level	Get: 1	Set: 2
Example:	"OPERATING_MODE_DEF_DEFROST,1,?" Get the current default defrost mode.	
Interface	RS-232, Ethernet	

OPERATING_MODE Current Operating Mode

Purpose:	Get/set the current operating mode.	
Parameter(s):	[n], ? or [n],[mode] [n] is the circuit number (1..4) [mode] is -1= INACTIVE (Note: Cannot "Set" this mode) 0 = STANDBY 1 = cool (default) – use the default cool mode 2 = defrost (default) – use the default defrost mode 3 = COOL 4 = Not Used 5 = COOL TEMP CONTROL 6 = COOL RAMP CONTROL 7 = Not Used 8 = COOL RMP+TMP CNTL 9 = DEFROST 10 = DEFROST RAMP CNTL 11 = DFR RMP+TEMP CNTL 12 = Not Used 13 = HEAT 14 = HEAT TEMP CONTROL	
Return Value:	[A][mode]	
Default Value:	N/A	
Security Level	Get: 1	Set: 2
Example:	"OPERATING_MODE,1,?" Get the current operating mode on circuit 1	
Interface	RS-232, Ethernet	

CIRC_VALV_OPEN_CNT Cooling Valve Open Count

Purpose:	Get/Set the number of times a valve has been opened.	
Parameter(s):	[n], [nn],? or [nn], [nnn] [n] is the circuit number (1..4) [nn] is the specific valve 0 = Cool 1 = Temp Control 2 = Defrost 3 = Auxiliary 4 = Return 5 = Bypass	
Return Value:	[A] or [A][nnnn]	

Default Value:	None	
Min: 0	Max: 1000000	
Security Level:	Get: 5	Set: 5
Example:	"CIRC_VALV_OPEN_CNT,1,0,?" Get circuit 1 cooling valve open count.	
Interface	RS-232, Ethernet	

CRYO_VALV_OPEN_CNT Cryo Valve Open Count

Purpose:	Get/Set the number of times the buffer valve has been opened.	
Parameter(s):	[n],? or [n], [nnnnn] [n] is the specific valve 0 = Buffer 1 = Rapid Bp Chk 2 = Not Used 3 = Cylinder Unloader 4 = Freeze Out Prevention [nnnnn] is the count	
Published:	Yes	
Return Value:	[A] or [A] [nnnnnn]	
Default Value:	N/A	
Min: 0	Max: 1000000	
Security Level:	Get: 5	Set: 5
Example:	"CRYO_VALV_OPEN_CNT,0,50" Set Buffer valve open count to 50.	
Interface	RS-232, Ethernet	

Circuit Sensor Readings Commands

CIRCUIT_VALVE_STATE Valve Open/Closed State of a Circuit's valve

Purpose:	Get the open/closed state of a valve belonging to a circuit. A value of 1 indicates the valve is open. A value of 0 indicates the valve is closed.	
Parameter(s):	[n],[valve],? [n] is circuit number (1..4) [valve] is Valve identifier: 0 = Cool 1 = Temp Control 2 = Defrost 3 = Auxiliary 4 = Return 5 = Bypass	
Return Value:	[A][n]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"CIRCUIT_VALVE_STATE,1,0,?" Get circuit 1 cool valve state	
Interface	RS-232, Ethernet	

CIRC_INLT_TEMP Circuit Inlet Temperature

Purpose:	Read the circuit inlet temperature sensor value. TC9/TC11	
Parameter(s):	[n],? [n] is circuit number (1..4)	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"CIRC_INLT_TEMP,1,?" Get circuit 1 inlet temperature	
Interface	RS-232, Ethernet	

CIRC_OTLT_TEMP Circuit Outlet Temperature

Purpose:	Read the circuit outlet temperature sensor value. TC10 / TC11	
Parameter(s):	[n],? [n] is circuit number (1..4)	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"CIRC_OTLT_TEMP,1,?" Get circuit 1 outlet temperature	
Interface	RS-232, Ethernet	

CIRC_FEED_TEMP Circuit Feed Temperature

Purpose:	Read the circuit feed temperature sensor value. TC13 / TC14	
Parameter(s):	[n],? [n] is circuit number (1..4)	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"CIRC_FEED_TEMP,1,?"	
Interface	RS-232, Ethernet	

CIRC_RTN_TEMP Circuit Return Temperature

Purpose:	Read the circuit return temperature sensor value. TC3 / TC5	
Parameter(s):	[n],? [n] is circuit number (1..4)	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"CIRC_RTN_TEMP,1,?"	
Interface	RS-232, Ethernet	

CIRC_PROC_CTL_TEMP Circuit Process Control Temperature

Purpose:	Read the circuit process control temperature sensor value. TC7 /TC8	
Parameter(s):	[n],? [n] is circuit number (1..4)	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"CIRC_PROC_CTL_TEMP,1,?"	
Interface	RS-232, Ethernet	

CIRC_BYPASS_TEMP Circuit Bypass Temperature

Purpose:	Read the circuit bypass temperature sensor value. TC15	
Parameter(s):	?	
Return Value:	[A][nnnn]	
Default Value:	N/A	
Security Level	Get: 1	Set: N/A
Example:	"CIRC_BYPASS_TEMP,?" get the circuit bypass temp	
Interface	RS-232, Ethernet	

System Fault Commands

PWR_WARN_BAND Power Management Warning Band

Purpose:	Get/Set the limits of the power warning band.	
Monitor Data:	voltage to pcb	
Parameter(s):	? or [nnn.n],[nnn.n] low limit, high limit	
Return Value:	[A] or [A][nnn.n],[nnn.n]	
Data Type:	Double	
Default Value:	21.0, 31.9	
Min: 10	Max: 40	

Units:	volts	
Security Level:	Get: 1	Set: 3
Example:	“PWR_WARN_BAND,23,31” Set the power management warning band to the range 23 – 31.	
Interface	RS-232, Ethernet	

PERFORMANCE_MONITOR Performance Monitor

Purpose:	Set/Get Performance Monitoring option, to display predictive diagnostic warnings	
Monitor Data:	Predictive diagnostics	
Parameter(s):	? or [n] [n] is Performance Monitoring option 0 = Disabled 1 = Level 1 Warning only 2 = Level 1, 2 Warning only 3 = All warning enabled (Level 1 Fault on HMI) 4 = All warning enabled (Level1 Fault not on HMI)	
Return Value:	[A] or [A][n]	
Data Type:	Integer	
Default Value:	0	
Min: 0		Max: 3
Units:	N/A	
Security Level:	Get: 1	Set: 3
Example:	“PERFORMANCE_MONITOR,?” Get the Performance Monitor warning enable/disable state	
Interface	RS-232, Ethernet	

TC_CALIBRATE Thermocouple Temperature Calibration

Purpose:	Get/set the thermocouple temperature calibration.
Monitor Data:	N/A
Parameter(s):	Get: [n], ? or [n],[nominator],[denominator],[offset] [n] is TC number. 1 for TC1, 2 for TC2 and * for all TC TC 1-TC20

Return Value:	[A] or [A][nominator/denominator+(offset)] or [A][nominator/denominator+(offset)],[nominator/denominator+(offset)]	
Data Type:	Double	
Default Value:	1/1+(0)	
Min: N/A		Max: N/A
Units:	N/A	
Security Level:	Get: 1	Set: 3
Example:	"TC_TEMP_OFFSETS,*,?" Get the temperature offsets for all thermocouples.	
Interface	RS-232, Ethernet	

SENSOR_VALID_LIMIT Sensor Valid Value Limits

Purpose:	Get/Set the high & low limits for sensor valid values.	
Monitor Data:	Each sensor	
Parameter(s):	[ID],? or [ID],[nnn1],[nnn2] [ID] is - TC[1..21] = Thermocouple number - PT[1.. 2] = pressure transducer [nnn1] is low limit [nnn2] is high limit	
Return Value:	[A] or [A][nnn.n],[nnn.n]	
Data Type:	Double	
Default Value:	TC -200,200 PT -70,600	
TC Min: -250 PT Min: -100		TC Max: 250 PT Min: 600
Units:	Degrees Celsius (signed), or PSI (signed)	
Security Level:	Get: 1	Set: 3
Example:	"SENSOR_VALID_LIMIT,TC2,?" Get the thermocouple TC2 temperature valid value limits	
Interface	RS-232, Ethernet	

SENSOR_FAULT_LIMIT Sensor Fault Limits

Purpose:	Get/Set the high & low limits and the out of range duration for sensor faults.	
Monitor Data:	Each sensor	
Parameter(s):	[ID],? or [ID],[nnn1],[nnn2],[nnn3] [ID] is - TC[1..21] = Thermocouple number - PT[1.. 2] = pressure transducer [nnn1] is low limit [nnn2] is high limit [nnn3] is delay until fault	
Return Value:	[A] or [A][nnn.n],[nnn.n],[nnnn]	
Data Type:	Double	
Default Value:	TC -250,250,3600 PT -70,600,5	
TC Min: -250 PT Min: -100 [nnn3]: 0		TC Max: 250 PT Max: 600 [nnn3] : 36000
Units:	Degrees Celsius (signed), PSI (signed), Seconds	
Security Level	Get: 1	Set: 3
Example:	"SENSOR_FAULT_LIMIT,TC2,?" Get the temperature fault limits for thermocouple 2	
Interface	RS-232, Ethernet	

LINE_TEMP_HIGH_LIMIT Liquid Line Temperature High Limit

Purpose:	Get/Set liquid line temperature high threshold limits for temperature and time delay for the COOLING WATER warning/alarm during continuous operation.	
Monitor Data:	Temperature and Time	
Parameter(s):	? or [n1,t1,n2,t2,n3,t3] n1 = 1st temperature threshold t1 = time delay in seconds allowed for the 1st temperature threshold before COOLING WATER alarm Compressor Off n2 = 2nd temperature threshold t2 = time delay in seconds allowed for the 2nd temperature threshold before COOLING WATER alarm Compressor Off n3 = 3rd temperature threshold t3 = time delay in seconds allowed for the 3rd temperature threshold before COOLING WATER alarm Compressor Off NOTE: Parameter Constraint: n1 < n2 < n3 t1 >= t2 >= t3	
Return Value:	[A] or [A][n1,t1,n2,t2,n3,t3]	
Data Type:	Integer	
Default Value:	n1: 42, t1: 120 n2: 50, t2: 30 n3: 60, t3: 15	
Min: n1: 32, t1:1 n2: 40, t2:0 n3: 60, t3:15	Max: n1: 44, t1:120 n2: 55, t2:120 n3: 65, t3:120	
Units:	n1, n2, n3 degrees C. t1, t2, t3 seconds	
Security Level	Get: 1	Set: 5
Example:	“LINE_TEMP_HIGH_LIMIT[40,30,50,20,60,10” Set the high liquid line temperature fault levels and delays 30 seconds above 40 C, 20 seconds above 50 C, and 10 seconds above 60 C. Once n1 is exceeded and once any one of the three pairs of temperature and delay is met the COOLING WATER fault will be generated.	
Interface	RS-232, Ethernet	

LINE_TEMP_LOW_LIMIT Line Temperature Low Limit

Purpose:	Get/Set liquid line temperature low threshold limits for temperature and time delay for the COOLING WATER warning/alarm during continuous operation.	
Monitor Data:	Temperature and Time	
Parameter(s):	? or [n1,t1,n2,t2] n1 = 1st temperature threshold t1 = time delay in seconds allowed for the 1st temperature threshold before COOLING WATER alarm Compressor On n2 = 2nd temperature threshold t2 = time delay in seconds allowed for the 2nd temperature threshold before COOLING WATER alarm Compressor Off NOTE: Parameter Constraint: n1 > n2 t1 <= t2	
Return Value:	[A] or [A][n1,t1,n2,t2]	
Data Type:	Integer	
Default Value:	n1: 12, t1: 60 n2: 9, t2: 900	
Min: n1: 8, t1:0 n2: 5, t2:0	Max: n1: 13, t1:900 n2: 12, t2:3600	
Units:	n1, n2 degrees C. t1, t2seconds	
Security Level	Get: 1	Set: 5
Example:	"LINE_TEMP_LOW_LIMIT,12,60,9,1500" Set the low liquid line temperature warning limits to 60 seconds for temperatures of 12 C or lower and fault limits for 1500 seconds for temperatures of 9 C or below.	
Interface	RS-232, Ethernet	

LINE_TEMP_STARTUP_LIMIT Line Temperature Startup Limit

Purpose:	Get/Set startup liquid line temperature high threshold limits for temperature and time for the WATER TEMP HIGH warning/alarm during compressor startup.	
Monitor Data:	Temperature and Time	
Parameter(s):	? or [n1,t1] n1 = Liquid Line temperature threshold during startup for compressor to start and/or operate until t1 duration expired. t1 = time duration in seconds allowed for the n1 Liquid Line temperature threshold logic	
Return Value:	[A] or [A][n1,t1]	
Data Type:	Integer	
Default Value:	n1: 85, t1: 14	
Min: n1: 32, t1:0	Max: n1: 100, t1:20	
Units:	n1 degrees C. t1 seconds	
Security Level	Get: 1	Set: 5
Example:	"LINE_TEMP_STARTUP_LIMIT,80,20" Set the liquid line temperature fault duration to 20 seconds and during this interval set the max allowable temperature to 80 C.	
Interface	RS-232, Ethernet	

6 Preventive Maintenance

Preventative Maintenance

The best way to ensure maximum productivity for your system is through Polycold's Preventative Maintenance servicing option.

Polycold recommends that the user inspect the system at daily, weekly, monthly and quarterly intervals.

Polycold recommends that every 12 months a preventative maintenance service visit is performed by Polycold authorized service personnel.

Benefits of Polycold preventive maintenance include:

- Improved system reliability
- Decreased cost of replacement
- Decreased system downtime

Preventive maintenance activities include

- Equipment check
- Top off charge (if required),
- Evacuate and recharge (if required)
- Valve replacement, as necessary
- Insulation inspection and repair
- Data backup
- Battery replacement, as required, (every 5 years)

In addition, the Polycold Engineer will record any equipment deterioration and recommend replacement parts or repair before these items cause system failure. Preventive maintenance will result in savings due to an increase of effective system service life.

NOTICE

Refrigerant removal or charging must be performed by Edwards Service personnel or Edwards authorized service providers.

Customers must never attempt to add or remove refrigerant from the unit or the system.

Preventive Maintenance Schedules

Interval	Action
Daily	Ensure the unit is functioning as expected
Weekly	Ensure the unit is functioning as expected
	Check Temperatures (during process)
	Check Pressures (during process)
Monthly	Perform Weekly Maintenance
	Check Time to Cool Down
	Check for air flow from E-box fans
Quarterly	Perform Monthly Maintenance
	Check system balance pressure
	Verify LCD display is not missing characters
	Verify HMI keypad / Remote Control functions properly
	Verify Insulation is intact
	Verify Oil Level in Compressor is appropriate
	Power cycle the system, leaving it off for at least 10 seconds
	Replace Fan Filter (as appropriate)
Annual	Perform Quarterly Maintenance
	Replace fan filter (mandatory) and check fan operation
	Replace valve and valve components as necessary
	Review event files for errors and backup system data (future capability)
	Check Cool Down Cycle Time, Pressure, and Temperature
	Check Defrost Cycle Time, Pressure, and Temperature
	Verify Water Flow and Temperatures
	Inspect Frame, Compressor, and Components for wear
	Reinsulate (as appropriate)
	Perform Compressor Pump Down Test
	Perform Leak Check on fittings within the Cryochiller and feed throughs
	Clean electronic control box and replace mother board battery as required (every 3-5 years)
	Inspect all harness connections.
	Top off charge as required
	Evacuate and recharge as necessary

7

Appendixes

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Appendix A: Contact Edwards

Contacting Technical Support

When contacting Polycold Division of Edwards Vacuum for Technical Support, please follow the procedures described here and have the following information available.

1. Unit Information
 - Serial number of the unit:
 - Model number:
 - Name of tool:
 - Balance pressure of the unit after being off for 48 hours or TC9 at ambient temperature (~ 17°C):
 - TC readouts 1-10 in cool mode and standby after 30 minutes:
2. Site Information
 - Company Name:
 - Site Location:
 - Street Address:
 - City, State Zip:
3. Primary Contact Information:
 - Contact Name:
 - Contact Phone:
 - Contact E-mail:

4. Secondary Contact Information:
 - Contact Name:
 - Contact Phone:
 - Contact E-mail:
5. Describe the malfunction observed and any error codes received during the failure.
 - Time that this issue has been occurring
 - Work that was done on the equipment prior to the error
 - Actions taken after the error and the results of those actions
 - Other information that may assist the Specialist
6. Contact Edwards Vacuum Technical Support at these numbers:

Table 7-1: Edwards Contact Information

Edwards Location	GUTS® Contact Number
North America	+1-800-FOR-GUTS (800-367-4887) (US, Canada)
Europe	+49-1804-CALL-GUTS (1804-2255-4887)
Japan	+81-45-477-5980
China	+86-21-5131-7066
Taiwan	+886-3-5525225
Korea	+82-31-288-2500
Singapore	+65-6464-1481

For additional contact information, please go to the Edwards Vacuum web site at www.edwardsvacuum.com or send an E-mail to techsupport.CTIP_US@edwardsvacuum.com.

Appendix B: SDS



INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders

Edwards s.r.o.

Chemwatch: 5366-71

Version No: 6.1.11.7

Safety data sheet according to REACH Regulation (EC) No 1907/2006, as amended by UK REACH Regulations SI 2019/758

Issue Date: 20/01/2021

Print Date: 15/06/2021

L.REACH.GB.EN

SECTION 1 Identification of the substance / mixture and of the company / undertaking

1.1. Product Identifier

Product name	INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders
Synonyms	Not Available
Proper shipping name	REFRIGERANT GAS, N.O.S., such as mixture F1, mixture F2 or mixture F3 (contains argon, 1,1,1,3,3,3-hexafluoropropane and 1,1,1,3,3,3-pentafluoropropane)
Chemical formula	Not Applicable
Other means of identification	Not Available

1.2. Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Refrigerated Gas
Uses advised against	Not Applicable

1.3. Details of the supplier of the safety data sheet

Registered company name	Edwards s.r.o.
Address	Jana Sigmunda 300, Lutín, 783 49 Czech Republic
Telephone	+420 580 582 728
Fax	Not Available
Website	www.edwardsvacuum.com
Email	info@edwardsvacuum.com

1.4. Emergency telephone number

Association / Organisation	CHEMWATCH EMERGENCY RESPONSE
Emergency telephone numbers	+44 20 3901 3542
Other emergency telephone numbers	+44 808 164 9592

Once connected and if the message is not in your preferred language then please dial 01

SECTION 2 Hazards identification

2.1. Classification of the substance or mixture

Classified according to GB-CLP Regulation, UK SI 2019/720 and UK SI 2020/1567 [1]	H336 - Specific target organ toxicity - single exposure Category 3 (narcotic effects), H280 - Gas under Pressure (Compressed gas)
Legend:	1. Classified by Chemwatch; 2. Classification drawn from GB-CLP Regulation, UK SI 2019/720 and UK SI 2020/1567

2.2. Label elements

Hazard pictogram(s)	
Signal word	Warning

Hazard statement(s)

H336	May cause drowsiness or dizziness.
H280	Contains gas under pressure; may explode if heated.

Supplementary statement(s)

Not Applicable

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders

Precautionary statement(s) Prevention

P271	Use only outdoors or in a well-ventilated area.
P261	Avoid breathing gas

Precautionary statement(s) Response

P312	Call a POISON CENTER/doctor/physician/first aider/if you feel unwell.
P304+P340	IF INHALED: Remove person to fresh air and keep comfortable for breathing.

Precautionary statement(s) Storage

P405	Store locked up.
P410+P403	Protect from sunlight. Store in a well-ventilated place.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.

Precautionary statement(s) Disposal

P501	Dispose of contents/container to authorised hazardous or special waste collection point in accordance with any local regulation.
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2.3. Other hazards

REACH - Art.57-59: The mixture does not contain Substances of Very High Concern (SVHC) at the SDS print date.

SECTION 3 Composition / information on ingredients

3.1.Substances

See 'Composition on ingredients' in Section 3.2

3.2.Mixtures

1.CAS No 2.EC No 3.Index No 4.REACH No	%[weight]	Name	Classified according to GB-CLP Regulation, UK SI 2019/720 and UK SI 2020/1567	Nanoform Particle Characteristics
1.7440-37-1 2.231-147-0 3.Not Available 4.Not Available	0-75	<u>argon</u>	Gas under Pressure (Compressed gas); H280 [1]	Not Available
1.460-73-1 2.419-170-6 3.Not Available 4.Not Available	0-62	<u>1,1,1,3,3,3-pentafluoropropane</u>	Gas under Pressure (Liquefied gas); H280 [1]	Not Available
1.690-39-1 2.425-320-1 3.Not Available 4.01-0000017172-78-XXXX	0-62	<u>1,1,1,3,3,3-hexafluoropropane</u>	Gas under Pressure (Liquefied gas), Specific target organ toxicity - single exposure Category 3 (narcotic effects); H280, H336 [1]	Not Available
1.354-33-6 2.206-557-8 3.Not Available 4.Not Available	4-53	<u>pentafluoroethane</u>	Gas under Pressure (Compressed gas); H280 [1]	Not Available
1.75-73-0 2.200-896-5 3.Not Available 4.Not Available	14-45	<u>tetrafluoromethane</u>	Gas under Pressure (Compressed gas); H280 [1]	Not Available
1.75-46-7 2.200-872-4 3.Not Available 4.Not Available	3-20	<u>trifluoromethane</u>	Gas under Pressure (Liquefied gas); H280 [1]	Not Available
Legend:		1. Classified by Chemwatch; 2. Classification drawn from GB-CLP Regulation, UK SI 2019/720 and UK SI 2020/1567; 3. Classification drawn from C&L; * EU IOELVs available; [e] Substance identified as having endocrine disrupting properties		

SECTION 4 First aid measures

4.1. Description of first aid measures

Eye Contact	▶ If product comes in contact with eyes remove the patient from gas source or contaminated area. ▶ Take the patient to the nearest eye wash, shower or other source of clean water. ▶ Open the eyelid(s) wide to allow the material to evaporate. ▶ Gently rinse the affected eye(s) with clean, cool water for at least 15 minutes. Have the patient lie or sit down and tilt the head back. Hold the eyelid(s) open and pour water slowly over the eyeball(s) at the inner corners, letting the water run out of the outer corners. ▶ The patient may be in great pain and wish to keep the eyes closed. It is important that the material is rinsed from the eyes to prevent further damage. ▶ Ensure that the patient looks up, and side to side as the eye is rinsed in order to better reach all parts of the eye(s) ▶ Transport to hospital or doctor. ▶ Even when no pain persists and vision is good, a doctor should examine the eye as delayed damage may occur. ▶ If the patient cannot tolerate light, protect the eyes with a clean, loosely tied bandage. ▶ Ensure verbal communication and physical contact with the patient. DO NOT allow the patient to rub the eyes DO NOT allow the patient to tightly shut the eyes
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Continued...

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	DO NOT introduce oil or ointment into the eye(s) without medical advice DO NOT use hot or tepid water.
Skin Contact	If skin contact occurs: ▶ Immediately remove all contaminated clothing, including footwear. ▶ Flush skin and hair with running water (and soap if available). ▶ Seek medical attention in event of irritation. In case of cold burns (frost-bite): ▶ Move casualty into warmth before thawing the affected part; if feet are affected carry if possible ▶ Bathe the affected area immediately in luke-warm water (not more than 35 deg C) for 10 to 15 minutes, immersing if possible and without rubbing ▶ DO NOT apply hot water or radiant heat. ▶ Apply a clean, dry, light dressing of "fluffed-up" dry gauze bandage ▶ If a limb is involved, raise and support this to reduce swelling ▶ If an adult is involved and where intense pain occurs provide pain killers such as paracetamol ▶ Transport to hospital, or doctor ▶ Subsequent blackening of the exposed tissue indicates potential of necrosis, which may require amputation.
Inhalation	▶ Following exposure to gas, remove the patient from the gas source or contaminated area. ▶ NOTE: Personal Protective Equipment (PPE), including positive pressure self-contained breathing apparatus may be required to assure the safety of the rescuer. ▶ Prostheses such as false teeth, which may block the airway, should be removed, where possible, prior to initiating first aid procedures. ▶ If the patient is not breathing spontaneously, administer rescue breathing. ▶ If the patient does not have a pulse, administer CPR. ▶ If medical oxygen and appropriately trained personnel are available, administer 100% oxygen. ▶ Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or Poison Control Centre for further instruction. ▶ Keep the patient warm, comfortable and at rest while awaiting medical care. ▶ MONITOR THE BREATHING AND PULSE, CONTINUOUSLY. ▶ Administer rescue breathing (preferably with a demand-valve resuscitator, bag-valve mask-device, or pocket mask as trained) or CPR if necessary.
Ingestion	▶ Not considered a normal route of entry. ▶ For advice, contact a Poisons Information Centre or a doctor. ▶ Avoid giving milk or oils. ▶ Avoid giving alcohol.

4.2 Most important symptoms and effects, both acute and delayed

See Section 11

4.3. Indication of any immediate medical attention and special treatment needed

for intoxication due to Freons/ Halons;

A: Emergency and Supportive Measures

- ▶ Maintain an open airway and assist ventilation if necessary
- ▶ Treat coma and arrhythmias if they occur. Avoid (adrenaline) epinephrine or other sympathomimetic amines that may precipitate ventricular arrhythmias. Tachyarrhythmias caused by increased myocardial sensitisation may be treated with propranolol, 1-2 mg IV or esmolol 25-100 microgm/kg/min IV.
- ▶ Monitor the ECG for 4-6 hours

B: Specific drugs and antidotes:

- ▶ There is no specific antidote

C: Decontamination

- ▶ Inhalation; remove victim from exposure, and give supplemental oxygen if available.
- ▶ Ingestion; (a) Prehospital: Administer activated charcoal, if available. **DO NOT** induce vomiting because of rapid absorption and the risk of abrupt onset CNS depression. (b) Hospital: Administer activated charcoal, although the efficacy of charcoal is unknown. Perform gastric lavage only if the ingestion was very large and recent (less than 30 minutes)

D: Enhanced elimination:

- ▶ There is no documented efficacy for diuresis, haemodialysis, haemoperfusion, or repeat-dose charcoal.

POISONING and DRUG OVERDOSE, Californian Poison Control System Ed. Kent R Olson; 3rd Edition

- ▶ Do not administer sympathomimetic drugs unless absolutely necessary as material may increase myocardial irritability.
- ▶ No specific antidote.
- ▶ Because rapid absorption may occur through lungs if aspirated and cause systematic effects, the decision of whether to induce vomiting or not should be made by an attending physician.
- ▶ If lavage is performed, suggest endotracheal and/or esophageal control.
- ▶ Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach.
- ▶ Treatment based on judgment of the physician in response to reactions of the patient

For frost-bite caused by liquefied petroleum gas:

- ▶ If part has not thawed, place in warm water bath (41-46 C) for 15-20 minutes, until the skin turns pink or red.
- ▶ Analgesia may be necessary while thawing.
- ▶ If there has been a massive exposure, the general body temperature must be depressed, and the patient must be immediately rewarmed by whole-body immersion, in a bath at the above temperature.
- ▶ Shock may occur during rewarming.
- ▶ Administer tetanus toxoid booster after hospitalization.
- ▶ Prophylactic antibiotics may be useful.
- ▶ The patient may require anticoagulants and oxygen.

[Shell Australia 22/12/87]

For gas exposures:

BASIC TREATMENT

- ▶ Establish a patent airway with suction where necessary.
- ▶ Watch for signs of respiratory insufficiency and assist ventilation as necessary.
- ▶ Administer oxygen by non-rebreather mask at 10 to 15 l/min.
- ▶ Monitor and treat, where necessary, for pulmonary oedema .
- ▶ Monitor and treat, where necessary, for shock.
- ▶ Anticipate seizures.

ADVANCED TREATMENT

- ▶ Consider orotracheal or nasotracheal intubation for airway control in unconscious patient or where respiratory arrest has occurred.
- ▶ Positive-pressure ventilation using a bag-valve mask might be of use.

Continued...

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- ▶ Monitor and treat, where necessary, for arrhythmias.
- ▶ Start an IV D5W TKO. If signs of hypovolaemia are present use lactated Ringers solution. Fluid overload might create complications.
- ▶ Drug therapy should be considered for pulmonary oedema.
- ▶ Hypotension with signs of hypovolaemia requires the cautious administration of fluids. Fluid overload might create complications.
- ▶ Treat seizures with diazepam.
- ▶ Proparacaine hydrochloride should be used to assist eye irrigation.

BRONSTEIN, A.C. and CURRANCE, P.L.

EMERGENCY CARE FOR HAZARDOUS MATERIALS EXPOSURE: 2nd Ed. 1994

SECTION 5 Firefighting measures

5.1. Extinguishing media

SMALL FIRE: Use extinguishing agent suitable for type of surrounding fire.

LARGE FIRE: Cool cylinder.

DO NOT direct water at source of leak or venting safety devices as icing may occur.

5.2. Special hazards arising from the substrate or mixture

Fire Incompatibility	▶ Avoid contamination with oxidising agents i.e. nitrates, oxidising acids, chlorine bleaches, pool chlorine etc. as ignition may result
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5.3. Advice for firefighters

Fire Fighting	GENERAL ▶ Alert Fire Brigade and tell them location and nature of hazard. ▶ Wear breathing apparatus and protective gloves. ▶ Fight fire from a safe distance, with adequate cover. ▶ Use water delivered as a fine spray to control fire and cool adjacent area.
Fire/Explosion Hazard	▶ Containers may explode when heated - Ruptured cylinders may rocket ▶ Fire exposed containers may vent contents through pressure relief devices. ▶ High concentrations of gas may cause asphyxiation without warning. ▶ May decompose explosively when heated or involved in fire. ▶ Contact with gas may cause burns, severe injury and/ or frostbite. Decomposition may produce toxic fumes of: carbon monoxide (CO) carbon dioxide (CO₂) hydrogen fluoride other pyrolysis products typical of burning organic material. NOTE: Avoid using on fires with fuel containing its own oxygen (oxidising agent), eg. gun powder, rocket propellants, cellulose nitrate, organic peroxides The fire suppression of polyfluoroalkyls is due to their heat capacity and chemical suppression by fluorine. It has been noted that the presence of CF groups (as opposed to CF_x; x=F, F₂, H) is significant in chemical inhibition by fluorocarbons Fire suppression occurs by a combination of physical (primarily heat capacity) and chemical (reduction of radicals important in flame propagation) mechanisms. Agents such as water and carbon dioxide which are essentially chemically inert in flame environments are predominately physical in their suppression mechanism. The suppression effectiveness of CF₃Br has been identified as being principally due to catalytic scavenging of flame radicals by the bromine atom.

SECTION 6 Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

See section 8

6.2. Environmental precautions

See section 12

6.3. Methods and material for containment and cleaning up

Minor Spills	▶ Avoid breathing vapour and any contact with liquid or gas. Protective equipment including respirator should be used. ▶ DO NOT enter confined spaces where gas may have accumulated. ▶ Increase ventilation.
Major Spills	▶ Clear area of all unprotected personnel and move upwind. ▶ Alert Emergency Authority and advise them of the location and nature of hazard. ▶ Wear breathing apparatus and protective gloves. ▶ Prevent by any means available, spillage from entering drains and water-courses. ▶ Remove leaking cylinders to a safe place. ▶ Fit vent pipes. Release pressure under safe, controlled conditions ▶ Burn issuing gas at vent pipes. ▶ DO NOT exert excessive pressure on valve; DO NOT attempt to operate damaged valve.

6.4. Reference to other sections

Personal Protective Equipment advice is contained in Section 8 of the SDS.

SECTION 7 Handling and storage

7.1. Precautions for safe handling

Safe handling	·Consider use in closed pressurised systems, fitted with temperature, pressure and safety relief valves which are vented for safe dispersal. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature ·The tubing network design connecting gas cylinders to the delivery system should include appropriate pressure indicators and vacuum or suction lines. ·Fully-welded types of pressure gauges, where the bourdon tube sensing element is welded to the gauge body, are recommended.
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Continued...

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders

	- Before connecting gas cylinders, ensure manifold is mechanically secure and does not contain another gas. DO NOT transfer gas from one cylinder to another.
Fire and explosion protection	See section 5
Other information	- Do NOT store halogenated aliphatics in areas containing alkali or alkaline earth metals such as powdered aluminum, zinc, or beryllium. - Outside or detached storage is preferred. - Cylinders should be stored in a purpose-built compound with good ventilation, preferably in the open. - Such compounds should be sited and built in accordance with statutory requirements. - The storage compound should be kept clear and access restricted to authorised personnel only. - Cylinders stored in the open should be protected against rust and extremes of weather.

7.2. Conditions for safe storage, including any incompatibilities

Suitable container	DO NOT use aluminium or galvanised containers - Cylinder: - Ensure the use of equipment rated for cylinder pressure. - Ensure the use of compatible materials of construction. - Valve protection cap to be in place until cylinder is secured, connected. - Cylinder must be properly secured either in use or in storage.
Storage incompatibility	For saturated perfluorocarbons: - Standard oxidation-reduction potentials do not apply to PFCs. The materials are unaffected by electrochemical reactions and do not dissociate in aqueous media. - They are essentially already fully oxidised and are unaffected by standard oxidizing agents such as permanganates, chromates, etc. The only known oxidation takes place only at high temperatures by thermal decomposition. - Likewise, the materials are only reduced under extreme conditions, requiring reducing agents such as elemental sodium - Avoid magnesium, aluminium and their alloys, brass and steel. Trifluoromethane: - reacts violently with alkaline earth and alkali metals - reacts violently with aluminium oxide at elevated temperatures producing hydrogen chloride and phosgene vapours - is incompatible with beryllium, decaborane, diborane, difluoromethylene, dihypofluorite, fluorine, lithium, magnesium, potassium, acetylene-1,2-dioxide, potassium acetylene-1,2-dioxide, potassium-sodium alloy, sodium amide, titanium, uranium hydride, zinc - attacks aluminium, magnesium, zinc and their alloys As a general rule, hydrofluorocarbons tend to be flammable unless they contain more fluorine atoms than hydrogen atoms. - Compressed gases may contain a large amount of kinetic energy over and above that potentially available from the energy of reaction produced by the gas in chemical reaction with other substances Haloalkanes: - are highly reactive: some of the more lightly substituted lower members are highly flammable; the more highly substituted may be used as fire suppressants, not always with the anticipated results. - may react with the lighter divalent metals to produce more reactive compounds analogous to Grignard reagents. - may produce explosive compounds following prolonged contact with metallic or other azides - may react on contact with potassium or its alloys - although apparently stable on contact with a wide range of halocarbons, reaction products may be shock-sensitive and may explode with great violence on light impact; severity generally increases with the degree of halocarbon substitution and potassium-sodium alloys give extremely sensitive mixtures. BREITHERICK L.: Handbook of Reactive Chemical Hazards - react with metal halides and active metals, eg. sodium (Na), potassium (K), lithium (Li), calcium (Ca), zinc (Zn), powdered aluminium (Al) and aluminium alloys, magnesium (Mg) and magnesium alloys.

7.3. Specific end use(s)

See section 1.2

SECTION 8 Exposure controls / personal protection

8.1. Control parameters

Ingredient	DNELs Exposure Pattern Worker	PNECs Compartment
1,1,1,3,3,3-hexafluoropropane	Inhalation 4 960 mg/m ³ (Systemic, Chronic) Inhalation 61 147 mg/m ³ (Systemic, Acute) Inhalation 1 240 mg/m ³ (Systemic, Chronic) *	0.186 mg/L (Water (Fresh)) 0.019 mg/L (Water - Intermittent release) 1.86 mg/L (Water (Marine)) 0.915 mg/kg sediment dw (Sediment (Fresh Water)) 0.092 mg/kg sediment dw (Sediment (Marine)) 0.065 mg/kg soil dw (Soil)
pentafluoroethane	Inhalation 16 444 mg/m ³ (Systemic, Chronic) Inhalation 1 753 mg/m ³ (Systemic, Chronic) *	0.1 mg/L (Water (Fresh)) 1 mg/L (Water (Marine)) 0.6 mg/kg sediment dw (Sediment (Fresh Water))
trifluoromethane	Inhalation 1 439 mg/m ³ (Systemic, Chronic) Inhalation 358 mg/m ³ (Systemic, Chronic) *	0.155 mg/L (Water (Fresh)) 0.016 mg/L (Water - Intermittent release) 1.545 mg/L (Water (Marine)) 0.665 mg/kg sediment dw (Sediment (Fresh Water)) 0.067 mg/kg sediment dw (Sediment (Marine)) 0.043 mg/kg soil dw (Soil)

* Values for General Population

Occupational Exposure Limits (OEL)

INGREDIENT DATA

Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available

Not Applicable

Emergency Limits

Continued...

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Ingredient	TEEL-1	TEEL-2	TEEL-3
argon	65,000 ppm	2.30E+05 ppm	4.00E+05 ppm
1,1,1,3,3-pentafluoropropane	900 ppm	25,000 ppm	1.50E+05 ppm
tetrafluoromethane	92 ppm	1,000 ppm	6,000 ppm
trifluoromethane	440 ppm	4,900 ppm	29,000 ppm

Ingredient	Original IDLH	Revised IDLH
argon	Not Available	Not Available
1,1,1,3,3-pentafluoropropane	Not Available	Not Available
1,1,1,3,3,3-hexafluoropropane	Not Available	Not Available
pentafluoroethane	Not Available	Not Available
tetrafluoromethane	Not Available	Not Available
trifluoromethane	Not Available	Not Available

MATERIAL DATA

8.2. Exposure controls

8.2.1. Appropriate engineering controls	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection. The basic types of engineering controls are: Process controls which involve changing the way a job activity or process is done to reduce the risk. Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.
8.2.2. Personal protection	
Eye and face protection	▶ Chemical goggles. ▶ Full face shield may be required for supplementary but never for primary protection of eyes. ▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.
Skin protection	See Hand protection below
Hands/feet protection	▶ Butyl rubber gloves -Butyl rubber gloves should be used when handling halogenated aliphatics . -Nitrile, PVC-coated nitrile, and PVC protective equipment are not recommended ▶ When handling sealed and suitably insulated cylinders wear cloth or leather gloves. ▶ Insulated gloves: NOTE: Insulated gloves should be loose fitting so that may be removed quickly if liquid is spilled upon them. Insulated gloves are not made to permit hands to be placed in the liquid; they provide only short-term protection from accidental contact with the liquid.
Body protection	See Other protection below
Other protection	-Halogen-selective detectors use a specialized sensor that allows the monitor to detect compounds containing fluorine, chlorine, bromine, and iodine with-out interference from other species. These detectors are typically easy to use, feature higher sensitivity than the nonselective detectors (detection limits are typically <5 ppm when used as an area monitor and <1.4 gm/yr [<0.05 oz/yr] when used as a leak pinpointer). -Compound-Specific Detectors are typically capable of detecting the presence of a single compound without interference from other compounds. ▶ Protective overalls, closely fitted at neck and wrist. ▶ Eye-wash unit. ▶ Ensure availability of lifeline in confined spaces. ▶ Staff should be trained in all aspects of rescue work.

Respiratory protection

Type AX Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)

Selection of the Class and Type of respirator will depend upon the level of breathing zone contaminant and the chemical nature of the contaminant. Protection Factors (defined as the ratio of contaminant outside and inside the mask) may also be important.

Required minimum protection factor	Maximum gas/vapour concentration present in air p.p.m. (by volume)	Half-face Respirator	Full-Face Respirator
up to 10	1000	AX-AUS / Class1	-
up to 50	1000	-	AX-AUS / Class 1
up to 50	5000	Airline *	-
up to 100	5000	-	AX-2
up to 100	10000	-	AX-3
100+			Airline**

* - Continuous Flow ** - Continuous-flow or positive pressure demand

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO₂), G = Agricultural chemicals, K = Ammonia(NH₃), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

- ▶ Cartridge respirators should never be used for emergency ingress or in areas of unknown vapour concentrations or oxygen content.
- ▶ The wearer must be warned to leave the contaminated area immediately on detecting any odours through the respirator. The odour may indicate that the mask is not functioning properly, that the vapour concentration is too high, or that the mask is not properly fitted. Because of these limitations, only restricted use of cartridge respirators is considered appropriate.
- ▶ Cartridge performance is affected by humidity. Cartridges should be changed after 2 hr of continuous use unless it is determined that the humidity is less than 75%, in which case, cartridges can be used for 4 hr. Used cartridges should be discarded daily, regardless of the length of time used

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- ▶ Positive pressure, full face, air-supplied breathing apparatus should be used for work in enclosed spaces if a leak is suspected or the primary containment is to be opened (e.g. for a cylinder change)
- ▶ Air-supplied breathing apparatus is required where release of gas from primary containment is either suspected or demonstrated.

8.2.3. Environmental exposure controls

See section 12

SECTION 9 Physical and chemical properties**9.1. Information on basic physical and chemical properties**

Appearance	Colourless		
Physical state	Liquified Gas	Relative density (Water = 1)	Not Available
Odour	Not Available	Partition coefficient n-octanol / water	Not Available
Odour threshold	Not Available	Auto-ignition temperature (°C)	Not Applicable
pH (as supplied)	Not Applicable	Decomposition temperature	Not Applicable
Melting point / freezing point (°C)	<-100	Viscosity (cSt)	Not Applicable
Initial boiling point and boiling range (°C)	<-128	Molecular weight (g/mol)	Not Applicable
Flash point (°C)	Not Applicable	Taste	Not Available
Evaporation rate	Not Available	Explosive properties	Not Available
Flammability	Not Applicable	Oxidising properties	Not Available
Upper Explosive Limit (%)	Not Applicable	Surface Tension (dyn/cm or mN/m)	Not Available
Lower Explosive Limit (%)	Not Applicable	Volatile Component (%vol)	Not Available
Vapour pressure (kPa)	Not Available	Gas group	Not Available
Solubility in water	Not Applicable	pH as a solution (%)	Not Applicable
Vapour density (Air = 1)	>1	VOC g/L	Not Available
Nanoform Solubility	Not Available	Nanoform Particle Characteristics	Not Available, Not Available, Not Available, Not Available, Not Available, Not Available
Particle Size	Not Available		

9.2. Other information

Not Available

SECTION 10 Stability and reactivity

10.1.Reactivity	See section 7.2
10.2. Chemical stability	▶ Unstable in the presence of incompatible materials. ▶ Product is considered stable. ▶ Hazardous polymerisation will not occur. ▶ Extremely high temperatures. ▶ Presence of elevated temperatures.
10.3. Possibility of hazardous reactions	See section 7.2
10.4. Conditions to avoid	See section 7.2
10.5. Incompatible materials	See section 7.2
10.6. Hazardous decomposition products	See section 5.3

SECTION 11 Toxicological information**11.1. Information on toxicological effects**

Inhaled	Inhalation of vapours may cause drowsiness and dizziness. This may be accompanied by narcosis, reduced alertness, loss of reflexes, lack of coordination and vertigo. Inert gas narcosis may result following exposure. Inert gas narcosis is directly related to the pressure of the inert gas. The best known form of this narcosis is produced by nitrogen and is common amongst divers breathing compressed air.. Inert gases of the noble gas series, except possibly helium and neon, also cause narcosis and anaesthesia. Exposure to high concentrations of fluorocarbons may produce cardiac arrhythmias or cardiac arrest due to sensitisation of the heart to adrenalin or noradrenalin. Deaths associated with exposures to fluorocarbons (specifically halogenated aliphatics) have occurred in occupational settings and in inhalation of bronchodilator drugs. Bronchospasm consistently occurs in human subjects inhaling fluorocarbons. At a measured concentration of 1700 ppm of one of the commercially available aerosols there is a biphasic change in ventilatory capacity, the first reduction occurring within a few minutes and the second delayed up to 30 minutes. In a cardiac sensitisation assay with 1,1,1,3,3-pentafluoroethane, using dogs, no effects were noted at 20,000 ppm, the highest level tested. In rats and mice exposed to concentrations of 200,000 ppm and 100,000 ppm respectively, no fatalities occurred. There was evidence of transient anaesthetic effects in rats and transient underactivity in mice. Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident, a single organ alone is (almost) never involved.
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	Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin) Material is highly volatile and may quickly form a concentrated atmosphere in confined or unventilated areas. The vapour may displace and replace air in breathing zone, acting as a simple asphyxiant. This may happen with little warning of overexposure. Symptoms of asphyxia (suffocation) may include headache, dizziness, shortness of breath, muscular weakness, drowsiness and ringing in the ears. If the asphyxia is allowed to progress, there may be nausea and vomiting, further physical weakness and unconsciousness and, finally, convulsions, coma and death. Significant concentrations of the non-toxic gas reduce the oxygen level in the air. As the amount of oxygen is reduced from 21 to 14 volume %, the pulse rate accelerates and the rate and volume of breathing increase. Common, generalised symptoms associated with non-toxic gas inhalation include : ▶ central nervous system effects such as headache, confusion, dizziness, progressive stupor, coma and seizures; ▶ respiratory system complications may include tachypnoea and dyspnoea; ▶ cardiovascular effects may include circulatory collapse and arrhythmias; ▶ gastrointestinal effects may also be present and may include mucous membrane irritation and nausea and vomiting.
Ingestion	Not normally a hazard due to physical form of product. Considered an unlikely route of entry in commercial/industrial environments
Skin Contact	In common with other halogenated aliphatics, fluorocarbons may cause dermal problems due to a tendency to remove natural oils from the skin causing irritation and the development of dry, sensitive skin. They do not appear to be appreciably absorbed. Material on the skin evaporates rapidly and may cause tingling, chilling and even temporary numbness Vapourising liquid causes rapid cooling and contact may cause cold burns, frostbite, even through normal gloves. Frozen skin tissues are painless and appear waxy and yellow. Signs and symptoms of frost-bite may include "pins and needles", paleness followed by numbness, a hardening and stiffening of the skin, a progression of colour changes in the affected area, (first white, then mottled and blue and eventually black; on recovery, red, hot, painful and blistered). Entry into the blood-stream through, for example, cuts, abrasions, puncture wounds or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
Eye	Direct contact with the eye may not cause irritation because of the extreme volatility of the gas; however concentrated atmospheres may produce irritation after brief exposures..
Chronic	Principal route of occupational exposure to the gas is by inhalation. It is generally accepted that the fluorocarbons are less toxic than the corresponding halogenated aliphatic based on chlorine. Repeated inhalation exposure to the fluorocarbon FC-11 does not produce pathologic lesions of the liver and other visceral organs in experimental animals. There has been conjecture in non-scientific publications that fluorocarbons may cause leukemia, cancer, sterility and birth defects; these have not been verified by current research. The high incidence of cancer, spontaneous abortion and congenital anomalies amongst hospital personnel, repeatedly exposed to fluorine-containing general anaesthetics, has caused some scientists to call for a lowering of the fluorocarbon exposure standard to 5 ppm since some are mutagens.

11.2.1. Endocrine Disruption Properties

Not Available

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders	TOXICITY	IRRITATION
	Not Available	Not Available
argon	TOXICITY	IRRITATION
	Not Available	Not Available
1,1,1,3,3-pentafluoropropane	TOXICITY	IRRITATION
	dermal (rat) LD50: >2000 mg/kg ^[2] Inhalation(Mouse) LC50; >100000 ppm4h ^[2]	Not Available
1,1,1,3,3,3-hexafluoropropane	TOXICITY	IRRITATION
	Inhalation(Rat) LC50; >189000 ppm4h ^[1]	Not Available
pentafluoroethane	TOXICITY	IRRITATION
	Inhalation(Rat) LC50; 592813.698 ppm4h ^[2]	Not Available
tetrafluoromethane	TOXICITY	IRRITATION
	Inhalation(Rat) LC50; ~25000 ppm4h ^[1]	Not Available
trifluoromethane	TOXICITY	IRRITATION
	Inhalation(Rat) LC50; >663000 ppm4h ^[2]	Not Available
Legend:	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. * Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances	

ARGON	No known carcinogenic, mutagenic or specific reproductive effects. [BOC]
1,1,1,3,3-PENTAFLUOROPROPANE	Disinfection by products (DBPs) re formed when disinfectants such as chlorine, chloramine, and ozone react with organic and inorganic matter in water. The observations that some DBPs such as trihalomethanes (THMs), di-/trichloroacetic acids, and 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX) are carcinogenic in animal studies have raised public concern over the possible adverse health effects of DBPs. To date, several hundred DBPs have been identified. Numerous haloalkanes and haloalkenes have been tested for carcinogenic and mutagenic activities. In general, the genotoxic potential is dependent on the nature, number, and position of halogen(s) and the molecular size of the compound. for 1,1,1,3,3-pentafluoropropane (HFC-245fa): Acute toxicity: In experimental animals HFC-245fa possesses a low order of acute inhalation toxicity, although it may sensitise the heart at high

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	exposure levels (44,000 ppm or greater; . 241,000 mg /m3). Long-term exposure to HFC-245fa vapour at high concentrations (50,000 ppm; 274,000 mg/m3) was tolerated with only minimal signs of toxicity. Some exposure-related clinical signs of central nervous system depression (such as irregular respiration, restless behaviour, intermittent muscular contractions, abnormal posture and reduced response to external stimuli) were seen. In rats, trifluoroacetic acid (TFA) and inorganic fluorides were identified as major, and 3,3,3-trifluoropropanoic acid and 1,1,1,3,3-pentafluoropropan-2-ol as minor urinary metabolites, respectively. The metabolic pathway leading to the formation of TFA has not been identified. Changes in motor activity, ataxia, respiratory depression recorded. NOEL (pups): No embryotoxic effects at 50,000 ppm * NOEL (dams): 2000 ppm (decrease in body weight gains at 10,000 and 50,000 ppm) *
1,1,1,3,3,3- HEXAFLUOROPROPANE	Single exposure by inhalation caused narcosis and cardiac sensitisation, a potentially fatal disturbance of heart rhythm associated with a heightened sensitivity to the action of epinephrine; in a cardiac sensitisation screening test in dogs exposed to concentrations of 50,000 to 250,000 ppm evidence of sensitization occurred at 150,000 ppm. Repeated exposures caused a reduced startling response in rats. No other significant toxicological effects were observed. No-Observed-Adverse-Effect-Level (NOAEL): 20,000 ppm. Developmental studies conducted in rats and rabbits at dose levels of 5000, 20,000 or 50,000 ppm produced no evidence of developmental toxicity. HFC 236fa was not uniquely toxic to the rat or rabbit conceptus. Specific studies to evaluate the effect on female reproductive performance have not been conducted; however, limited information obtained from studies on developmental toxicity do not indicate adverse effects on female reproductive performance. Tests have shown that HFC 236fa does not cause genetic damage in bacterial or mammalian cell cultures. * DuPont MSDS
PENTAFLUOROETHANE	Cardiac sensitisation threshold limit >245400 mg/m3 Anaesthetic effects threshold limit 490800 mg/m3 * DuPont SDS
TETRAFLUOROMETHANE	For perfluoropropane (PF3) and other aliphatic perfluoroalkanes (PFAs) Perfluoroalkanes (PFAs) are very stable. They are not oxidized even by ozone to any appreciable extent; their atmospheric half-life greater than 5000 y PFAs are chemically inert; included in this family is Teflon (a polymeric, high-molecular-weight PFA). The major concern from exposure to high concentrations of gaseous PFAs is their potential for cardiac toxicity. Cardiac effects are known to occur when humans or animals are exposed to high concentrations of other fluorinated hydrocarbons (FCs), including Freons FCs, such as chlorofluorocarbons, could induce cardiac arrhythmias by sensitising the heart to epinephrine. For perfluorinated carbons (PFCs): PFCs are inert fluids composed of a complex combination of organic compounds resulting from the distillation of electrochemically fluorinated (ECF) compounds. This class consists of branched, linear and cyclic perfluorinated hydrocarbons having carbon numbers predominantly in the range of C5-Cl8 and boiling in the range of approximately 25 C-255 C (77 F-491 F). Perfluorinated amine and ether compounds may also be present Acute oral and inhalation toxicity tests with perfluoroalkanes show no toxicity at any dose tested, and even extremely high-dose intraperitoneal injection resulted in no lethality. In contrast, perfluoroalkenes (such as octafluorocyclopentene, perfluoroisobutylene, hexafluoropropene) have shown evidence of inhalation toxicity, in some cases, extreme. PFCs are among the least toxic of all known organic chemicals. The material may produce peroxisome proliferation. Peroxisomes are single, membrane limited, cytoplasmic organelles that are found in the cells of animals, plants, fungi and protozoa. Peroxisome proliferators include certain hypolipidaemic drugs, phthalate ester plasticisers, industrial solvents, herbicides, food flavours, leukotriene D4 antagonists and hormones. Numerous studies in rats and mice have demonstrated the hepatocarcinogenic effects of peroxisome proliferators, and these compounds have been unequivocally established as carcinogens.
TRIFLUOROMETHANE	Repeated exposure of dogs to 5000 ppm and rats to 1000 ppm resulted in no toxic effects.
ARGON & 1,1,1,3,3,3- HEXAFLUOROPROPANE & TRIFLUOROMETHANE	No significant acute toxicological data identified in literature search.

Acute Toxicity	✗	Carcinogenicity	✗
Skin Irritation/Corrosion	✗	Reproductivity	✗
Serious Eye Damage/Irritation	✗	STOT - Single Exposure	✓
Respiratory or Skin sensitisation	✗	STOT - Repeated Exposure	✗
Mutagenicity	✗	Aspiration Hazard	✗

Legend: ✗ – Data either not available or does not fill the criteria for classification
✓ – Data available to make classification

SECTION 12 Ecological information

12.1. Toxicity

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders	Endpoint	Test Duration (hr)	Species	Value	Source
	Not Available	Not Available	Not Available	Not Available	Not Available

argon	Endpoint	Test Duration (hr)	Species	Value	Source
	Not Available	Not Available	Not Available	Not Available	Not Available

1,1,1,3,3,3-pentafluoropropane	Endpoint	Test Duration (hr)	Species	Value	Source
	NOEC(ECx)	96h	Fish	10mg/l	2
	EC50	72h	Algae or other aquatic plants	>118mg/l	2
	LC50	96h	Fish	>81.8mg/l	2
	EC50	48h	Crustacea	>=97.9mg/l	2

1,1,1,3,3,3-hexafluoropropane	Endpoint	Test Duration (hr)	Species	Value	Source
	NOEC(ECx)	72h	Algae or other aquatic plants	>=186mg/l	2
	EC50	72h	Algae or other aquatic plants	>186mg/l	2
	LC50	96h	Fish	292mg/l	2

Continued...

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	EC50	48h	Crustacea	299mg/l	2
pentafluoroethane	Endpoint	Test Duration (hr)	Species	Value	Source
	EC50	72h	Algae or other aquatic plants	>114mg/l	2
	LC50	96h	Fish	>81.8mg/l	2
	EC50	48h	Crustacea	>97.9mg/l	2
	NOEC(ECx)	96h	Fish	10mg/l	2
	EC50	96h	Algae or other aquatic plants	142mg/l	2
tetrafluoromethane	Endpoint	Test Duration (hr)	Species	Value	Source
	Not Available	Not Available	Not Available	Not Available	Not Available
trifluoromethane	Endpoint	Test Duration (hr)	Species	Value	Source
	EC50(ECx)	96h	Algae or other aquatic plants	154.54mg/l	2
	LC50	96h	Fish	633.26mg/l	2
	EC50	96h	Algae or other aquatic plants	154.54mg/l	2
Legend: Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 (QSAR) - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data					

DO NOT discharge into sewer or waterways.

12.2. Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
1,1,1,3,3-pentafluoropropane	HIGH	HIGH
1,1,1,3,3,3-hexafluoropropane	HIGH	HIGH
pentafluoroethane	HIGH	HIGH
tetrafluoromethane	LOW	LOW
trifluoromethane	LOW	LOW

12.3. Bioaccumulative potential

Ingredient	Bioaccumulation
1,1,1,3,3-pentafluoropropane	LOW (LogKOW = 2.0383)
1,1,1,3,3,3-hexafluoropropane	LOW (LogKOW = 2.6461)
pentafluoroethane	LOW (LogKOW = 1.5472)
tetrafluoromethane	LOW (LogKOW = 1.18)
trifluoromethane	LOW (LogKOW = 0.64)

12.4. Mobility in soil

Ingredient	Mobility
1,1,1,3,3-pentafluoropropane	LOW (KOC = 275.5)
1,1,1,3,3,3-hexafluoropropane	LOW (KOC = 393.3)
pentafluoroethane	LOW (KOC = 154.4)
tetrafluoromethane	LOW (KOC = 48.64)
trifluoromethane	LOW (KOC = 35.04)

12.5. Results of PBT and vPvB assessment

	P	B	T
Relevant available data	Not Available	Not Available	Not Available
PBT	✗	✗	✗
vPvB	✗	✗	✗
PBT Criteria fulfilled?	No		
vPvB	No		

12.6. Endocrine Disruption Properties

Not Available

12.7. Other adverse effects

One or more ingredients within this SDS has the potential of causing ozone depletion and/or photochemical ozone creation.

SECTION 13 Disposal considerations

Continued...

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders

13.1. Waste treatment methods

Product / Packaging disposal	Evaporate or incinerate residue at an approved site. Ensure damaged or non-returnable cylinders are gas-free before disposal.
Waste treatment options	Not Available
Sewage disposal options	Not Available

SECTION 14 Transport information

Labels Required

	
Marine Pollutant	NO

Land transport (ADR-RID)

14.1. UN number	1078												
14.2. UN proper shipping name	REFRIGERANT GAS, N.O.S., such as mixture F1, mixture F2 or mixture F3 (contains argon, 1,1,1,3,3,3-hexafluoropropane and 1,1,1,3,3-pentafluoropropane)												
14.3. Transport hazard class(es)	<table><tr><td>Class</td><td>2.2</td></tr><tr><td>Subrisk</td><td>Not Applicable</td></tr></table>	Class	2.2	Subrisk	Not Applicable								
Class	2.2												
Subrisk	Not Applicable												
14.4. Packing group	Not Applicable												
14.5. Environmental hazard	Not Applicable												
14.6. Special precautions for user	<table><tr><td>Hazard identification (Kemler)</td><td>20</td></tr><tr><td>Classification code</td><td>2A</td></tr><tr><td>Hazard Label</td><td>2.2</td></tr><tr><td>Special provisions</td><td>274 582 662</td></tr><tr><td>Limited quantity</td><td>120 ml</td></tr><tr><td>Tunnel Restriction Code</td><td>3 (C/E)</td></tr></table>	Hazard identification (Kemler)	20	Classification code	2A	Hazard Label	2.2	Special provisions	274 582 662	Limited quantity	120 ml	Tunnel Restriction Code	3 (C/E)
Hazard identification (Kemler)	20												
Classification code	2A												
Hazard Label	2.2												
Special provisions	274 582 662												
Limited quantity	120 ml												
Tunnel Restriction Code	3 (C/E)												

Air transport (ICAO-IATA / DGR)

14.1. UN number	1078														
14.2. UN proper shipping name	Refrigerant gas, n.o.s. * (contains argon, 1,1,1,3,3,3-hexafluoropropane and 1,1,1,3,3-pentafluoropropane)														
14.3. Transport hazard class(es)	<table><tr><td>ICAO/IATA Class</td><td>2.2</td></tr><tr><td>ICAO / IATA Subrisk</td><td>Not Applicable</td></tr><tr><td>ERG Code</td><td>2L</td></tr></table>	ICAO/IATA Class	2.2	ICAO / IATA Subrisk	Not Applicable	ERG Code	2L								
ICAO/IATA Class	2.2														
ICAO / IATA Subrisk	Not Applicable														
ERG Code	2L														
14.4. Packing group	Not Applicable														
14.5. Environmental hazard	Not Applicable														
14.6. Special precautions for user	<table><tr><td>Special provisions</td><td>Not Applicable</td></tr><tr><td>Cargo Only Packing Instructions</td><td>200</td></tr><tr><td>Cargo Only Maximum Qty / Pack</td><td>150 kg</td></tr><tr><td>Passenger and Cargo Packing Instructions</td><td>200</td></tr><tr><td>Passenger and Cargo Maximum Qty / Pack</td><td>75 kg</td></tr><tr><td>Passenger and Cargo Limited Quantity Packing Instructions</td><td>Forbidden</td></tr><tr><td>Passenger and Cargo Limited Maximum Qty / Pack</td><td>Forbidden</td></tr></table>	Special provisions	Not Applicable	Cargo Only Packing Instructions	200	Cargo Only Maximum Qty / Pack	150 kg	Passenger and Cargo Packing Instructions	200	Passenger and Cargo Maximum Qty / Pack	75 kg	Passenger and Cargo Limited Quantity Packing Instructions	Forbidden	Passenger and Cargo Limited Maximum Qty / Pack	Forbidden
Special provisions	Not Applicable														
Cargo Only Packing Instructions	200														
Cargo Only Maximum Qty / Pack	150 kg														
Passenger and Cargo Packing Instructions	200														
Passenger and Cargo Maximum Qty / Pack	75 kg														
Passenger and Cargo Limited Quantity Packing Instructions	Forbidden														
Passenger and Cargo Limited Maximum Qty / Pack	Forbidden														

Sea transport (IMDG-Code / GGVSee)

14.1. UN number	1078				
14.2. UN proper shipping name	REFRIGERANT GAS, N.O.S. (contains argon, 1,1,1,3,3,3-hexafluoropropane and 1,1,1,3,3-pentafluoropropane)				
14.3. Transport hazard class(es)	<table><tr><td>IMDG Class</td><td>2.2</td></tr><tr><td>IMDG Subrisk</td><td>Not Applicable</td></tr></table>	IMDG Class	2.2	IMDG Subrisk	Not Applicable
IMDG Class	2.2				
IMDG Subrisk	Not Applicable				
14.4. Packing group	Not Applicable				
14.5. Environmental hazard	Not Applicable				
14.6. Special precautions for user	<table><tr><td>EMS Number</td><td>F-C , S-V</td></tr><tr><td>Special provisions</td><td>274</td></tr></table>	EMS Number	F-C , S-V	Special provisions	274
EMS Number	F-C , S-V				
Special provisions	274				

Continued...

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders

Limited Quantities | 120 mL

Inland waterways transport (ADN)

14.1. UN number	1078										
14.2. UN proper shipping name	REFRIGERANT GAS, N.O.S., such as mixture F1, mixture F2 or mixture F3 (contains argon, 1,1,1,3,3,3-hexafluoropropane and 1,1,1,3,3-pentafluoropropane)										
14.3. Transport hazard class(es)	2.2 Not Applicable										
14.4. Packing group	Not Applicable										
14.5. Environmental hazard	Not Applicable										
14.6. Special precautions for user	<table><tr><td>Classification code</td><td>2A</td></tr><tr><td>Special provisions</td><td>274; 582; 662</td></tr><tr><td>Limited quantity</td><td>120 ml</td></tr><tr><td>Equipment required</td><td>PP</td></tr><tr><td>Fire cones number</td><td>0</td></tr></table>	Classification code	2A	Special provisions	274; 582; 662	Limited quantity	120 ml	Equipment required	PP	Fire cones number	0
Classification code	2A										
Special provisions	274; 582; 662										
Limited quantity	120 ml										
Equipment required	PP										
Fire cones number	0										

14.7. Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

14.8. Transport in bulk in accordance with MARPOL Annex V and the IMSBC Code

Product name	Group
argon	Not Available
1,1,1,3,3-pentafluoropropane	Not Available
1,1,1,3,3,3-hexafluoropropane	Not Available
pentafluoroethane	Not Available
tetrafluoromethane	Not Available
trifluoromethane	Not Available

14.9. Transport in bulk in accordance with the ICG Code

Product name	Ship Type
argon	Not Available
1,1,1,3,3-pentafluoropropane	Not Available
1,1,1,3,3,3-hexafluoropropane	Not Available
pentafluoroethane	Not Available
tetrafluoromethane	Not Available
trifluoromethane	Not Available

SECTION 15 Regulatory information

15.1. Safety, health and environmental regulations / legislation specific for the substance or mixture

argon is found on the following regulatory lists

Europe EC Inventory

European Union - European Inventory of Existing Commercial Chemical Substances (EINECS)

1,1,1,3,3-pentafluoropropane is found on the following regulatory lists

Europe EC Inventory

1,1,1,3,3,3-hexafluoropropane is found on the following regulatory lists

Not Applicable

pentafluoroethane is found on the following regulatory lists

Europe EC Inventory

European Union - European Inventory of Existing Commercial Chemical Substances (EINECS)

tetrafluoromethane is found on the following regulatory lists

Europe EC Inventory

European Union - European Inventory of Existing Commercial Chemical Substances (EINECS)

trifluoromethane is found on the following regulatory lists

Europe EC Inventory

European Union - European Inventory of Existing Commercial Chemical Substances (EINECS)

This safety data sheet is in compliance with the following EU legislation and its adaptations - as far as applicable - : Directives 98/24/EC, - 92/85/EEC, - 94/33/EC, - 2008/98/EC, - 2010/75/EU; Commission Regulation (EU) 2020/878; Regulation (EC) No 1272/2008 as updated through ATPs.

15.2. Chemical safety assessment

No Chemical Safety Assessment has been carried out for this substance/mixture by the supplier.

Continued...

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders

ECHA SUMMARY

Ingredient	CAS number	Index No	ECHA Dossier
argon	7440-37-1	Not Available	Not Available

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Comp.	GHS04; Wng	H280
2	Comp.; Ref. Liq.; Liq.	GHS04; Wng; Dgr	H280; H281

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

Ingredient	CAS number	Index No	ECHA Dossier
1,1,1,3,3-pentafluoropropane	460-73-1	Not Available	Not Available

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Liq.	GHS04; Wng	H280
2	Liq.; Narc. STOT SE 3; Eye Irrit. 2	GHS04; Wng; GHS07	H280; H336; H319

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

Ingredient	CAS number	Index No	ECHA Dossier
1,1,1,3,3,3-hexafluoropropane	690-39-1	Not Available	01-0000017172-78-XXXX

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Liq.	GHS04; Wng	H280
2	Liq.; Narc. STOT SE 3	GHS04; Wng; GHS07	H280; H336

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

Ingredient	CAS number	Index No	ECHA Dossier
pentafluoroethane	354-33-6	Not Available	Not Available

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Comp.	GHS04; Wng	H280
2	Comp.; Liq.	GHS04; Wng	H280

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

Ingredient	CAS number	Index No	ECHA Dossier
tetrafluoromethane	75-73-0	Not Available	Not Available

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Comp.	GHS04; Wng	H280
2	Comp.	GHS04; Wng	H280

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

Ingredient	CAS number	Index No	ECHA Dossier
trifluoromethane	75-46-7	Not Available	Not Available

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Liq.	GHS04; Wng	H280
2	Liq.; Comp.; Skin Irrit. 2; Eye Irrit. 2; Resp. STOT SE 3	GHS04; Wng; GHS07	H280; H315; H319; H335

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

National Inventory Status

National Inventory	Status
Australia - AIIIC / Australia Non-Industrial Use	Yes
Canada - DSL	Yes
Canada - NDSL	No (argon; 1,1,1,3,3-pentafluoropropane; 1,1,1,3,3,3-hexafluoropropane; pentafluoroethane; tetrafluoromethane; trifluoromethane)
China - IECSC	Yes
Europe - EINEC / ELINCS / NLP	Yes
Japan - ENCS	No (argon)
Korea - KECI	Yes
New Zealand - NZIoC	Yes
Philippines - PICCS	Yes

Continued...

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders

National Inventory	Status
USA - TSCA	Yes
Taiwan - TCSI	Yes
Mexico - INSQ	No (1,1,1,3,3-pentafluoropropane)
Vietnam - NCI	No (1,1,1,3,3,3-hexafluoropropane)
Russia - FBEPH	No (1,1,1,3,3-pentafluoropropane; 1,1,1,3,3,3-hexafluoropropane)
Legend:	Yes = All CAS declared ingredients are on the inventory No = One or more of the CAS listed ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)

SECTION 16 Other information

Revision Date	20/01/2021
Initial Date	07/08/2020

Full text Risk and Hazard codes

H281	Contains refrigerated gas; may cause cryogenic burns or injury.
H315	Causes skin irritation.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation.

SDS Version Summary

Version	Date of Update	Sections Updated
5.1.1.1	01/12/2020	Disposal
6.1.1.1	20/01/2021	Name
6.1.3.1	22/04/2021	Regulation Change
6.1.4.1	29/04/2021	Regulation Change
6.1.5.1	10/05/2021	Regulation Change
6.1.6.1	13/05/2021	Regulation Change
6.1.7.1	17/05/2021	Regulation Change
6.1.8.1	20/05/2021	Regulation Change
6.1.9.1	24/05/2021	Regulation Change
6.1.10.1	27/05/2021	Regulation Change
6.1.10.2	30/05/2021	Template Change
6.1.10.3	04/06/2021	Template Change
6.1.10.4	05/06/2021	Template Change
6.1.11.4	07/06/2021	Regulation Change
6.1.11.5	09/06/2021	Template Change
6.1.11.6	11/06/2021	Template Change
6.1.11.7	15/06/2021	Template Change

Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

For detailed advice on Personal Protective Equipment, refer to the following EU CEN Standards:

EN 166 Personal eye-protection
EN 340 Protective clothing
EN 374 Protective gloves against chemicals and micro-organisms
EN 13832 Footwear protecting against chemicals
EN 133 Respiratory protective devices

Definitions and abbreviations

PC—TWA: Permissible Concentration-Time Weighted Average
PC—STEL: Permissible Concentration-Short Term Exposure Limit
IARC: International Agency for Research on Cancer
ACGIH: American Conference of Governmental Industrial Hygienists
STEL: Short Term Exposure Limit
TEEL: Temporary Emergency Exposure Limit.
IDLH: Immediately Dangerous to Life or Health Concentrations
ES: Exposure Standard
OSF: Odour Safety Factor
NOAEL :No Observed Adverse Effect Level
LOAEL: Lowest Observed Adverse Effect Level
TLV: Threshold Limit Value
LOD: Limit Of Detection
OTV: Odour Threshold Value
BCF: BioConcentration Factors

Continued...

INERT-HFC POLYCOLD® Refrigerant for Gas Cylinders

BEI: Biological Exposure Index
AIIIC: Australian Inventory of Industrial Chemicals
DSL: Domestic Substances List
NDSL: Non-Domestic Substances List
IECSC: Inventory of Existing Chemical Substance in China
EINECS: European Inventory of Existing Commercial chemical Substances
ELINCS: European List of Notified Chemical Substances
NLP: No-Longer Polymers
ENCS: Existing and New Chemical Substances Inventory
KECI: Korea Existing Chemicals Inventory
NZIoC: New Zealand Inventory of Chemicals
PICCS: Philippine Inventory of Chemicals and Chemical Substances
TSCA: Toxic Substances Control Act
TCSI: Taiwan Chemical Substance Inventory
INSQ: Inventario Nacional de Sustancias Químicas
NCI: National Chemical Inventory
FBEPH: Russian Register of Potentially Hazardous Chemical and Biological Substances

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