

Operations and Maintenance Guide

Applicable models: 4400B, 6500B

ETS-90183 REV A



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1. GENERAL INFORMATION

1.1. Preface

This manual explains Power+ ORC operation and maintenance. Please familiarize yourself with the manual prior to working with the product and refer to it or contact ElectraTherm with any questions.



Do not attempt to operate this product until you have read thoroughly and understand completely all instructions, warnings, etc., contained in this manual. Failure to comply can result in accidents involving fire, electric shock, explosion, asphyxiation, burns, other serious personal injury, or equipment damage. Keep this manual with the machine and review frequently for continuous safe operation.



Only trained and authorized personnel are to perform maintenance on this machine. Do not perform unauthorized modifications to the machine. Failure to comply may result in warranty violation, equipment damage, serious injury, or death. ElectraTherm, Inc. assumes no responsibility for unauthorized maintenance or modifications performed on the machine.

1.2. Disclosure

This document contains confidential and proprietary information and is supplied solely to permit authorized parties to evaluate details concerning ElectraTherm products and services. The document is believed to contain the most recent and correct information at the date of publication and will be revised periodically without notice. ElectraTherm, Inc. makes no warranty, either expressed or implied, regarding the accuracy, completeness, sufficiency, or suitability of any material herein for any specific purpose, particularly with respect to possible nuances resulting from language translation. Interested parties should contact ElectraTherm, Inc. for further assistance regarding the most recent material, product, system, operating, and maintenance information.

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1.3. Revision History

REVISION	DATE	REASON FOR CHANGE
A	21 May 2020	Initial Release

1.4. Supplementary Documentation

The Table Below lists documents that are supplementary to the O&M.

ET PART #	DESCRIPTION OF DOCUMENT
ETS-90187	POWER PLUS SUPPLEMENTAL INFORMATION, VDE, 4400B
ETS-90163	ELECTRATHERM, SCHEMATIC, ELECTRICAL, 4400B, 001
ETS-90164	ELECTRATHERM, SCHEMATIC, ELECTRICAL, 6500B, 001
ETS-90167	SCHEMATIC, ELECTRICAL, 75B VDE INVERTER, 001
ETS-90160	P&ID, WATER CONDENSING, 4000B
ETS-90161	P&ID, 6000B

1.5. Machine Model Identification / Data Plate

The Power+ ORC can be identified by the dataplate on the machine, as shown below in Figure 1-1 and as detailed in Table 1-1

The image shows a detailed view of the ElectraTherm Power+ ORC dataplate. It is a rectangular plate with a silver-colored metal finish. At the top, it features the ElectraTherm logo and 'BY BITZER GROUP' text. Below this, there are several fields for identification: Model, Serial Number, MFG Date, MFG #, Start Date, and Tare Weight. There are also fields for High Side (Working Fluid) and Low Side (Working Fluid). Further down, there are fields for Hot Water and Cooling Water, and a section for Max Hot Water Flow Rate and Operational Hot Water Temp Range. The bottom section includes fields for Refrigerant, Min. Refrigerant Charge, Oil, and Oil Charge. At the very bottom, there is a section for Customer Requirements and contact information for ElectraTherm, including the address, phone number, and website. The plate is marked with 'THIS IS SMART POWER™' at the bottom.

Figure 1-1: Power+ ORC Dataplate

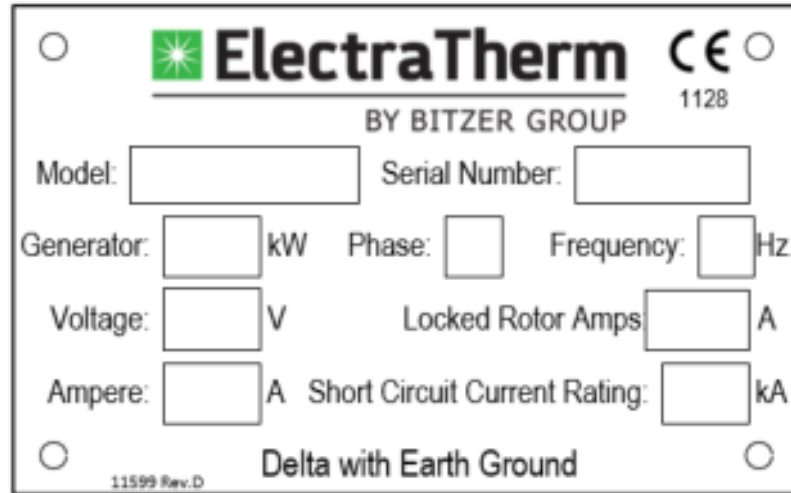
Machine Data Plate Information						
MFG #	Power Plus Model #	Serial Number	MAP & MAT (WF-High Side)	MAP & MAT (WF-Low Side)	MAP & MAT (Hot Water)	MAP & MAT (Cold Water)
4400B	ET-50 4000 WC	43XX+	10 BAR @ 116°C	10 BAR @ 50°C	10 BAR @ 116°C	10 BAR @ 38°C
6500B	ET-6500	63XX+	24 BAR @ 122°C	13.8 BAR @ 50°C	10 BAR @ 122°C	10 BAR @ 38°C

Machine Data Plate Information (continued)						
MFG #	Max HW flow rate m3/hr	Operational HW temp Range	Refrigerant (working fluid)	Min Refrigerant Charge	Oil	Oil Charge
4400B	54m3/hr	77-116°C	R-245FA	182kg	100 ISO alkylbenzene	13.5kg
6500B	80m3/hr	77-132°C	R-245FA	182kg	100 ISO alkylbenzene	13.5kg

Table 1-1: Power Plus ORC Data

1.6. Generator Identification Plate / Data Plate

The Power+ ORC electrical ratings can be identified by the electrical dataplate on the machine, as shown below in Figure 1-2 and Table 1-2



ElectraTherm
BY BITZER GROUP

Model: Serial Number:

Generator: kW Phase: Frequency: Hz

Voltage: V Locked Rotor Amps A

Ampere: A Short Circuit Current Rating: kA

Delta with Earth Ground

11599 Rev.D

Figure 1-2: Power+Generator Dataplate

Generator name plate Decode								
Model#	Serial #	Output	Voltage	Phase	Amps	Freq	LRA	SCCR
ET-50 4000 WC	43XX+	75kW	400	3	114	50Hz	690	25kA
ET-50 4000 WC	43XX+	75kW	480	3	95	60Hz	743	25kA
ET-6500	63XX+	125kW	400	3	190	50Hz	1006	25kA
ET-6500	63XX+	125kW	480	3	158	60Hz	1050	25kA

Table 1-2: Power Plus Generator Data

1.7. ElectraTherm Contact Information

ElectraTherm, Inc.
4080 Enterprise Way
Flowery Branch, GA 30542 USA

PHONE:

General Inquiries: +1-877-883-7101 (Toll Free)
+1-678-267-7700
Sales: +1-678-267-7703
Customer Service: +1-678-267-7704

EMAIL:

Sales: sales@electratherm.com
Customer Service: csg@electratherm.com
Operation/warranty issues: service@electratherm.com

For warranty or service inquiries on equipment, email service@electratherm.com
Include ElectraTherm serial number of the equipment and brief description in the subject line of the email, Include extra information, attach pictures and Service Request Document in email. Service Request Document is located in Appendix 6.5 of this document.

WEBSITE:

www.electratherm.com

2. Introduction

Congratulations on your purchase of an ElectraTherm Power+ Heat to Power generating system. We appreciate your business. You will soon generate emission-free electricity from your heat source. This User Guide covers safety, operation and maintenance of the machine, and should be kept readily available to the operator for reference. The operator should read this manual carefully prior to operation to ensure safe, smooth functioning of the machine.

While designed for simplicity, reliability and safety, the machine brings with it common industrial hazards including high voltage, compressed gases, moving parts, heavy assemblies, hot liquids and noise. Operations described herein require special skills and may require licenses and/or permits depending on local regulations where the machine is installed. If in doubt, contact ElectraTherm and/or your local building and utility authorities for guidance.

Should you encounter any unusual circumstances during installation, operation, or maintenance, please STOP and inquire - ElectraTherm is here to help.

When you receive the machine, please inspect carefully, account for all accessories listed on the packing list and check if there are any parts damaged during transportation. If any part is missing or parts are found to be damaged, please contact your local distributor or ElectraTherm immediately. Again, thank you for your purchase.

2.1. Safety

Throughout this manual, important safety information will often be preceded by the terms "ATTENTION", "CAUTION", and "DANGER".



This indicates important operational information.



This indicates a situation where equipment damage or injury may result.



This refers to situations that may result in severe equipment damage, serious injury or even death.

The machine is designed to be as safe as possible. During normal use the machine operations are safe as long as appropriate caution is observed at all times.

2.2. Hazards Associated with this Machine

2.2.1. High Voltage

Hazardous voltages do exist in the power and control cabinets. Exposed line voltages of up to 500 V exist in the power cabinet. The primary disconnect switch on the power cabinet should be used to disconnect and lock out the machine.



Arc flash hazards may exist in the machine's power cabinet. Exposure of personnel to arc flash hazards must be minimized by selection of properly rated upstream components and restricting access to the power cabinet to qualified personnel with the appropriate level of protective equipment as determined by a site-specific arc flash hazards analysis.

By IEC standards, the electrical cabinets are defined as low voltage systems. Insulated gloves should be worn when accessing the cabinets if components are energized. The primary electrical disconnect on the power cabinet door will disconnect all electrical components in both cabinets, although the grid connection terminals will remain live. The control cabinet door is equipped with a disconnect switch that will only disconnect the control cabinet.



Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and/or maintenance of this equipment. Do not touch any electrical connection before you first ensure that the power has been disconnected.

2.2.2. High Temperature

The machine requires a heat source operating up to 300°F (150°C). At these temperatures, less than one second of exposure to bare skin is enough to cause burns. Always be mindful of hot equipment including, but not limited to: the evaporator, pre-heater, expander, working fluid plumbing, and hot water plumbing. Whenever possible, allow the machine to cool before maintenance.

2.2.3. High Pressures



The machine is subject to high internal system pressures during normal operation. Access valves and fittings should never be opened while the machine is operating. Any time maintenance needs to be performed while the machine is operating, eye and ear protection should be worn.

Several safety interlocks protect the machine from reaching unsafe internal pressures. The machine can be divided into two different pressure regions, the "high-pressure" side from the feed pump outlet to the expander inlet, and the "low-pressure" side from the expander outlet to the feed pump inlet (See Figure 2-1: Organic Rankine Cycle in the Power+ Generator). On the low-pressure side there are controls in the software to shut down the machine if pressure exceeds the shutdown limit. In addition, there are two ASHRAE-approved pressure relief valves (PRVs) installed on a 3-way dual-shutoff safety valve. On the high-pressure side, there are controls in the software to shut down the machine if pressure exceeds the shutdown limit. In addition, there is a physical pressure switch that opens to shut down the machine and prevent restart until pressure returns to a safe level.  See Appendix 6.1 for shutdown limits. PRV settings are shown in Table 2-1 below:

PRV Pressure Relief Valve Values		
Machine Type	4400B	6500B

High side PRV Limit	N/A	350 PSI
Low Side PRV Limit	150 PSI	200 PSI

Table 2-1

2.2.4. Mechanical Hazards

The machine has only three moving parts: the expander / generator, the bypass valve, and the feed pump. At any time the machine is operating, all supplied guards and shrouds should be in place around these components. If maintenance is being performed, the machine must be isolated from all energy sources before removing the guards.



Be aware that even though the machine may be disconnected and locked out, the expander and generator can still spin without warning. This is caused by a change in temperature and/or pressure within the machine.

2.2.5. Chemical Hazards

The machine contains 400 lb (185 kg) of Honeywell Genetron HFC-245fa working fluid. This compound has low toxicity, non-flammable, and non-ozone-depleting. However, caution must be observed.



In large quantities, vaporized working fluid displaces oxygen, and is an asphyxiant. The first signs of over-exposure are a headache and dizziness.

Caution should also be observed in the presence of open flames. Such heat sources can cause the working fluid vapor to decompose into more toxic gases. Smoking is not permitted near the machine. Evaporating working fluid is also highly endothermic and can present a frostbite hazard on bare skin. Additional information can be found in the MSDS in Appendix 5.4



Only HFC-245fa is to be used as a working fluid in the Power+ Generator. Alternative working fluids will cause performance degradation and may create risk of fire and/or explosion causing injury or death. Use only preferred refrigerants; all performance estimates are based on operation with Honeywell Genetron. If Honeywell Genetron cannot be procured for use, please contact ElectraTherm for alternate manufactures.

The machine also contains approximately 5% by mass (of the working fluid) of Alkylbenzene oil. The oil can be a minor skin irritant but presents only a minimal safety hazard. Additional information can be found in the MSDS in Appendix 6.7.



Using any oil except that approved by ElectraTherm can lead to equipment damage including machine o-ring or pump shaft seal failure and loss of working fluid. ElectraTherm is not responsible for damage caused to the machine by the use of incorrect oil.

2.3. Technical Information

The Power+ Generator is a self-contained power generation system that utilizes an Organic Rankine Cycle (ORC) to recover thermal energy from a hot water source and convert some of that energy to electricity. The machine uses an environmentally-safe working fluid, Honeywell Genetron HFC-245fa, to drive a proprietary twin-screw expander that in turn drives an induction generator. Both the expander and generator are in a common Semi-Hermetic housing, the generator is cooled by the vapor leaving the expander.

2.3.1. Organic Rankine Cycle (ORC)

The Organic Rankine cycle is a variation of the Rankine cycle, the process by which most water/steam turbines operate. The ORC utilizes an organic fluid with a boiling point much lower than water, allowing heat recovery from lower temperature sources such as biomass, geothermal, and waste heat sources. In the machine, the cycle operates as shown in Figure 2-1

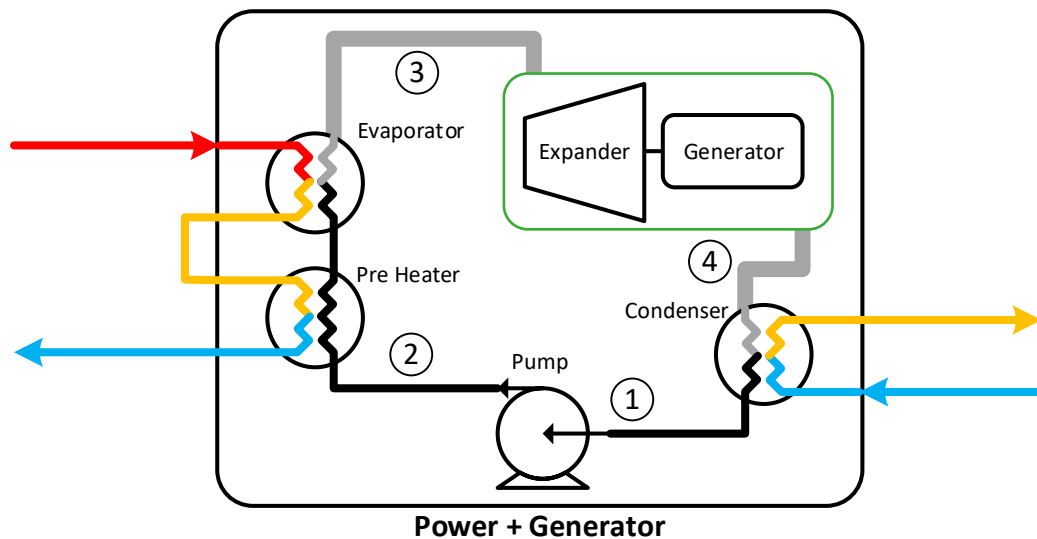


Figure 2-1: Organic Rankine Cycle in the Power+ Generator

- 1) Low pressure, low temperature working fluid flows to the feed pump. The pump pressurizes the liquid working fluid.
- 2) High pressure liquid working fluid flows from the pump through the pre-heater and evaporator, where it absorbs thermal energy from the hot water source and boils into a high pressure vapor.
- 3) The high pressure vapor passes through the twin-screw expander driving the induction generator (as the vapor expands) to generate electricity.
- 4) The low pressure vapor passes through a water cooled condenser, transferring thermal energy out of the loop. The low temperature low pressure liquid returns to the feed pump, and the cycle repeats.

On average, the machine converts approximately 8% - 10% of the thermal energy to electrical energy.

2.3.2. Induction Generator

The induction generator is a simple, robust, and proven power-generation technology. It does not employ brushes, commutator, slip rings, exciter, regulator, synchronizer, or other complex parts. The induction generator relies on the grid connection for excitation, and voltage and frequency regulation.

When operating at speeds up to 2.5% above synchronous, the generator produces power. When starting the machine, the control program monitors the generator RPM. As the generator approaches grid speed, the generator contactor closes, there is a momentary inrush of power as the grid provides excitation current. Since the generator is already spinning near grid speed, inrush current spikes are very brief, though they can be high. A motor rated breaker is required for connecting the Power+ to the site grid, to handle the inrush current. If inrush spikes are a concern, contact ElectraTherm for more information.

3. Operations

The machine is designed to deliver the maximum possible power output given the available thermal conditions, with little or no operator input. The Human-machine Interface, or HMI, is provided to assist technicians in monitoring the system parameters, setting default values for different site conditions, and troubleshooting alarms & other abnormal behavior.

In this chapter, the basic operation of the machine is presented. This includes an explanation of the physical controls, the various HMI screens and their functions, ORC startup & shutdown processes, alarm functionality, and considerations for system optimization.

3.1. Physical Controls

The physical controls are located to the left of the HMI. They consist of three status indicator lights and four basic function buttons, as shown in Figure 3-1.

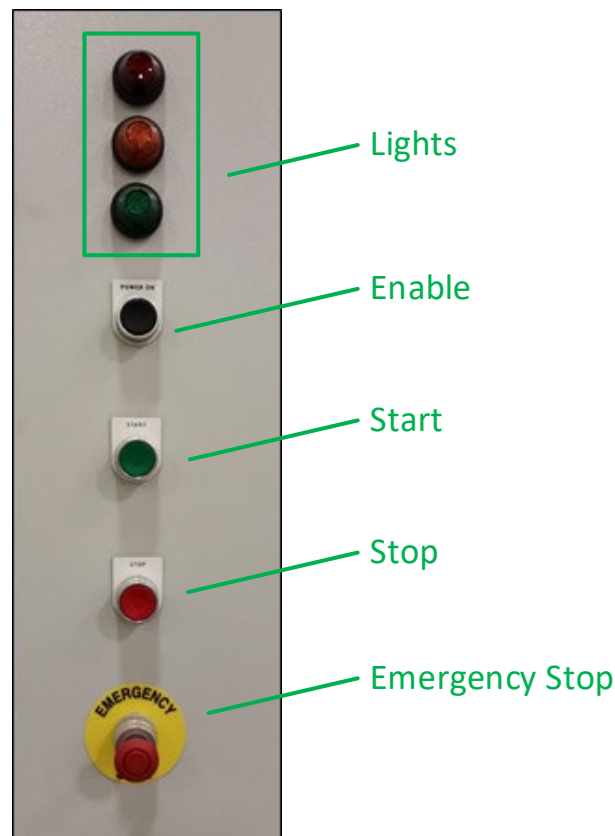


Figure 3-1: Physical Controls

3.1.1. Lights

The lights can be used to determine the status of a machine which has been powered on. If no lights are lit, the Master Control Relay (MCR) is opened and must be reset by pressing the black 'ENABLE' button, or turning the "Test / Manual / Auto (TMA) switch into "AUTO" see section 3.1.3 for more information on the TMA Switch.

When the red light at the top is flashing, there is a fault that will prevent the MCR from closing, the fault must be cleared before the MCR can be closed and the unit can be started. Reference Alarm list on HMI to see what fault is preventing the MCR from closing. See Table 3-1 for a full list of the lights and how they represent the machine status.

State	RED	YELLOW	GREEN
MCR-Off	off	off	off
MCR-On (Fault)	flashes	off	off
MCR-On (No Fault)	on	off	off
Waiting for Conditions	on	on	off
Start delay	off	on	off
Starting (pre-lube)	off	flashes	off
Starting (warm up)	off	flashes	off
Starting (ramp to grid speed)	off	flashes	off
Running (Gen on grid)	off	off	on
Restart Delay (60 sec min)	on	flashes	off

Table 3-1: Light Tower / Machine Status

3.1.2. Physical Control Buttons

There are four buttons on the Power+: 'ENABLE', 'START', 'STOP', and 'EMERGENCY STOP'.

The 'ENABLE' button is used to reset/enable the MCR. Before resetting the MCR any fault conditions must be resolved.

The 'START' button is one of three ways to start the machine; when pressed, the machine will begin the startup process. The machine can also be started from the HMI or when the "remote start" contact is closed via the customer terminal strip.

The 'STOP' button is used to initiate a controlled, orderly shutdown of the machine. When pressed, the machine will initiate a normal shutdown to take the system off-grid.

The 'EMERGENCY STOP' button is used to quickly stop the machine. When pressed, the machine will be taken off-grid immediately by opening the MCR (see sections 3.4 and 3.5 for an explanation of the difference between a normal stop and emergency stop).



The Emergency Stop button should only be used in emergency circumstances. Frequent use can cause excessive wear to electrical and mechanical components. Use the Stop button during normal operation.

3.1.3. Test / Manual / Auto Switch (TMA)

The Test / Manual / Auto Switch (TMA) is located to the right of the HMI as shown in Figure 3-2 circled in yellow.



Figure 3-2: TMA Switch

The Power+ has three Operating settings controlled by a 3-position switch as shown below in Figure 3-3

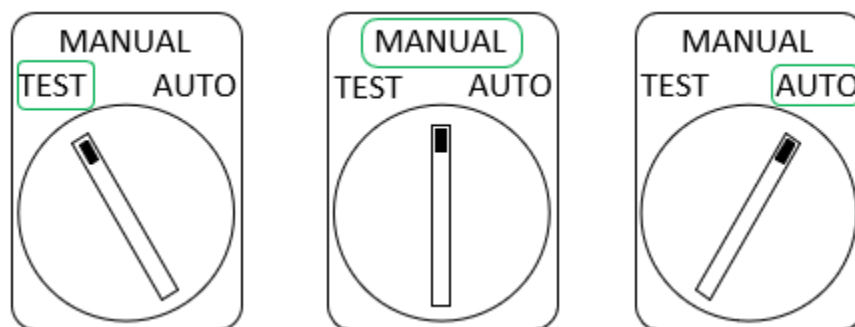


Figure 3-3: Positions of Switch

3.1.3.1. "TEST" mode - switch in left position:

Disabled Software features:

The ability to "start" the ORC from any input method is disabled. This includes the panel start button,

remote start button, screen start button, and remote connection via HMI start command.

Enabled Software features:

The only options available in test mode are the test screens, test functions, IO screens, and configuration screens. Default settings can only be loaded while in Test mode.

Mode "test" operation:

This mode is used when operator is on site performing routine maintenance or troubleshooting.

3.1.3.2. "MANUAL" Mode - switch in middle position:

Disabled features in "MANUAL" mode:

In manual mode, the test functions are disabled, as is any ability to automatically restart.

Operation in "MANUAL" mode

The machine starts via manual inputs only (panel start button, remote start button, screen start button, or remote HMI connection.) The machine will not automatically restart, and will need the operator to remotely push the start button following a shutdown for any reason. All shutdowns will require a start button to be pushed to re-start the equipment. The Power+ can be remotely or locally restarted after every shutdown with the exception of the 4 shutdowns outlined in the "Auto" mode below. These shutdowns require operator intervention to correct before a restart is allowed.

3.1.3.3. "AUTO" Mode – switch in right position:

Disabled features in "AUTO" mode:

In auto mode, the test functions are disabled.

Operation in "AUTO" mode

- 1) Switching the Power+ to "Auto" mode, or turning on the main power with the switch in "Auto" mode, will automatically start the Power+. Alarm/fault shutdowns will automatically restart the ORC once the fault is cleared.
- 2) The stop button will interrupt/halt the auto restart mode. If the stop button is pushed while the machine is in "auto" mode, this will disable the automatic restart until a manual start has been performed (via the start button, remote input, or HMI screen button), at which point the auto-restart capability will be enabled again. This is to allow the machine to be put in a stopped/off state remotely, without the machine restarting continuously.

Auto Restart limitations in "Auto" Mode:

It should be noted that any conditions that cause an alarm or fault that initiates a shutdown must clear (resolve) before an auto restart will initiate. Automatic restart (after alarm condition clears) will occur for all shutdowns except the following  alarms, which require operator inspection of equipment:

- 1) Expander inlet pressure switch alarm
 - a. Requires inspection at machine to determine cause of overpressure.
- 2) Generator contactor stuck closed alarm
 - a. Requires inspection of machine because contactor is stuck closed
- 3) Generator contactor fault alarm
 - a. Requires inspection of the machine to determine why the contactor will not close.
- 4) Phase Rotation Alarm
 - a. Requires inspection and re-phasing of incoming feeds.

3.2. Human-Machine Interface (HMI) Screens

The HMI display is the main control point for operators of the machine. It can be used to start & stop the machine, set parameters, select operating modes, and view active and past alarms. The display itself is an interactive touch-screen which is operated by pressing the various control icons on each screen.

If a button is selected and an input is necessary, a number keypad will show. A password will be required to adjust certain settings or access certain screens. If the password is unknown and clarification of access is needed, contact ElectraTherm Service.

If a value can be entered, the keypad will show the range of values allowed: type the new value in and select "Enter" or "Ent".

3.2.1. MAIN SCREEN

When first powered up, the HMI will show the 'Main Screen' by default, as depicted in Figure 3-4.

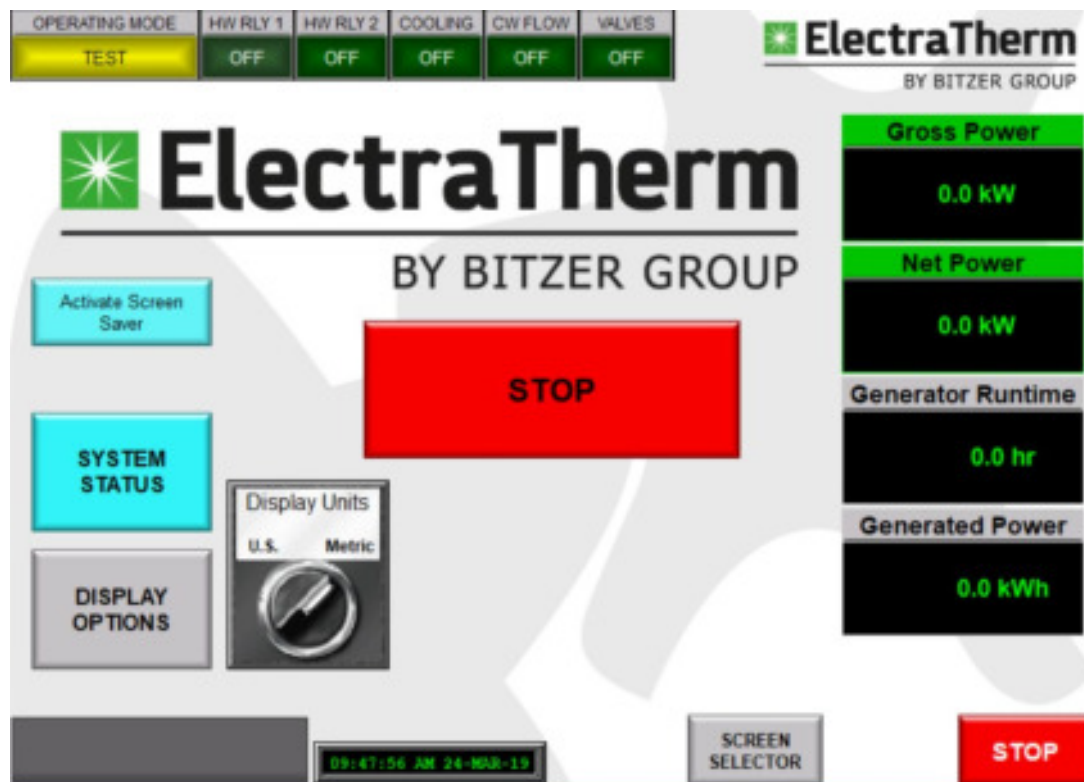


Figure 3-4: Main HMI Screen

The 'Main Screen' has seven interactive icons. They are:

- 1) **START / STOP:** The 'START' icon will start the machine. It is intended to allow the operator to quickly get a machine which has already been properly setup back online after having been powered down. The 'START' icon will only appear if all condition for startup are met. During operation the 'START' icon will be replaced by a 'STOP' icon – as shown above in Figure 3-4. The 'STOP' icon will shut down a machine which is running.

- 2) **STOP:** Note that there is a 'STOP' icon located in the lower-right corner of each screen. This enables the operator to shut down a machine without having to navigate to any screen.
- 3) **DISPLAY UNITS:** This switch will change the unit system for all screens.
- 4) **SCREEN SELECTOR:** The 'SCREEN SELECTOR' icon brings up the screen navigation menu bar.
- 5) **DISPLAY OPTIONS:** This icon gives the user the ability to change the primary language displayed on each of the screens. It should be noted that while the text on each screen will reflect the language selected, the text within the screen navigation menu cannot be updated. The date and time can also be updated from this screen.
- 6) **SYSTEM STATUS:** The 'System Status' icon takes the user directly to the 'System Status' screen. This allows the operator to observe the current operational status of the machine without needing to navigate through the menu bar.
- 7) **ACTIVATE SCREEN SAVER:** Turns off the HMI screen, the unit is still on and fully functional, but the display is no longer lit. Touching the screen will wake up the HMI turning the display back on.

3.2.2. AUTO CONTROLS SCREEN

The 'Auto Controls' screen provides information about the running conditions in one place as shown below in Figure 3-5.

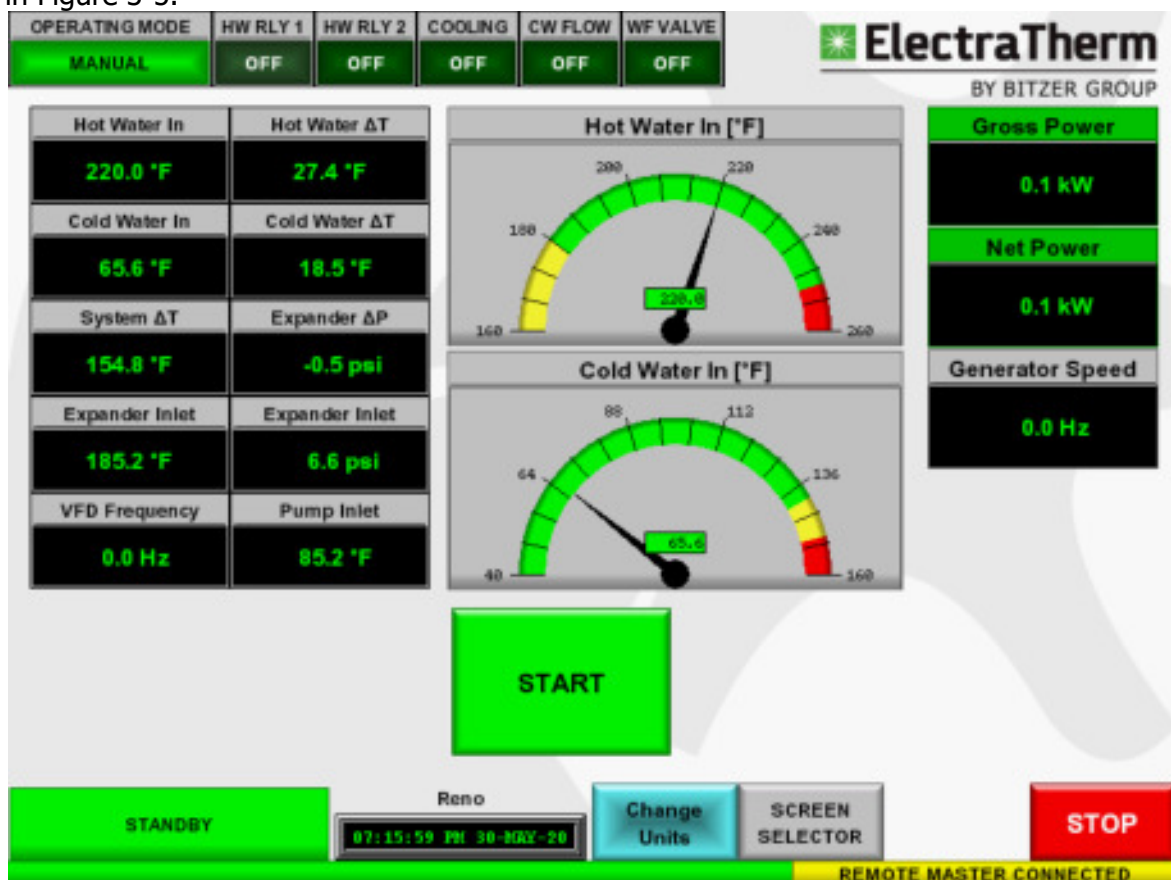


Figure 3-5: Auto Control HMI Screen

The 'Hot Water In' and 'Cold Water In' gauges provide a quick visual display letting the operator know if the water conditions are within the operating range. Both gauges need to be in the "GREEN" range for the machine to start. The 'Hot Water In' range is fixed based on the limits of the mode. The 'Cold Water In' green range will adjust with the hot water temperature to ensure there is the needed

temperature difference for operation.

3.2.3. SYSTEM STATUS SCREEN

The 'System Status' screen provides information about the running condition in a graphical representation of the cycle as shown below in Figure 3-6. Here the operator can see how much power is being made, and the water conditions coming into and leaving the unit.

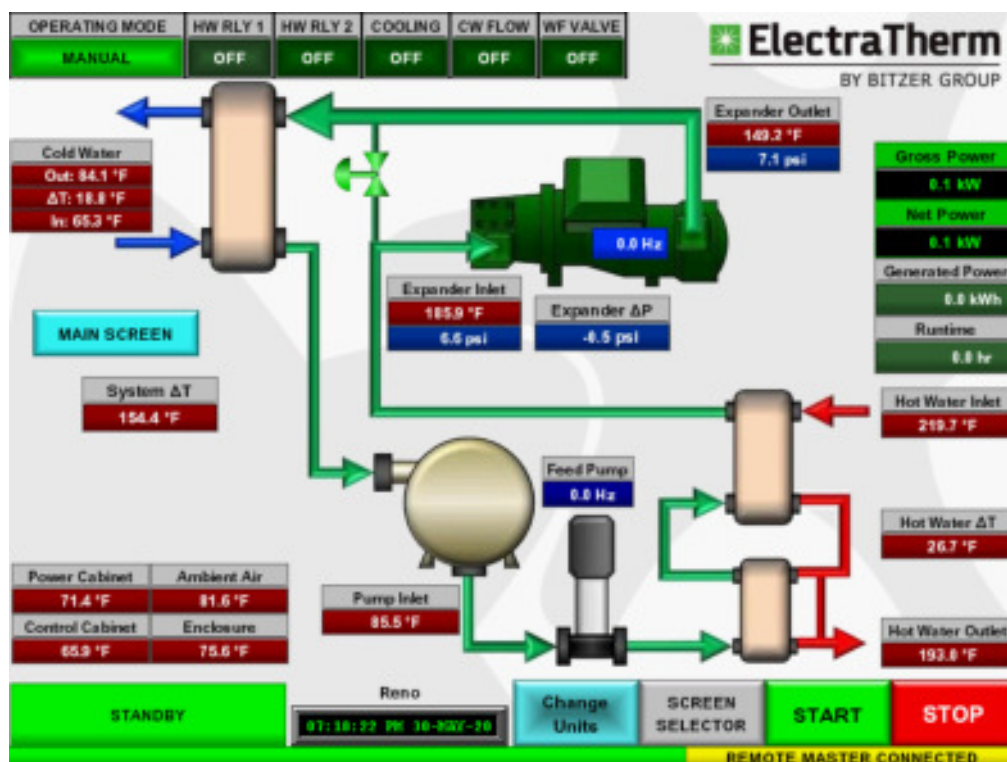


Figure 3-6: System Status HMI Screen

3.2.4. ALARMS SCREEN

The 'Alarms Screen' maintains a list of active alarm conditions, past alarm conditions, and controls events like button pushes. The 'Alarm Help' button will pull up a full list of the alarms based on number, each one linking to a help dialog for that alarm. For a full list of Alarms refer to Appendix 6.2

3.2.5. FAN CONTROLS

The 'Fan Controls' screen allows the user to set fan speed signals as a function of ambient temperature. This option is only used if the Power+ is being used to send a signal to a Liquid Loop Radiator providing the cooling water to the ORC.

3.2.6. VFD STATUS

The 'VFD Status' screen provides additional information from the VFD that is driving the feed pump in the machine. This includes the status from the drive and any faults from the drive.

3.2.7. ELECTRICAL INFORMATION

The 'Electrical Information' screen provided additional information from the unit's onboard power meter. This includes; Gross Power, Frequency, Total Power Factor, Line to Line Voltage, and Current.

3.2.8. LOGGING – SECONDS AND MINUTES

The 'Logging' screens show the unit data over time. This can be used to see how the conditions are changing overtime, and how the unit is responding to those changes

3.2.9. CONTACT INFORMATION

The 'Contact Information' screen provides; phone number, address, and e-mail for ElectraTherm. This screen also provides the software version currently installed; this information will be needed when contacting ElectraTherm for Troubleshooting assistance.

3.2.10. SETUP

The 'Setup' screen is used to configure the machine for the specifics of your site. Please refer to the "ETS-90182 Installation and Commissioning Guide"

3.3. STARTUP SEQUENCE

The Power+ ORC follows a specific starting sequence to ensure safe operation. The machine will send discrete signals to the customer site via dry contacts on the "Customer Terminal Strip". Refer to "ETS-90182 Installation and Commissioning Guide" for specifics of wiring to the customer terminal strip. It should be noted that use of these signals is not necessary for machine operation, they are provided to simplify the installation. However, the following sequence must be followed for successful machine operation.

1. The unit receives a start signal - this can be from the following sources: HMI Button Push, Physical Button Push (green), Remote Start Signal wired to the customer terminal strip, or Remote HMI Button Push from a remotely connected computer.
2. The Cooling Relays are closed signalling the site that the unit is ready to receive cold water.
3. The cold water flow switch is satisfied once a sufficient flow rate of water is detected at the machine.



The cold water must be flowing through the machine before the introduction of hot water. This will ensure the capability for heat rejection and prevent the uncontrolled buildup of internal pressure.

4. After the cold water flow has been verified with the flow switch, the hot water relays will close to signal the site that the unit is ready to receive hot water.
5. The unit then goes into a "Waiting for Conditions" mode until the hot and cold water temperatures are within the starting limits. These limits are represented by the green bands on the water temperature gauges of the auto controls screen see section 3.2.2.
6. Once the conditions are met the unit goes into a starting mode, an audible alarm sound to alert people nearby that the machine is starting.
7. The feed pump will cycle on for a few seconds to mix the working fluid to ensure lubrication is

- present at the expander – the pump then turns back off.
8. The bypass valve closes.
 9. The feed pump turns on again and builds pressure. As the system pressure builds the expander / generator starts to rotate.
 10. When the expander / generator is close to the grid frequency the generator contactor closes connecting the unit to the site grid.
 11. The unit controls will start to maximize the power production based on the conditions coming into the unit (hot and cold water temperature and flowrate).

3.4. NORMAL SHUTDOWN SEQUENCE

The Power+ ORC follows a specific shut down sequence to ensure safe operation. Whenever possible a normal shutdown should be used. Certain alarms will also trigger a normal shutdown. See Appendix 6.2 for alarm details.

1. The unit receives a stop signal - this can be from the following sources: HMI Button Push, Physical Button Push (red), Remote Stop Signal wired to the customer terminal strip, or Remote HMI Button Push from a remotely connected computer.
2. The hot water relays open signalling the site that hot water is no longer needed by the unit.
3. The feed pump ramps down to decreases system pressure.
4. The bypass valve opens at the same time the generator contactor is open. This removes all torque from the generator and at the same time relieves any residual pressure from the evaporator to the condensers.

NOTE: The unit is equipped with a passive braking system that uses braking resistors and capacitors to slow down the expander / generator. During some normal shutdowns this can be engaged to prevent the unit from accelerating above 70Hz.

5. The cold water relays stay on to cool the unit off until the internal pressure reaches a safe level.

3.5. EMERGENCY SHUTDOWN SEQUENCE

In the event of an emergency stop the unit undergoes a very rapid shutdown and deceleration. This should be limited to true emergency situations – certain critical alarms will also trigger an emergency stop. See Appendix 6.2 for alarm details.

1. The unit receives an emergency stop signal - this can be from the following sources: Physical Button Push (red mushroom), Remote Emergency Stop Signal wired to the customer terminal strip.
2. The feed pump shuts off, the bypass valve opens, the generator contactor opens, and the hot water relays all open at the same time.
3. The excess system energy is dissipated through the passive braking system that uses braking resistors to slow down the expander / generator. During all emergency shutdowns this braking system is engaged to prevent the unit from accelerating above 70Hz.

4. ROUTINE MAINTENANCE

4.1. Routine Maintenance Definition.

Routine maintenance covers all maintenance items expected to be carried out for normal operation. Maintenance is required every 4400 hours. See Maintenance Schedule in Appendix 6.3 Record all maintenance and email to ElectraTherm's Customer Service Group.

4.2. Routine Maintenance Item Descriptions.

Maintenance Item Description	Required Service Maintenance Interval: hours/(years)
Inspect all plumbing, flanges, and valves for leaks	4400 / (0.5)
Inspect hardware for wear/damage	4400 / (0.5)
Grease pump motor bearings	4400 / (0.5)
Clean cabinet and enclosure cooling fans and filters	4400 / (0.5)
Inspect for electrical wear/damage	4400 / (0.5)
Check for NCGs in working fluid	4400 / (0.5)
Check HX water-side pressure drop	8800 / (1)
Clean Skid / Clean LLR	8800 / (1)
Verify operability of safety equipment	8800 / (1)
Replace High/Low Sides PRVs	17600 / (2)
Replace HMI and PLC battery	17600 / (2)
Bitzer Expander Replacement	35200 / (4)
Replace VFD internal cooling fan	26400 / (3)

Table 4-1: Routine Maintenance Items

4.3. Routine Maintenance items detailed maintenance

4.3.1. Inspect all plumbing, flanges, and valves for leaks.

1. Check water flanges for leaks visually.
2. Check working fluid plumbing for leaks visually with a liquid leak detector, or a Refrigerant leak detector/sniffer. Check all flanged connections, valves, lubrication filters, filter/driers, sensors and miscellaneous fittings in the working fluid plumbing and on the expander.
3. Check Air system fittings for leaks both audibly and with a liquid leak detector. With the machine off, and the air system under pressure, listen for large leaks around the air compressor, air lines, and the solenoid valve located at the air operated valve(s). Check these areas using a liquid leak detector around the fittings to check for smaller leaks. Cycle the WF bypass valve open and closed and ensure that there are no leaks when the valve is in either position

4.3.2. Inspect Mechanical Hardware for wear/damage

Check all mechanical hardware for wear or damage. Inspect valve handles, working fluid pump, door latches. Check Torque on plumbing connections and hardware connections as detailed below in Table 4-2:

PART LOCATION	MACHINE TYPE	SIZE	GRADE (METRIC)	TYPE	TORQUE (lb·ft)	TORQUE (N·m)
Tank to Tank Table	4400B	M12x1.75x35L	8.8		60	81
4400B,4400B+	4400B	M12x1.75x50L	8.8		60	81
Expander to Expander Table	4400B,6500B	M12x1.75x50L	8.8		60	81
Evaporator to Table	4400B	M12x1.75x35L	8.8		60	81
Pre-Heater to Base	4400B	M12x1.75x35L	8.8		60	81
Condenser to Table	4400B	M12x1.75x35L	8.8		60	81
Expander Inlet Flange	4400B,6500B	M16	8.8		111	150
Expander Outlet Flange	4400B,6500B	M20	8.8		148	200
Pump Flanges	4400B	M16x2.00x80L	8.8		70	95
Pump Base	4400B	M12x1.75x100L	8.8		37	50
1 1/4" Class 150 Flange	4400B	M14x2.00x60L	8.8		45	61
1 1/2" Class 150 Flange	4400B	M14x2.00x60L	8.8		45	61
2" Class 150 Flange	4400B	M16x2.00x80L	8.8		90	122
2 1/2" Class 150 Flange	4400B	M16x2.00x80L	8.8		90	122
3" Class 150 Flange		M16x2.00x80L	8.8		115	156
2" Class 150 Flange		M16x2.00x80L	8.8			

Table 4-2: Mechanical Hardware

4.3.3. Grease Pump Motor Bearings

Locate the zerk fittings on the pump motor and add 5 pumps of Exxon Mobil Polyrex EM grease to each Zerk fitting on the pump motor.



Figure 4-1: Grease Pump Motor Bearings

4.3.4. Clean Cabinet and Enclosure cooling fans and filters

The Electrical Power and Control Cabinets have cooling fans and intake air filters. Clean dust from the fans with a brush and vacuum. Remove the air filters, clean them with a brush vacuum and wash them with soap and water. Allow the filters to dry and place them back into the fans and filter assemblies. If machine is equipped with enclosure cooling fans, clean any debris and dust from the fan blades with a brush and vacuum. Verify operation of all cooling fans by manually controlling them on and off from the test screens on the HMI.

4.3.5. Inspect for Electrical wear/damage

Check all electrical connections with a thermal camera (while machine is operating). Loose connections will be at a higher temperature than surrounding cabling.

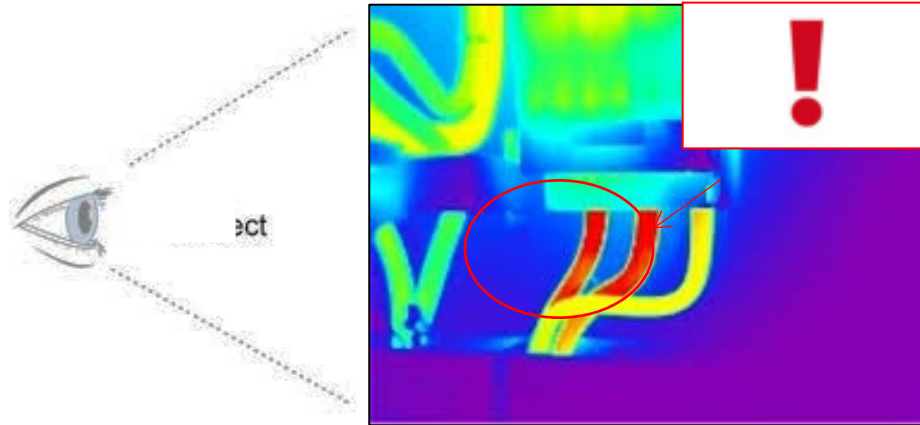


Figure 4-2



ELECTROCUTION HAZARD. This work MUST be performed with the ORC powered down, with the incoming power feed locked out, and tagged out per local requirements.

If you do not have a thermal camera, go through each cabinet and apply pressure to each connection. If there are loose connections, tighten the terminal.



Figure 4-3



Figure 4-4

4.3.6. Check for NCG's in working fluid

Check for non-condensable gases (NCG's) every year.

- Shut down the machine and wait 1 minute.
- Read the Expander Low Pressure and Liquid Temperature (WF Tank Outlet Temperature on 4400B, Pump Inlet Temperature on 6500B) from the System Status screen.
- Plot the pressure and temperature as a single point on Figure 4-5 below.

HFC-245fa Saturation Curve

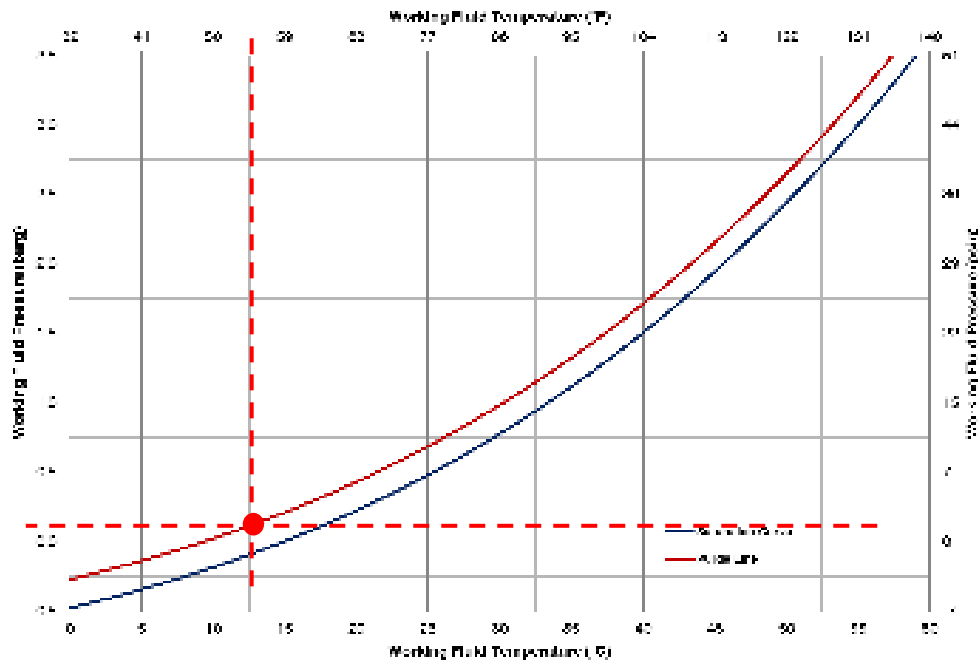


Figure 4-5

If the point is in the **RED** area, the machine needs to be purged. Remove NCG's using appropriate refrigeration procedures as required by local rules and regulations.

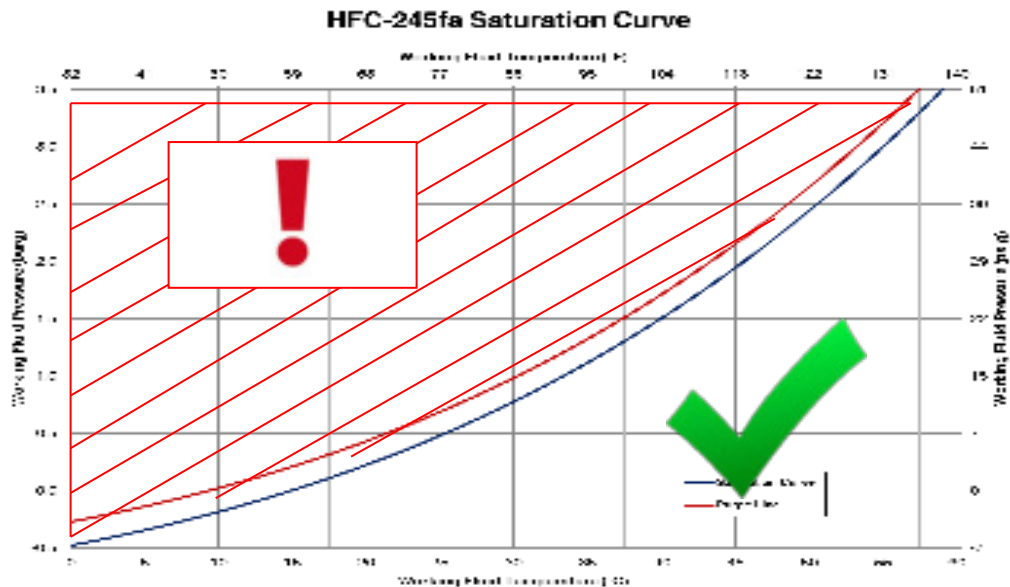


Figure 4-6: HFC-245fa Saturation Curve

4.3.7. Check HX water side pressure drop

The pressure drop across the heat exchangers should be recorded during commissioning for baseline pressure drop numbers at the sites nominal hot water and cold water flow rates. A pressure gauge needs to be installed on the inlet and outlet of the HW and CW plumbing going into and out of the ORC. Charts are shown below for pressure drops vs. flow rates for new, clean heat exchangers. Record the pressure drop at nominal flow rates. If a heat exchanger is getting fouled or obstructed, the pressure drop will increase above the curve for the flow rates. Pressure Drop vs. Flow rate curves are machine type specific, and shown below.

4400B

Heat Exchanger Pressure Drop v. Flow Rate

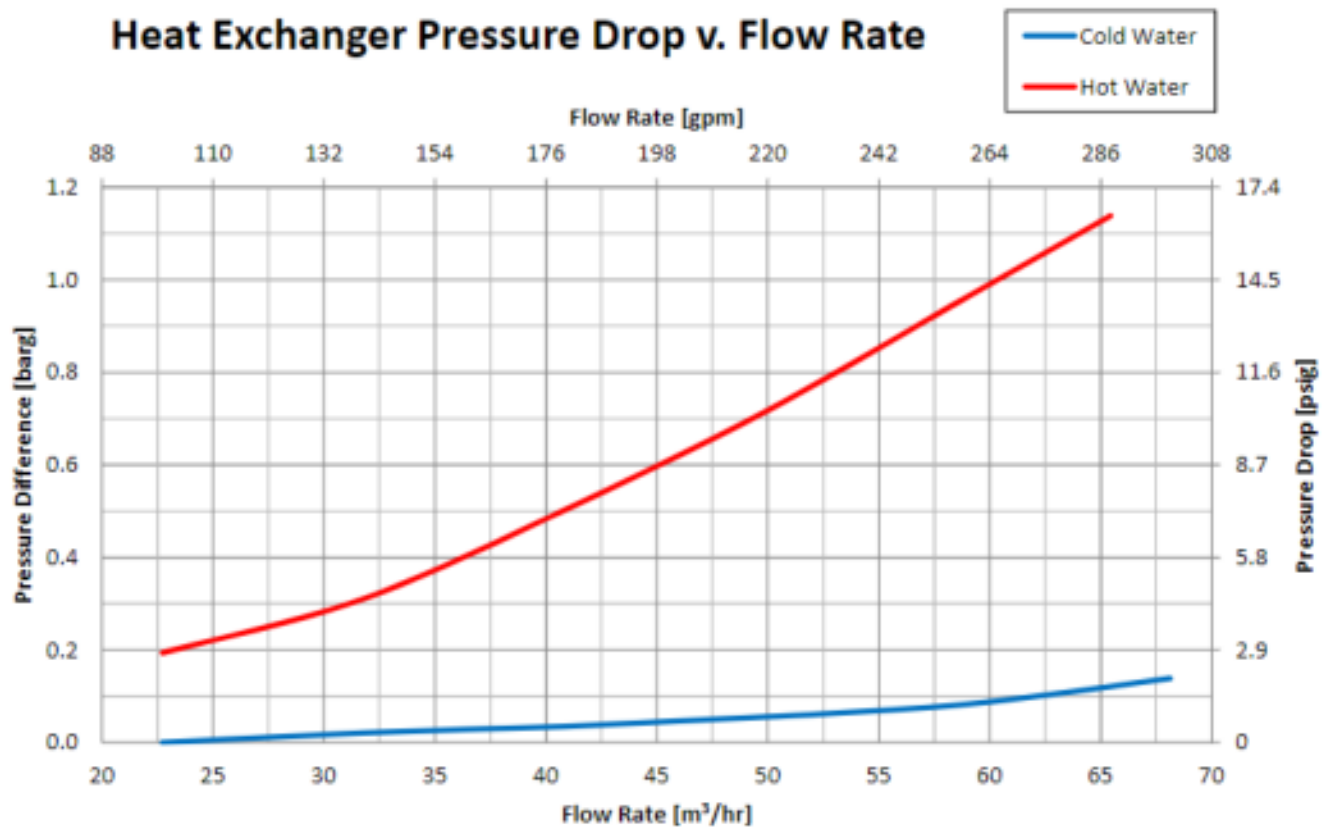


Figure 4-7: 4400B Heat Exchanger Pressure Drop v. Flow Rate

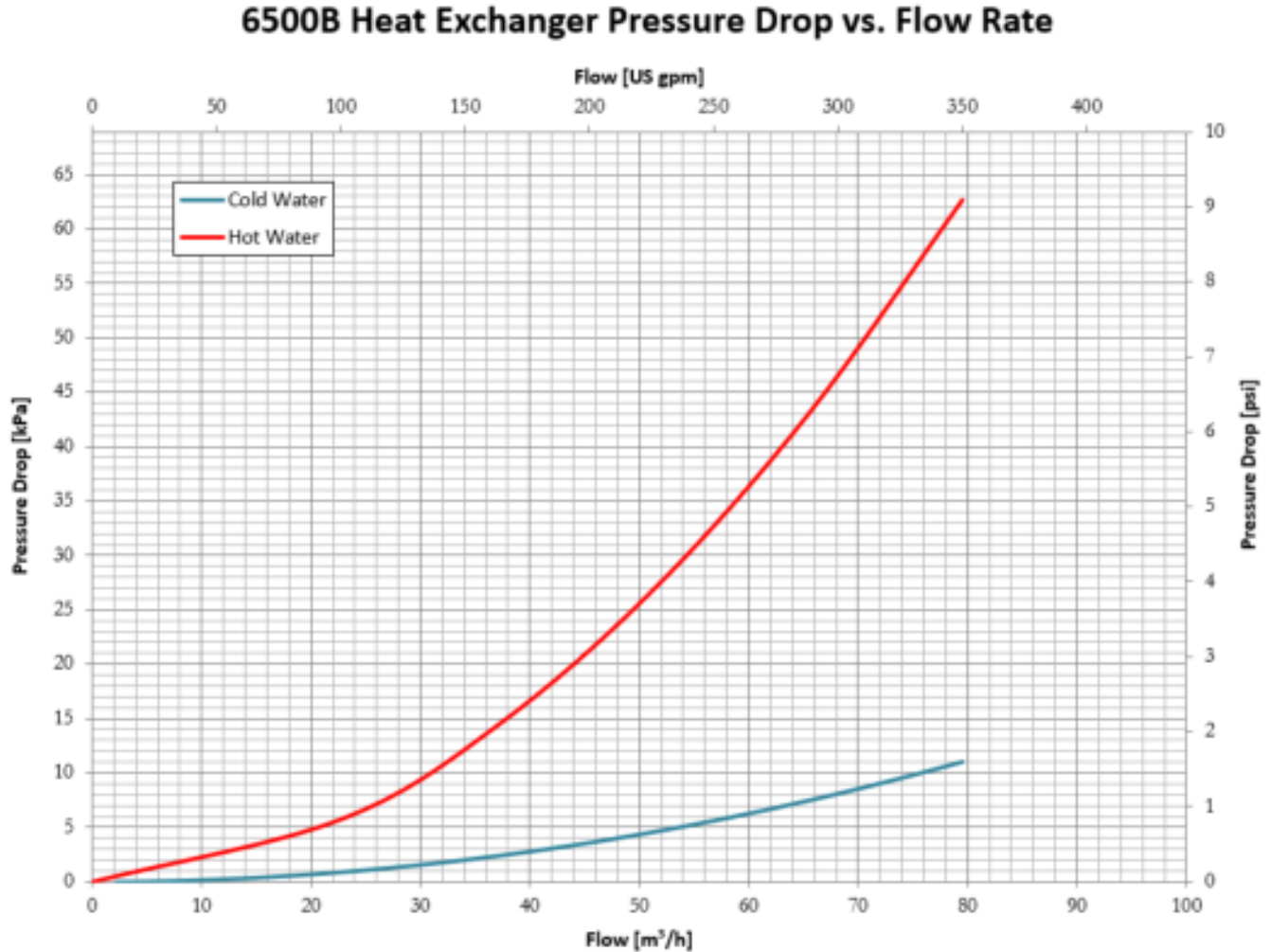


Figure 4-8: 6500B Heat Exchanger Pressure Drop v. Flow Rate

4.3.8. Clean skid, clean equipment

Clean up loose dirt debris using a vacuum. Clean equipment with soap and water.

4.3.9. Verify Operability of safety equipment

With the machine shut down, but powered up, from the test screen, test the red, yellow, green light outputs, as well as the buzzer/horn output and verify operability.

From the IO Screen, verify that the start, stop, enable, and emergency stop buttons work smoothly, and indicate proper operation.

4.3.10. Replace High/low side PRV's

Service Pressure Relief Valves (PRV's) on a replacement schedule according to the local codes and requirements where the equipment is installed. The "PRV" is a safety valves installed on the working fluid plumbing to release working fluid in the event of a system over pressurization on either the high pressure or low pressure side of the working fluid plumbing. Two Valves are installed on a shuttle valve allowing each PRV to be removed and replaced without the need to transfer working fluid out of the ORC. Low pressure working fluid plumbing is located between the outlet of the expander, condenser, and inlet of the working

fluid pump. High pressure working fluid plumbing is located between the outlet of the working fluid pump, pre heater, evaporator, and inlet of the expander. Note: The 4400B machines do not have high side PRV's.

With the valve stem all the way out, replace the PRV on the left.

This is also the valve position for normal operation. In this position the stem of the shuttle valve is not in contact with the working fluid.

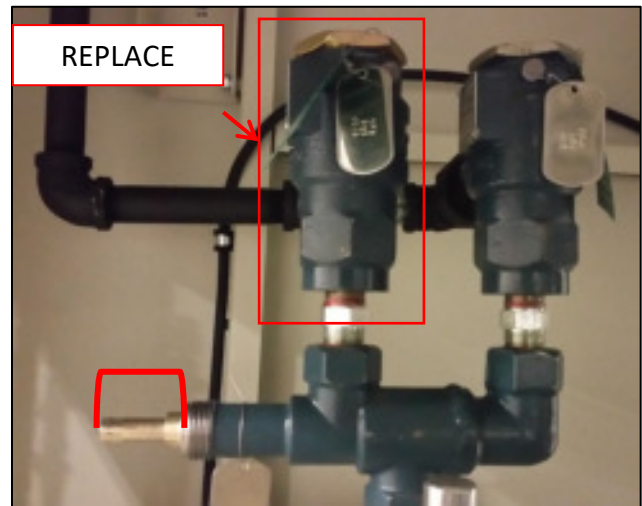


Figure 4-9

With the valve stem all the way in, replace the PRV on the right.

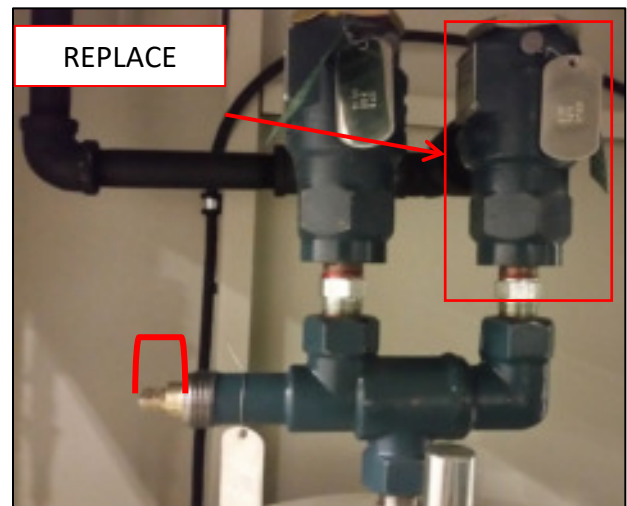


Figure 4-10

4.3.11. Replace PLC/HMI Battery

The PLC and the HMI both use a standard CR2354 type battery. The battery on the PLC has a plastic tab mounted to it so that the batter can be removed by hand.



Figure 4-11: Panasonic CR2354 3V Battery

HMI Battery Replacement:

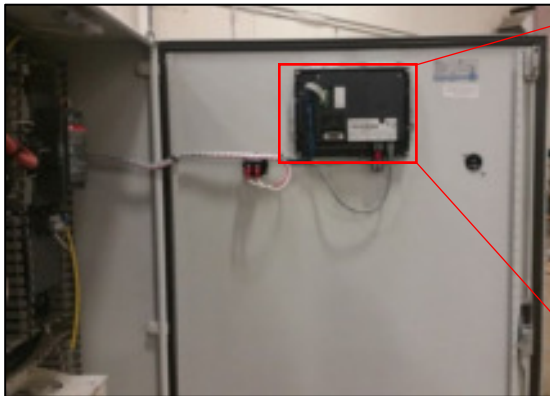


Figure 4-12

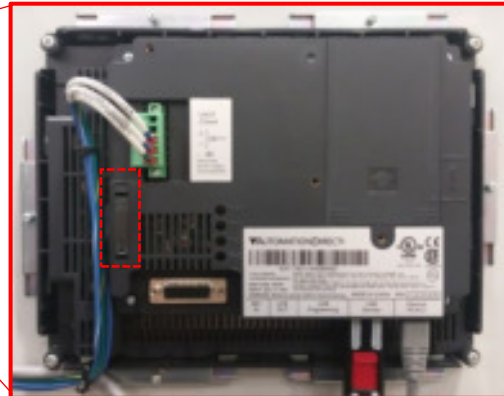


Figure 4-13

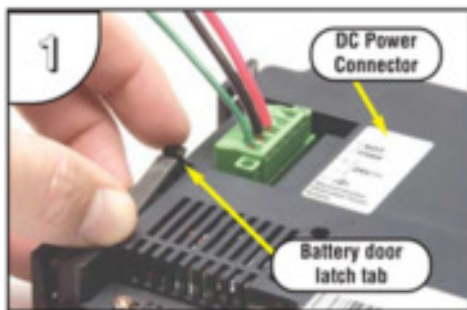


Figure 4-14



Figure 4-15

Images © Automation Direct. Used with permission.

PLC Battery Replacement. Note the tape tab and re-apply it to the new battery as shown below.

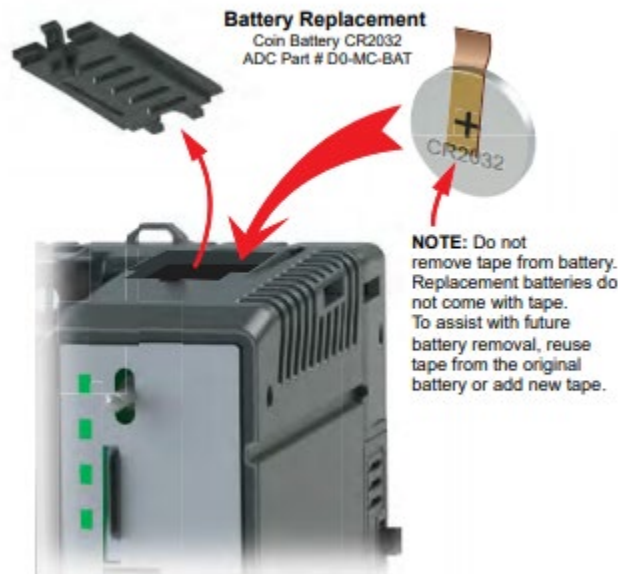


Figure 4-16: Battery Replacement

4.3.12. BITZER Expander/Generator replacement

The BITZER Expander/Generator Replacement is performed after 35,200 hours of operation/4 years, and detailed information on that can be found in the supplementary Document "ETS-90184, Power Plus ORC Non-Routine Maintenance Manual"

4.3.13. Replace VFD internal cooling fan

Replace VFD cooling fan every 3 years. VFD size and location will vary by machine type.

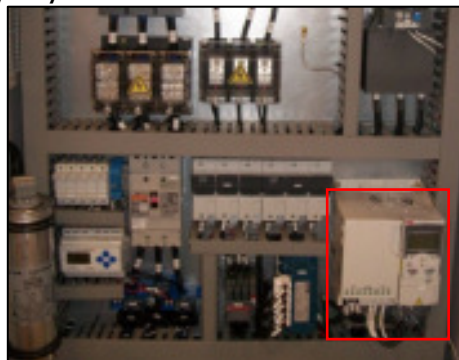


Figure 4-17: VFD Internal Cooling Fan



ELECTROCUTION HAZARD. This work MUST be performed with the ORC powered down, with the incoming power feed locked out, and tagged out per local requirements.

Shut off the power panel and open the disconnect switch.
Wait for ALL lights on VFD to turn off.



Figure 4-18: VFD Lights Still Active



Figure 4-19: VFD Lights Turned Off

Use a flat head screw driver to prop the fan housing up



Figure 4-20

Disconnect the fan from the VFD and remove the fan housing



Figure 4-21

Pull the tabs at the bottom apart to release the fan. Insert new fan into housing and replace housing into VFD.

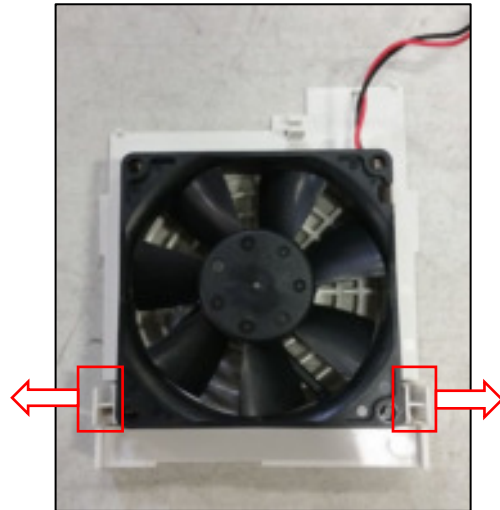


Figure 4-22: Fan Housing

5. Alarms and Troubleshooting

The 'Alarms Screen' maintains a list of active alarm conditions, past alarm conditions, and controls events like button pushes. The 'Alarm Help' button will pull up a full list of the alarms based on number, each one linking to a help dialog for that alarm. For a full list of Alarms refer to Appendix 6.2.

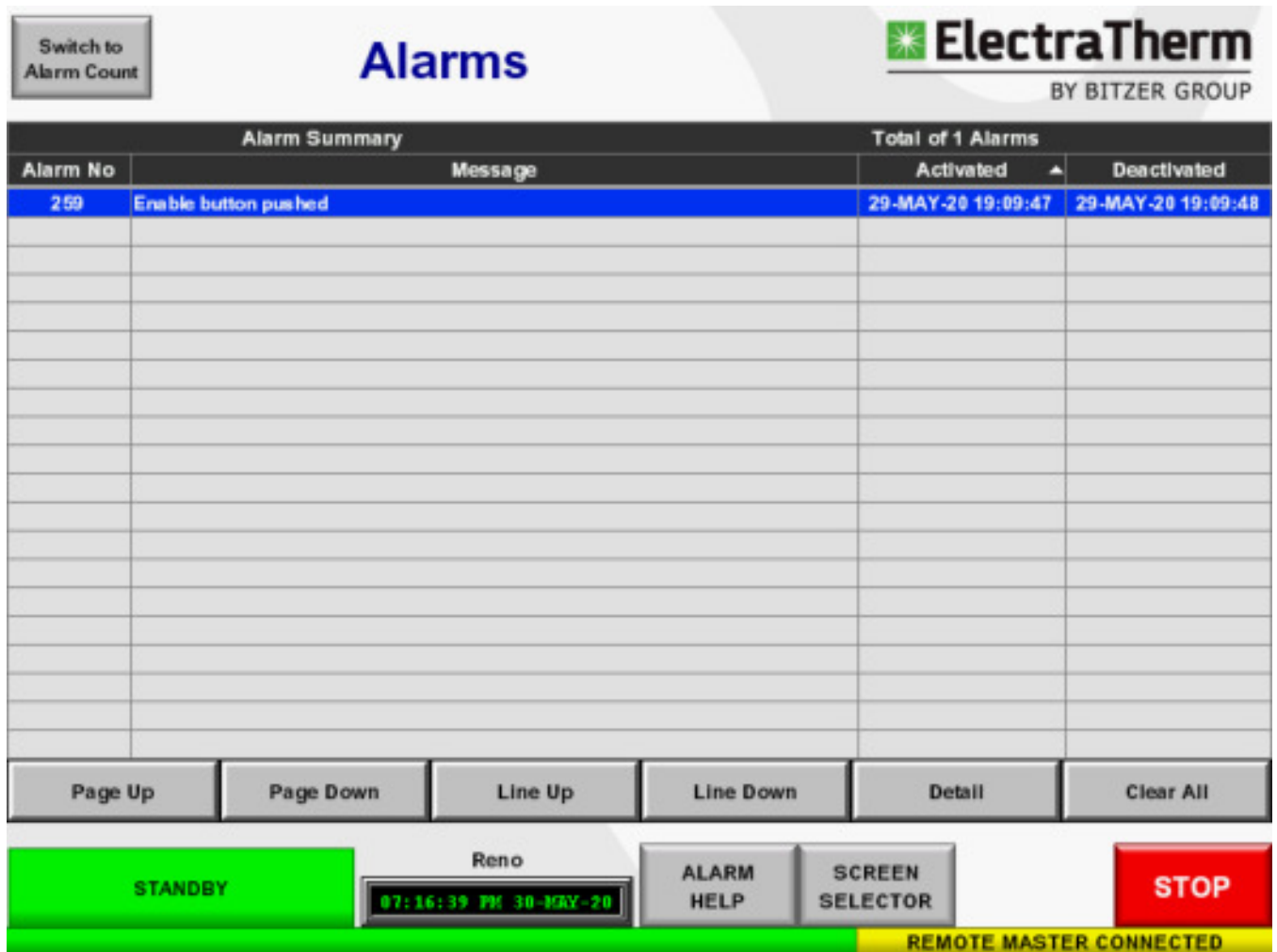


Figure 5-1: Alarm Screen

6. Appendices

6.1. SHUTDOWN LIMITS

Machine shutdown limits are shown below, in Table 6-1: Shutdown Limits.

Alarm #	Alarm Name	Alarm Activation Value S6000	Alarm Reset/Clear value S6000	Alarm Activation Value S4000	Alarm Reset/Clear Value S4000
196	High pressure switch	Pressure Switch opens @300psi(20.68Bar)	Pressure switch closed AND press Enable	Pressure switch opens @ 275 psi(18.96bar)	Pressure switch closed AND press Enable
234	Ambient temperature high	HMI setting	HMI setting - 10°F(5.5°C)	HMI setting	HMI setting - 10°F(5.5°C)
235	WF tank temperature high	≥180°F(65.55°C)	<135°F(57.2°C)	≥150°F(65.55°C)	<135°F(57.2°C)
240	Evaporator pressure high	≥262 psi	<220 psi	≥200 psi	<180 psi
242	System (condensing) pressure high	≥120 psi	<100 psi	≥70 psi	<60 psi
245	Hot water temperature high	>275°F(135°C) or lower user set in HMI limit	<270°F(132°C) or user set HMI limit - 5°F	>250°F (121°C) or lower user set in HMI limit	<245°F(118.33°C) or user set HMI limit - 5°F
251	Low net kW	< user set minimum in HMI, 5 kW minimum	automatic	< user set minimum in HMI, 5 kW minimum	automatic

Table 6-1: Shutdown Limits

6.2. ALARM LIST:

All of the Alarms on the Power Plus ORC have troubleshooting help, available from the Alarm help screen. Alarms, triggers, and troubleshooting are listed on the following pages. The troubleshooting tips are only a guide, contact ElectraTherm for additional information. The Alarm List is believed to contain the most recent and correct information at the date of publication and will be revised periodically without notice. ElectraTherm, Inc. makes no warranty, either expressed or implied, regarding the accuracy, completeness, sufficiency, or suitability of any material herein for any specific purpose, particularly with respect to possible nuances resulting from language translation. Interested parties should contact ElectraTherm, Inc. for further assistance regarding the most recent material, product, system, operating, and maintenance information.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
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192	Local Grid Protection Relay (GPR) open	GPR detects phase loss or imbalance	The Grid Protection Relay (GPR) monitors voltage and current on all three primary power phases. When it detects sufficiently abnormal conditions, it will trigger an Emergency Stop to prevent damage to the Power+. 1) Check the Electrical Information screen. With the Power+ off grid, all three phase voltages, and the grid frequency, should read close to the grid nominal values.
193	Remote GPR	Customer terminal jumper missing OR Site GPR active	Check site GPR, or if none check for jumper on customer terminal strip.
194	Emergency Stop active	E-stop button	The emergency stop button triggers a rapid stop of the Power+. While the button is latched in, this alarm will remain active and it will not be possible to restart. The emergency stop button must be pulled out (reset) to clear this fault.
195	Remote Emergency Stop activated	Remote E-Stop Aux contact closes (retrofit) OR Remote E-Stop Aux contact opens	The remote emergency stop options allows a site-connected interrupt in the Power+ emergency stop circuit. The terminals used for this circuit must have a jumper installed between them if this function is not desired. 1) If installed, check the remote E-stop button and associated wiring. 2) If not installed, check for the jumper on the customer connection terminal strip and replace if necessary.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
196	EXPANDER HIGH PRESSURE SWITCH ACTIVATED!	Expander High Pressure switch opens	The expander high pressure switch is a critical fault indicator. Several other safety systems must fail for system pressure to get this high. The Power+ should not be operated until the cause is located and resolved. This fault will trigger an emergency stop. 1) Check the wiring from the switch to the PLC. A loose wire could cause a false alarm. 2) Check for damage to any of the working fluid piping. 3) Test operation of the bypass valves. 4) Test the expander inlet PT, wiring, and input card. 5) Once the cause is located and resolved, press Enable to resume operation.
198	Generator contactor fault	When generator contactor closes, aux contactor must close within 0.5 sec, and remain closed the contactor is closed	Once the generator contactor is enabled, the feedback contact to the PLC must close within 0.5 second and remain closed while the enable output is on. 1) Check the wiring between the generator enable relay output and generator contactor. 2) Check the wiring between the auxiliary feedback contact and the PLC input. 3) Check that the relay output card is functioning properly. Test electrical continuity of the relay output fuse, replace if open.
199	GENERATOR CONTACTOR STUCK CLOSED!	Generator Aux contact stays closed for 1000ms when contactor enable is switched off	If the generator is consuming power (negative Gross Power), the generator contactor is fused closed and cannot disconnect from the grid! Open the primary disconnect that supplies the Power+. Contact your distributor immediately. 1) If the generator contactor has failed, it will need to be replaced before restoring power to the Power+. 2) If the generator is not consuming power, the generator auxiliary contact has failed. Contact your distributor to request a replacement.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
200	Phase rotation backwards	Phase/voltage relay detects that phases are wired backwards	This alarm warns that the Power+ is not connected correctly to 3-phase power. This will cause the generator to spin the wrong way, which could cause severe damage to the machine. 1) Disconnect the Power+ at the supply panel. Open the power cabinet, and switch the wires for phases A and C on the incoming power connection. 2) If swapping supply phases does not clear this alarm, check for other alarms that are also active. If any of the fuses are open on the sensing lines, it will cause a false trip of this alarm.
201	Generator overspeed	Startup-Generator not enabled Shutdown-Overspeed from excess pressure	If measured generator speed exceeds 2 Hz above grid frequency, the Power+ will shut down to prevent damage to the expander. 1 1) Check to make sure that the generator contactor and relay output are working properly. 2) If during shutdown make sure breaking hardware has no loose wires or connections
202	Generator consuming power	Less than 0.5 kW generation after 4 seconds on grid	The Power+ should begin generating power within 4 seconds of connecting to the grid. Running the generator as a motor can cause severe damage to the expander. This fault activates emergency stop. 1) Ensure that there is sufficient heat and cooling (temperature and flow) for the Power+ to operate.
203	Soft starter fault	Soft starter installed	soft starter is faulted. Check soft starter and wiring.
209	Analog input card power fault - Base, Slot 1	All channels go to 8000 when +24V and/or 0V removed from card OR channel shorted to +24V makes all channels go to 1665	When an analog input card is not supplied with +24VDC or a neutral (0V) reference, or a channel is shorted to +24 VDC, all input channels read incorrectly. 1) Check power wiring to the input card. Repair loose +24 VDC and/or ground wire. 2) Determine which channel is shorted to ground by disconnecting them one at a time until the fault resolves. Repair wiring or replace the sensor as needed.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
210	RTD Module 1 Fault	Fault bit received from RTD card	Check wiring / sensor / card
211	RTD Module 2 Fault		
212	RTD Card 1 Fault		
213	RTD Card 2 Fault		
214	RTD Card 3 Fault		
216	Expander Inlet PT fault	Expander inlet PT open circuit	Individual analog input faults occur when the channel is open, shorted to ground, or the input current is less than ~3 mA. 1) If multiple inputs on a single card are showing faults, check that the connector is seated firmly. 2) Check that the analog input card is installed securely. 3) Check the wiring of the input/sensor for damage. 4) Check the sensor/input source for damage.
217	Expander Outlet PT fault	Expander outlet PT open circuit	Individual analog input faults occur when the channel is open, shorted to ground, or the input current is less than ~3 mA. 1) If multiple inputs on a single card are showing faults, check that the connector is seated firmly. 2) Check that the analog input card is installed securely. 3) Check the wiring of the input/sensor for damage. 4) Check the sensor/input source for damage.
218	Remote kW Output Limit fault	Remote Max kW SP enabled Remote Max kW open circuit	Individual analog input faults occur when the channel is open, shorted to ground, or the input current is less than ~3 mA. 1) Ensure that Remote kW Limit is enabled if installed. The field device must provide a 4-20 mA signal. Contact your distributor for more information. 2) If you do not have the Remote kW Limit installed, disable the option. 3) If multiple inputs on a single card are showing faults, check that the connector is seated firmly. 4) Check that the analog input card is installed securely. 5) Check the wiring of the input/sensor for damage. 6) Check the sensor/input source for damage.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
219	Speed Sensing Signal Fault	Speed Sensing enabled Speed Sensing input open circuit	Individual analog input faults occur when the channel is open, shorted to ground, or the input current is less than ~3 mA. 1) If multiple inputs on a single card are showing faults, check that the connector is seated firmly. 2) Check that the analog input card is installed securely. 3) Check the wiring of the input/sensor for damage. 4) Check the sensor/input source for damage.
220	Enclosure RTD fault	Fault bit	RTD faults trigger when the signal input is exactly 0 for 10 seconds, indicating an open or short circuit. 1) If multiple RTDs on a single card are showing faults, check that the connector is seated firmly. 2) Check that the RTD card is installed securely. 3) Check the wiring of the RTD for damage. 4) Check the RTD for damage.
221	Cold Water Inlet RTD fault	Fault bit	
222	Cold Water Outlet RTD fault	Fault bit	
223	Hot Water Inlet RTD fault	Fault bit	
224	Hot Water Outlet RTD fault	Fault bit	
225	Ambient Air RTD fault	Fault bit	
226	Pump Inlet RTD fault	Fault bit	
227	Expander Inlet RTD fault	Fault bit	
228	Expander Outlet RTD fault	Fault bit	
229	Power Cabinet RTD fault	Fault bit	
230	Control Cabinet RTD fault	Fault bit	

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
231	Generator rotation not detected	Startup Expander dP > 2 psi Measured rotation < 1 Hz 3 second timer	During pre-lube and startup, the Power+ needs to detect at least 1 Hz generator rotation while the expander $\Delta P > 2$ psi (0.14 bar). If rotation is not detected for 3 seconds, startup will be aborted. 1) Check for sufficient hot water flow. If the hot water is hot enough to start, but very low flow, it may not transfer enough heat into the Power+ to spin the generator. 2) Check the wiring for the Speed Sensing. Wiring to the inputs and the connection to the FC-33, and the FC-33 connection to the Analog Input card. 3) Check the power at the FC-33 card
232	Generator did not reach On Grid speed	Once the VFD starts ramping on Startup, the generator must get on grid within 60 seconds	After the VFD begins the startup ramp, the generator must reach the On Grid speed of 57 Hz within 60 seconds. Failure will trigger shutdown. Auto-Restart is allowed, if enabled. 1) This can be caused by a vapor bubble in the feed pump. Often, another start attempt will succeed. 2) Ensure adequate hot water flow - pumps on, valves fully open or closed as needed.
233	Insufficient cold water flow	1) Startup 2) On Grid OR shutting down CW control On CW flow switch Off	For safety and proper performance, the Power+ requires a minimum cold water flow of 150 gpm (9.5 L/s) for a 4400B, or 225 gpm (14.2 L/s) for a Series 6500B. Flow is measured with a flow switch on the cold water inlet. During startup, the Power+ will wait for the flow switch to close. If the switch opens during operation, it will trigger a shutdown. Auto-restart is allowed. 1) Ensure that the cold water source is operating: valves open, pumps on, etc. 2) If cold water flow is confirmed, check the operation of the flow switch.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
234	Ambient temperature above maximum	Ambient RTD installed Ambient temperature > HMI setting	Ambient RTD only. To prevent the Power+ operating when the ambient temperature is too high to make minimum output, the maximum ambient start temperature can be adjusted on the Site Options screen. 1) If the Power+ needs to be started, the temperature limit can be adjusted. 2) Wait until the ambient temperature cools off.
235	Working fluid temperature too high	4400B Tank out temp > 150°F 6500B Tank out temp > 180°F	This alarm warns that the working fluid is too hot at the tank outlet/pump inlet. This should be the coldest part of the cycle, immediately after the condensers. If the working fluid is not cooled, the pressure relief valve (PRV) may open, venting the working fluid. This alarm will cause shutdown of the Power+. 1) Ensure that the cooling loop is operating properly, and the condensing water is cold enough. 2) The Power+ will continue cooling to bring the internal pressure down to a safe level. Leave it powered. 3) Using an infrared thermometer, check the temperature of the tank and the condensers, and compare to the values shown on the HMI. If there is a significant difference, the RTD or input card may be faulty.
236	VFD fault: see VFD Status screen	VFD fault relay input open	The Variable Frequency Drive (VFD) that controls the pump monitors a number of internal faults. When the drive detects a fault, it will cause the Power+ to shut down and flag this alarm. 1) If VFD Modbus communication is installed, check the VFD Status screen to identify the fault. If not, open the power panel and check the fault indication on the VFD module screen. 2) Details for troubleshooting the fault can be found in the Alarm Help, or the manual for the VFD. 3) If the VFD does not show an active or recent fault, check the wiring from the alarm relay on the drive to the PLC.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
238	Remote stop activated	Remote stop input opened OR Pendant stop button pushed	A remote stop button can be wired to the Customer Terminal Strip in the control panel. This switch should be normally closed/momentary open to trigger a shutdown of the Power+. If this feature is not installed, a jumper must be installed between the indicated terminals. 1) Check that the switch is closed and all wire connections are tight. 2) If not used, ensure that the jumper is installed between the correct terminals.
239	System warmup timeout	Warmup limit $\neq$ 999 minutes (HMI) Warmup exceeded time limit set in HMI	If the working fluid/oil or the expander are too cold at startup, the warmup cycle runs to heat them before startup. By default, the warmup can run indefinitely if heat is not available. If desired, a limit can be set to abort startup if the system does not warm up within the allowed time. This alarm indicates that the allowed warmup time has been reached, and startup aborted. 1) If this functionality is desired, no troubleshooting is needed. Ensure heat and cooling are available to the Power+ to allow successful startup. 2) If this function is not needed, set the Warmup Time Limit on the Startup Parameters screen to 999.
240	Expander inlet pressure too high	Expander inlet PT no fault 10 second delay after On Grid Inlet pressure > 200 psi	Expander inlet pressure may not exceed the pressure rating of the expander. If it exceeds 200 psi (13.8 bar), the Power+ will shut down until the pressure decreases below 100 psi (6.9 bar). If in Auto mode, the Power+ will restart once the pressure has decreased. 1) Ensure that cooling is sufficient for inlet heat conditions. 2) Observe Power+ operation for any abnormalities.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
241	Generator too hot	Generator winding thermal switch opens	The windings in the generator contain a thermal switch that opens if the wires get too hot. This prevents damage to the generator. The switch will reset by itself, but it should be determined why the generator overheated. 1) Check the air vents on the front and back of the generator. Clean them if fouled. 2) Ensure that the belt shroud fan (if equipped) is plugged in, operating correctly, and not obstructed. 3) Wait for the generator to cool off before restarting.
242	Condensing pressure too high	Expander outlet PT no fault S4k exp outlet pressure > 70 psi OR S6k exp outlet pressure > 80 psi OR exp outlet pressure > 60 psi before pre-reqs are met	System pressure is the pressure in the condensing side of the Power+. If this pressure exceeds 60 psi (4.1 bar) it will prevent startup. If the pressure exceeds 70 psi (4.8 bar) during operation [80 psi (5.5 bar) for the Series 6000], it will trigger shutdown. Cooling is enabled automatically above 50 psi (3.5 bar) and will remain on until pressure falls below 35 psi (2.4 bar). 1) When the pressure decreases below 50 psi (3.5 bar), the Power+ will be allowed to restart. 2) If the pressure gets too high, the Power+ will shutdown and stop the flow of hot water. If pressure does not decrease, ensure the hot water has turned off. 3) Test the expander outlet PT, wiring, and input card.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
244	Hot water never reached start temperature	HW temp(s) Out of Range Hot water wait limit $\neq$ 999 minutes (HMI) HW wait timer > HW wait limit	If the hot water temperature or system ΔT are below minimum settings at startup, start will be delayed until temperatures are in starting range. By default, the Power+ will wait indefinitely if heat is not available. If desired, a limit can be set on the Startup Parameters screen to abort startup if the hot water does not reach temperature in the specified time. This alarm indicates that the allowed wait time has been reached, and startup aborted. 1) If this functionality is desired, no troubleshooting is needed. Ensure heat and cooling are available to the Power+ to allow successful startup. 2) If this function is not needed, set the Hot Water Wait Time on the Startup Parameters screen to 999.
245	Hot water temperature too high	HW In RTD no fault (S4k) HW In temp > 250°F (S6k) HW In temp > 257°F AND, if Dual Heat Pre-heater In RTD no fault (S4k) Pre-heater In temp > 250°F (S6k) Pre-heater In temp > 257°F	The Power+ is designed for a hot water input temperature up to 240°F (116°C). Start is inhibited if the hot water temperature is above this limit. Once operating, the maximum temperature limit increases to 250°F (119°C) to allow for variation in the hot water source. These temperature limits are also applied to the Pre-heater inlet in the dual source configuration. 1) Reduce the hot water inlet temperature. 2) Verify hot water temperature with an IR thermometer, and compare to the displayed value. 3) Verify correct RTD performance.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
246	Veris power meter communication fault	Every Modbus read from Veris fails for 5 seconds	The Veris Power Meter provides grid and power generation information to the Power+ controls. If communication with the Veris fails, the Power+ is unable to operate and will shut down. 1) Ensure that the ZL-CMA15L converter is plugged into the PLC CPU. The Terminate jumper must be installed on the converter. 2) Check the wiring between the Modbus converter and the Veris meter. The Veris meter should have a 120Ω resistor installed in parallel between the (+) and (-) terminals. 3) Ensure that the Veris is programmed for 38400 baud communication rate.
247	Line frequency out of range	Veris alarm bit on for 2 seconds Line frequency < 45 Hz OR > 65 Hz OR voltage too low to determine frequency	The Power+ is unable to operate if the line frequency is more than ± 2 Hz from nominal grid frequency. This Veris alarm indicates a serious problem with the electrical grid. 1) The Power+ follows the frequency of the grid. This is a grid problem, contact your electrical utility.
248	Mode Switch Test	TMA: in Test Position	The Test/Manual/Auto (TMA) switch below the emergency stop button selects the allowed startup conditions for the Power+. When switched to the TEST position, the Power+ will shut down and be unable to restart. This mode is required to access test functions.
249	Mode Switch Fault	TMA: 0 0	The Test/Manual/Auto (TMA) switch below the emergency stop button is not providing input to the PLC. This could be caused by a loose wire or a faulty contact block. 1) Check the wiring to and from the TMA switch. 2) With the switch in the middle position and all wires removed, test for continuity on each contact block. Replace blocks that fail a continuity test.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
250	Net kW less than minimum	Net kW < HMI Min SP 60 second delay after On Grid Bypassed during shutdown	The minimum allowed output of the Power+ can be set in the Setup - Site Options screen. If net output falls below this limit, the Power+ will shut down. This condition is not monitored for the first 60 seconds after startup. 1) This is typically caused by a loss of thermal input: either the hot water temperature or the hot water flow is low. 2) High condensing temperatures can also cause low System ΔT, which can lead to shutdown.
251	Restart limit reached, press Stop to reset	5th Auto-restart attempt w/o 15 minutes of continuous runtime in between	The Power+ is limited to a maximum of 5 automatic restarts without at least 15 minutes of operation in between. This is to prevent overheating of the pump motor and generator. 1) Review the Alarm screen to determine why restart has been unsuccessful. Resolve the cause. 2) Press the Stop button to reset the counter, then press Start to resume operation.
252	Generator Bump Test	Standby Manual generator rotation test	Generator rotation should only be tested by trained personnel, there is significant potential to damage the Power+! The generator rotation test manually connects the generator to the power grid to observe that it rotates in the correct direction. Rotation direction is also monitored by the phase/voltage relay, so this test is only needed if the generator wiring is serviced or modified. This test should be performed with the drive belt/coupling removed. The Power+ cannot be started during this test.
253	Pump test run - Start inhibited	Standby Manual VFD test	The WF feed pump has been enabled via manual controls on the VFD Status or Setup - Test Functions screen. The Power+ cannot be started while the pump is in test.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
254	Programming ABB VFD	On while VFD parameters are writing	The required configuration for the ABB ACS-355 VFD can be written by the software from the Factory Settings - Default screen. Writing the parameter set can take several minutes, and the Power+ cannot be started until the write is complete.
256	Working fluid valve test	Standby Enable either WF valve	While the Power+ is in Standby, the working fluid valves can be operated manually from the Test Functions menu. While controlled in this fashion, the valves will prevent startup. 1) Disable the valve test on the Test Functions screen to allow startup.
257	Hot water temperature(s) not in start range	Startup Before Start Delay Timer HW In RTD no fault HW In temp < HMI Min Start temp HW In temp > HMI Max Start temp OR, if Dual Heat: Pre-heater In RTD no fault Pre-heater In temp < HMI Min Start temp Pre-heater In temp > HMI Max Start temp	The Power+ requires the hot water supply to be within the temperature range set on the Startup PArameters screen before startup can proceed. If the water temperature is outside the set range, the startup process will be delayed until conditions are satisfied. 1) Hot water temperature must be above the Minimum Start Temperature. 2) Hot water temperature must be below the Maximum Start Temperature.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
258	System ΔT below start minimum	ACC AND Ambient RTD no fault OR Not ACC AND CW In RTD no fault HW In RTD no fault System dT , HMI Min Start dT Before Start Delay Timer	The Power+ requires the System ΔT (hot water temperature - condensing temperature) be above the temperature set on the Startup Parameters screen before startup can proceed. If the water temperature is below the set range, the startup process will be delayed until conditions are satisfied. 1) System ΔT must be above the Minimum Start ΔT . 2) Increase the hot water temperature. 3) Decrease the condensing temperature.
260	Expander pre-lube completed	Pre-lube cycle completed	N/A
261	High pressure safety: Cooling active	Off grid Outlet pressure > 50 psi triggers Outlet pressure < 35 psi resets OR P+ going on grid resets	The Power+ monitors system pressure when it is turned on, and will call for cooling if pressure increases above 50 psi (3.45 bar). Cooling will remain on until the pressure decreases below 35 psi (2.41 bar). This alarm will not activate while the Power+ is On Grid. 1) Ensure that hot water is not flowing to the Power+. 2) If hot water is not flowing into the Power+, determine how the machine is getting hot. 3) Depending on site architecture and Power+ location, it may not be possible to prevent this alarm condition.
262	Safe pressure achieved: Cooling stopped	C205 resets	Notification alarm that alarm 261 has been cleared, and the pressures are safe.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
263	Cooling suspended until hot water heats up	Cold water suspend enabled Wait > 10 minutes for hot water C205 cooling safety off	If the Power+ has waited more than 10 minutes for hot water temperature and/or system ΔT to reach startup range, cooling suspend will turn off the call for cooling until the hot water reaches the necessary temperature. This option can be disabled in the Site Options screen. Cooling suspend will not activate if the high pressure safety alarm #205 is active. 1) If waiting for hot water temperature, determine why temperature is out of range. 2) If hot water temperature is in range, cold water may be too hot. Reduce cold water temperature to meet minimum system ΔT. 3) If possible, adjust the startup conditions on the Startup Parameters page to allow an increased range of water temperatures.
264	Enclosure temperature low	Enclosure RTD enabled Enclosure RTD no fault Enclosure temp < 32°F triggers Enclosure temp > 50°F resets	Enclosure RTD option only. This alarm activates when the temperature inside the Power+ enclosure falls below 32°F (0°C). The alarm will clear when the temperature rises above 50°F (10°C). This is an informational alarm only. It may assist troubleshooting other faults, but does not by itself indicate a problem with the Power+.
265	Enclosure temperature high	Enclosure RTD enabled Enclosure RTD no fault Enclosure temp > 104°F triggers Enclosure temp < 90°F resets	Enclosure RTD option only. This alarm activates when the temperature inside the Power+ enclosure rises above 120°F (49°C). The alarm will clear when the temperature falls below 90°F (32°C). This is an informational alarm only. It may assist troubleshooting other faults, but does not by itself indicate a problem with the Power+. The enclosure fans, if installed, turn on above 95°F (35°C) enclosure temperature, and remain on until the temperature falls below 80°F (27°C).

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
266	Power cabinet temperature low	2 cabinet Power+ Power Cab RTD no fault Power Cab temp < 32°F triggers Power Cab temp > 50°F resets	This alarm activates when the temperature inside the Power+ power cabinet falls below 32°F (0°C). The alarm will clear when the temperature rises above 50°F (10°C). This is an informational alarm only. It may assist troubleshooting other faults, but does not by itself indicate a problem with the Power+.
267	Power cabinet temperature high	2 cabinet Power+ Power Cab RTD no fault Power Cab temp > 104°F triggers Power Cab temp < 90°F resets	This alarm activates when the temperature inside the Power+ power cabinet rises above 120°F (49°C). The alarm will clear when the temperature falls below 90°F (32°C). This is an informational alarm only. It may assist troubleshooting other faults, but does not by itself indicate a problem with the Power+. The power cabinet fans turn on above 85°F (29°C) power cabinet temperature, and remain on until the temperature falls below 80°F (27°C).
268	Control cabinet temperature low	2 cabinet Power+ Control Cab RTD no fault Control Cab temp < 32°F triggers Control Cab temp > 50°F resets	This alarm activates when the temperature inside the Power+ control cabinet falls below 32°F (0°C). The alarm will clear when the temperature rises above 50°F (10°C). This is an informational alarm only. It may assist troubleshooting other faults, but does not by itself indicate a problem with the Power+.
269	Control cabinet temperature high	2 cabinet Power+ Control Cab RTD no fault Control Cab temp > 104°F triggers Control Cab temp < 90°F resets	This alarm activates when the temperature inside the Power+ control cabinet rises above 120°F (49°C). The alarm will clear when the temperature falls below 90°F (32°C). This is an informational alarm only. It may assist troubleshooting other faults, but does not by itself indicate a problem with the Power+. The control cabinet fans turn on above 85°F (29°C) control cabinet temperature, and remain on until the temperature falls below 80°F (27°C).

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
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271	Remote Emergency Stop reset	Remote E-Stop Aux contact opens	N/A
284	PLC battery low, replace soon	System bit in PLC Low or missing backup battery	The PLC that controls the Power+ contains a backup battery to maintain system settings. When the battery gets low, it must be replaced. The battery should also be replaced if an extended shutdown of the Power+ is expected. Replace the battery only with a new type CR2354. 1) Replace the PLC battery. The power does not need to be on during replacement. 2) If a new battery does not clear the alarm, carefully remove the CPU card and check the battery wires. If the wires are broken, replace the CPU.
289	Lube Line flow switch	Shutdown	This alarm can trigger and shut down the machine at very low power output. If alarm occurs at power output above 10kW check the wiring to the lube line flow switch. If problem does not resolve, replace lube line filter.
290	SD card not ready		PLC SD card not installed, or faulted
291	SD card 5% storage remaining	PLC SD card memory near full	Delete files of of SD card and re-install it into PLC. Store contents of SD card as required
293	PLC not in correct mode	PLC switch in Stop Mode	The PLC mode switch must be set to TERM to allow ElectraTherm to provide remote support for the Power+. Set it first to RUN, then to TERM.
296	MCR Off	MCR contact open	Notification alarm that MCR is open/off
297	Air Pressure Low	Air pressure switch open	Indicative of low air pressure in the system. Check that air compressor is operational. Check air compressor system for leaks.
298	MCR reset failed	MCR reset did not close MCR within 0.5 sec	Check wiring in MCR circuit to coil of MCR. Check MCR coil.
305	VDE inverter general fault	Discrete from 1200 PLC	Fault with VDE inverter. Check that MCR is closed. Else Power cycle equipment. If problem persists contact ElectraTherm.
306	VDE grid not OK	Discrete from 1200 PLC	Fault from VDE inverter that power grid is not in allowable operating range per BDEW requirements. Will clear when grid is OK.

Alarm	Alarm Text	Trigger condition(s)	Troubleshooting
307	VDE drives not ready	Discrete from 1200 PLC	Alarm while drives are initializing. Contact Electratherm if alarm persists.
308	VDE critical fault	Discrete from Siemens CU	Power cycle equipment. If problem persists contact ElectraTherm.
309	Module 5 AO Module fault	Fault bit from BRX module	Problem with BRX module. Power cycle machine. Contact ElectraTherm if problem persists.
311	VDE comm fault	Discrete from 1200 PLC, on Modbus or Profinet comm failure	Indicative of a communication fault between BRX PLC and Siemens PLC, or Siemens PLC and Siemens control unit. Check wiring between siemens control unit and switch. Check wiring between Siemens PLC and switch.
	Start of Day	Daily, at midnight	N/A

6.3. Routine Maintenance Schedule, Figure 5-1

ElectraTherm BY BITZER GROUP		CUMULATIVE RUN TIME HOURS ON POWER+ GENERATOR															
		4400	8800	13200	17600	22000	26400	30800	35200	39600	44000	48400	52800	57200	61600	66000	70400
REQUIRED SERVICE WORK		1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years							
Inspect all plumbing, flanges, and valves for leaks		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Inspect hardware for wear/damage		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Grease pump motor bearings		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Clean cabinet heat exchanger		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Inspect for electrical wear/damage		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Check for NOGs in working fluid		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Check HX water-side pressure drop		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Clean Skid / Clean LLR		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Verify operability of safety equipment		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Replace High/Low Sides PRVs		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Replace PLC battery		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Bitzer Expander Replacement		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Replace VFD internal cooling fan		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

continued on chart below

		CUMULATIVE RUN TIME HOURS ON POWER+ GENERATOR															
		88000	92400	96800	101200	105600	110000	114400	118800	123200	127600	132000	136400	140800	145200	149600	154000
REQUIRED SERVICE WORK		10 years	11 years	12 years	13 years	14 years	15 years	16 years	17 years	18 years	19 years	20 years					
Inspect all plumbing, flanges, and valves for leaks		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Inspect hardware for wear/damage		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Grease pump motor bearings		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Clean cabinet heat exchanger		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Inspect for electrical wear/damage		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Check for NOGs in working fluid		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Check HX water-side pressure drop		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Clean Skid / Clean LLR		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Verify operability of safety equipment		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Replace High/Low Sides PRVs		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Replace PLC battery		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Bitzer Expander Replacement		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Replace VFD internal cooling fan		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Figure 6-1: Routine Maintenance Schedule

6.4. CE Certification, Power Plus Model ET-50 WC 4000 & ET-6500

ElectraTherm Power Plus ORC models: ET-50 WC 4000 and ET-6500 were designed and built in accordance with the following CE directives and sound engineering practice:

6.4.1. Pressure Equipment Regulations 1999 [European Directive 97/23/EC]

6.4.2. Machinery Directive 2006/42/EC

- EN ISO 12100-1:2003+A1:2009/Safety of machinery - Basic concepts, general principles for design
Part 1: Basic terminology
- EN ISO 12100-2:2003+A1:2009 / Safety of machinery - Basic concepts, general principles for design
Part 2: Technical principles
- EN ISO 14121-1: 2007/ Safety of machinery - Risk assessment
Part 1: Principles

6.4.3. Low Voltage Directive 2006/95/EC

- EN 60204-1: 2006+A1:2009/ Safety of machinery - Electrical equipment of machines
Part 1: General requirements

6.4.4. Electromagnetic Compatibility Directive 2004/108/EC

- EN 61000-6-2: 2005 / Electromagnetic compatibility (EMC)
Part 6-2: Generic standards – Immunity for industrial environments
- EN 61000-6-4: 2007 / Electromagnetic compatibility (EMC)
Part 6-4: Generic standards – Emission standard for industrial environments

The Technical Construction File required by these directives is maintained at the corporate headquarters of ElectraTherm, Inc., 4080 Enterprise Way, Flowery Branch, GA, USA.

6.5. Service Request Document

For warranty or service inquiries on equipment, email service@electratherm.com

Include ElectraTherm Power Plus ORC serial number of the equipment and brief description in the subject line of the email. Include Service Request Document, and any pertinent information, notes or pictures in the email.



ElectraTherm

BY BITZER GROUP

ELECTRATHERM

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+01 877 883 7101

SERVICE REQUEST DOCUMENT

Company Name:	_____	Site Name:	_____
Company Address:	_____	Site Address:	_____
Company Address:	_____	Site Address:	_____
Company Country:	_____	Site Country:	_____
Company Phone Number:	_____	Site Phone Number:	_____
Company Contact:	_____	Site Contact:	_____
		Site Email Address:	_____

_____ **Todays Date**

_____ **Date of Issue/Problem with Equipment**

_____ **Machine Serial Number**

_____ **Is remote HMI/PLC access available for ElectraTherm (Y/N)***

*if no remote connection available, the machine run data may need to be downloaded from the USB stick in the machine, and emailed to ElectraTherm for evaluation. Provide 1 weeks worth of data around the time of the problem.

Type of service needed:

- ☐ **warranty**
- ☐ **maintenance**
- ☐ **repair**

Description of problem or work required(send pics and other pertinent info as separate attachments)

To create a service ticket within ElectraTherm Customer service database, email this to: service@electratherm.com
Include Machine Serial number and brief description of problem in subject line of email address. Also attach any other relative or pertinent information for the service request to the email.

6.6. Maintenance log

The following sheets are used to log routine maintenance activities and will need to be produced and referenced during warranty inquiries.

[illegible]

[illegible]

[illegible]

[illegible]

Maintenance Log:

[illegible]

[illegible]

6.7. MSDS/SDS

The MSDS/SDS sheets attached for the following three items found in the Power Plus ORC:

- 1) Honeywell Genetron HFC-R245fa Working fluid / Refrigerant
- 2) Nu Calgon Zerol 500 mineral oil
 - a. Lubrication oil used in working fluid/refrigerant
- 3) Exxon Mobil Polyrex EM Grease
 - a. Used on pump motor bearings

Genetron® 245fa**000000009878**

Version 2.9

Revision Date 04/03/2014

Print Date 06/06/2016

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Genetron® 245fa

MSDS Number : 000000009878

Product Use Description : Refrigerant, Heat transfer fluid

Manufacturer or supplier's details : Honeywell International Inc.
115 Tabor Road
Morris Plains, NJ 07950-2546

For more information call : 800-522-8001
+1-973-455-6300
(Monday-Friday, 9:00am-5:00pm)

In case of emergency call : **Medical: 1-800-498-5701 or +1-303-389-1414**
: **Transportation (CHEMTREC): 1-800-424-9300 or**
: **+1-703-527-3887**
:
: (24 hours/day, 7 days/week)

SECTION 2. HAZARDS IDENTIFICATION**Emergency Overview**

Form : Liquefied gas

Color : colourless

Odor : weak

Classification of the substance or mixture

Classification of the substance or mixture : Gases under pressure, Liquefied gas
Simple Asphyxiant

GHS Label elements, including precautionary statements

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Symbol(s)

:



Signal word

: Warning

Hazard statements

: Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.

Precautionary statements

: **Prevention:**

Use personal protective equipment as required.

Storage:

Protect from sunlight. Store in a well-ventilated place.

Hazards not otherwise
classified: May cause eye and skin irritation.
May cause cardiac arrhythmia.**Carcinogenicity**

No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP, IARC, or OSHA.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Formula

: CHF₂CH₂CF₃

Chemical nature

: Substance

Chemical Name	CAS-No.	Concentration
1,1,1,3,3-Pentafluoropropane	460-73-1	100.00 %

SECTION 4. FIRST AID MEASURES

Inhalation

: Move to fresh air. If breathing is irregular or stopped, administer artificial respiration. Use oxygen as required, provided a

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- qualified operator is present. Call a physician. Do not give drugs from adrenaline-ephedrine group.
- Skin contact : After contact with skin, wash immediately with plenty of water. If symptoms persist, call a physician. Take off all contaminated clothing immediately. Wash contaminated clothing before re-use.
- Eye contact : Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
- Ingestion : Do not induce vomiting without medical advice. Never give anything by mouth to an unconscious person. Call a physician immediately.

Notes to physician

- Treatment : Because of the possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, should be used with special caution and only in situations of emergency life support. Treatment of overexposure should be directed at the control of symptoms and the clinical conditions.

SECTION 5. FIREFIGHTING MEASURES

- Suitable extinguishing media : The product is not flammable.
ASHRAE 34
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
- Specific hazards during firefighting : This product is not flammable at ambient temperatures and atmospheric pressure.
However, this material can ignite when mixed with air under pressure and exposed to strong ignition sources.
Cool closed containers exposed to fire with water spray.
Do not allow run-off from fire fighting to enter drains or water courses.
Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.
Exposure to decomposition products may be a hazard to

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health.

In case of fire hazardous decomposition products may be produced such as:

Hydrogen fluoride

Carbon monoxide

Carbon dioxide (CO₂)

Carbonyl halides

Special protective equipment for firefighters : In the event of fire and/or explosion do not breathe fumes.
Wear self-contained breathing apparatus and protective suit.
No unprotected exposed skin areas.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions : Wear personal protective equipment.
Immediately evacuate personnel to safe areas.
Keep people away from and upwind of spill/leak.
Remove all sources of ignition.
Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.
Ensure adequate ventilation.

Environmental precautions : Should not be released into the environment.
Do not flush into surface water or sanitary sewer system.
Prevent further leakage or spillage if safe to do so.
Prevent spreading over a wide area (e.g. by containment or oil barriers).

Methods for cleaning up : Contain spillage, and then collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE**Handling**

Handling : Handle with care.
Do not get in eyes, on skin, or on clothing.
Do not use in areas without adequate ventilation.

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Perform filling operations only at stations with exhaust ventilation facilities.

Open drum carefully as content may be under pressure.

Do not breathe vapours or spray mist.

Advice on protection against fire and explosion : Normal measures for preventive fire protection.
Can form a combustible mixture with air at pressures above atmospheric pressure.
Keep product and empty container away from heat and sources of ignition.

Storage

Requirements for storage areas and containers : Store away from incompatible substances.
Keep away from direct sunlight.
Keep containers tightly closed in a dry, cool and well-ventilated place.
Ensure adequate ventilation, especially in confined areas.
Keep in original packaging, tightly closed.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Protective measures : Ensure that eyewash stations and safety showers are close to the workstation location.
Do not breathe vapours or spray mist.
Avoid contact with skin, eyes and clothing.

Engineering measures : Use with local exhaust ventilation.
Perform filling operations only at stations with exhaust ventilation facilities.

Eye protection : Do not wear contact lenses.
Wear as appropriate:
Safety glasses with side-shields
If splashes are likely to occur, wear:
Goggles or face shield, giving complete protection to eyes

Hand protection : Impervious butyl rubber gloves
Neoprene gloves
Gloves must be inspected prior to use.
Replace when worn.

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- Skin and body protection : Wear as appropriate:
Solvent-resistant gloves
Solvent-resistant apron and boots
If splashes are likely to occur, wear:
Protective suit
- Respiratory protection : In case of insufficient ventilation, wear suitable respiratory equipment.
Wear a positive-pressure supplied-air respirator.
For rescue and maintenance work in storage tanks use self-contained breathing apparatus.
- Hygiene measures : Handle in accordance with good industrial hygiene and safety practice.
Avoid contact with skin, eyes and clothing.
Ensure adequate ventilation, especially in confined areas.
Remove and wash contaminated clothing before re-use.
Contaminated work clothing should not be allowed out of the workplace.
Keep working clothes separately.
Wash hands before breaks and immediately after handling the product.

Exposure Guidelines

Components	CAS-No.	Value	Control parameters	Update	Basis
1,1,1,3,3-Pentafluoropropane	460-73-1	TWA : time weighted average	1,644 mg/m ³ (300 ppm)	2007	WEEL:US. AIHA Workplace Environmental Exposure Level (WEEL) Guides

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

- Physical state : Liquefied gas
- Color : colourless
- Odor : weak
- pH : Note: neutral

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Melting point/freezing point : -103 °C

Boiling point/boiling range : 15.3 °C

Flash point : Note: not applicable

Evaporation rate : < 1
Method: Compared to Ether (anhydrous).

: > 1
Method: Compared to CCl₄.

lower flammability limit : Note: None

upper flammability limit : Note: None

Vapor pressure : 1,227 hPa
at 20 °C(68 °F)
3,882 hPa
at 54.4 °C(129.9 °F)

Vapor density : 4.6 Note: (Air = 1.0)

Density : 1.32 g/cm³ at 20 °C

Water solubility : 7.18 g/l

Solubility in other solvents : Medium: Methanol
Note: partly soluble

Medium: Diethylether
Note: partly soluble

Partition coefficient: : log Pow: 1.35

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n-octanol/water

Note: The product is more soluble in octanol.

Ignition temperature : 412 °C

Decomposition temperature : > 250 °C

Molecular weight : 134.03 g/mol

Global warming potential (GWP) : 950

Ozone depletion potential (ODP) : 0

SECTION 10. STABILITY AND REACTIVITY

Chemical stability : Stable under normal conditions.

Possibility of hazardous reactions : Hazardous polymerisation does not occur.

Conditions to avoid : Protect from heat/overheating.
Keep away from direct sunlight.
Heat, flames and sparks.Incompatible materials to avoid : Strong acids and strong bases
Finely divided aluminium
Sodium
Potassium
Calcium
Magnesium
Zinc
Barium
Lithium
Strong oxidizing agentsHazardous decomposition products : In case of fire hazardous decomposition products may be produced such as:
Carbon monoxide
Carbon dioxide (CO₂)
Carbonyl halides
Hydrogen fluoride

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SECTION 11. TOXICOLOGICAL INFORMATION

- Acute inhalation toxicity : LC50: > 200000 ppm
Exposure time: 4 h
Species: rat
Note: No deaths Evidence of transient anesthetic effect.
- : LC50: > 100000 ppm
Exposure time: 4 h
Species: mouse
Note: No deaths Evidence of transient underactivity during exposure.
- Acute dermal toxicity : LD50: > 2,000 mg/kg
Species: rabbit
- Sensitisation : Cardiac sensitization
Species: dogs
Note: No effects noted at 35,000 ppm, the threshold for induction of cardiac arrhythmias in the presence of injected adrenalin was 44,000 ppm.
- Repeated dose toxicity : Species: rat
NOEL: 50000 ppm
Note: Embryotoxicity Not a teratogen
- : Species: rat (pups)
NOEL: 50000 ppm
- : Species: rat (dams)
NOEL: 2000 ppm
Note: due to decrease in body weight gains at 10,000 ppm and 50,000 ppm
- : Species: rat
Method: 2 Generation Inhalation Toxicity
Note: Exposures 6hrs/day, 7 days/wk at 0(control), 2000, 10,000 and 50,000 ppm.

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- : Species: rat (dams)
Note: Toxicity seen in dams at 10,000 and 50,000 ppm and in pups at 50,000 ppm. Increased mortality late in the lactation phase of the study.
- : Species: rat
Note: 28-day Inhalation Study NOAEL (No observed adverse effect level) - 50,000 ppm NOEL - 500 ppm Dose levels: 0,500, 2000, 10,000 and 50,000 ppm
- : Species: rat
Note: 90-day Inhalation Study Dose levels: 0,500, 2000, 10,000 and 50,000 ppm NOAEL (No observed adverse effect level) - 2,000 ppm
- : Note: Overall, subchronic studies showed dose-related increases in urinary fluoride levels, urine volumes and water consumption. Increases were noted in hematological parameters, BUN levels and serum liver enzyme activities (GOT, GPT). These increases did not follow a dose response; however, they indicate that HFC-245fa is metabolized in the liver. Significant recovery was noted in these parameters following a 2-week, non-exposure period which followed the 28-day exposure period. No histopathological effects were noted in the 28-day study. The 90-day study noted an increase in incidence and severity (trace to moderate) of myocarditis (inflammation of the heart muscle) at 10,000 and 50,000 ppm. This was not noted at the 500 or 2,000 ppm dose levels nor was it seen the 28-day study at 50,000 ppm.

Genotoxicity in vitro

- : Cell type: Human lymphocytes
Result: Weak positive activation without S9 at 30% v/v; not active with S9 up to 70% v/v.
- : Test Method: Ames test
Metabolic activation: with and without metabolic activation
Result: negative

Genotoxicity in vivo

- : Species: mouse
Cell type: Bone marrow
Application Route: Inhalation
Method: Mutagenicity (micronucleus test)
Result: negative

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SECTION 12. ECOLOGICAL INFORMATION**Ecotoxicity effects**

Toxicity to fish : EC50: > 81.8 mg/l
Exposure time: 96 h
Species: Oncorhynchus mykiss (rainbow trout)

: NOEC: > 10 mg/l
Exposure time: 96 h
Species: Oncorhynchus mykiss (rainbow trout)

Toxicity to daphnia and other aquatic invertebrates : EC50: > 97.9 mg/l
Exposure time: 48 h
Species: Daphnia magna (Water flea)

: NOEC: > 97.9 mg/l
Exposure time: 48 h
Species: Daphnia magna (Water flea)

Toxicity to algae : Growth inhibition
EC50: > 118 mg/l
Species: Algae
Method: OECD Test Guideline 201

Further information on ecology

Additional ecological information : This product is subject to U.S. Environmental Protection Agency Clean Air Act Regulations at 40 CFR Part 82. This product contains greenhouse gases which may contribute to global warming. Do NOT vent to the atmosphere. To comply with provisions of the U.S. Clean Air Act, any residual must be recovered. Refer to sections 610 and 612 for list of acceptable and unacceptable uses for this product.

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SECTION 13. DISPOSAL CONSIDERATIONS**SECTION 14. TRANSPORT INFORMATION**

DOT	UN/ID No.	: UN 3163
	Proper shipping name	: LIQUEFIED GAS, N.O.S. (1,1,1,3,3-Pentafluoropropane)
	Class	: 2.2
	Packing group	
	Hazard Labels	: 2.2
IATA	UN/ID No.	: UN 3163
	Description of the goods	: LIQUEFIED GAS, N.O.S. (1,1,1,3,3-Pentafluoropropane)
	Class	: 2.2
	Hazard Labels	: 2.2
	Packing instruction (cargo aircraft)	: 200
	Packing instruction (passenger aircraft)	: 200
IMDG	UN/ID No.	: UN 3163
	Description of the goods	: LIQUEFIED GAS, N.O.S. (1,1,1,3,3-PENTAFLUOROPROPANE)
	Class	: 2.2
	Hazard Labels	: 2.2
	EmS Number	: F-C, S-V
	Marine pollutant	: no

SECTION 15. REGULATORY INFORMATION**Inventories**US. Toxic Substances : On TSCA Inventory
Control ActAustralia. Industrial : On the inventory, or in compliance with the inventory
Chemical (Notification and

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Assessment) Act

Canada. Canadian Environmental Protection Act (CEPA). Domestic Substances List (DSL) : All components of this product are on the Canadian DSL.

Japan. Kashin-Hou Law List : On the inventory, or in compliance with the inventory

Korea. Toxic Chemical Control Law (TCCL) List : On the inventory, or in compliance with the inventory

Philippines. The Toxic Substances and Hazardous and Nuclear Waste Control Act : Not in compliance with the inventory

China. Inventory of Existing Chemical Substances : 1,1,1,3,3-Pentafluoropropane 460-73-1
: On the inventory, or in compliance with the inventory

New Zealand. Inventory of Chemicals (NZIoC), as published by ERMA New Zealand : On the inventory, or in compliance with the inventory

National regulatory information

SARA 302 Components : SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components : SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards : Sudden Release of Pressure Hazard
Acute Health Hazard

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California Prop. 65 : WARNING! This product contains a chemical known to the State of California to cause cancer.
Dichloromethane 75-09-2

Massachusetts RTK : Dichloromethane 75-09-2

Pennsylvania RTK : Dichloromethane 75-09-2

WHMIS Classification : A: Compressed Gas
This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

Global warming potential : 950

Ozone depletion potential (ODP) : 0

SECTION 16. OTHER INFORMATION

	HMIS III	NFPA
Health hazard	: 2	2
Flammability	: 1	1
Physical Hazard	: 0	
Instability	:	0

Hazard rating and rating systems (e.g. HMIS® III, NFPA): This information is intended solely for the use of individuals trained in the particular system.

Further information

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information

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and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text. Final determination of suitability of any material is the sole responsibility of the user. This information should not constitute a guarantee for any specific product properties.

Changes since the last version are highlighted in the margin. This version replaces all previous versions.

Previous Issue Date: 02/16/2012

Prepared by Honeywell Performance Materials and Technologies Product Stewardship Group



SAFETY DATA SHEET

Date Prepared : 05/22/2015

SDS No : NC 0111

ZeroI® 500 (4312-05)

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: ZeroI® 500 (4312-05)
PRODUCT DESCRIPTION: Synthetic Alkylate
PRODUCT CODE: 4312-05

DISTRIBUTOR

Nu-Calgon
 2008 Altom Court
 St. Louis, MO 63146
Emergency Phone: 800-554-5499

24 HR. EMERGENCY TELEPHONE NUMBERS

CHEMTREC: 800-424-9300

2. HAZARDS IDENTIFICATION

GHS LABEL

This product is not classified as hazardous according to 29CFR 1910.1200.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	Wt. %	CAS
Synthetic Alkylate(s)	*	Proprietary

COMMENTS: Ingredients and composition are withheld as trade secret in accordance with 29CFR1910.1200(i).

4. FIRST AID MEASURES

EYES: Immediately flush eyes with plenty of water. Get medical attention, if irritation persists.

SKIN: Immediately wash skin with soap and plenty of water. Remove contaminated clothing. Get medical attention if symptoms occur. Wash clothing before reuse.

INGESTION: Rinse mouth with water. Drink plenty of water. Do not induce vomiting. Get immediate medical attention if you feel unwell. Never give anything by mouth to an unconscious person.

INHALATION: Remove to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get immediate medical attention.

SIGNS AND SYMPTOMS OF OVEREXPOSURE

EYES: May cause eye irritation.

SKIN: May cause skin irritation.

5. FIRE FIGHTING MEASURES

FLAMMABLE CLASS: Non-flammable.

GENERAL HAZARD: Do NOT use water stream or water jet.

EXTINGUISHING MEDIA: Dry Chemical, CO₂, Foam, Fog or Water Spray.

HAZARDOUS COMBUSTION PRODUCTS: Oxides of carbon.

OTHER CONSIDERATIONS: Keep adjacent containers cool with water spray.

FIRE FIGHTING PROCEDURES: As in any fire, wear self-contained breathing apparatus pressure-demand, (MSHA/NIOSH approved or equivalent) and full protective gear.

FIRE FIGHTING EQUIPMENT: In case of fire wear a full-face positive pressure self contained breathing apparatus and protective suit.

6. ACCIDENTAL RELEASE MEASURES

SMALL SPILL: Contain and soak up spill with non-combustible absorbent material. Dampen and scoop spilled material into suitable containers, seal and label. Avoid mixing spilled material with other chemicals or debris. Avoid runoff into storm

sewers and ditches which lead to waterways.

LARGE SPILL: LARGE SPILLS: Shut off leak if safe to do so. Remove all possible sources of ignition. Contain spill with inert, absorbent material. Reclam into recovery or salvage drums or vacuum truck for proper disposal. Treat residues as small spills.

ENVIRONMENTAL PRECAUTIONS

WATER SPILL: Prevent material from entering drains or watercourses using sand, earth or other appropriate barriers.

LAND SPILL: Prevent contamination of the soil.

GENERAL PROCEDURES: Avoid contact with skin or eyes. Avoid contact with spilled materials. Use appropriate personal protective equipment. Ensure adequate ventilation.

SPECIAL PROTECTIVE EQUIPMENT: Use protective equipment recommended in Section 8.

7. HANDLING AND STORAGE

GENERAL PROCEDURES: Handle in accordance with good industrial hygiene and safety practices.

HANDLING: Avoid breathing (dust, vapor, mist, gas). Avoid contact with skin and eyes. Ground and bond containers when transferring material. Wash thoroughly after handling.

STORAGE: Keep container tightly closed in a dry, well-ventilated place away from heat, open flame, or sources of ignition. Store away from incompatible materials (see section 10).

STORAGE TEMPERATURE: Ambient.

LOADING TEMPERATURE: Ambient

ELECTROSTATIC ACCUMULATION HAZARD: Bond and ground during loading, unloading and transferring material to prevent electrostatic accumulation.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide adequate ventilation. Eye washes and showers for emergency use.

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Wear safety glasses with side shields (or goggles) or a face shield.

SKIN: Use protective clothing, sleeves, boots, face protection and chemical resistant gloves. Use extra precautions when working with heated materials.

RESPIRATORY: Use appropriate protection if there is risk of breathing the mists or vapors or heated materials. Use suitable respiratory equipment if risk of insufficient ventilation.

PROTECTIVE CLOTHING: Wear protective clothing appropriate to the risk of exposure.

WORK HYGIENIC PRACTICES: Wash hands, forearms and face before eating, drinking, smoking and using the restroom. Launder contaminated clothing before re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: Liquid

APPEARANCE: Clear colorless Liquid

PHYSICAL STATE COMMENTS: Clear, bright, viscous.

pH: Not Available

FLASH POINT AND METHOD: 204°C COC-ASTM D-92

AUTOIGNITION TEMPERATURE: Not Available

VAPOR PRESSURE: Not Available

BOILING POINT: Not Available

POUR POINT: -27°C

THERMAL DECOMPOSITION: Not Available

SPECIFIC GRAVITY: 0.87 at 15°C

VISCOSITY #1: 100 cSt at 40°C

VISCOSITY #2: 7.9 cSt at 100°C

10. STABILITY AND REACTIVITY

HAZARDOUS POLYMERIZATION: None

STABILITY: Stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat, sparks or open flames.

POSSIBILITY OF HAZARDOUS REACTIONS: None Expected.

HAZARDOUS DECOMPOSITION PRODUCTS: Under normal conditions, no hazardous decomposition products should be produced.

INCOMPATIBLE MATERIALS: Strong oxidizers.

11. TOXICOLOGICAL INFORMATION

ACUTE

DERMAL LD₅₀: > 2000 mg/kg

ORAL LD₅₀: > 2000 mg/kg

EYE EFFECTS: Minimal irritation.

SKIN EFFECTS: Minimal irritation.

CARCINOGENICITY

Notes: Contains no ingredient listed as a carcinogen.

REPEATED DOSE EFFECTS: None Expected.

IRRITATION: Not a primary irritant.

SENSITIZATION: None Expected.

REPRODUCTIVE EFFECTS: None Expected.

MUTAGENICITY: None Expected.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA: Not classified as an environmental hazard.

ECOTOXICOLOGICAL INFORMATION: This product is not expected to be toxic to aquatic life.

BIOACCUMULATION/ACCUMULATION: Expected to have a very slow rate of bioaccumulation.

DISTRIBUTION: Insoluble in water. Adsorbs to soil and has low mobility.

CHEMICAL FATE INFORMATION: Expected to be partially or slowly biodegradable.

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: Dispose of contents/container to a licensed contractor or facility in accordance with local, state and federal regulations.

PRODUCT DISPOSAL: Materials are suitable for burning or disposal at a supervised incineration facility.

EMPTY CONTAINER: Clean container thoroughly and dispose to licensed disposal contractor. Do not weld, cut, or braze empty containers, or allow product residue to come in contact with other sources of ignition as they may contain residue which could ignite.

14. TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)

PROPER SHIPPING NAME: Not regulated for Transport

ROAD AND RAIL (ADR/RID)

PROPER SHIPPING NAME: Not regulated for Transport

AIR (ICAO/IATA)

SHIPPING NAME: Not regulated for Transport

VESSEL (IMO/IMDG)

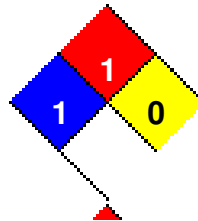
SHIPPING NAME: Not regulated for Transport

15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**311/312 HAZARD CATEGORIES:** Not hazardous.**313 REPORTABLE INGREDIENTS:** No ingredients at detectable levels.**TSCA (TOXIC SUBSTANCE CONTROL ACT)****TSCA STATUS:** All components listed or exempt.**CANADA****DOMESTIC SUBSTANCE LIST (INVENTORY):** All components are listed or exempt.**16. OTHER INFORMATION****REASON FOR ISSUE:** Updated to GHS Format with GHS classification**APPROVED BY:** Audris King **TITLE:** HS&E Manager**PREPARED BY:** A. King **Date Prepared:** 05/22/2015**HMIS RATING**

HEALTH	☐	1
FLAMMABILITY	☐	1
PHYSICAL HAZARD	☐	0
PERSONAL PROTECTION	☐	

NFPA CODES

MANUFACTURER DISCLAIMER: The information is based on the data of which we are aware and is believed to be correct as of the data hereof. Since the information contained herein may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modification of the information, we do not assume any responsibility for the result of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.

Product Name: MOBIL POLYREX EM
Revision Date: 08 Apr 2013
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MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: MOBIL POLYREX EM
Product Description: Base Oil and Additives
Product Code: 2015A020G010, 641688-00, 97Y278
Intended Use: Grease

COMPANY IDENTIFICATION

Supplier: EXXON MOBIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA. 22037 USA
24 Hour Health Emergency 609-737-4411
Transportation Emergency Phone 800-424-9300
ExxonMobil Transportation No. 281-834-3296
Product Technical Information 800-662-4525, 800-947-9147
MSDS Internet Address <http://www.exxon.com>, <http://www.mobil.com>

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

Reportable Hazardous Substance(s) or Complex Substance(s)

Name	CAS#	Concentration*
AMINES, C12-14-ALKYL, ISOOCYL PHOSPHATES	68187-67-7	1 - 5%

* All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines (see (M)SDS Section 15).

POTENTIAL HEALTH EFFECTS

Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

Product Name: MOBIL POLYREX EM

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SECTION 4 FIRST AID MEASURES

INHALATION

Under normal conditions of intended use, this material is not expected to be an inhalation hazard.

SKIN CONTACT

Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight Streams of Water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Firefighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Smoke, Fume, Aldehydes, Sulfur oxides, Incomplete combustion products, Oxides of carbon

FLAMMABILITY PROPERTIES

Flash Point [Method]: >204°C (399°F) [EST. FOR OIL, ASTM D-92 (COC)]

Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. US regulations require reporting releases of this material to the environment which exceed the applicable reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National Response Center can be reached at (800)424-8802.

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PROTECTIVE MEASURES

Avoid contact with spilled material. Warn or evacuate occupants in surrounding and downwind areas if required due to toxicity or flammability of the material. See Section 5 for fire fighting information. See the Hazard Identification Section for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for advice on the minimum requirements for personal protective equipment. Additional protective measures may be necessary, depending on the specific circumstances and/or the expert judgment of the emergency responders.

For emergency responders: Respiratory protection: respiratory protection will be necessary only in special cases, e.g., formation of mists. Half-face or full-face respirator with filter(s) for dust/organic vapor or Self Contained Breathing Apparatus (SCBA) can be used depending on the size of spill and potential level of exposure. If the exposure cannot be completely characterized or an oxygen deficient atmosphere is possible or anticipated, SCBA is recommended. Work gloves that are resistant to hydrocarbons are recommended. Gloves made of polyvinyl acetate (PVA) are not water-resistant and are not suitable for emergency use. Chemical goggles are recommended if splashes or contact with eyes is possible. Small spills: normal antistatic work clothes are usually adequate. Large spills: full body suit of chemical resistant, antistatic material is recommended.

SPILL MANAGEMENT

Land Spill: Scrape up spilled material with shovels into a suitable container for recycle or disposal.

Water Spill: Stop leak if you can do it without risk. Confine the spill immediately with booms. Warn other shipping. Skim from surface.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted.

Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7

HANDLING AND STORAGE

HANDLING

Avoid contact with skin. Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is not a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8

EXPOSURE CONTROLS / PERSONAL PROTECTION

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

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ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No protection is ordinarily required under normal conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

Chemical resistant gloves are recommended. If contact with forearms is likely wear gauntlet style gloves.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

Chemical/oil resistant clothing is recommended.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping.

ENVIRONMENTAL CONTROLS

Comply with applicable environmental regulations limiting discharge to air, water and soil. Protect the environment by applying appropriate control measures to prevent or limit emissions.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Note: Physical and chemical properties are provided for safety, health and environmental considerations only and may not fully represent product specifications. Contact the Supplier for additional information.

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GENERAL INFORMATION

Physical State: Solid

Form: Semi-fluid

Color: Blue

Odor: Characteristic

Odor Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 °C): 0.884

Flash Point [Method]: >204°C (399°F) [EST. FOR OIL, ASTM D-92 (COC)]

Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D

Autoignition Temperature: N/D

Boiling Point / Range: > 330°C (626°F) [Estimated]

Vapor Density (Air = 1): N/D

Vapor Pressure: < 0.013 kPa (0.1 mm Hg) at 20 °C [Estimated]

Evaporation Rate (n-butyl acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5 [Estimated]

Solubility in Water: Negligible

Viscosity: 95 cSt (95 mm²/sec) at 40 °C

Oxidizing Properties: See Hazards Identification Section.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: >250°C (482°F)

DMSO Extract (mineral oil only), IP-346: < 3 %wt

Decomposition Temperature: N/D

NOTE: Most physical properties above are for the oil component in the material.

SECTION 10 STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

Route of Exposure	Conclusion / Remarks
Inhalation	
Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data for material.	Negligible hazard at ambient/normal handling temperatures. Based

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	on assessment of the components.
Ingestion	
Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin	
Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data for material.	Mildly irritating to skin with prolonged exposure. Based on assessment of the components.
Eye	
Irritation: No end point data for material.	May cause mild, short-lasting discomfort to eyes. Based on assessment of the components.

CHRONIC/OTHER EFFECTS

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitizing in test animals.

The following ingredients are cited on the lists below: None.

--REGULATORY LISTS SEARCHED--

1 = NTP CARC

3 = IARC 1

5 = IARC 2B

2 = NTP SUS

4 = IARC 2A

6 = OSHA CARC

SECTION 12

ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

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SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

RCRA Information: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed as hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity or reactivity and is not formulated with contaminants as determined by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14 TRANSPORT INFORMATION

LAND (DOT): Not Regulated for Land Transport

LAND (TDG): Not Regulated for Land Transport

SEA (IMDG): Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA): Not Regulated for Air Transport

SECTION 15 REGULATORY INFORMATION

OSHA HAZARD COMMUNICATION STANDARD: When used for its intended purposes, this material is not classified as hazardous in accordance with OSHA 29 CFR 1910.1200.

Complies with the following national/regional chemical inventory requirements: AICS, IECSC, KECI, TSCA
Special Cases:

Inventory	Status
NDSL	Restrictions Apply

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EPCRA SECTION 302: This material contains no extremely hazardous substances.

SARA (311/312) REPORTABLE HAZARD CATEGORIES: None.

SARA (313) TOXIC RELEASE INVENTORY: This material contains no chemicals subject to the supplier notification requirements of the SARA 313 Toxic Release Program.

The following ingredients are cited on the lists below:

Chemical Name	CAS Number	List Citations
DIPHENYLAMINE	122-39-4	18

--REGULATORY LISTS SEARCHED--

1 = ACGIH ALL	6 = TSCA 5a2	11 = CA P65 REPRO	16 = MN RTK
2 = ACGIH A1	7 = TSCA 5e	12 = CA RTK	17 = NJ RTK
3 = ACGIH A2	8 = TSCA 6	13 = IL RTK	18 = PA RTK
4 = OSHA Z	9 = TSCA 12b	14 = LA RTK	19 = RI RTK
5 = TSCA 4	10 = CA P65 CARC	15 = MI 293	

Code key: CARC=Carcinogen; REPRO=Reproductive

SECTION 16	OTHER INFORMATION
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N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 06: Protective Measures was modified.

Section 09: Phys/Chem Properties Note was modified.

Section 09: Boiling Point C(F) was modified.

Section 09: n-Octanol/Water Partition Coefficient was modified.

Section 08: Comply with applicable regulations phrase was modified.

Section 09: Vapor Pressure was modified.

Hazard Identification: Health Hazards was modified.

Section 11: Dermal Lethality Test Data was modified.

Section 11: Dermal Lethality Test Comment was modified.

Section 11: Oral Lethality Test Data was modified.

Section 11: Inhalation Lethality Test Data was modified.

Section 11: Dermal Irritation Test Data was modified.

Section 11: Eye Irritation Test Data was modified.

Section 11: Oral Lethality Test Comment was modified.

Section 11: Inhalation Irritation Test Data was modified.

Section 09: Relative Density - Header was modified.

Section 09: Flash Point C(F) was modified.

Section 09: Viscosity was modified.

Section 14: LAND (TDG) - Header was modified.

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Composition: Component table was modified.
Section 15: List Citations Table was modified.
Section 15: National Chemical Inventory Listing - Header was modified.
Section 15: National Chemical Inventory Listing was modified.
Section 15: Community RTK - Header was modified.
Section 11: Additional Health Information was modified.
Section 09: Melting Point C(F) was modified.
Section 15: Special Cases Table was modified.
Section 01: Company Contact Methods Sorted by Priority was modified.
Section 09: Vapor Pressure was added.

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