PCS Cooling System Operations and Maintenance (O&M) Manual

Y09944 Rev A

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Approved Use

External Use - NDA Required	
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1 About This Manual

This Manual provides instructions on commissioning, operating and maintaining the Northern Power Systems Power Converter Cooling System, CL25 & 50.

Any personnel who operate or maintain this equipment should be familiar with the complete documentation package and should have it available for reference. Be sure to read the important safety instructions in Section 2, “Safety Information.”

1.1 Typographical Conventions

This manual uses the following typographical conventions.

Element	Convention	Example
Drawing	Italicized names of drawings provided by Northern Power Systems	*1012128.pdf* *J04713 WC1300 Converter Schematic.pdf*

1.2 Getting Help

Northern Power
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If you have comments, suggestions, or questions about this manual, email us at service@northernpower.com

2 Safety Information

The following is a list of safety definitions and symbols noted throughout the manual and/or located on the equipment. Safety symbols in the manual appear in the left-hand column. The corresponding text appears to the right.

Symbol	Definition
DANGER	DANGER indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.
WARNING	WARNING indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.
CAUTION	CAUTION indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury.
NOTICE	Statements used for stating instructions or for the protection of personnel or property. This statement indicates that there is a potentially hazardous situation that, if not avoided, may result in damage to the equipment.
	This symbol indicates authorized personnel only.
	This symbol indicates a potential electrical hazard.
	This symbol indicates a switch must be opened to prevent a hazard.
	This symbol indicates a potential pinching hazard.

Symbol	Definition
	This symbol indicates a potential burning hazard.
	This symbol indicates that safety glasses are required.
	This symbol indicates a loud noise hazard and that hearing protection must be worn.
	This symbol indicates that protective gloves must be worn.
	This symbol indicates a chemical gas hazard.
	This symbol indicates a potential crushing hazard from moving parts.
	This symbol indicates a crush hazard from above.
	This symbol indicates a chemical hazard.
	This symbol indicates a device is susceptible to electrostatic discharge.
	This symbol indicates a falling hazard and that proper fall protection equipment is required.

Symbol	Definition
	This symbol indicates an explosion hazard.
	This symbol indicates a burn hazard from hot surfaces.

2.1 *Safety Precautions*

	Proper precautions must be followed by anyone operating, opening, or servicing the equipment. Read section “Component Documentation” for specific warnings related to individual system components.
	The converter must be secured and de-energized before any maintenance activities take place.
	Read applicable turbine Operating and Maintenance manual for operating instructions and procedures regarding turbine lock out.
	ONLY authorized personnel may work on this equipment. Read, understand, and observe the safety precautions throughout this manual.

2.2 *Equipment Electrical Hazards*

When following safety precautions in this manual, the following equipment electrical hazards apply

Equipment	Nominal Operating Voltage
AC distribution	480 Vrms
Control system	24 Vdc

2.3 *Safety Warnings*

DANGER		HAZARDOUS VOLTAGE MAY BE PRESENT. Contact may cause electric shock or burns. Turn off and lock out the system during any breaks in operation or prior to servicing.
DANGER		FALL HAZARD when turbine hatch open. Fall prevention required (100% tie off harness) when deck grating removed.
DANGER		HAZARDOUS VOLTAGE MAY BE PRESENT. Do not remove grid connection space dead front panel when turbine transformer is energized.
WARNING		THIS EQUIPMENT IS SUPPLIED BY THREE SOURCES OF POWER. Contact may cause electric shock or burns. Turn off and lock out the system prior to servicing.
NOTICE		This equipment includes parts and components which are susceptible to damage from electrostatic discharge (ESD). Use proper grounding equipment and techniques when working on or around this equipment.

WARNING		RISK OF ELECTRIC SHOCK FROM ENERGY STORED IN CHARGED CAPACITORS. Module contains film capacitors which may be charged. Discharge DC bus completely before inserting or removing FlexPhase™ Power Modules.
WARNING		BATTERY EXPLOSION. Replace only with specified batteries.
WARNING		USE CORRECT FUSE For continued protection against risk of equipment damage and fire, replace only with fuse of the specified type, current and voltage rating.

3 System Overview

The CL25/50 cooling system is designed to be controlled by and work seamlessly at any operating point with either 3 or 6 module versions of the NPS FP2000 Power Converter System (PCS) platform. It is composed of a pump station and a water to air heat exchanger (as required by the PCS configuration: (1) for 3 module, (2) for 6 module). The pump station is generally intended to be installed near the PCS, and the heat exchanger(s) within, on top of, or outside of the building/container in which the PCS is located. A version of the pump and heat exchangers is also packaged within the Outdoor rated PCS variant.

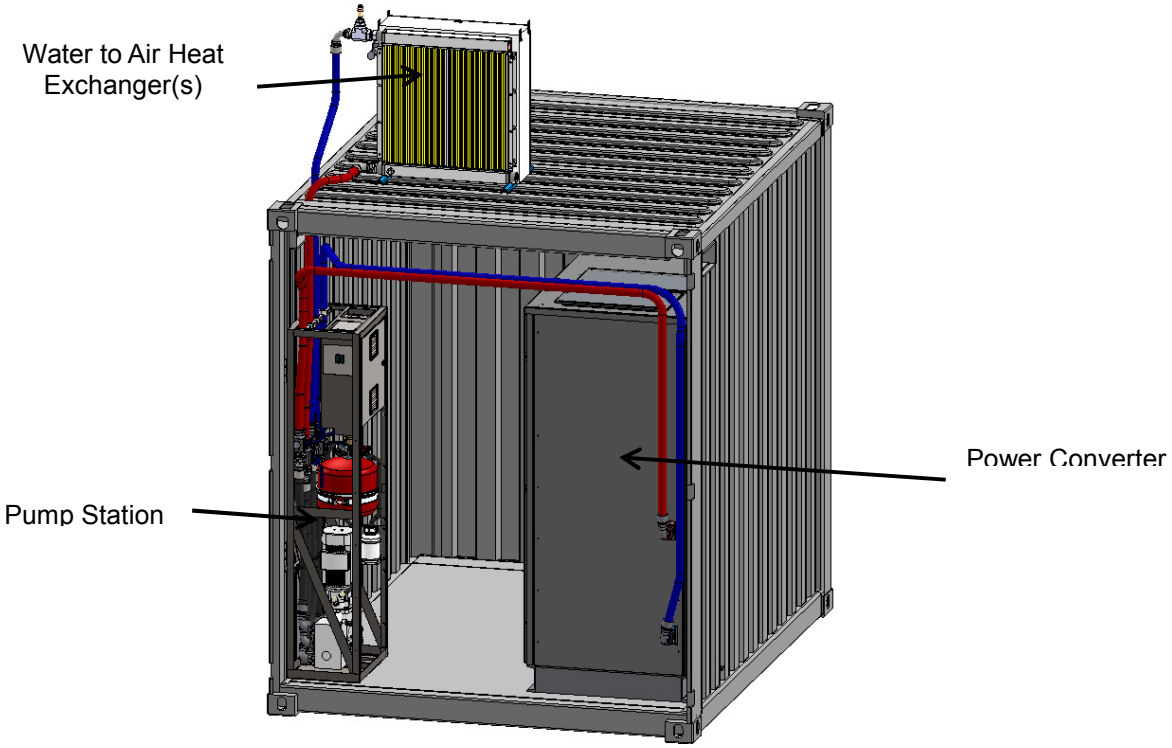


Figure 3-1: ISO Container General Arrangement

3.1 *Interface and Arrangement*

The pump station assembly is comprised of: a pump with manifolds, isolation valves, expansion tank assembly, and controls and power distribution, all packaged within a compact frame (Figure 3-2). It is intended to be positioned opposite the PCS within the width of a standard ISO container or within a building, with the hose/pipe routing overhead (see Figure 3-1, single heat exchanger shown).

The heat exchanger assembly is comprised of: a water-to-air heat exchanger (1 for 25kW, 2 for 50kW), variable speed fan, ambient temperature RTD, and automatic air valve. It will generally be installed a) outside the ISO container or building, or b) within a separate section within the ISO container or building where outside air is allowed.

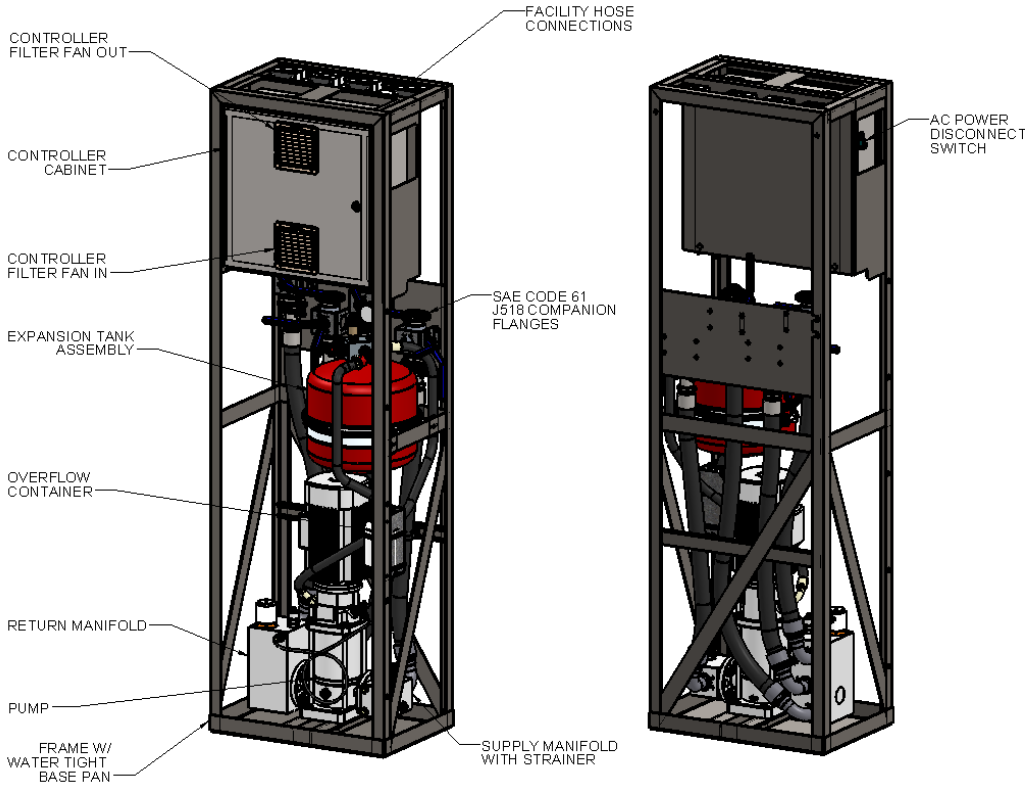


Figure 3-2: Pump Station Assembly

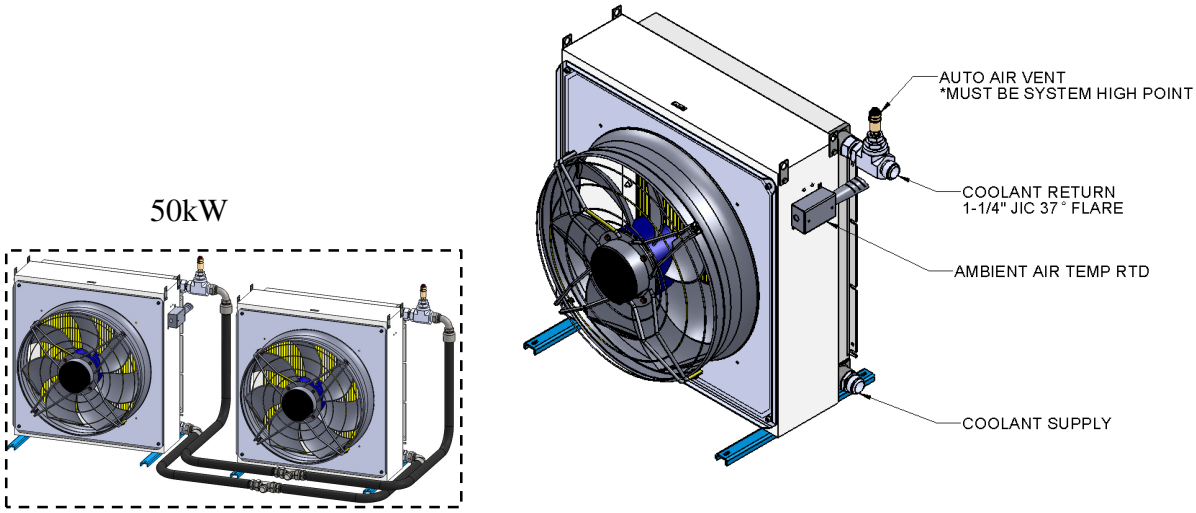


Figure 3-3: Water to Air Heat Exchanger Assembly

The total distance of PCS to pump station, and pump station to heat exchanger(s) must not exceed 12m (24m total hose length, supply and return).

See NPS Cooling System Interface Drawing for specific mounting requirements and dimensions.

3.2 *Theory of operation*

The PLC within the NPS FP2000 PCS controls the cooling system by controlling the pump speed, fan speed, and a coolant heater, in response to the PCS cooling requirements at any given ambient and coolant temperature. The PLC controls the cooling system to use the minimum amount of power required to maintain safe reliable operation of the PCS. In addition, the PLC manages the system to minimize condensation within the PCS cabinet.

The pump is controlled to maintain a minimum flow in the PCS, and increases this flow in proportion the commanded electrical current.

The heat exchanger fan speed is controlled to limit the temperature difference between the PCS inlet temperature and the ambient temperature to 12 °C, while also limiting the fan operation when the coolant at the inlet of the PCS is below 40 °C.

To help prevent condensation, the system includes an automatic three way bypass valve and a 3kW coolant heater. The bypass valve is set to bypass the radiators below 25 °C and to become fully open above 40 °C. The heater is set to turn on when the coolant is less than 25°C and less than 3°C above ambient temperature.

The cooling system includes a pressurized expansion tank whose minimum pressure ensures positive pressure exists on the system coolant at the lowest expected storage temperature, and includes a receiving volume adequate to ensure coolant expansion is accounted for at the maximum possible coolant temperature. Expansion tank pressure is adjustable via a Schrader valve connection, should it be necessary in a maintenance condition (*use clean N2 only*).

To aid maintenance conditions, the system includes a pressure gauge, a dedicated test port, a fill port, and a drain port. A pressure switch, set to the minimum operating pressure, is monitored by the PLC to ensure the cooling system is at least that pressure prior to operating.

A pressure relief valve is included to ensure no hazardous overpressure conditions can occur within the piping system.

3.3 *Specifications*

Supply Power	400-480VAC, 50 or 60hz
Communication: PCS to Cooling	Profinet
Pump motor	2.2kW, 3500rpm, 3 phase
Heat exchanger motor	1.25kW, 1170rpm, 3 phase
Sound Pressure	<80dB@1m per Heat Exchanger
Coolant Heater	3kW, 3 phase
Fluid Connections- heat exchangers:	1-1/4 JIC 37° Flare
Fluid Connection- Pump Station	1-1/4 SAE J518, Flat Flange
Fluid Connections- PCS:	1-1/4 SAE J518, Flat Flange
Pressure drop at Rated- 6 module:	369kPa (54psid)
Pressure drop at Rated- 3 module:	326kPa (47psid)
Flow at Rated- 6 module:	2.2 l/s (34.9gpm)
Flow at Rated- 3 module:	1.3 l/s (20.6gpm)
Flow rate	Variable, to 25% of full flow
Heat load – 3 module PCS:	23kW
Heat load – 6 module PCS:	47kW
Cooling Fluid:	50/50 mix Inhibited Propylene Glycol De-ionized Water (e.g. Dowfrost HD)
System type	Pressurized & closed to atmospheric exchange
System pressure (fill pressure)	4 bar (58psi) @20°C
MAX operating pressure (PRV set point)	6 bar (87psi)
Test Pressure	10.3bar (150Psi)
MAX supply coolant temperature :	60°C
MIN supply coolant dT:	+3°C greater than ambient

4 Installation

4.1 *Mechanical Fixation*

The pump station must be bolted to the floor and wall when installed within a mobile container (e.g. ISO container), or the floor only when installed within a building.

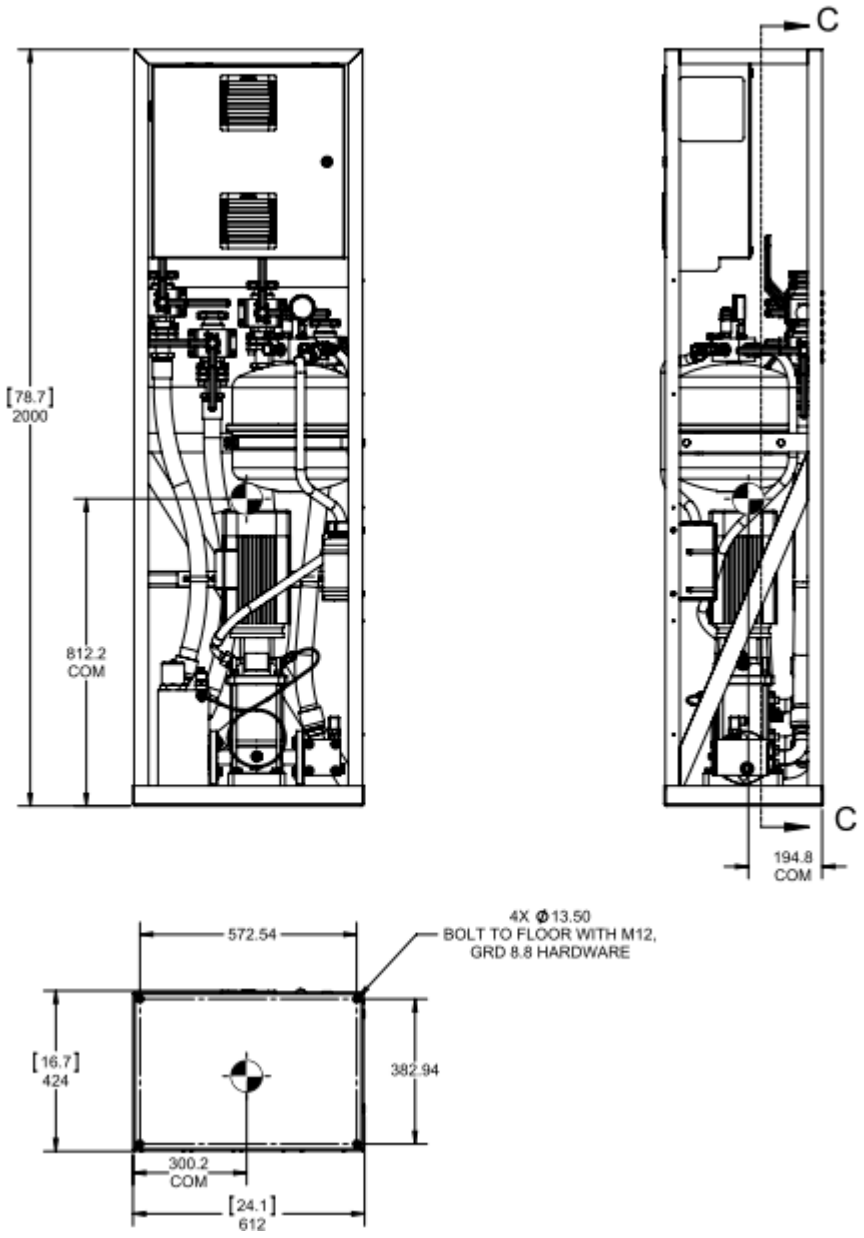


Figure 4-1

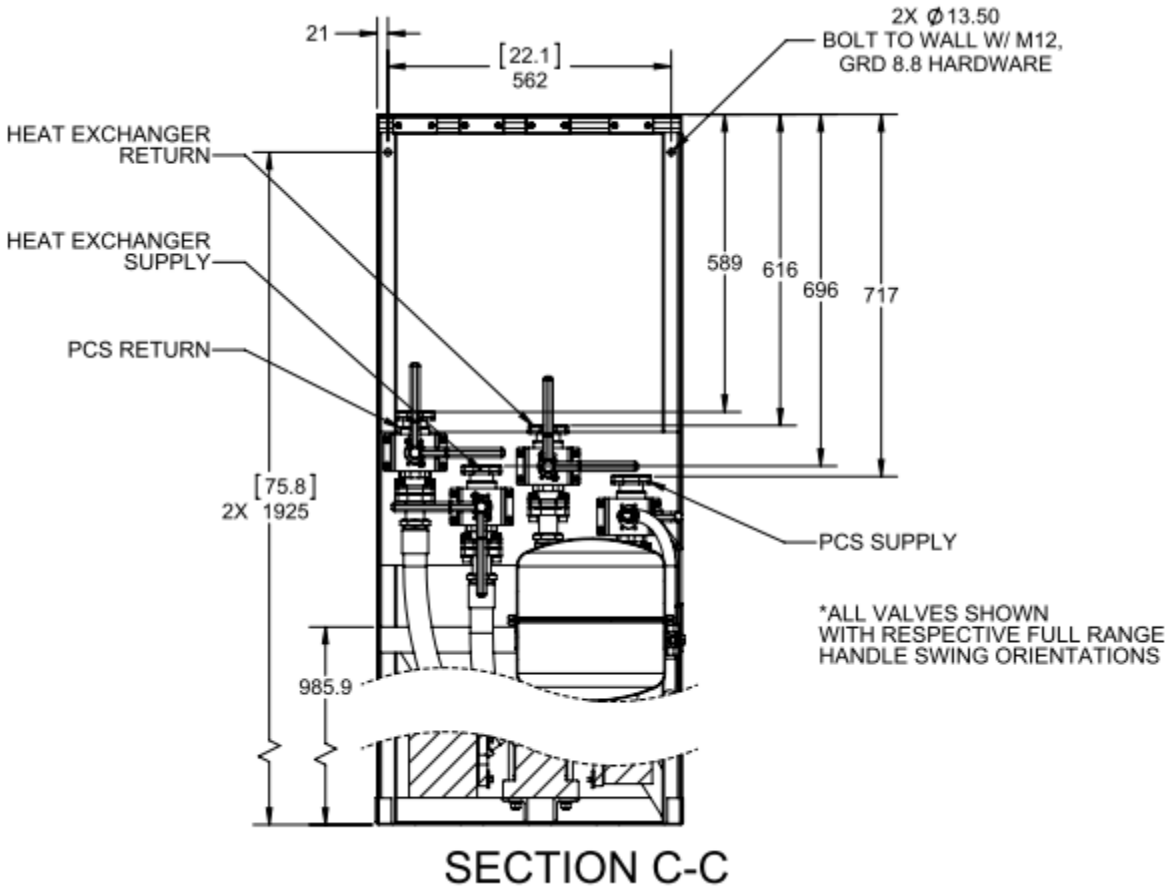

21
[22.1]
562
2X Ø13.50
BOLT TO WALL W/ M12,
GRD 8.8 HARDWARE
HEAT EXCHANGER
RETURN
HEAT EXCHANGER
SUPPLY
PCS RETURN
589
616
696
717
[75.8]
2X 1925
PCS SUPPLY
*ALL VALVES SHOWN
WITH RESPECTIVE FULL RANGE
HANDLE SWING ORIENTATIONS
985.9
SECTION C-C

Figure 4-2

The radiator (water to air heat exchanger) must be bolted to the surface on which it is mounted. This may be the roof of the mobile container (e.g. ISO container), a frame, or a concrete pad. Installation requirements are the same whether a single (CL25) or double (CL50) radiator system is chosen.

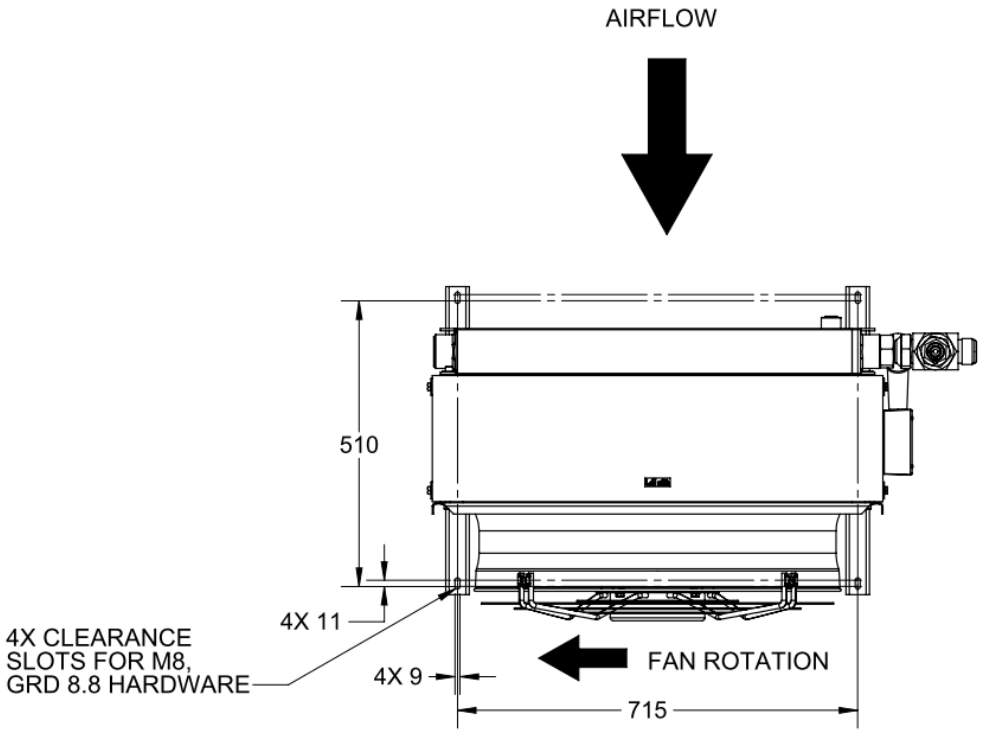


Figure 4-3

The ambient air temperature sensor is shown as mounted to the side of the heat exchanger. For best measurement accuracy, the sensor should be permanently mounted to the structure which houses the PCS system, far from the path of the warm air leaving the heat exchanger.

4.2 *Electrical Connections*

Refer to Cooling System Electrical Schematic. All connections are made through the top of the PCS pump station. See figure 4-4 below. The installer should remove the controller cabinet gland plates and install cable glands (not supplied) for all connections listed.

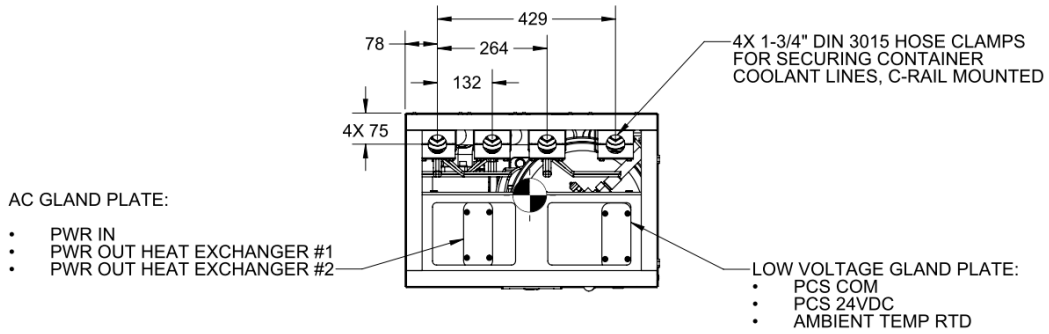


Figure 4-4

The pump is controlled by a variable frequency drive (VFD) which requires a control panel be installed for all manual (non-PCS commanded) operations such as fill & purge operations. This unit is NOT included with the cooling system, and must be purchased separately (see Figure 4-5).

Part Number	**Description**
ACS-CP-C	ABB ACS310 VFD Basic Control Panel

Overview

The following table summarizes the key functions and displays on the Basic control panel.

No.	Use
1	LCD display – Divided into five areas: a. Upper left – Control location: LOC: drive control is local, that is, from the control panel REM: drive control is remote, such as the drive I/O or fieldbus. b. Upper right – Unit of the displayed value. c. Center – Variable; in general, shows parameter and signal values, menus or lists. Shows also fault and alarm codes. d. Lower left and center – Panel operation state: OUTPUT: Output mode PAR: Parameter mode MENU: Main menu. FAULT: Fault mode. e. Lower right – Indicators: FWD (forward) / REV (reverse): direction of the motor rotation Flashing slowly: stopped Flashing rapidly: running, not at setpoint Steady: running, at setpoint SET: Displayed value can be modified (in the Parameter and Reference modes).
2	RESET/EXIT – Exits to the next higher menu level without saving changed values. Resets faults in the Output and Fault modes.
3	MENU/ENTER – Enters deeper into menu level. In the Parameter mode, saves the displayed value as the new setting.
4	Up – • Scrolls up through a menu or list. • Increases a value if a parameter is selected. • Increases the reference value in the Reference mode. • Holding the key down changes the value faster.
5	Down – • Scrolls down through a menu or list. • Decreases a value if a parameter is selected. • Decreases the reference value in the Reference mode. • Holding the key down changes the value faster.
6	LOC/REM – Changes between local and remote control of the drive.
7	DIR – Changes the direction of the motor rotation.
8	STOP – Stops the drive in local control.
9	START – Starts the drive in local control.



Figure 4-5

4.3 *Hose Connections*

Hose end connections to the pump station are SAE Code 61 (J518) companion flanges. Split flange kits are not included.

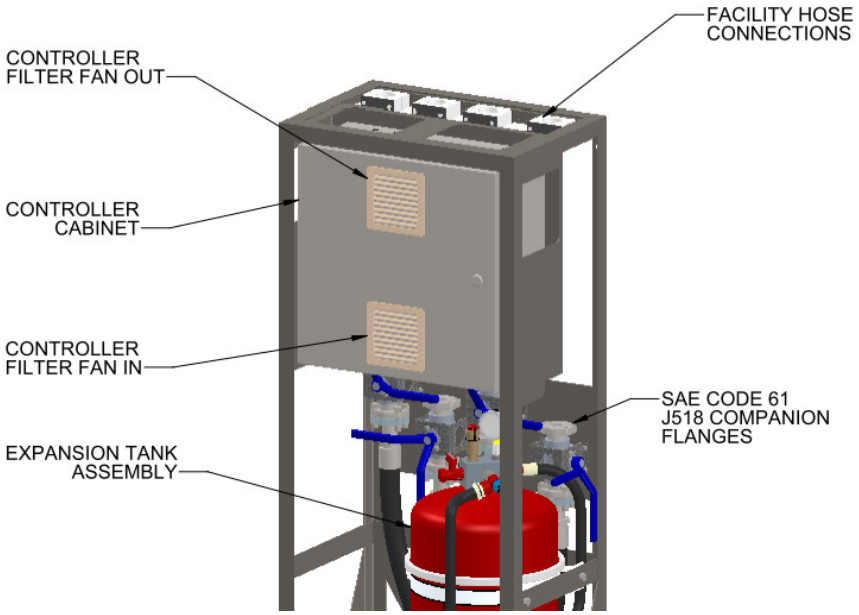


Figure 4-6

Hose connections to the radiator(s) are 1-1/4” JIC 37° flare.

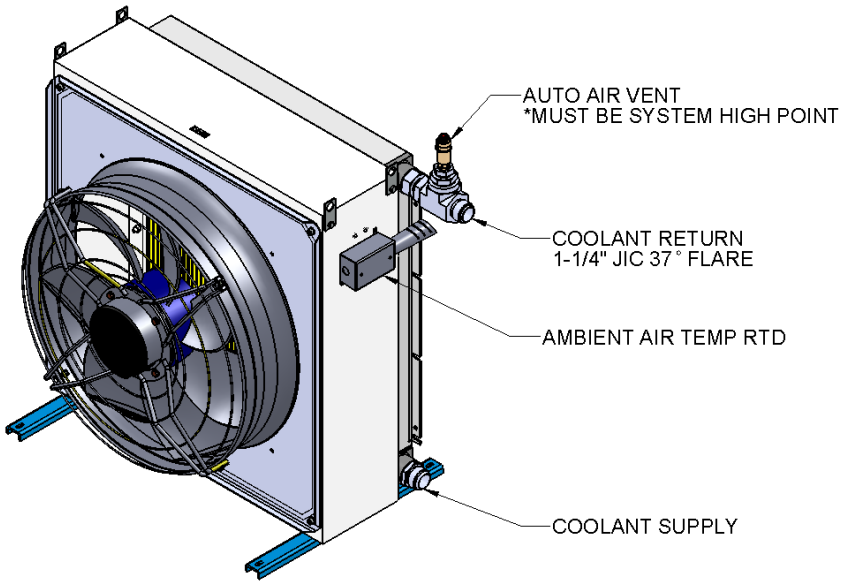


Figure 4-7

4.4 *System Fill & Air Purge*

1. Install ABB ACS310 Basic Control Panel on the pump VFD. With system powered, use keypad to set VFD to 'LOC' mode (ref. ABB ACS310 User Manual).
2. Fill system with coolant by attaching the soft PVC (1/2" ID) line from a supplied glycol feeder pump (any manual or powered pump capable of attaining 4bar pressure, 5-15l/min) to pump station fill port (use barb fitting supplied with pump station), and clamping with a hose clamp.

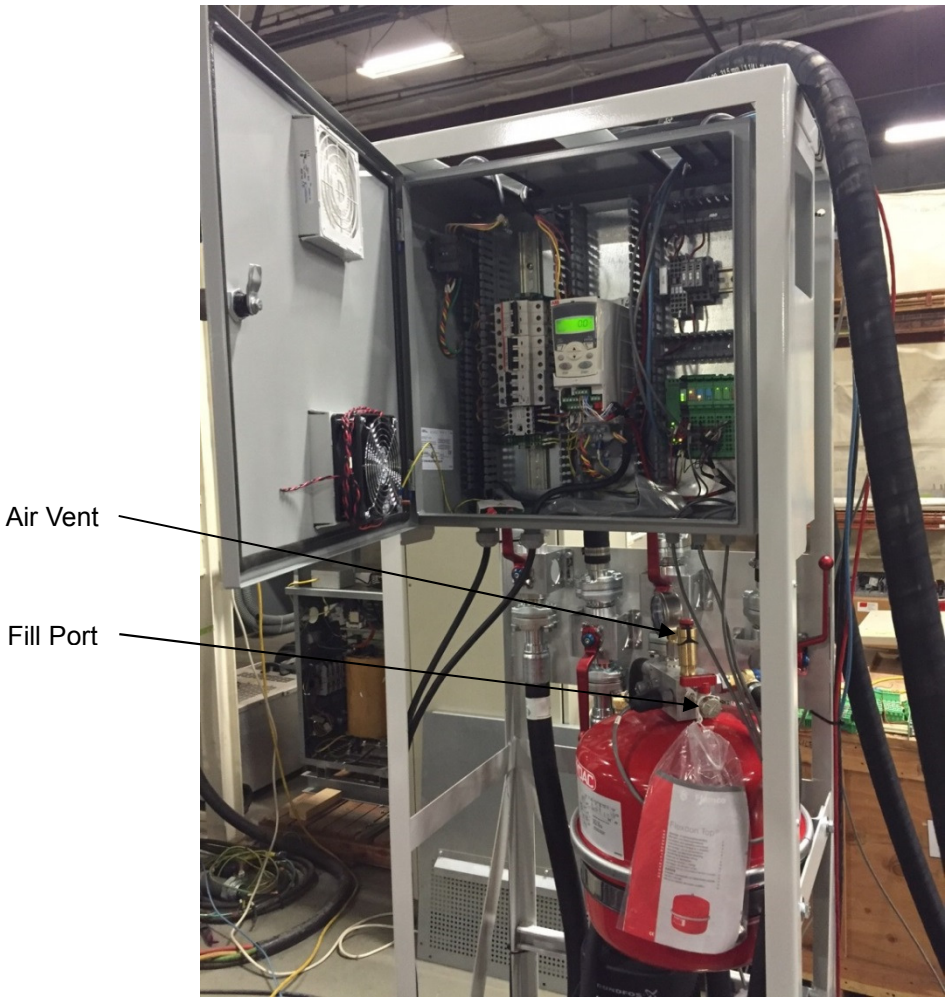


Figure 4-8

3. Slowly (5-15l/min) fill system until pressure reads 4bar on expansion tank gauge. NOTE: air should be heard escaping air vent located on expansion tank, and each heat exchanger.
4. Place VFD in 'LOC' mode. Spin pump at 25 Hz for 5-10 seconds. This should drive out more air. Correct pressure with feeder pump as required to maintain 4 bar cold fill pressure. Continue to drive pump for 5-10 seconds and add glycol in this manner until no more air escapes and pressure is stable.
5. Spin pump at 45 Hz. Pump should be smooth with occasional air releases from vent valve.
6. Increase pump speed to 60hz. Run until no more air escapes (up to 4 hours).

5 Operation

5.1 *Normal Operation*

Ensure AC power disconnect switch is in the ‘ON’ position (see Figure 3-2).

The cooling system is controlled automatically by the PCS PLC. There is no user interface during normal operation.

6 Maintenance

6.1 *Adding Coolant*

The normal cold (20°C) pressure for the system is 4 bar. Coolant should be added per section 4.4 when gauge pressure is more than 0.1bar below specification.

6.2 *System Drain*

The system should first be drained from its normal cold fill pressure down to atmospheric pressure through the fill port as detailed in section 4.4.

The pump may be drained by removing the housing plug (Figure 6-1).

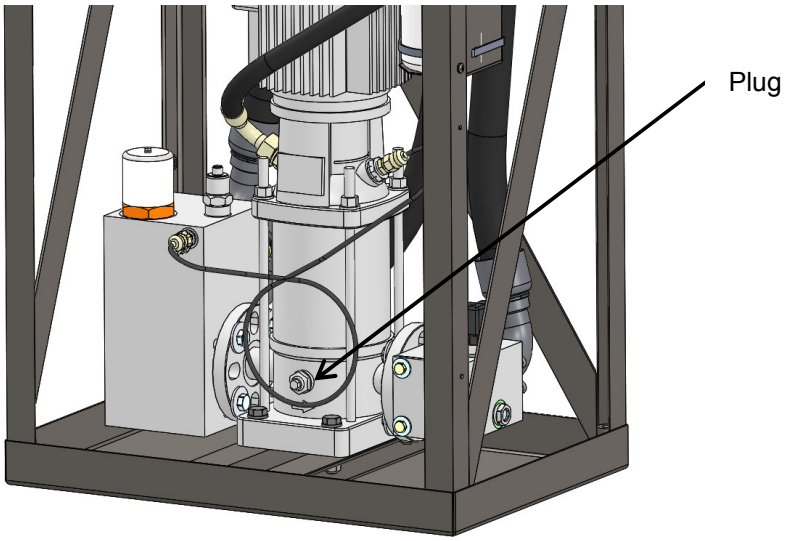


Figure 6-1

The heat exchanger(s) may be drained by placing a suitable containment device below the drain port and removing plug (

2).

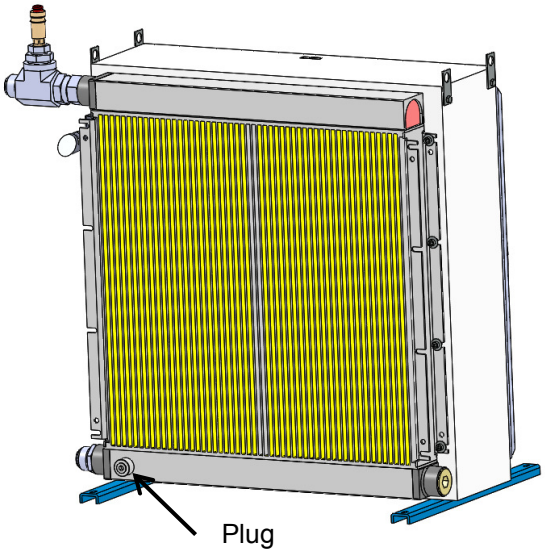


Figure 6-2

Refer to NPS FP2000 Operation and Maintenance Manual for guidance on draining of PCS cabinet piping.

6.3 *Expansion Tank*

The expansion tank is pressurized with clean dry nitrogen from the manufacturer. The tank pressure may be checked using any air pressure gauge capable of interfacing a Schrader type valve. Note: enough coolant must be drained from system such that tank pressure gauge reads 0bar before tank gas pressure may be read. Base gas pressure is 1.5bar.

6.4 *Hose Replacement*

Hoses should be inspected annually for signs of aging (discoloration, cracks, etc.). The expected lifetime is 7-10 years. Hose replacement requires that all coolant first be drained from the system.

6.5 *Radiator Cleaning*

Each heat exchanger should be inspected for trapped debris such as leaves and dirt, every 3-6 months depending, or as local conditions warrant. Material may be removed via soft brush, pressurized clean water, and/or vacuum.

6.6 *Strainer Cleaning*

The pump station is equipped with a 1mm pore size strainer located on the discharge side of the pump. Although the system should not generate particulate which could clog the strainer, the presence of contaminants due to unauthorized use of pipe thread sealants could lead to low flow conditions which may cause the Inverter to limit power due to insufficient cooling.

To clean, close all pump station ball valves, and drain pump (see 6.22). Remove the 4 bolts holding cover in place, and extract strainer. Rinse with clean water until all debris is removed, and re-install.

6.7 *Coolant*

The coolant should be tested annually per the coolant manufacturer's recommended procedure. See NPS FP2000 Operation and Maintenance Manual for maximum coolant conductivity requirement.

6.8 *Controller Air Filters*

Both the inlet and outlet vents (see Figure 6-3) of the electrical controller cabinet contain air filters which should be replaced annually. Replace filters by prying grills from both openings (no tools required), and removing old filters.

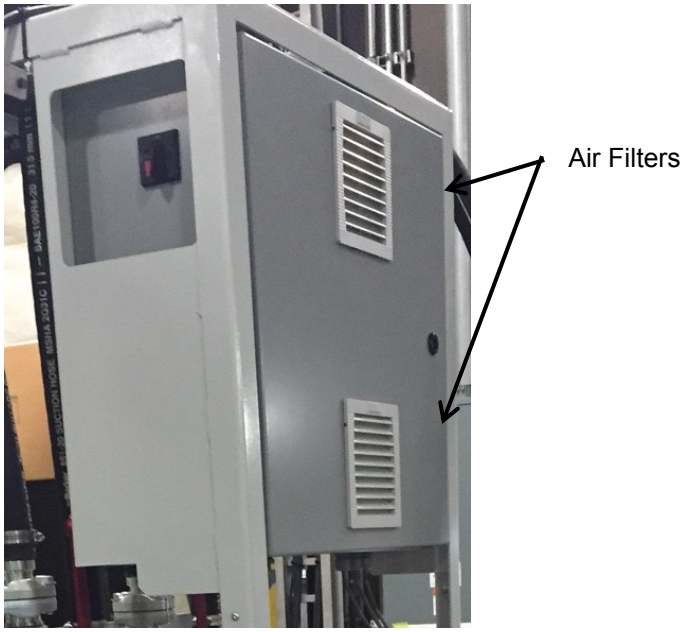


Figure 6-3

7 Troubleshooting

Malfunction	Probable Cause	Corrective Action
Low pressure warning causes pump to stop	Coolant leak	Inspect for leaking coolant, repair & refill
	Expansion tank pressure loss	Check pressure/replace expansion tank
Coolant temperature greater than 12 degrees (Celsius) over ambient at full PCS current	Heat exchanger fan inoperable	Check for fan function
	Heat exchanger fins blocked	Clean heat exchanger fins
Low coolant flow	Strainer clogged	Clean strainer
	Failing pump	See manufacturer's documentation on repair/replacement
Coolant fails to warm at low temps	Heater failure	Check heater breaker/replace heater

Note: all potential malfunctions listed assume that the PCS has previously warned of an overheat condition.

8 System Drawings and Diagrams

Document Name	Document Description
J09949	Cooling system electrical schematic
G09952	Cooling system interface/plan drawing
1018995	Pump station assembly drawing
1018889	Heat exchanger assembly drawing
G10074	P&ID, Flexphase cooling system
ABBSAUA0000044201	User's Manual ACS310 Drives