Model: N/A Serial #: All	July 26, 2013
Product Bulletin # PH-003	

PACE-X VFD Cooling System Operation & Maintenance

General Information

PACE-X Power House and Driller's Cabin controls include liquid-cooled Converteam Delta modules for the Variable Frequency Drives (VFDs). This document defines the operation, performance and maintenance of the VFD cooling system, and helps qualified personnel understand the basics of the cooling system and troubleshoot in case of failure.

> Read this bulletin thoroughly before starting the procedure. Complete a Job Safety Analysis (JSA) to include everyone affected by the task being performed. All JSA attendees must sign the JSA form. Pay particular attention to positions of people, pinch points, and strains or slips associated with pushing or pulling.

The temperature of the cooling liquid must be kept higher than the temperature of the electrical room to avoid condensation on the cooling plate of the liquid-cooled drive.

Refer to Figure 1 to determine whether the drive operating conditions (combination of room temperature, humidity and cooling liquid temperature) are safe, or to determine the proper cooling liquid temperature.

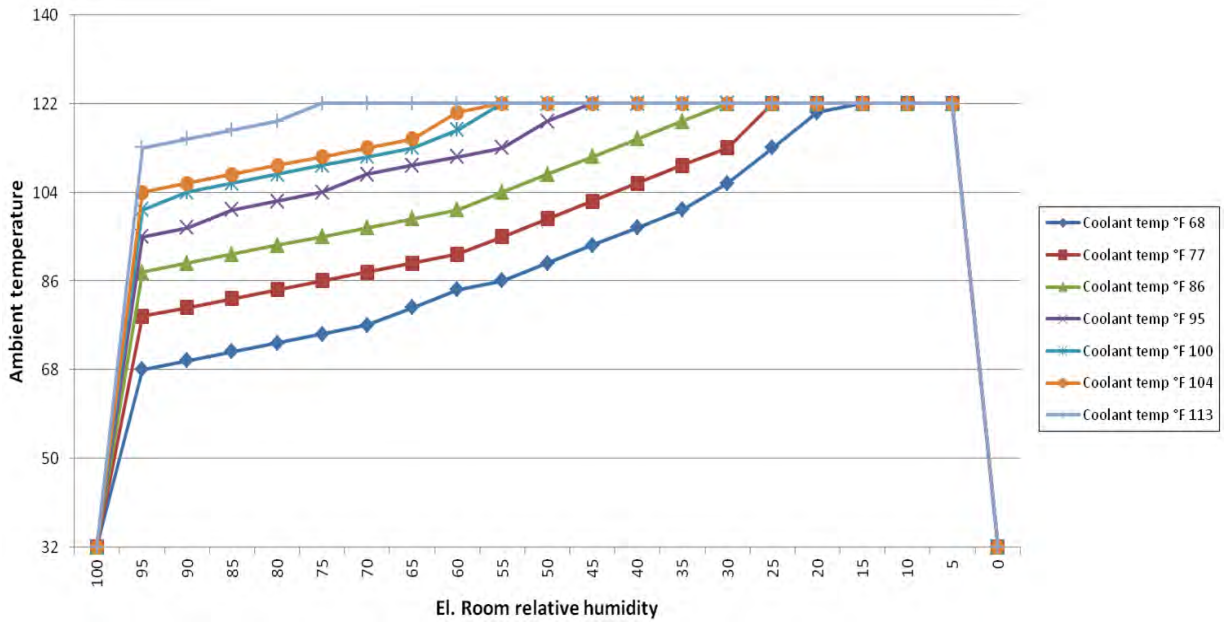


Figure 1: Condensation Safe Operating Area

To use the chart plot the ambient temperature and relative humidity on the graph, and note the coolant temperature. If the plotted point is above the line representing the coolant temperature, then take steps to decrease the temperature or relative humidity or increase the coolant temperature.

> Increasing the temperature of the cooling liquid above 113°F decreases the nominal output current of the drive. The curves in the graph are valid at sea level altitude (1,013 mbar).

See Section “HMI Setpoints” on page 6 for additional information.

Scope

Subsystems involved in this procedure are listed below. See Figure 2 for additional information.

Electrical Controls

1. Two centrifugal pumps — 3-phase, 600V, 3 hp
   - Operates in duty/standby mode
   - Duty changeover every 12 hours
   - MCC starter controls from PLC
   - Duty pump starts as soon as PLC and MCC are powered up
2. One heat exchanger fan — 3-phase, 600V, 5 hp
   - Runs when liquid temperature reaches setpoint on the HMI temperature control screen.
3. One immersion heater — 1-phase, 208V, 1.25 kW
   - Turns ON when coolant temperature drops below setpoint on the HMI temperature control screen.

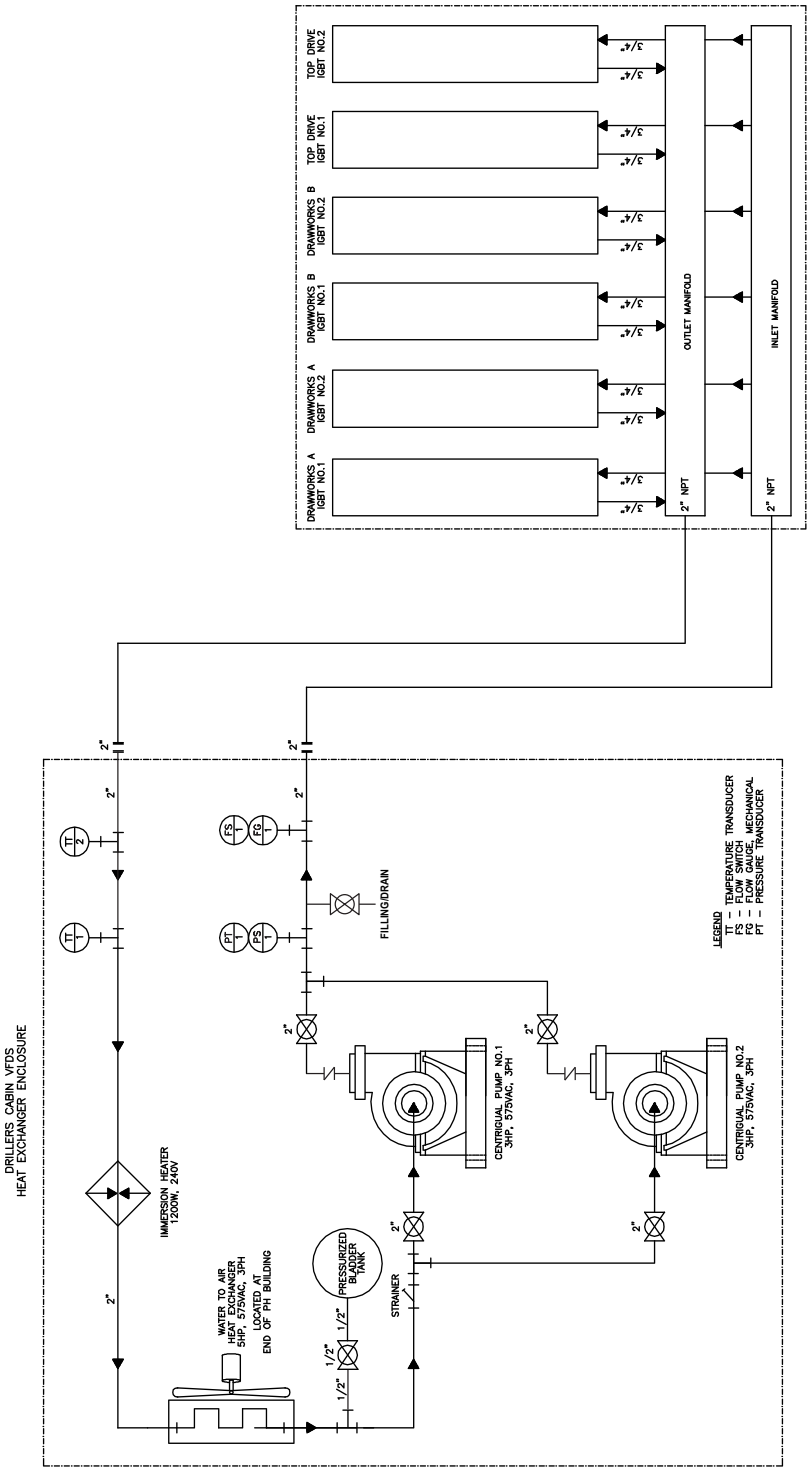


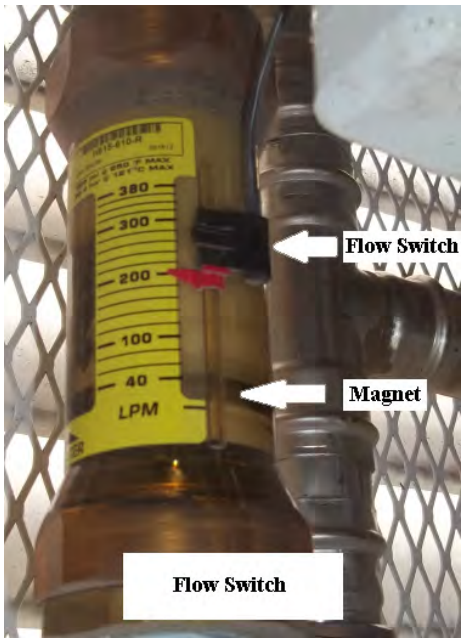
Figure 2: Driller's Cabin VFD Cooling System

Instrumentation

See Figure 3 for pictures of the devices listed below.

1. Pressure transmitter: 0 to 100 psi (4–20 mA signal to PLC)
2. Flow switch: Adjustable at flow indicator (gauge). Discrete signal to PLC.
3. Temperature transmitters:
   - Two each for coolant temperature (0 to 300°F, 4–20 mA signal to PLC)
   - One each for ambient temperature (-4 to 167°F, 4–20 mA signal to PLC)

System Pressure



System Flow

Coolant Temperature

Ambient Temperature

Figure 3: Cooling System Instrumentation

HMI Setpoints

The HMI screenshots shown below indicate the setpoints used for the cooling system. Use these screens to monitor coolant temperature and system pressure.

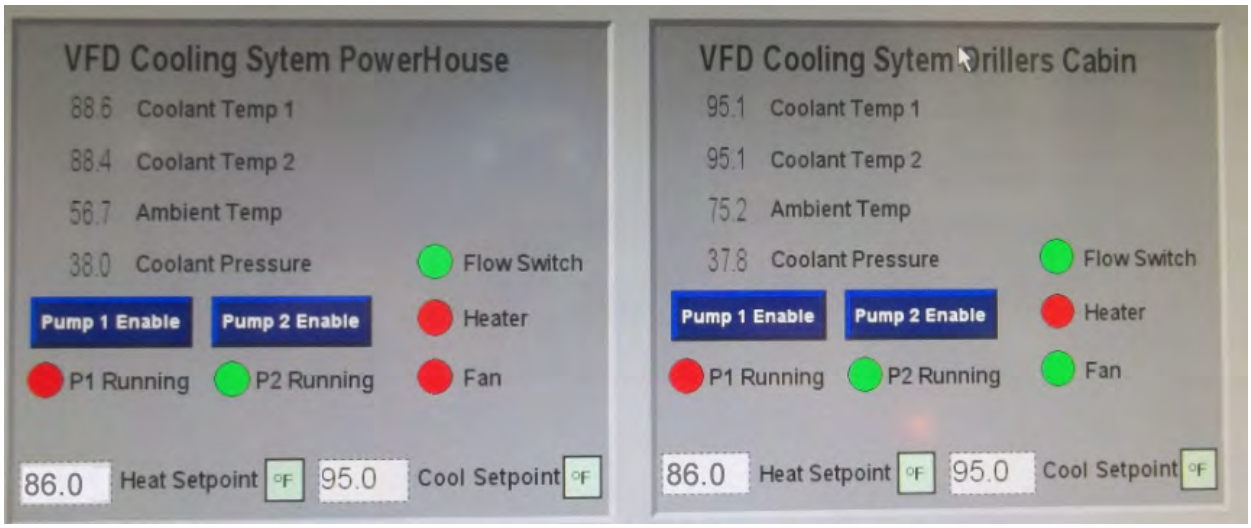


Figure 4: Power House and Driller's Cabin Cooling System Status and Setpoints

Procedure

Before starting this procedure verify the following initial conditions.

- All cooling system sensors (temperature and pressure transmitters) are wired correctly and showing correct values in the HMI.
- The cooling system pressure gauge is calibrated and matches the HMI pressure value.
- The flow switch discrete signal to the PLC comes healthy when any cooling pump starts from the MCC in HAND mode. Adjust the flow switch on the flow gauge until it matches. Flow in the flow gauge should be showing greater than 50 gal/min.
- The VFD cooling pumps are healthy and in AUTO.
- The heat exchanger fan is healthy and in AUTO.

VFD Cooling System Auto Operation

Verify the following in Auto mode:

- When both pumps are operating in Auto mode, only the duty pump starts. The pump should develop approximately 36 psi. At 100°F coolant temperature, the system pressure should be approx. 39 psi.

- The flow switch comes healthy.
- The tank immersion heater turns ON when the coolant temperature drops below 86°F (HMI adjustable temperature setpoint—heat setpoint) and turns OFF at 91°F.
- The heat exchanger fan turns ON when the coolant temperature goes above 95°F (HMI adjustable temperature setpoint—cool setpoint) and turns OFF at 90°F.

The pump should be ON for heater operation.

- When both pumps are OFF, the system pressure should be approximately 18–20 psi and the flow switch must turn OFF. See Figure 6.
- The Power House cooling system has approximately 30 gallons of coolant and the Driller's Cabin has approximately 25 gallons of cooling fluid.
- Cross interlocks in the PLC to avoid both pumps running simultaneously in Auto.

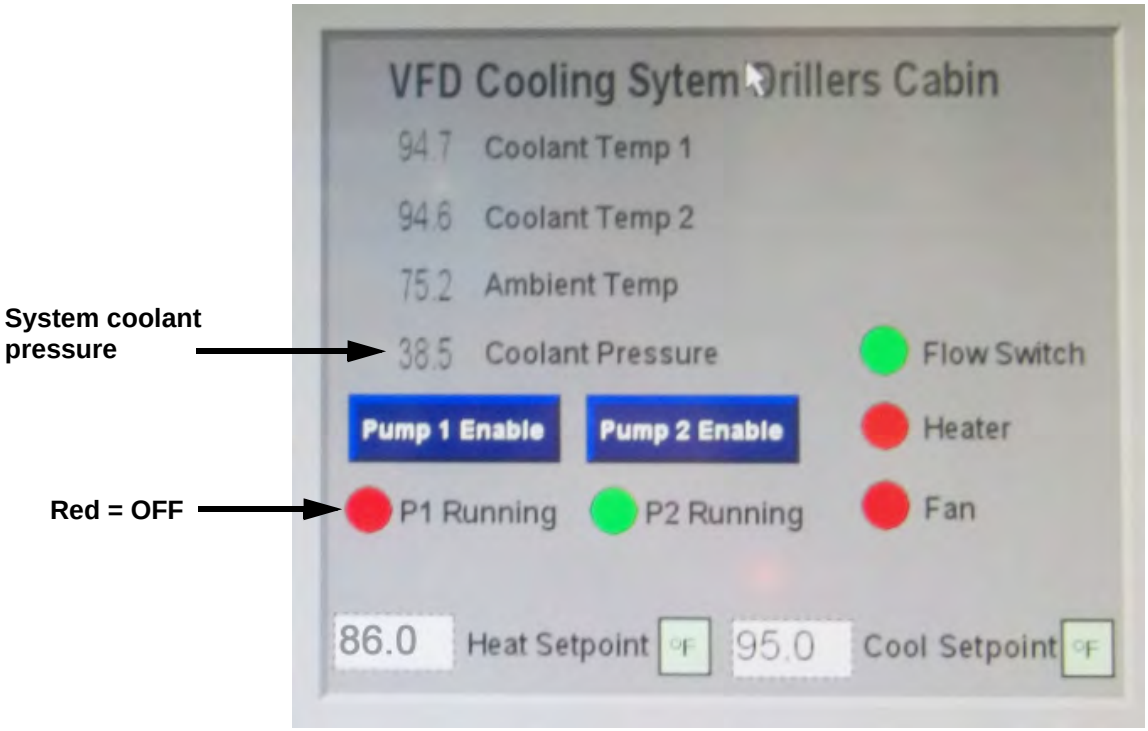


Figure 5: System Pressure when Coolant Temperature around 95°F

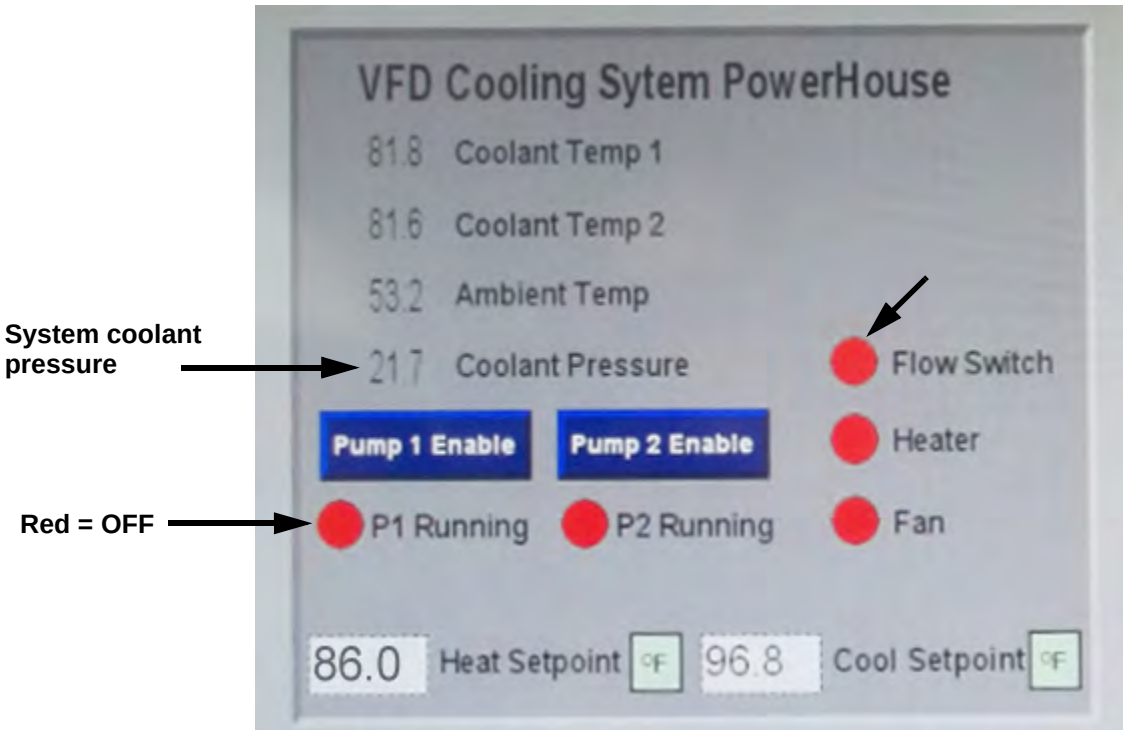


Figure 6: System Pressure with both Pumps OFF

Pressurizing the Cooling System

Required Parts

- Hydrostatic pump (120V, 0.5 hp) with pressure gauge
- Water hose connector (¾" NPT male to garden hose male)
- Kink-free 50' hose
- Pressure hose with ball valve
- Empty drum (50 gallons)
- Glycol (20 gallons)
- Water (20 gallons)
- 120V, 15A power source (generator or 120 V outlet in Power House or Driller's Cabin)
- Extension cord

Procedure

1. Remove the top plug from the bleeder valve. (See Figure 7.)

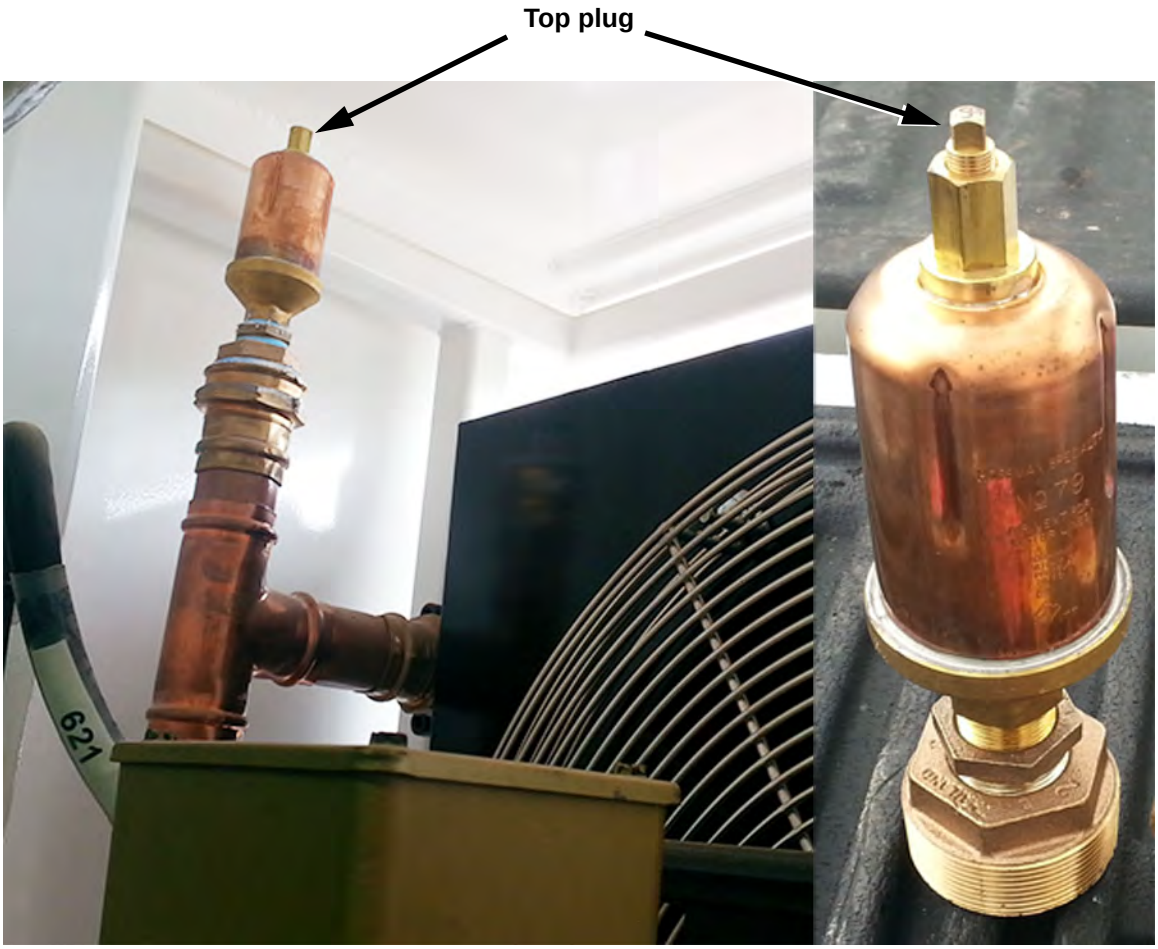


Figure 7: Bleeder Valve Top Plug

2. Connect the pressure hose to the cooling system intake (filling/drain). (See Figure 8). Keep the ball valve open.

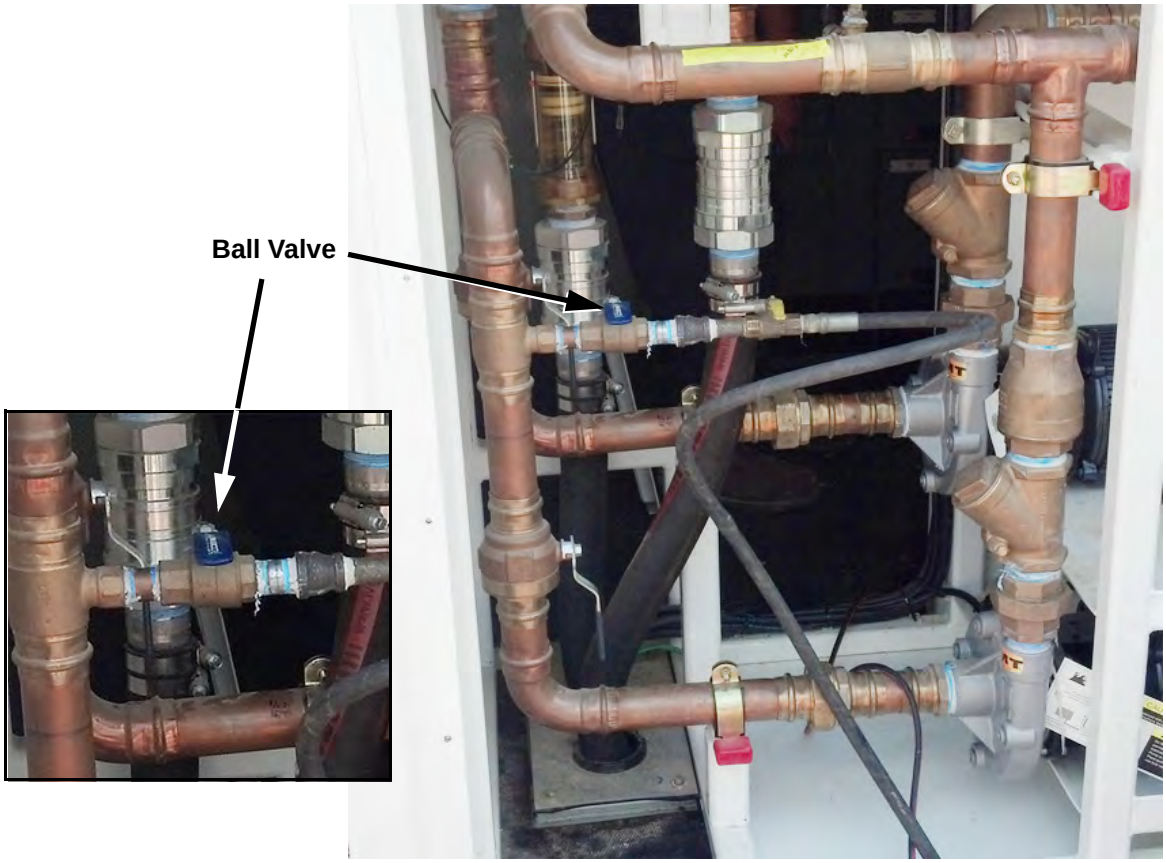


Figure 8: Pressure Hose connected to the Intake

3. Insert the garden hose (suction side connection of hydrostatic pump) into the drum. (See Figure 9.)

Figure 9: Garden Hose in Drum

4. Mix the glycol and the water in the drum.

5. Connect the hydrostatic pump to the 120V power source.

> Make sure the 120V source switch is easily accessible. The hydrostatic pump develops pressure rapidly and may reach more than 100 psi in a few seconds.

6. Start the hydrostatic pump.
7. Monitor the pressure gauge on the hydrostatic pump. Listen for air escaping out of the bleeder valve.
8. When the pressure reaches 35 psi, stop the hydrostatic pump.

> Initial wait time for the pressure to reach 35 psi is approximately 10–15 minutes.

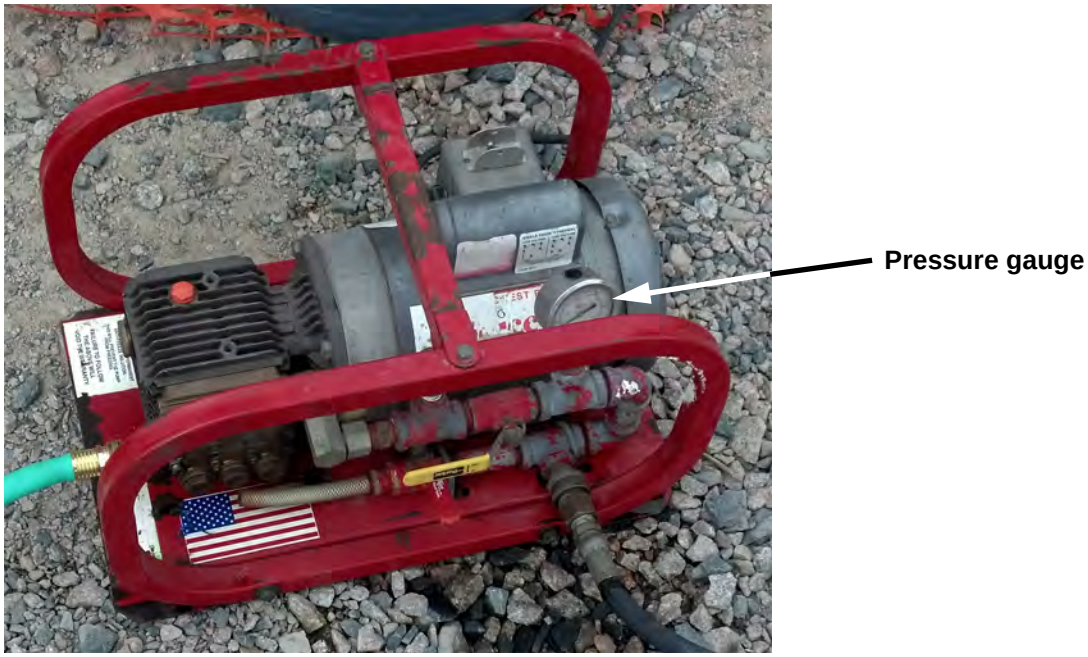


Figure 10: Hydrostatic Pump

9. Start the main VFD cooling pump.
10. Stop the pump after one minute.
11. Wait 5 minutes until air from the bleeder valve is released.

Figure 11: VFD Cooling Pump

12. Repeat Steps 6 through 11 two to three times until all air in the system is released.
13. Shut the intake valve. Run the VFD cooling pump for 15 minutes. Stop the cooling pump and verify no air is released from the bleeder valve. Verify the pressure gauge shows 18–20 psi in the line when both cooling pumps are off and pressure remains constant.
14. Close the top plug on the bleeder valve. Refer to Figure 7 on page 9.

15. Close the intake line ball valve and the hose ball valve.

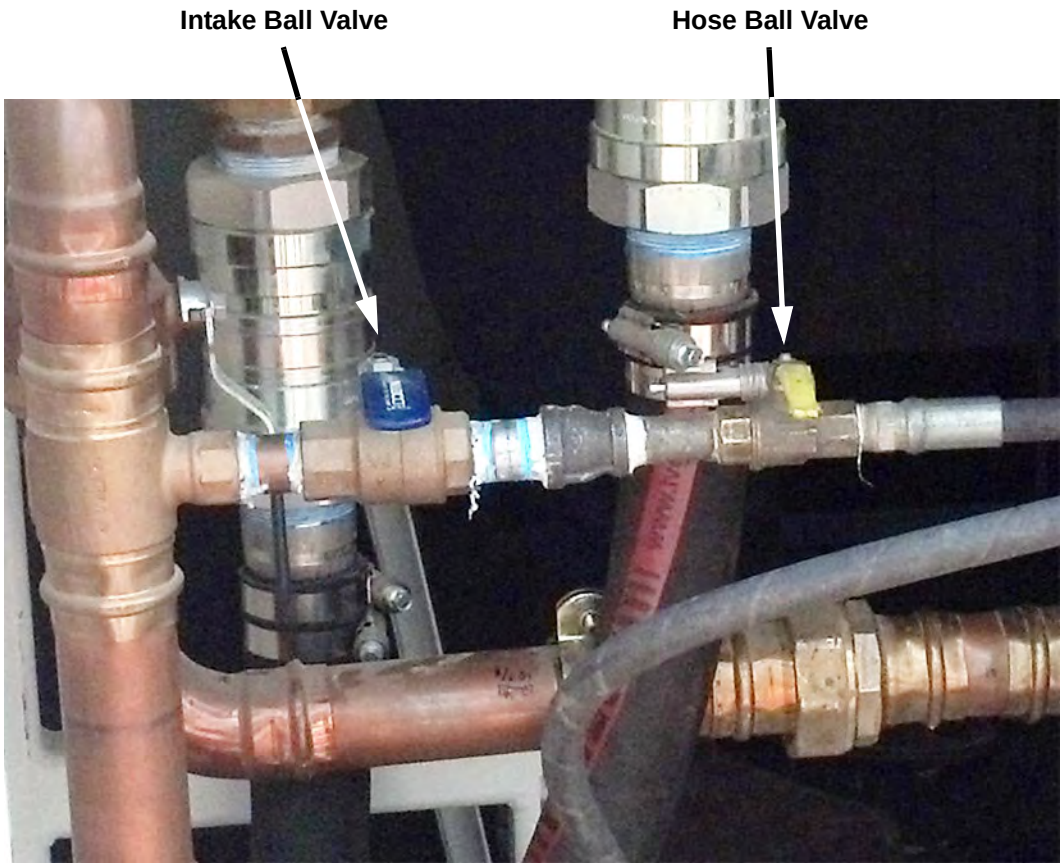


Figure 12: Intake and Hose Valves

16. Disconnect the pressure hose and start the VFD cooling pump. The system should run at 35 psi.

Purging the Cooling System

Follow this procedure to release air trapped in the line when 600V rig power is not available to run the cooling pumps. This condition typically occurs after a rig move when generators are not hooked up. If a leak or pressure loss is found, this procedure will help to avoid rig downtime.

Procedure

1. Repeat steps 2 through 6 in section “Pressurizing the Cooling System” on page 8. Stop the hydrostatic pump when pressure reaches 35 psi.

2. In the VFD cabinet, each inverter (Delta) module has a vent valve on top of the Delta module. (See Figure 13). Put the clear hose pipe in the empty bucket/bottle and open the air vent valve.

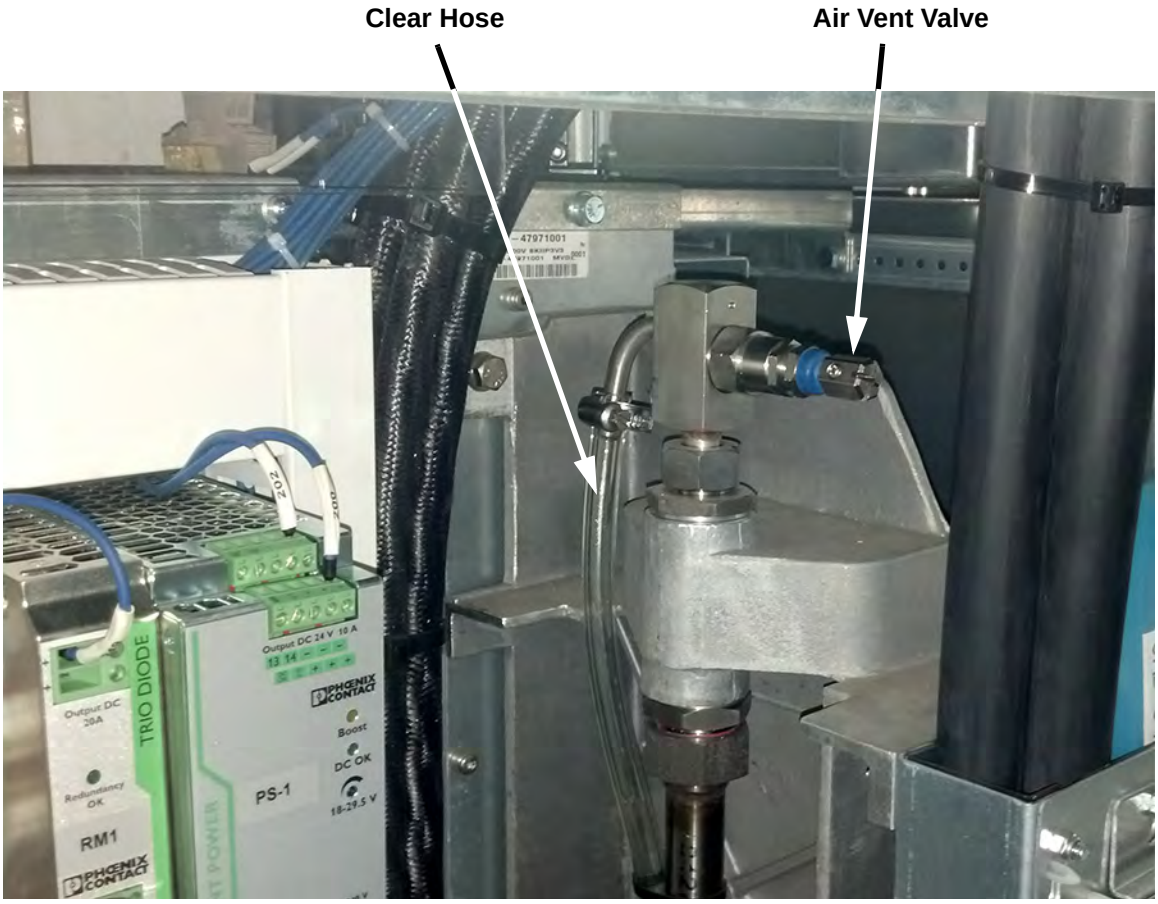


Figure 13: Clear Hose and Air Vent Valve in the VFD Delta Module

3. Keep the vent valve open until all the air in the Delta module is released and fluid starts coming out.
4. Close the vent valve and check the system pressure on the pressure gauge.
5. If the pressure dropped below 35 psi, start the hydrostatic pump and maintain line pressure at 35 psi.
6. Stop the pump and repeat steps 2 through 4 for the remaining Delta modules.
7. When air from all Delta modules has been released, decrease the line pressure to 20 psi and close the intake valve. Disconnect the hose, and the system is ready to go.

Alarms and Troubleshooting

Table 1: VFD Cooling System Alarms

Alarms	Trigger	Corrective Actions
VFD Cooling Pressure Low	System pressure drops below 15 psi	• Ensure both pumps are off. • Check for leaks. • Check both pumps tripped. • Release air trapped in the system.
VFD Cooling Low Flow	System flow drops below 50 gal/min	• Ensure pump is not running. • Check for leaks. • Check for faulty flow switch. • Check for wiring/loose connection.