



Walmart Glycol Pump Skid Control

Sequence of Operation

Rev 3.1_01OCT2024

All setpoints and time delays listed in this document shall be exposed for manipulation at the Carel CpCO display

Glycol Pump Skid

The Glycol Pump Skid (GPS) is a stand-alone assembly piped to a +15° SST DX refrigeration rack liquid and suction line, similar to a conventional refrigerated fixture. The GPS consists of a primary/standby pump arrangement piped to a dual-circuit glycol chiller or Heat Exchanger (HX). The DX portion of the GPS is a two-line set connection from the refrigeration rack that to the HX. Both GPS DX circuits receive liquid refrigerant from the refrigeration rack and are equipped with an Electronic Expansion Valve (EEV) for each HX. If the refrigeration side is equipped with liquid line solenoids, they will be normally closed, with manual lift, and be energized to open in unison with the EEV enable. The HX removes heat from the circulating glycol fluid to chill the fluid down to approximately 20°F. The suction vapor from the HX flows back to the suction side of the DX refrigeration rack.

Piping to the fixtures for the glycol fluid is separate from the DX circuit. Fluid piping connects to the GPS pump outlet (supply) and inlet (return) to the HX in a loop fashion. In normal operation the pumps continuously circulate 20°F supply fluid through this loop. The loop supply and return piping will branch to each designated fixture to provide cooling. Each fixture has temperature control of a solenoid to maintain appropriate fixture temperature (see WeatherPack SOO, not associated with GPS SOO).

The end of loop (EOL) is the connection point between fluid supply and return loop piping after all fixtures have been supplied fluid. A mechanical balance valve will be set at the EOL for the minimum flow requirement to safely operate the pumps, should all fixture solenoids be satisfied. A differential pressure transmitter on the skid, piped to each side of the loop, is used to control pump speed. As fixture solenoids are closed based on fixture temperature being satisfied, EOL differential will increase, and pumps will decrease speed accordingly to maintain the differential pressure setpoint required to maintain full flow to all fixtures at lowest possible pump kW.

GPS shall incorporate a Carel CpCO controller to operate all GPS functions except for the EEVs, which shall be controlled by a standalone EEV controller with an enable from the CpCO.

Glycol Pump Control

Glycol pump shall be enabled in normal operation to continuously circulate fluid 24x7, provided there is sufficient fluid present in the loop so as not to run the pumps dry and damage pump seals. Additionally, the DX refrigeration rack must also be at sufficient operating suction pressure to properly chill the fluid, so as not to circulate warm fluid to the fixtures in the event of refrigeration rack failure. A transducer mounted at the pump return shall determine when the fluid pressure is sufficient to safely operate the pumps, indicating the glycol loop is adequately charged. Transducers mounted on each GPS DX suction line shall determine that the refrigeration rack is operated at a low enough suction pressure to enable the pumps.

Logic to enable the pump assembly if all the following are true:

- GPS local On/Off switches is closed to the ON position.
- Pump Return Transducer is greater than 15 psig for 1 minute, disabled below 10 psig no time delay
- Rack SST is below 32°F, disabled above 40°F.

Once enabled, the pump variable speed reference will be set based on the EOL differential pressure deviation from a user defined value set at startup with all fixture solenoids open. PID modulates speed higher as EOL differential drops from user defined value. As EOL differential exceeds the user defined value, PID modulates speed lower to maintain user defined value setpoint. Pump speed is held above 30%, or 18Hz.

If a pump operates for 30 seconds without establishing pressure rise indicative of flow, as read by the DP transmitter, the operating pump will be shut down and the lag pump will be enabled, and a Pump Flow alarm will be triggered. If this continues for 5 minutes without either pump establishing flow, pump operation will cease and a general flow fail alarm (user reset) will be triggered.

VFD Run Light output will close when glycol pump is enabled, and the system differential pressure is greater than 10psi as a proof of flow. The light will shut off if the differential pressure falls below the Flow Proof Differential Pressure of 2psi.

VFD Fail Light output will close when the Pump VFD Fail input closes.

Should the CpCO controller fail, or on startup during flush and fill, the pumps will need to be able to operate safely in Hand Mode. Each pump will have a mechanical low-pressure control at the pump return line set to 5 psig to disable the pumps. Low pressure control will enable the pumps at 15 psig.

Heat Exchanger

Each circuit of the dual circuit heat exchanger (HX) consists of an EEV controlled by an Emerson EXD-SH1 controller. Each EEV controller will communicate via modbus to the CpCO controller for remote setpoint manipulation and to view sensor values. In normal operation, CpCO will enable the EEVs to maintain approximately 20°F supply fluid. The EEV controllers will maintain superheat at the superheat setpoint on each respective circuit.

A fluid return temperature sensor to the HX and fluid supply temperature sensors from the HX shall be factory wired to CpCO for staging of the EEVs. Each EEV controller will have a DX suction temperature sensor and DX suction transducer wired directly to the controller. In addition, CpCO shall disable the EEV on Wednesdays at 6 and 7am to zero reference the EEV to ensure stable EEV operation.

Having multiple redundant sensors installed is an important means of freeze protection to ensure the HX cannot chill the supply fluid below 13°F under any circumstances. 35% propylene glycol will tend to slush below 10°F and freeze at 0°F which will inhibit and/or stop fluid flow to the fixtures and must be avoided. Proof of fluid flow is critical before enabling the EEVs. Additionally, the fluid return sensor will be incorporated to disable the liquid solenoids in the event the fluid supply sensor(s) failure.

Lead Electronic Expansion Valve enables when all the following are true:

- GPS On/Off switch is ON.
- Supply Fluid Temp is above 21°F, disabled below 19°F
- Return Fluid Temp is above 22°F, disabled below 20°F
- Pump supply transducer is 10 psig higher than the pump return transducer for 1 minute.
- **EEV superheat greater than 2°F**

Lag Electronic Expansion Valve enables when all the following are true:

- GPS On/Off switch is ON.
- Supply Fluid Temp is above 22°F, disabled below 18°F
- Return Fluid Temp is above 22°F, disabled below 20°F
- Pump supply transducer is 10 psig higher than the pump return transducer for 1 minute.
- **EEV superheat greater than 2°F**

Lead/Lag position will alternate each time both EEVs are ON, resulting in a First On/First Off rotation. An Interstage Delay Timer must expire between each staging up/down action, but is not applied to cycling based on superheat.

Alarms

Critical (will impact equipment function)

- Unit Turned Off
 - Secondary skid has been turned off for 5 minutes via controller keypad or skid on/off switch.
- Flow Fail
 - Both pumps unable to achieve flow for 5 minutes.
 - Requires manual reset to restore operation.
- Rack Disabled
 - Rack indicated inactive by SST exceeding 40°F.
 - Auto reset when SST falls below -32°
- Low Pump Suction
 - Pump suction has fallen below x psig, indicating low glycol level and a likely glycol leak.
 - Pumps shut down to protect from cavitation
- Pump Short Cycle
 - Pumps have cycled on low pump suction 5 times within 24 hours, indicating a critically low glycol level.
 - Pump operation is locked out. Requires manual reset to restore operation.
- Low pressure alarm
 - Rack suction saturation temperature has remained below 10°F for 5 minutes
 - Requires manual reset to restore operation.
- Temp freeze
 - Glycol return temperature has fallen below 22°F.
 - Auto reset when glycol temperature exceeds 25°F.

Warning (equipment will continue to function using redundancies)

- Sens Fault Supply Temp
 - Invalid reading from Supply Temperature sensor. Secondary skid will continue to call for refrigeration and stage on and off using return temperature sensor. Loss of both sensors will interrupt skid operation.
- Sensor Fault Pump Suct P
 - Invalid reading from pump suction transducer Secondary skid will continue to call for pump and refrigeration ignoring pump suction pressure. This will conceal a low glycol fault.
- Pump 1 or 2 VFD Fault
 - Pump VFD Fault. Unit will switch to other pump.
- Sens Fault Diff Press
 - Invalid reading from differential pressure sensor. Secondary skid will continue operating using pump suction and discharge readings to calculate differential pressure.
- Sens Fault EEV Pres 1 or 2

- Invalid reading from EEV controller pressure sensor. Secondary skid will continue to operate at reduced refrigerating capacity. If both sensors fail, skid loses visibility to rack operation and will cease to operate.
- Sens Fault EEV Suc Temp 1 or 2
 - Invalid reading from EEV controller temperature sensor. Circuit will be removed from staging to use alternate circuit.
- Comm Loss EXV1 or 2
 - Loss of comm with EXV controller. Secondary skid will operate using remaining controller for monitoring rack activity. If comms are lost with both controllers, secondary skid will cease to operate.
- Step Mtr EXV1 or 2
 - EXV stepper motor error. Circuit will be removed from staging to use alternate circuit. User will need to look at EXV controller to see which valve motor on that controller has failed.
- Low Superheat 1 or 2
 - Superheat below 3°F. Circuit will be removed from staging to use alternate circuit. Automatic reset when superheat exceeds 7°F.
- Pump 1 Flow or Pump 2 Flow
 - Pump has failed to achieve flow. Secondary skid has switched to other pump. Alarm will clear when affected pump has started and achieved flow, or when power is cycled.

Informative (equipment will continue to function unaffected)

- Sens Fault Pump Dis Pres
 - Invalid reading from pump discharge pressure sensor. Flow will be assumed and continue to operate without discharge pressure reading. Since this sensor functions as backup to the Differential Pressure sensor, this sensor fault should be addressed to maintain redundancy.
- Sens Fault Ret Temp
 - Invalid reading from Return Temperature sensor. Sensor is monitoring only, no impact to secondary skid operation, except loss of visibility to Temp Freeze alarm and redundancy with Supply Temp sensor. Loss of both sensors will interrupt skid operation.
- High Supply Temp
 - Outlet Fluid Temperature has remained above 25°F for 15 minutes.
- Low Supply Temp
 - Glycol supply temperature has remained below 15°F for 5 minutes.

GPS CpCO Failure Procedure

In the event of GPS CpCO failure with proper power supplied to the GPS, refrigeration rack should be pumped down due to normally closed GPS EEV's disabled due to CpCO outputs being normally open. Follow this procedure to get chilled fluid flowing to the fixtures in this order:

1. Verify glycol pump low pressure control is closed, which indicates enough fluid is in the loop to start pumps.
2. Switch one Pump to Hand Mode at pump keypad. Pump should enable at full speed. If pump short cycles on its LPC, VFD speed should be reduced, or fluid needs to be added to the loop.
3. After stable pump runtime, install jumpers on the EEV enable terminals to enable refrigeration.
4. Verify refrigeration rack starts up from pump-down condition and maintains below 40°F after initial pull down, amount of time this takes dependent on fluid temp at restart.
5. Verify EEVs positions are modulating down from 100% and superheat setpoint is being achieved.
6. Order a replacement CpCO Medium controller.