

# Natural Refrigerant Training Summit

Building a Sustainable Workforce

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## Understanding the High Pressure Control Valve

Rusty Walker

Hillphoenix



NORTH AMERICAN  
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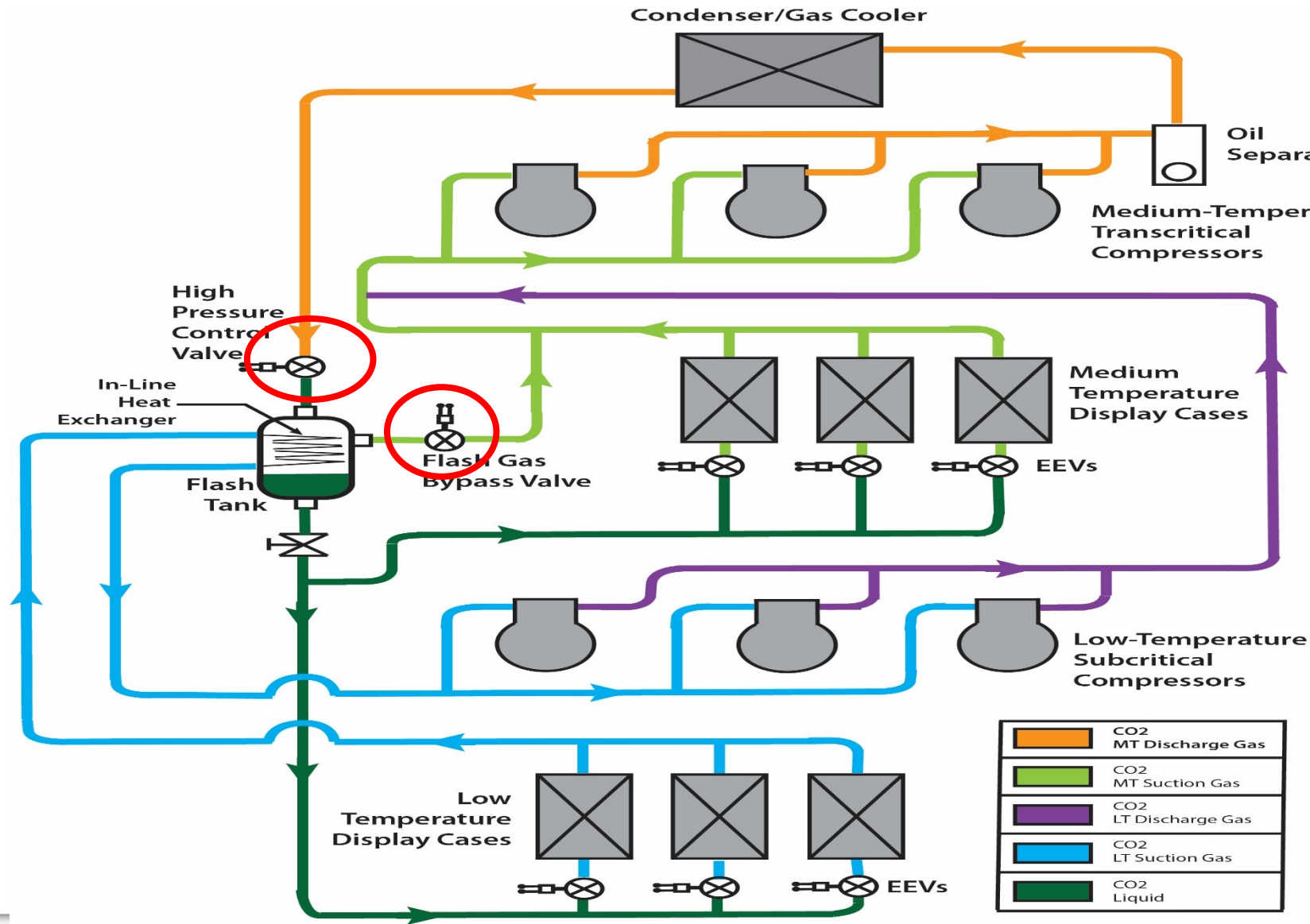
# Troubleshooting the High Pressure Control Valve and Flash Gas Bypass Valve

Rusty Walker

# Advansor R-744 Booster Refrigeration System

- Utilizes same vapor-compression refrigeration cycle as used in traditional refrigeration systems, including the same components.
- Since CO<sub>2</sub> has a high volumetric heat capacity, smaller diameter piping may be used for the system.
- The same refrigerant moves between the low- and medium-temperature compressors. The LT compressors discharge to the suction of the MT. In other words, the LT compressors serve as a **booster** to the MT compressors. One refrigerant two sets of compression.
- Under some operating conditions (high ambient) the CO<sub>2</sub> can become supercritical. Thus a special type of condenser is utilized. A condenser that works as a gas cooler under higher ambient conditions

# Advansor CO2 Booster System Diagram



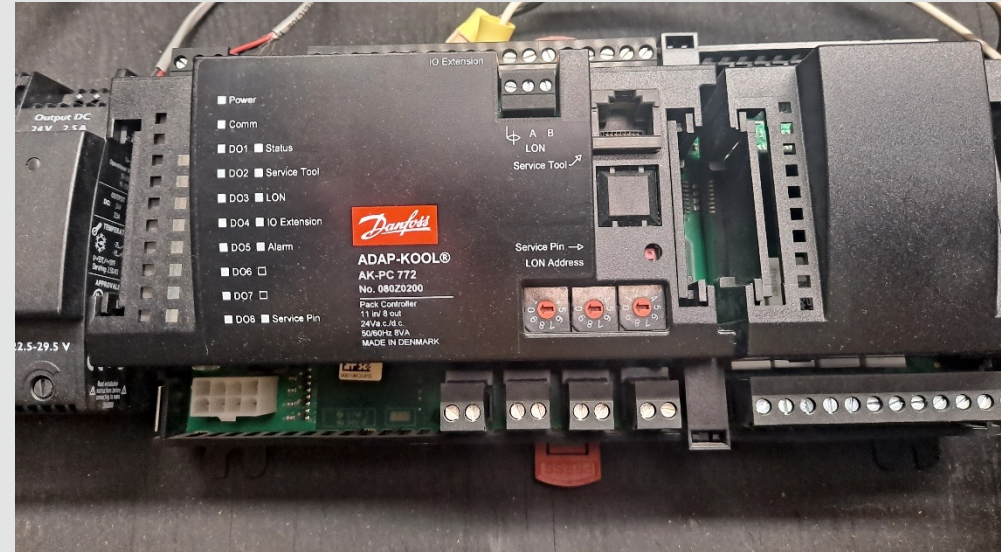
## 3 Inputs

- Drop Leg Pressure
- Drop Leg Temperature at the outlet of the condenser/gas cooler
- Receiver Pressure

## 2 Outputs

- 0-10 VDC to operate the HPCV
- Four wire stepper valve to operate FGBV

# Controllers for HPCV/FGBV



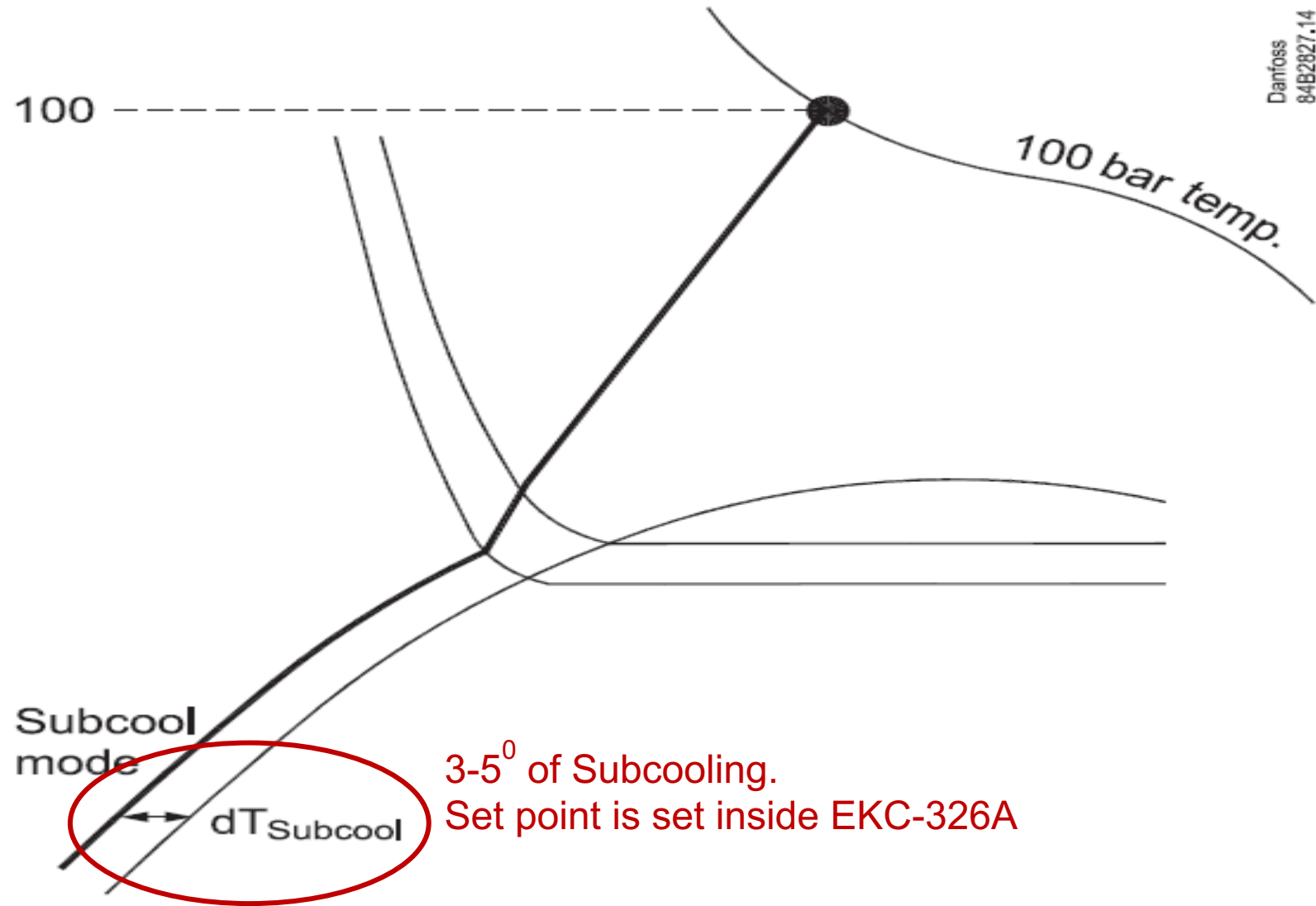
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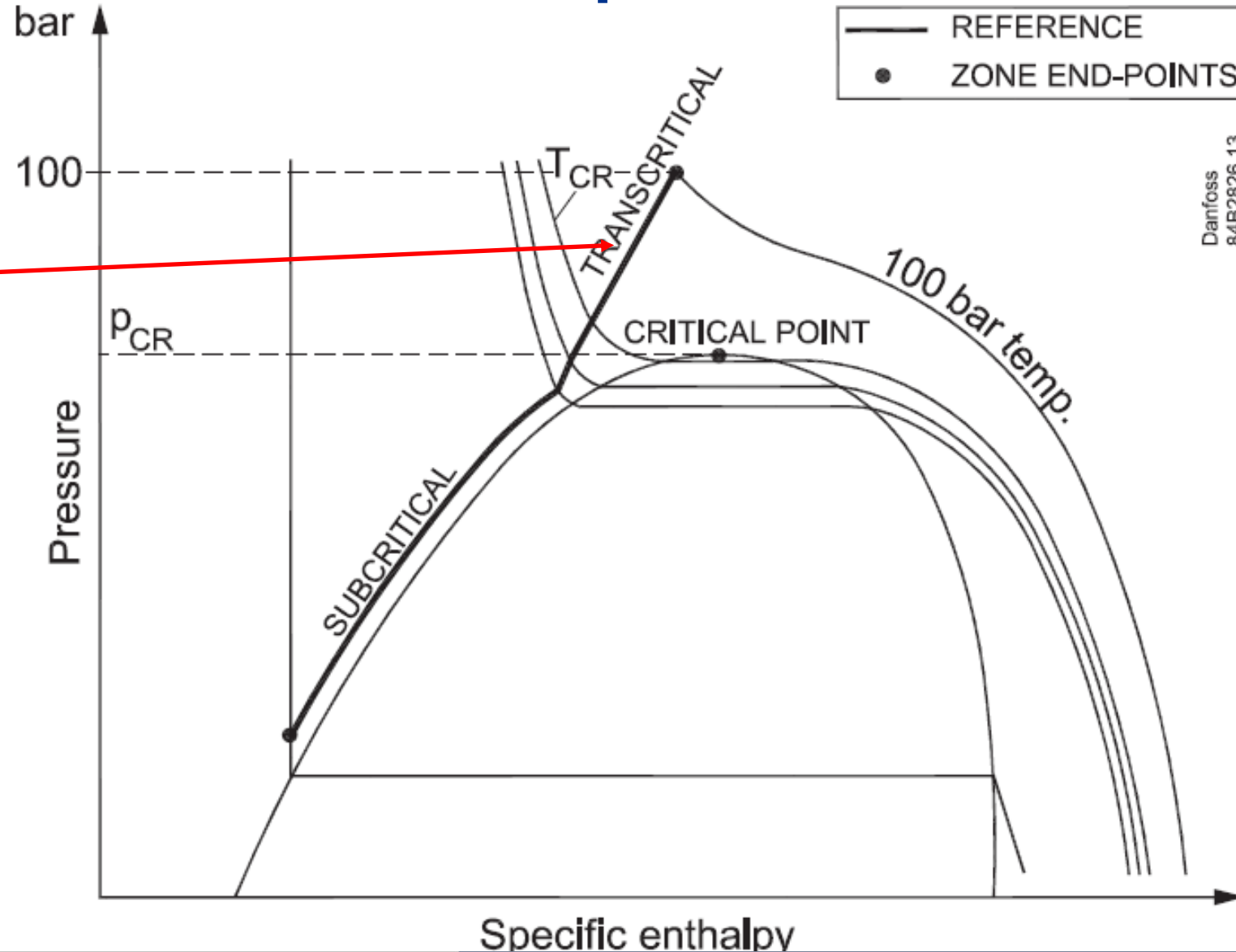
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# Subcritical Operation



# Transcritical Operation

**Maximum COP control**  
The controller maintains optimum pressure in the transcritical range based on a pressure and temperature reading. The reference line is defined with a point at 100 bar. The desired temperature can be set here



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# High Pressure Valve (Vhp)

Corresponding pressure is Vhp setting

## Sensors

- Pgc = Gas Cooler Pressure
- Sgc = Gas Cooler Outlet Temperature
- Sc3 = Ambient Temperature

## Valve

- Vhp = High Pressure Valve

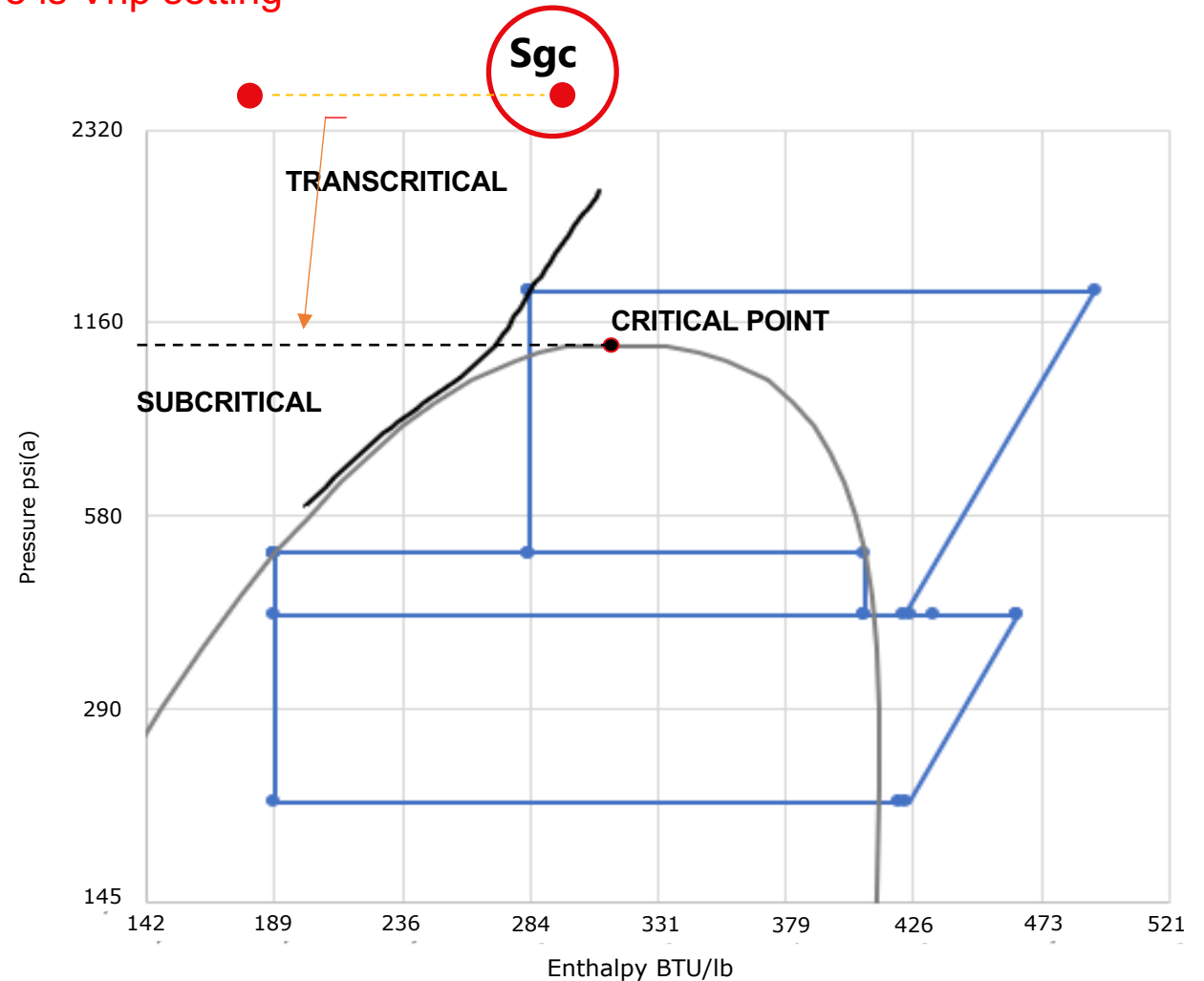
## Key Set Points

- Pgc Min. = Valve Closing%
- Pgc Max. = Valve Opening%

The pack controller monitors Sc3 to determine Sgc and Pgc locations on Optimal COP line.

Fan speed will be adjusted to keep Sgc on the Optimal COP line.

Vhp position will be adjusted to keep Pgc on the Optimal COP line.





# Drain Leg Temp Sensor

IMPORTANT: Sensors must be installed according guidance below

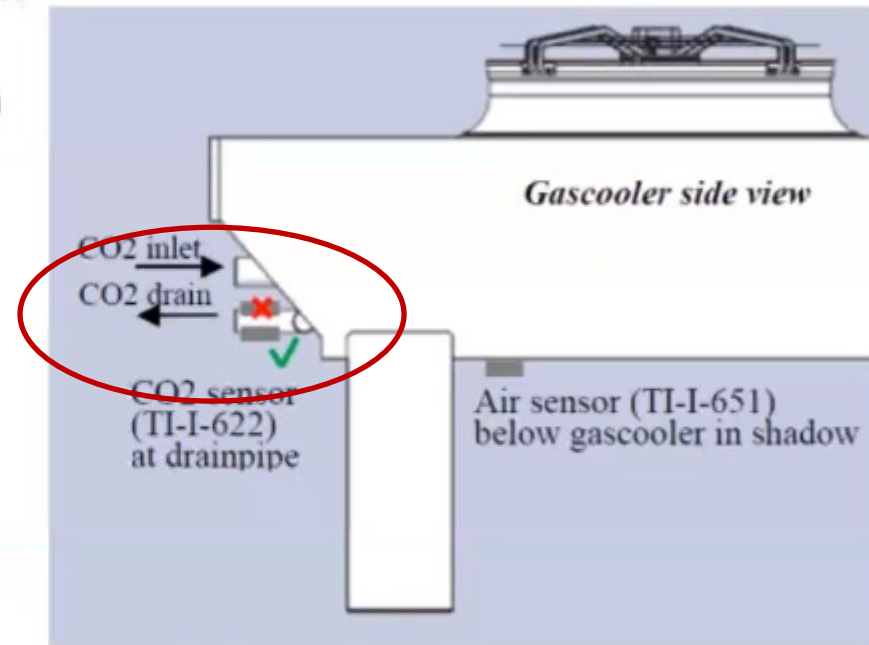
## Mounting of CO2 and Air sensors on gascooler:

CO2 sensor(s) TI-I-622(A/B) must be mounted on drain from gascooler at 5 or 7 o'clock on horizontal pipe, min. 30 cm (12 inch) from the gascooler, as shown on sketch.

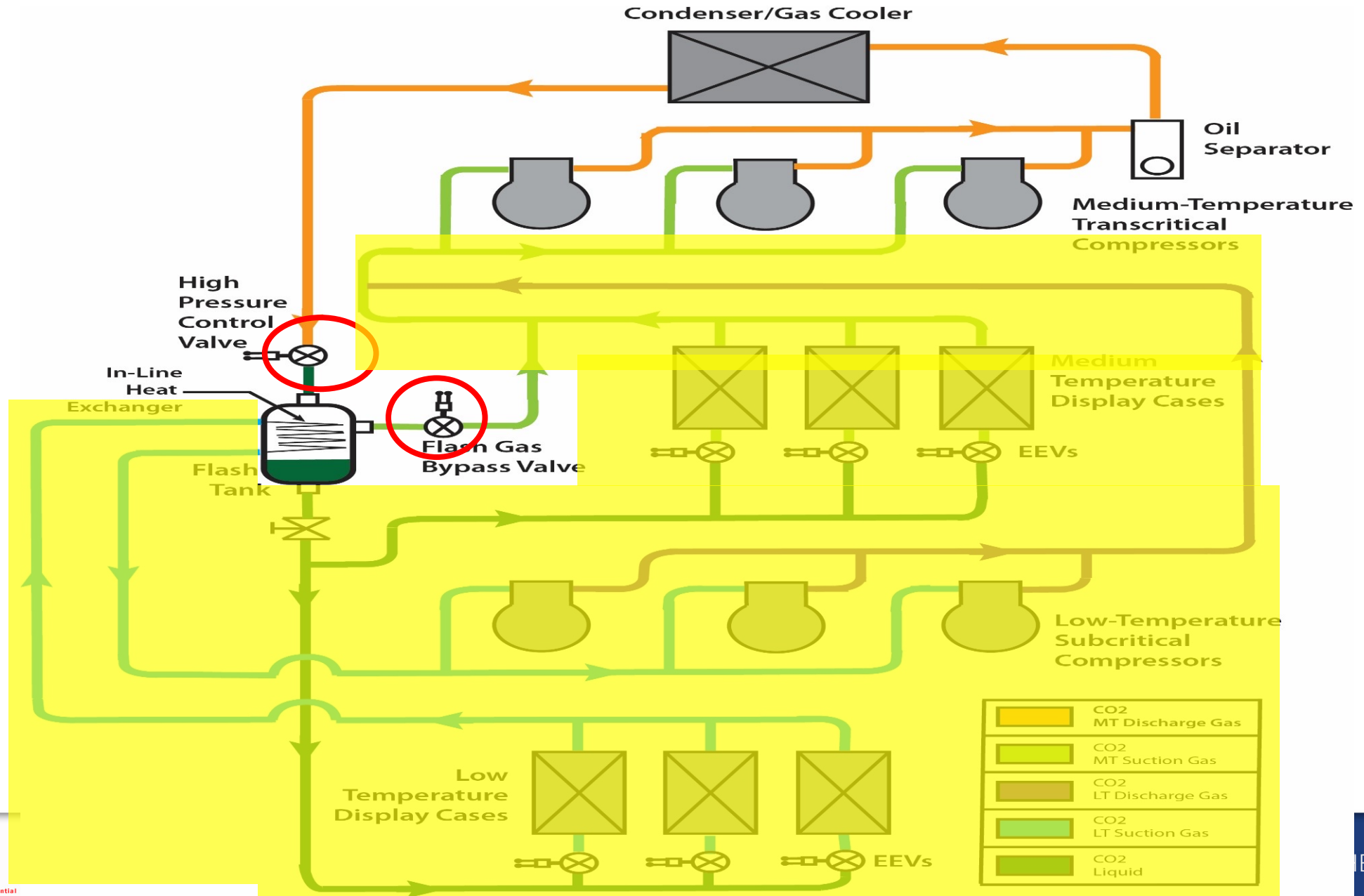
Air sensor TI-I-651 must be mounted in airstream in shadow below gascooler.

### Materials to use:

- Metal clamps, thermal paste and waterproof insulation for CO2 sensor
- Branch for Air sensor

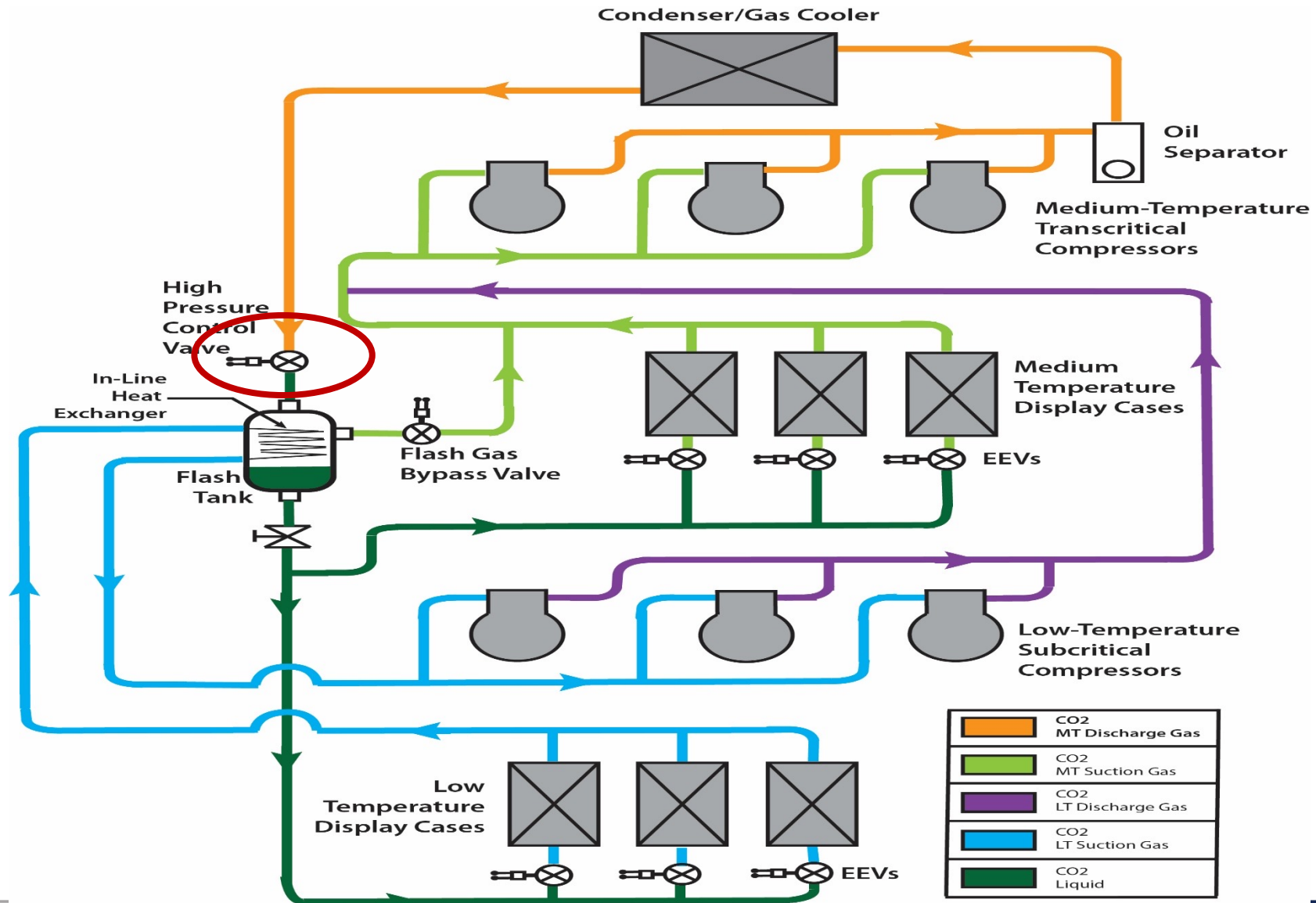


# Advansor CO2 Booster System Diagram



# High Pressure Control Valve

# High Pressure Control Valve (ICMT)

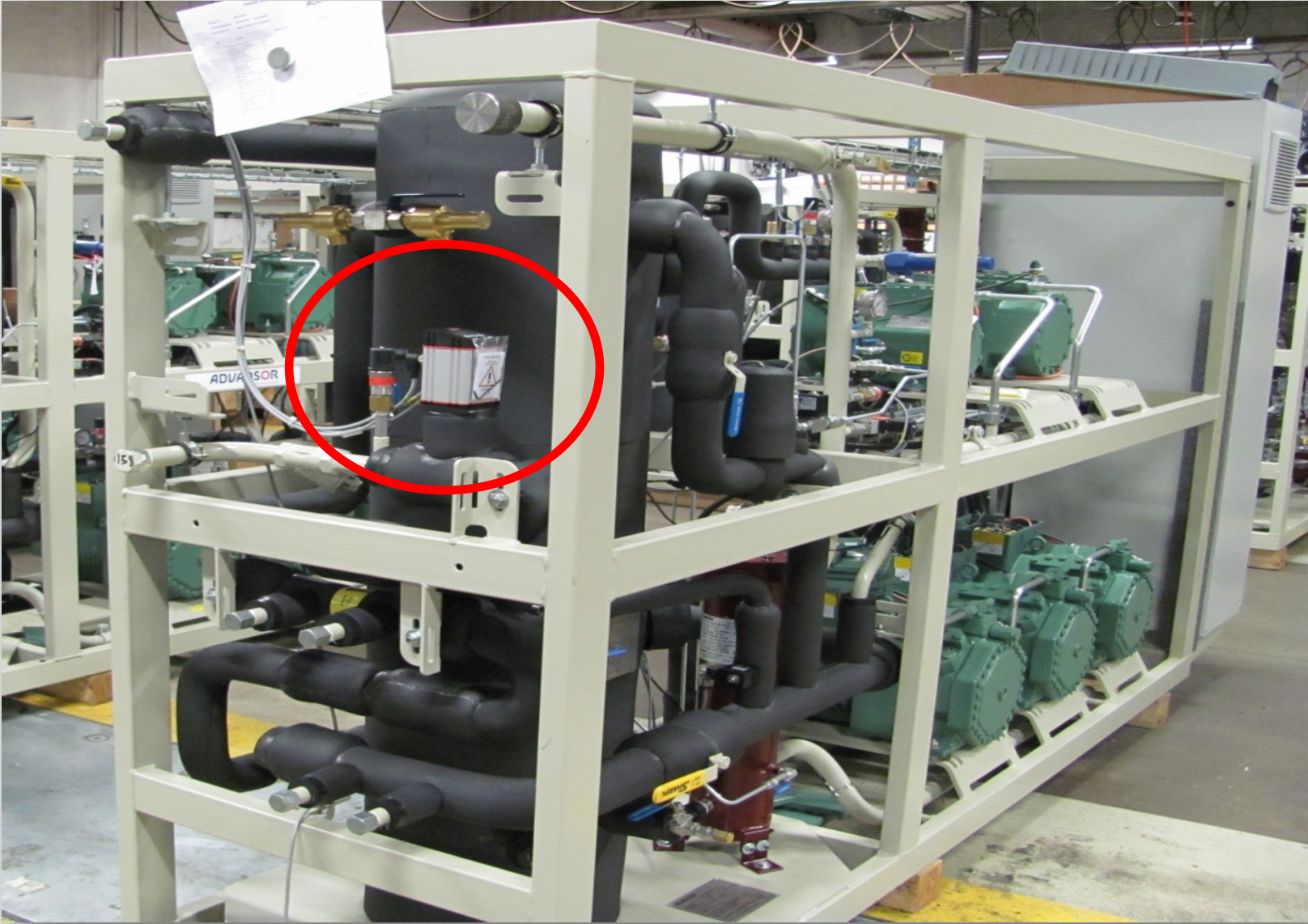


# High Pressure Control Valve

- ❑ Subcritical - The ICMT valve controls subcooling to about 3-5<sup>0</sup>F
- Transitional - Between 72<sup>0</sup>F – 85<sup>0</sup>F
- Tries to maintain 3- 5<sup>0</sup>F Subcooling while the fans are controlled to 77<sup>0</sup>F
- ❑ Transcritical - Above 85<sup>0</sup>F ICMT work to drop the pressure of the supercritical gas to create a change of state



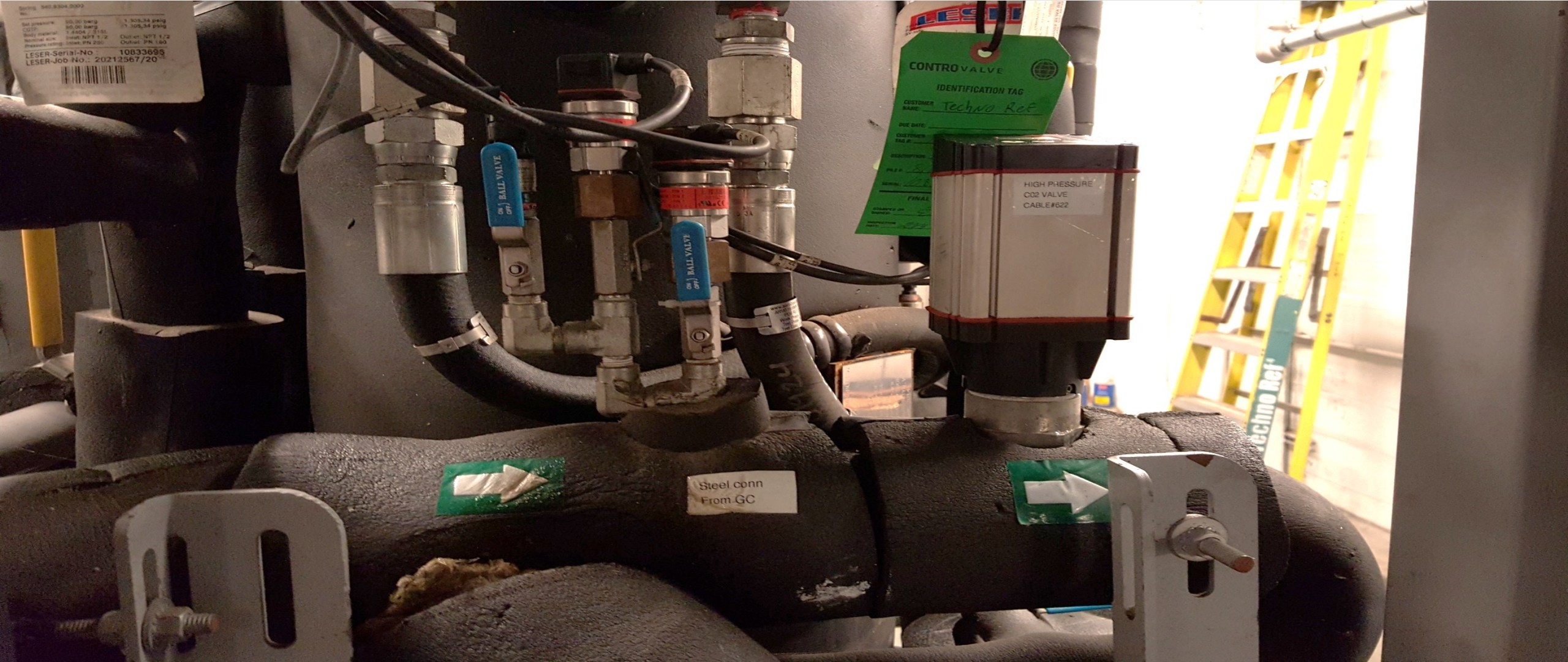
# High Pressure Control Valve (ICMTS)



# High Pressure Control Valve (ICMT)

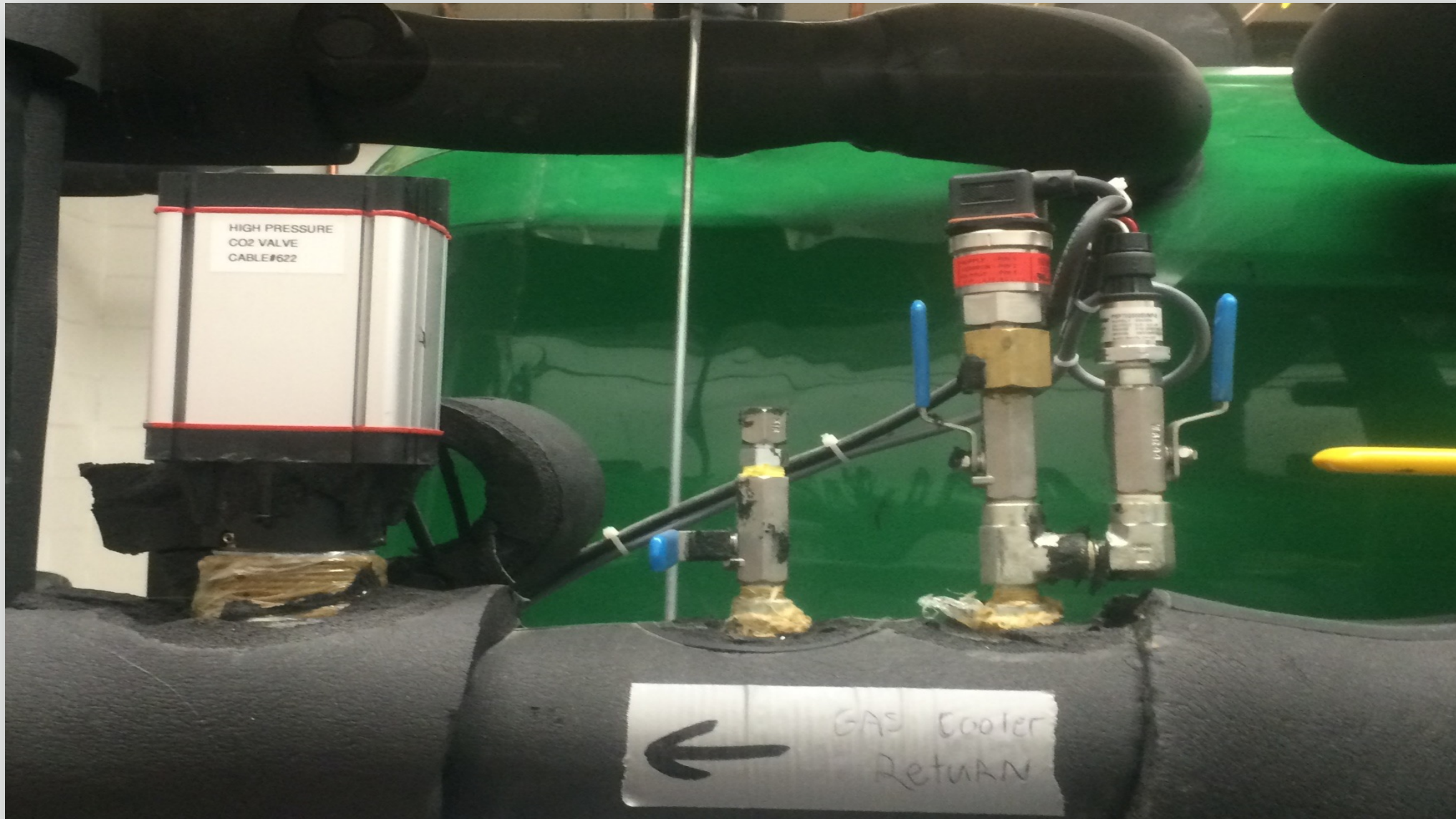


# High Pressure Control Valve (ICMT)





# High Pressure Control Valve (ICMT)



# High Pressure Control Valve (ICMT)



# High Pressure Control Valve (ICMT)



# High Pressure Control Valve ICMTS



# ICMT Valve Bad Gap



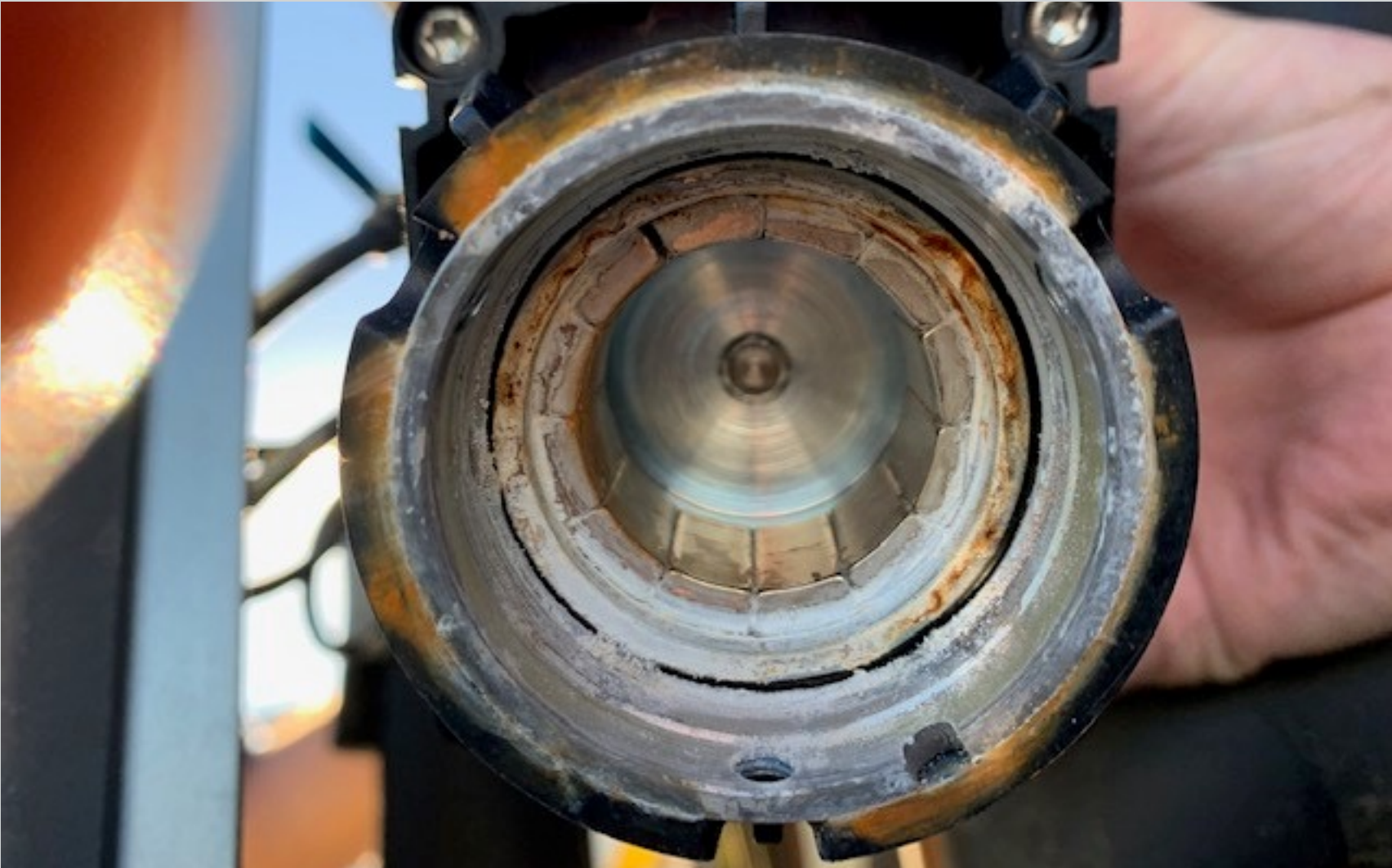
# High Pressure Control Valve



# High Pressure Control Valve Manual Operation



# ICMT Actuator





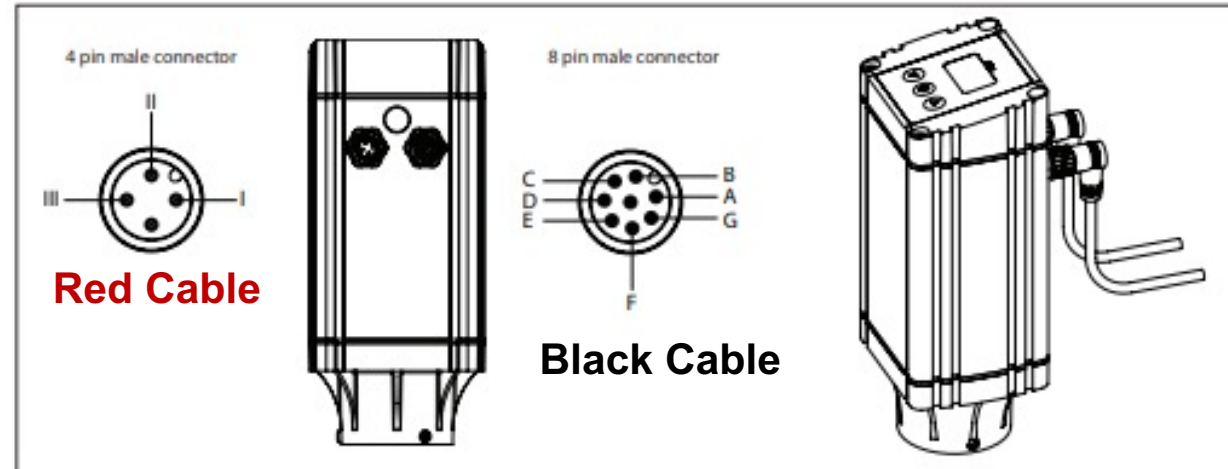
# High Pressure Control Valve



# High Pressure Control Valve Cable

## Wiring the ICAD actuator

There are two cables which are connected to the ICAD motor with M12 connectors:



### Communication connector / cable

Ref.	Color		Description
A	Black	-	Common Alarm
B	Brown	-	ICM fully open
C	Red	-	ICM fully closed
D	Orange	-	GND ground
E	Yellow	+	0/4 - 20 mA Input*
F	Green	+	0/2 - 10 V Input. Also used with GND (orange wire) as a digital input #1 for on-off operation or floating 3-point control
G	Blue	+	0/4 - 20 mA Output*

} Digital Output

### Power connector/cable (3 wires)

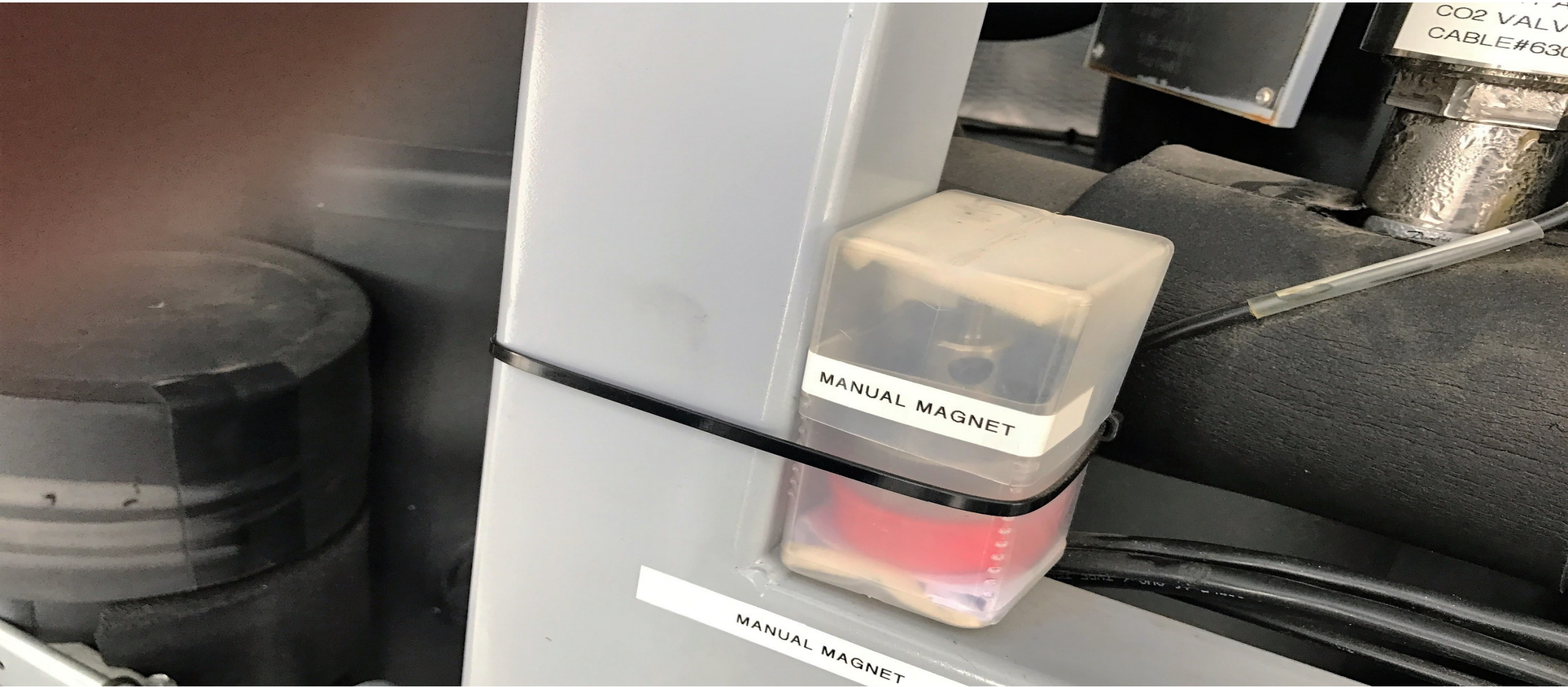
I	Black	+	Fail safe supply Battery / UPS (uninterruptable power supply) 19 V d.c.
II	White	+	Supply voltage
III	Brown	-	24 V d.c.

# High Pressure Control Valve Alarms

## Alarms

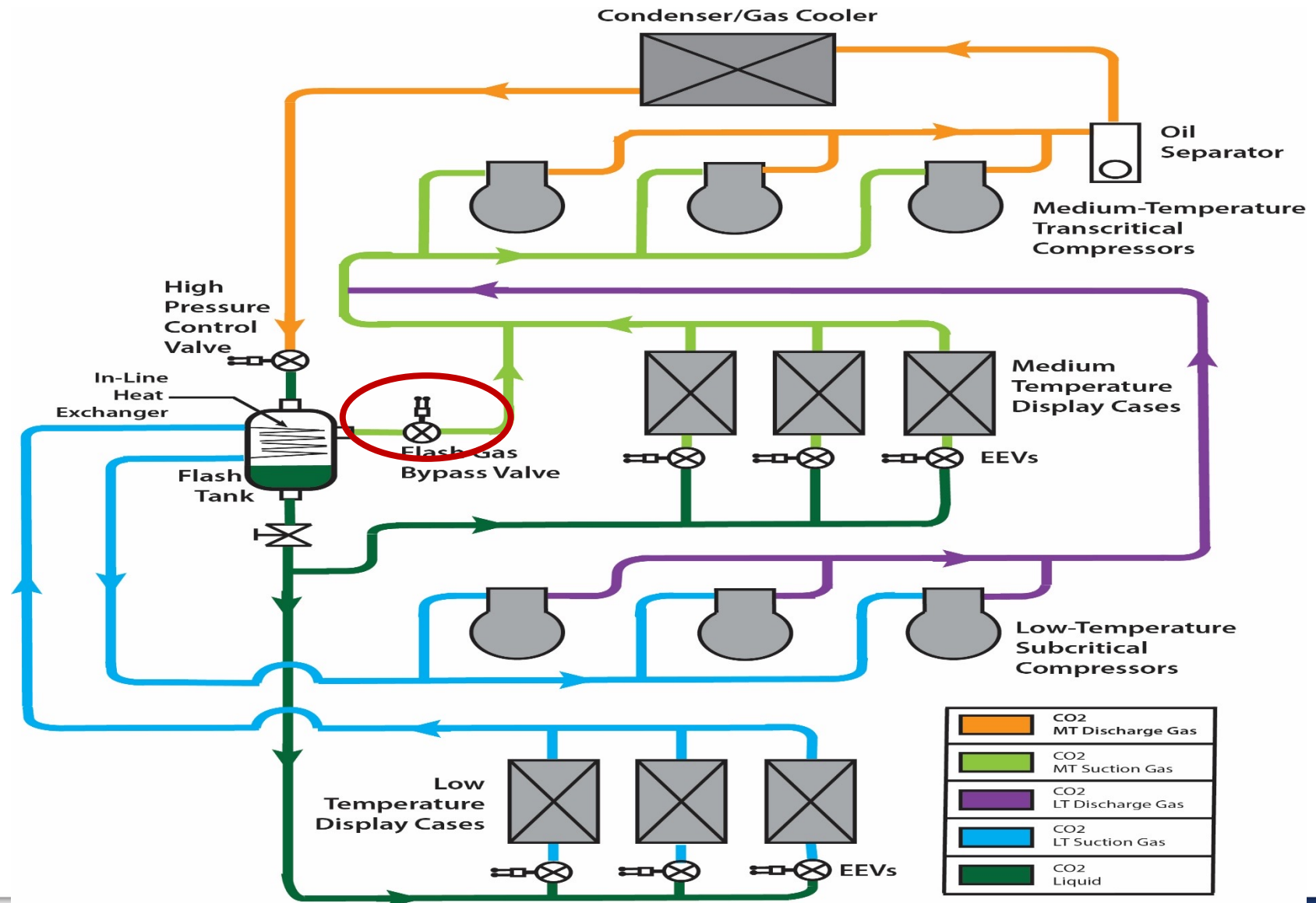
Description	ICAD alarm text	Definition of event	Comments
No Valve type selected	<b>A1</b>	Alarm ON	At start-up <b>A1</b> will be displayed until parameter <b>j26</b> is set
Controller fault	<b>A2</b>	Alarm ON	Internal fault inside electronics. Carry out: 1) Power OFF and Power ON If <b>A2</b> still active. 2) Make a Reset to factory setting If <b>A2</b> still active. Return ICAD to Danfoss
Analog input error	<b>A3</b>	Alarm ON	Not active if <b>j01</b> = 2, or <b>j02</b> = 2 When <b>j03</b> = 1 and AI A > 22 mA When <b>j03</b> = 2 and AI A > 22 mA or AI A < 2 mA When <b>j03</b> = 3 and AI A > 12 V When <b>j03</b> = 4 and AI A > 12 V or AI A < 1 V
Low voltage of fail safe Supply	<b>A4</b>	Alarm ON	If 5 V < fail safe supply < 18 V. Enabled by <b>j08</b>
Check supply to ICAD	<b>A5</b>	Alarm ON	If supply voltage < 18 V
Calibration extended failed	<b>A6</b>	Alarm ON	Check valve type selected. Check presence of foreign debris inside ICM valve
Thermal overload	<b>A8</b>	Alarm ON	ICAD stepper motor temperature too high
Valve locked	<b>A9</b>	Alarm ON	Only active if <b>i16</b> = 1 If the ICM valve is locked for more than 15 seconds (unable to reach its requested position) <b>A9</b> will flash in display. <b>A9</b> alarm can only be reset by Power OFF/ON of ICAD

# Magnet for High Pressure Control Valve

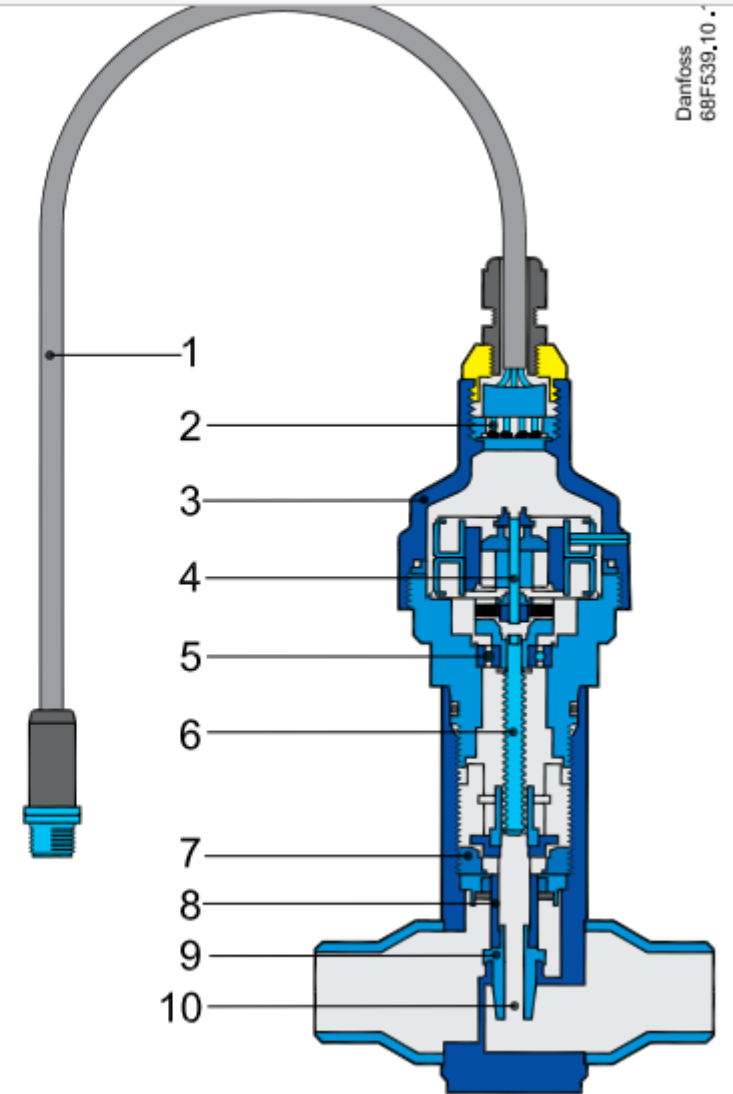


# Flash Gas Bypass Valve

# Flash Gas Bypass Valve (CCM)



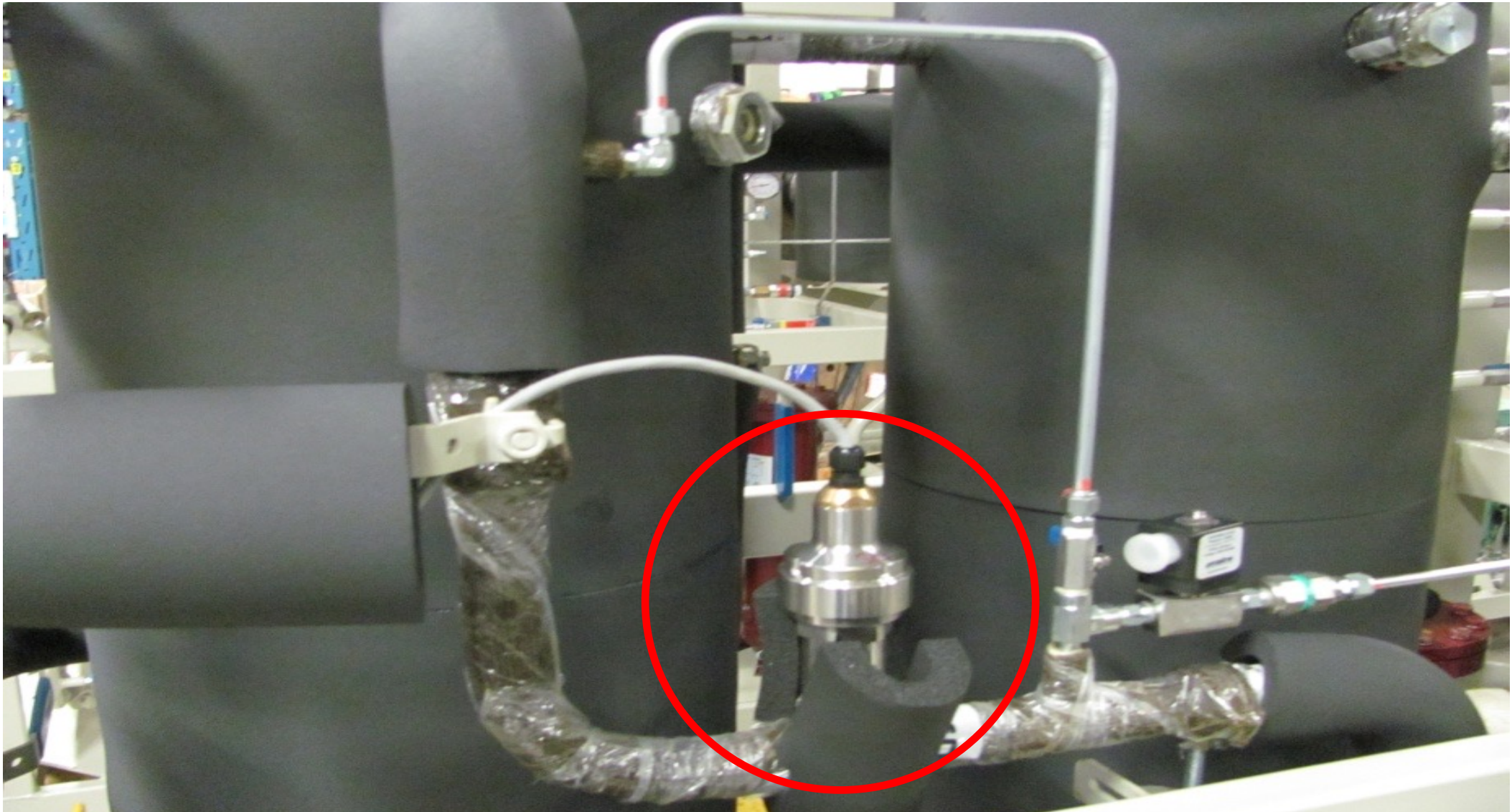
# Flash Gas Bypass Valve (CCM)



1. Cable
2. Glass seal
3. Motor housing
4. Stepper motor
5. Bearing
6. Spindle
7. Insert
8. Valve piston
9. Valve seat
10. Valve port

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# Flash Gas Bypass Valve (CCM) with Bypass Line

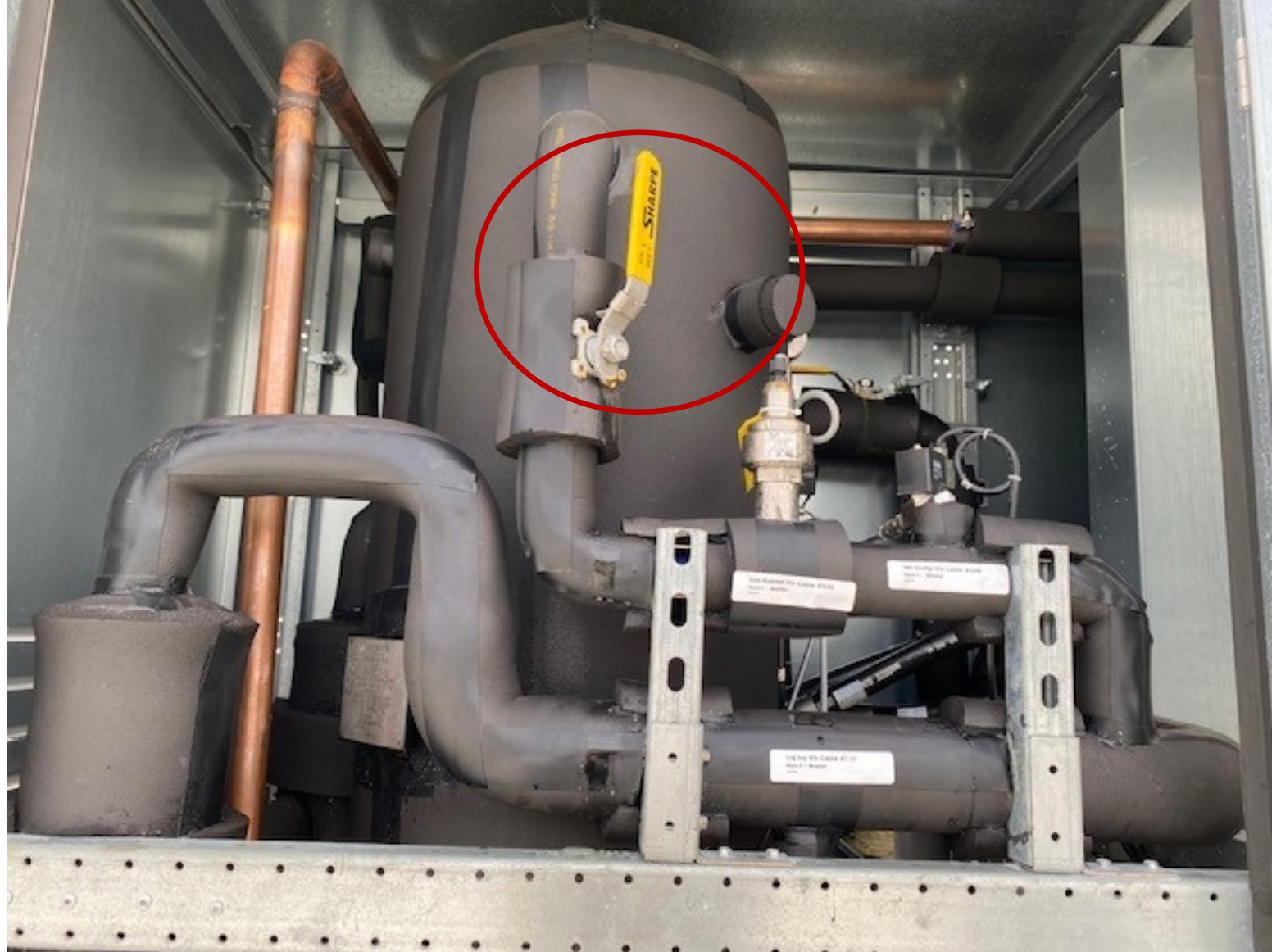




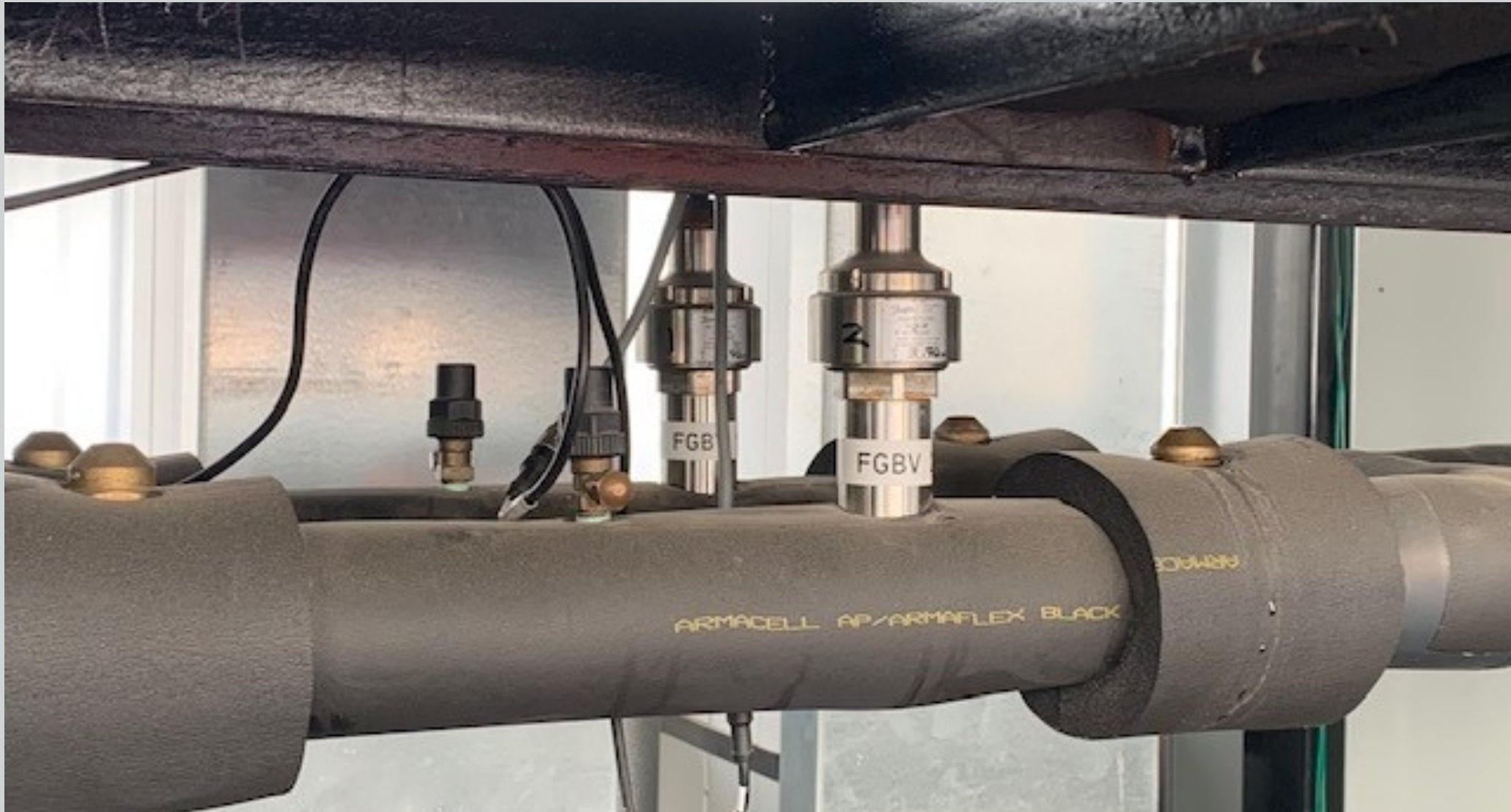
# Flash Gas Bypass Line (Why???)



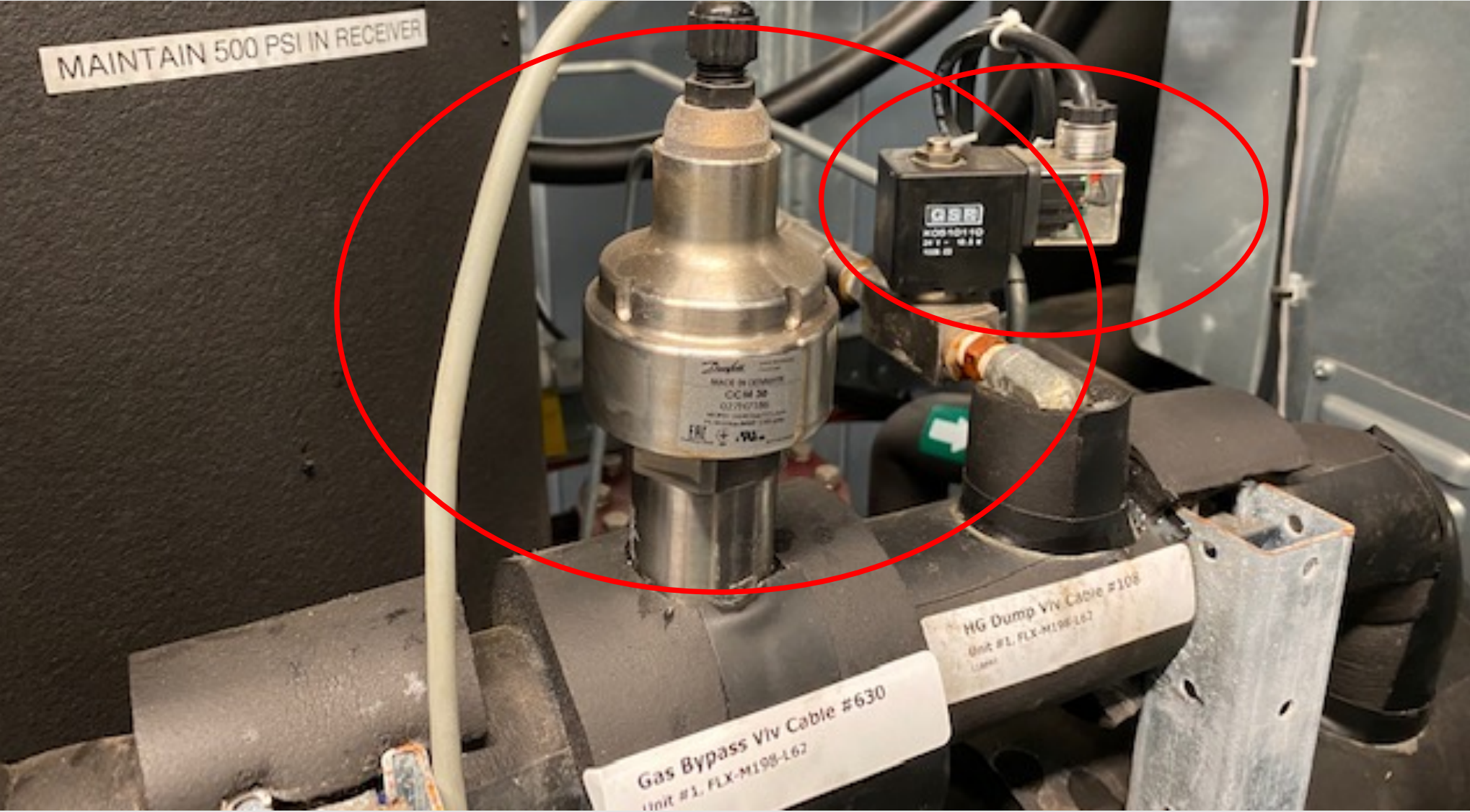
# Flash Gas Bypass Valve (CCM) Isolation Valve



# Flash Gas Bypass in Parallel



# Flash Gas Bypass Valve (CCM) with Hot Gas Dump



# Controller UPS

If rack losses power  
UPS will keep power to  
shut down the High  
Pressure Control Valve  
(HPCV) and Flash Gas  
Bypass alve.



# Questions?

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## Troubleshooting HPCV/FGBV

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