Natural Refrigerant Training Summit

Building a Sustainable Workforce

Understanding the HPVC and FGBV

Rusty Walker

NASRC

NORTH AMERICAN Sustainable Refrigeration Council

Natural Refrigerant Training Summit

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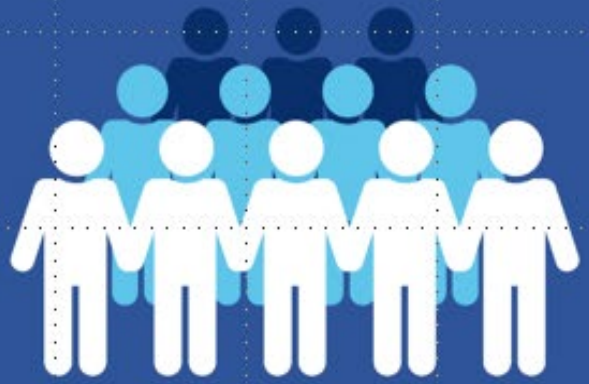
Who We Are

A 501c3 nonprofit working to create a sustainable future for supermarket refrigeration by removing barriers to natural refrigerant adoption.

160+
member companies



55K+
food retail locations

Goals

- Build a sustainable technician workforce
- Increase funding for natural refrigerant equipment
- Improve technology options, education, and awareness

What are Natural Refrigerants?

CO_2	C_3H_8	NH_3
R744 Carbon Dioxide	**R290** Propane	**R717** Ammonia

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Troubleshooting the High-Pressure Control Valve and Flash Gas Bypass Valve

Rusty Walker

It’s Only Refrigeration

Advansor R-744 Booster Refrigeration System

- Utilizes the same vapor-compression refrigeration cycle as used in traditional refrigeration systems, including the same components.
- Since CO_2 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_2 can become supercritical. Thus, a special type of condenser is utilized.
  A condenser that works as a gas cooler under higher ambient conditions

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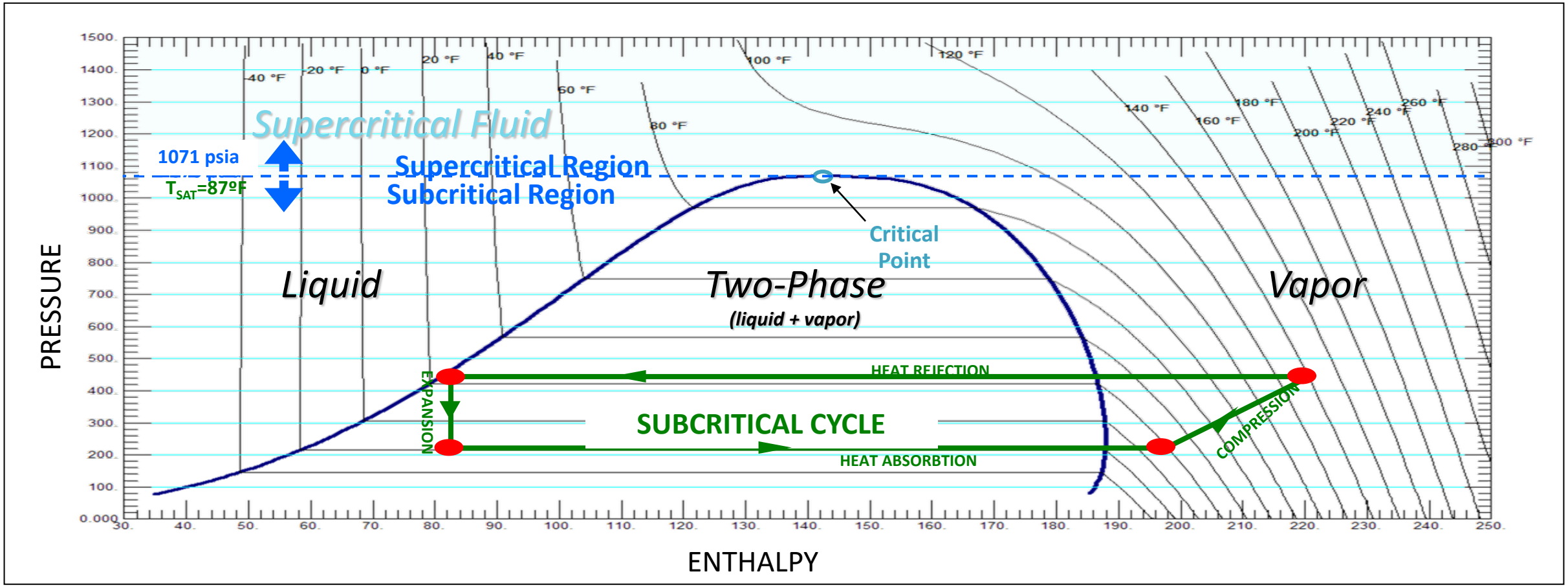
Useful CO_2 Definitions

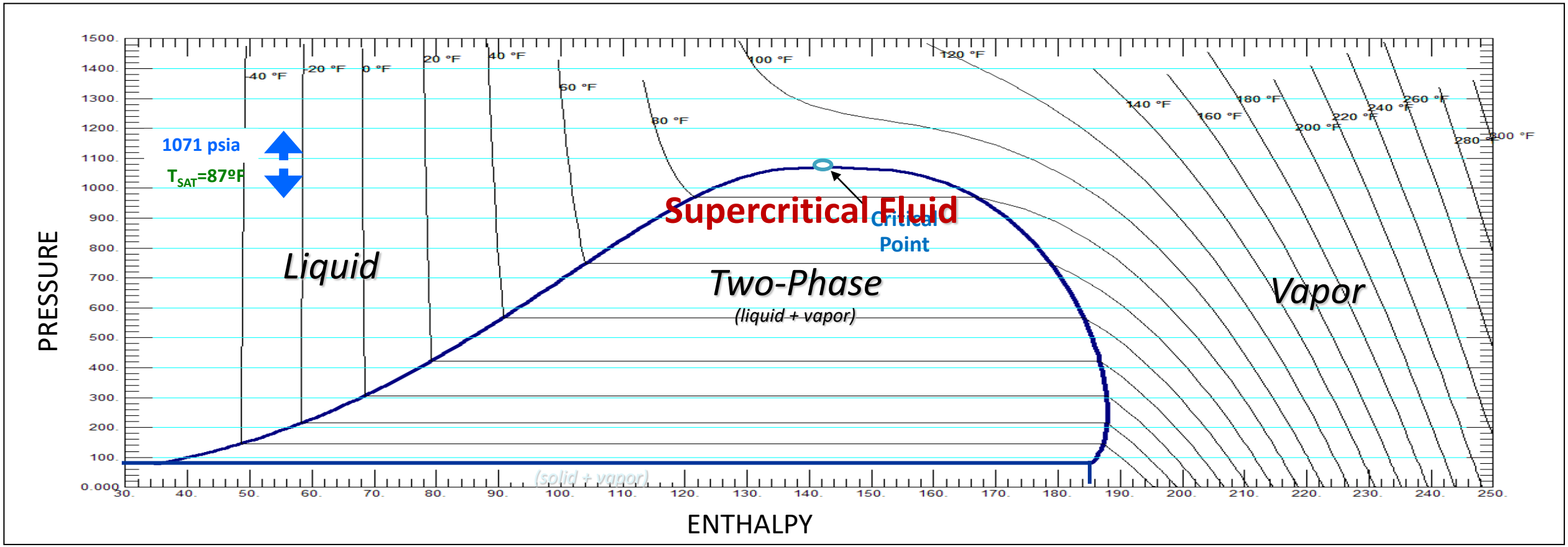
Useful Definition

- Subcritical - When a compound is above its boiling point and below critical point under pressure, where the pressure of the refrigerant is maintained well below that refrigerants critical pressure and temperature.



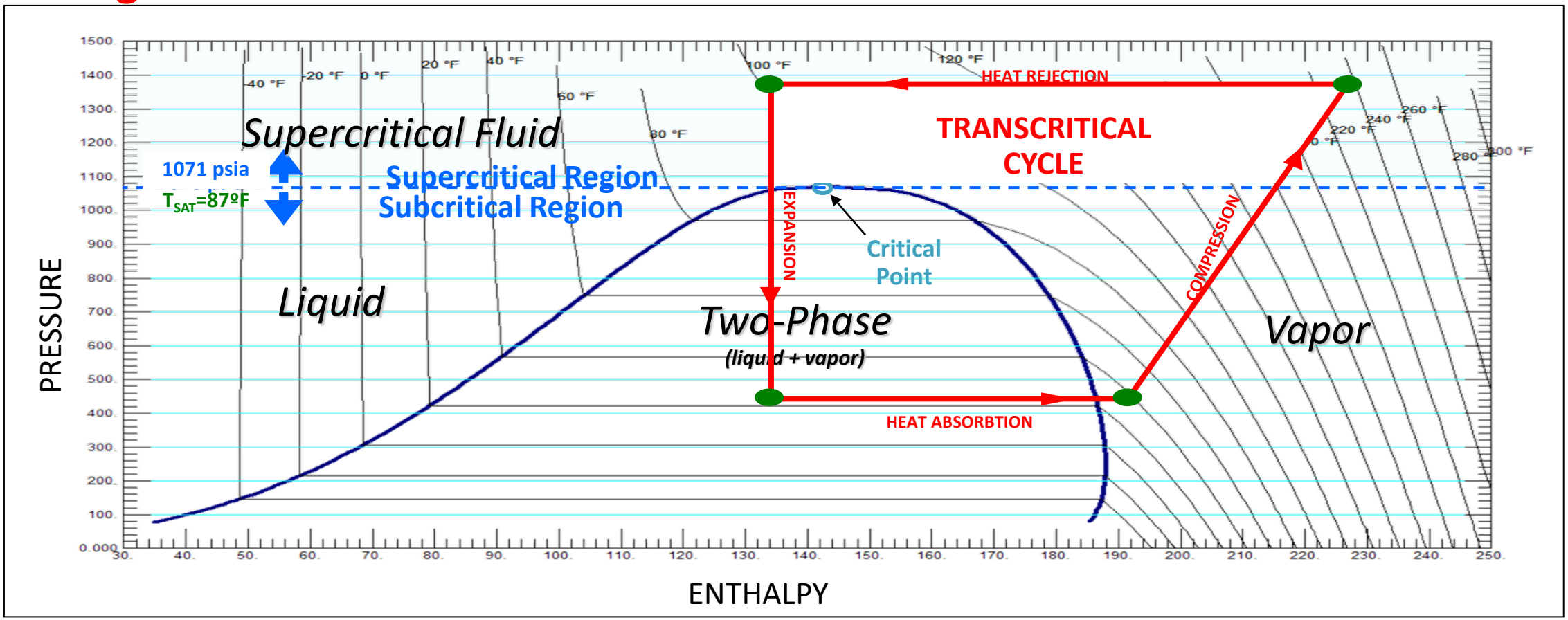
Useful Definition

- Supercritical Fluid – This will occur when sufficient temperature and pressure is applied to take it beyond its critical point. The substances therefore no longer can be defined as being in either a liquid or gas phases..



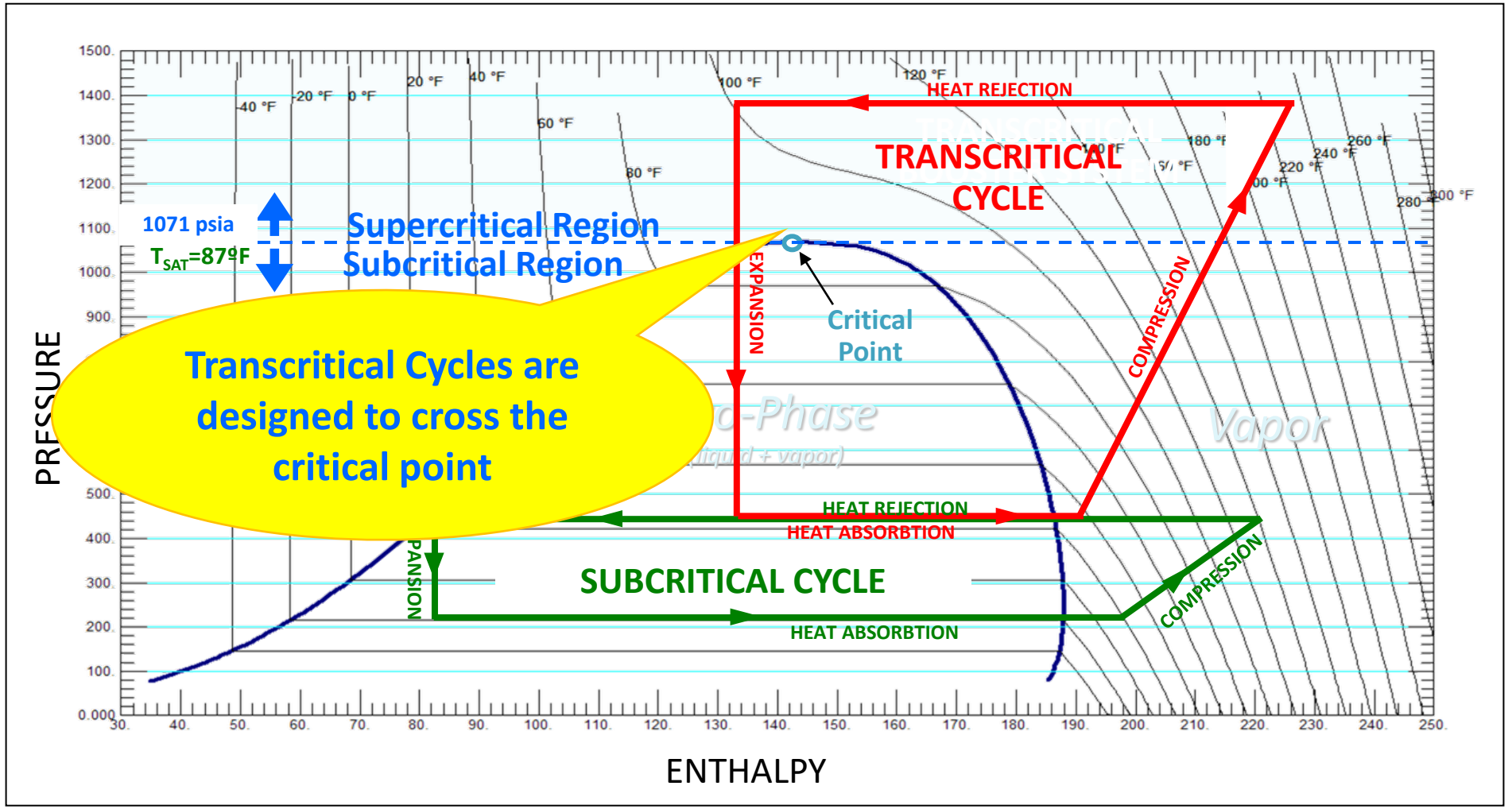
Useful Definition

- Transcritical Cycle – Where the high side of the system operates **above** the critical point and the low side of the system operates **below** the critical point. **The system them transition between subcritical and supercritical and back again**



Subcritical vs. Supercritical

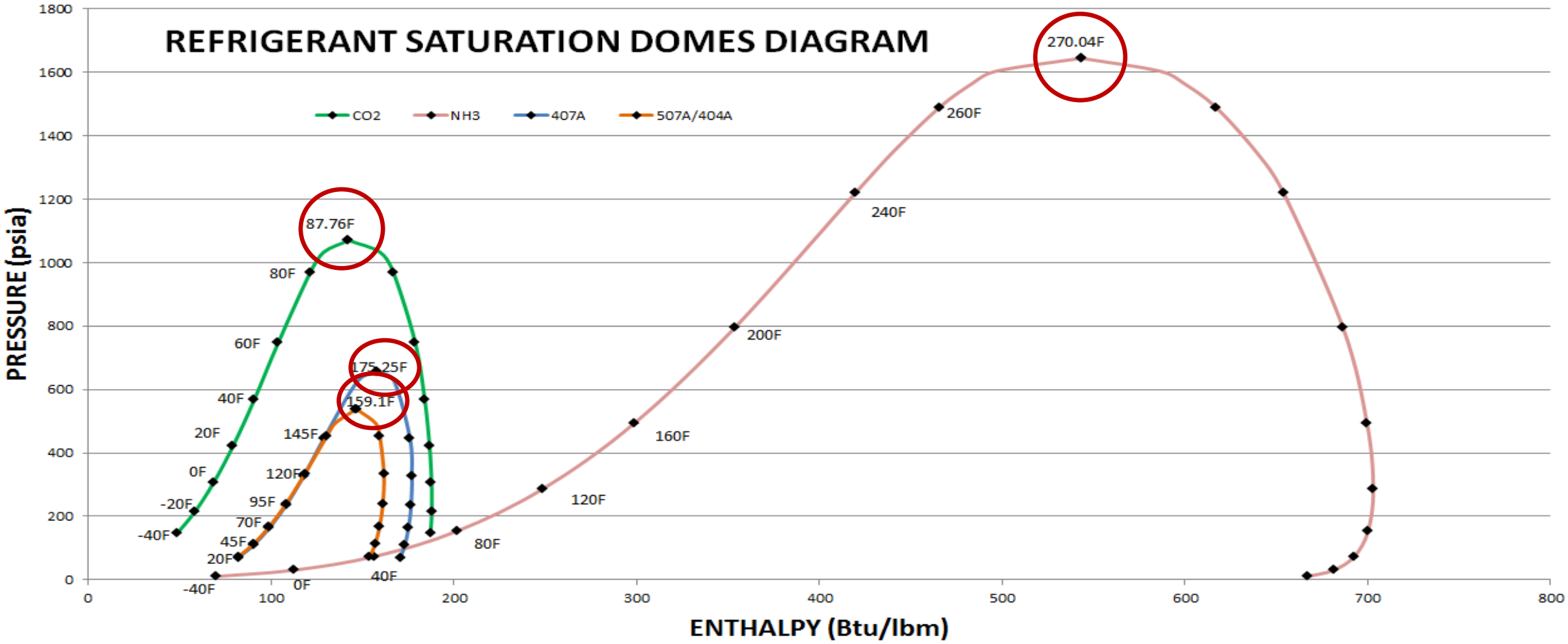
CO2 Cycles on P-h Diagram: Subcritical vs. Supercritical



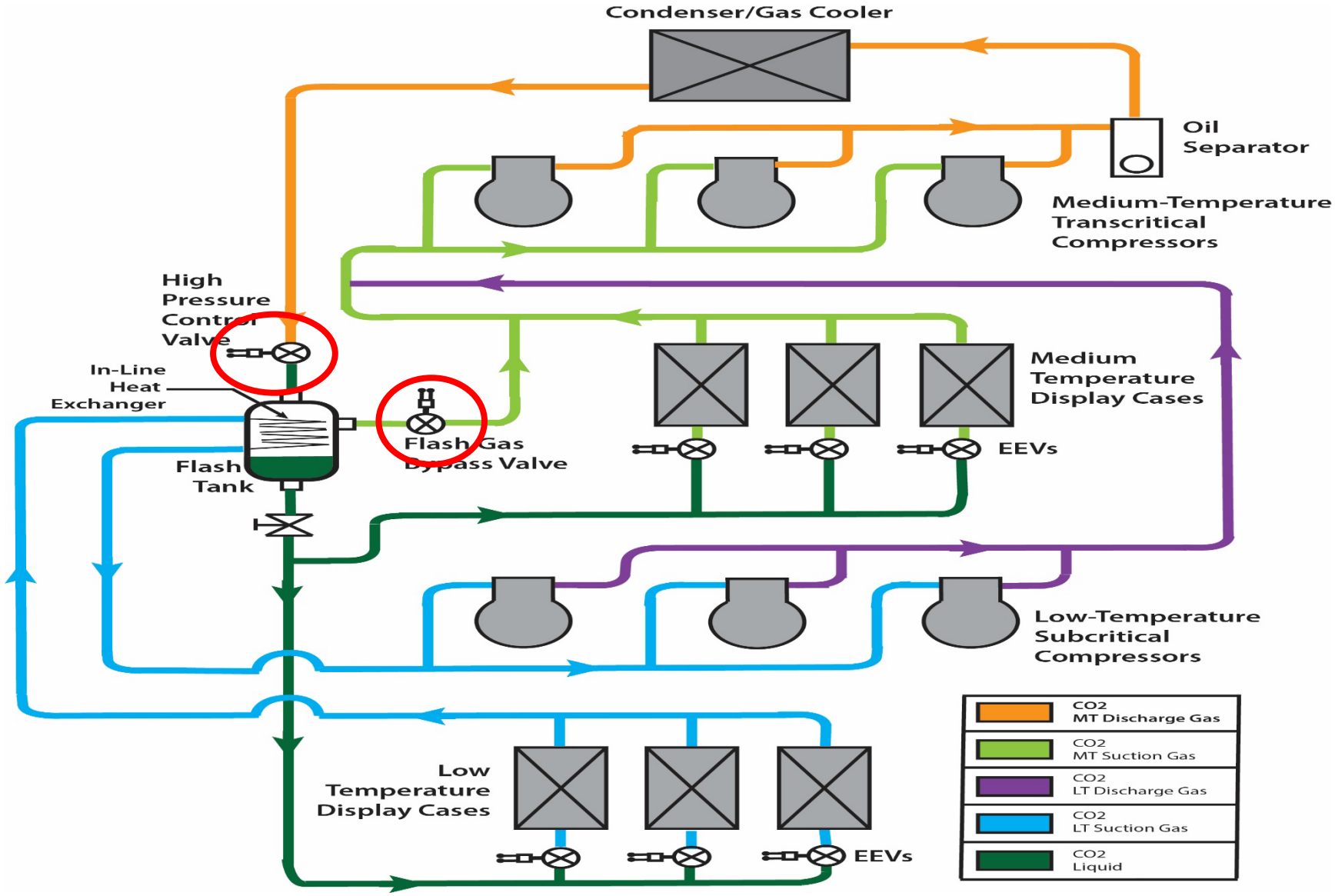
Critical Point

- Critical Point- The very top of the refrigerant enthalpy diagram is the critical point. **At a temperature above 87.7ºF or 1055psig, CO_2 cannot exist as a liquid. The highest pressure and temperature where the refrigerant can still condense.**
- The liquid expands and becomes less dense until, **at the critical point, the densities of liquid and vapor become equal**, eliminating the distention between the two phases and merging together into a single phase.
- All Refrigerants have a critical point, CO_2 has a low critical point vs. other refrigerants

Critical Point of Other Refrigerants



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

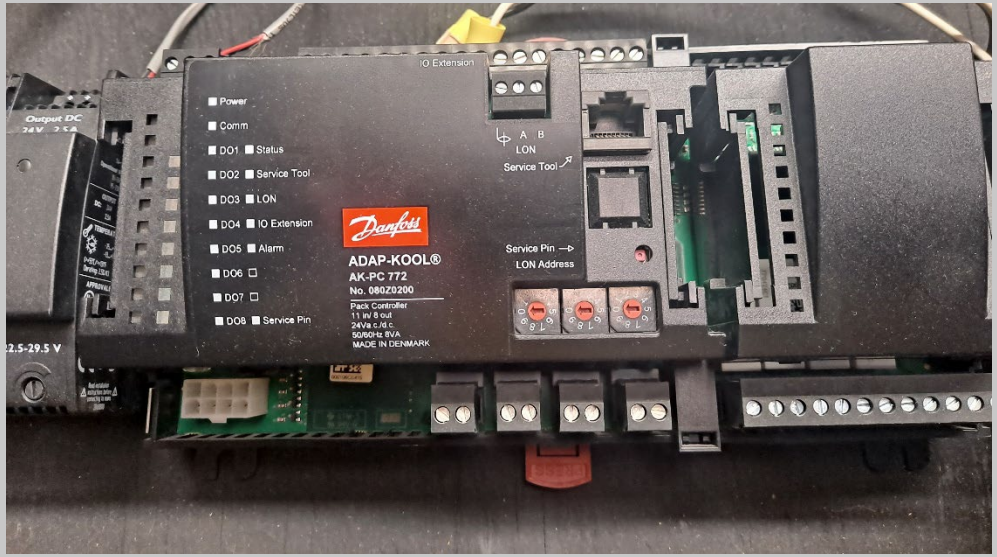
High pressure Control Vavle

- 0-10 VDC to operates the ICMT
- OR our wire stepper valve for CCMT

Flash Gas Bypass Valve

- Four wire stepper valve to operate FGBV

Controllers for HPCV/FGBV



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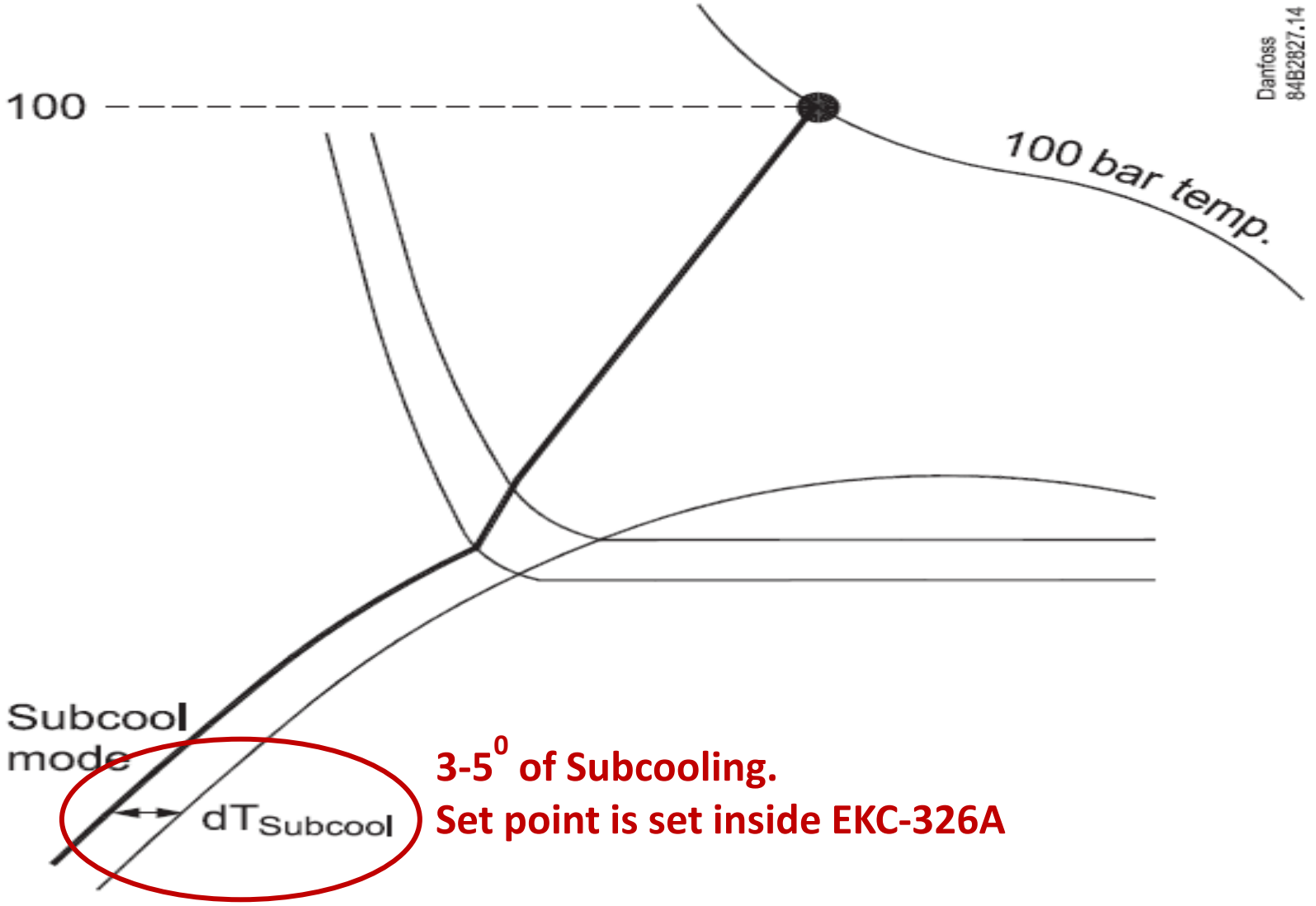
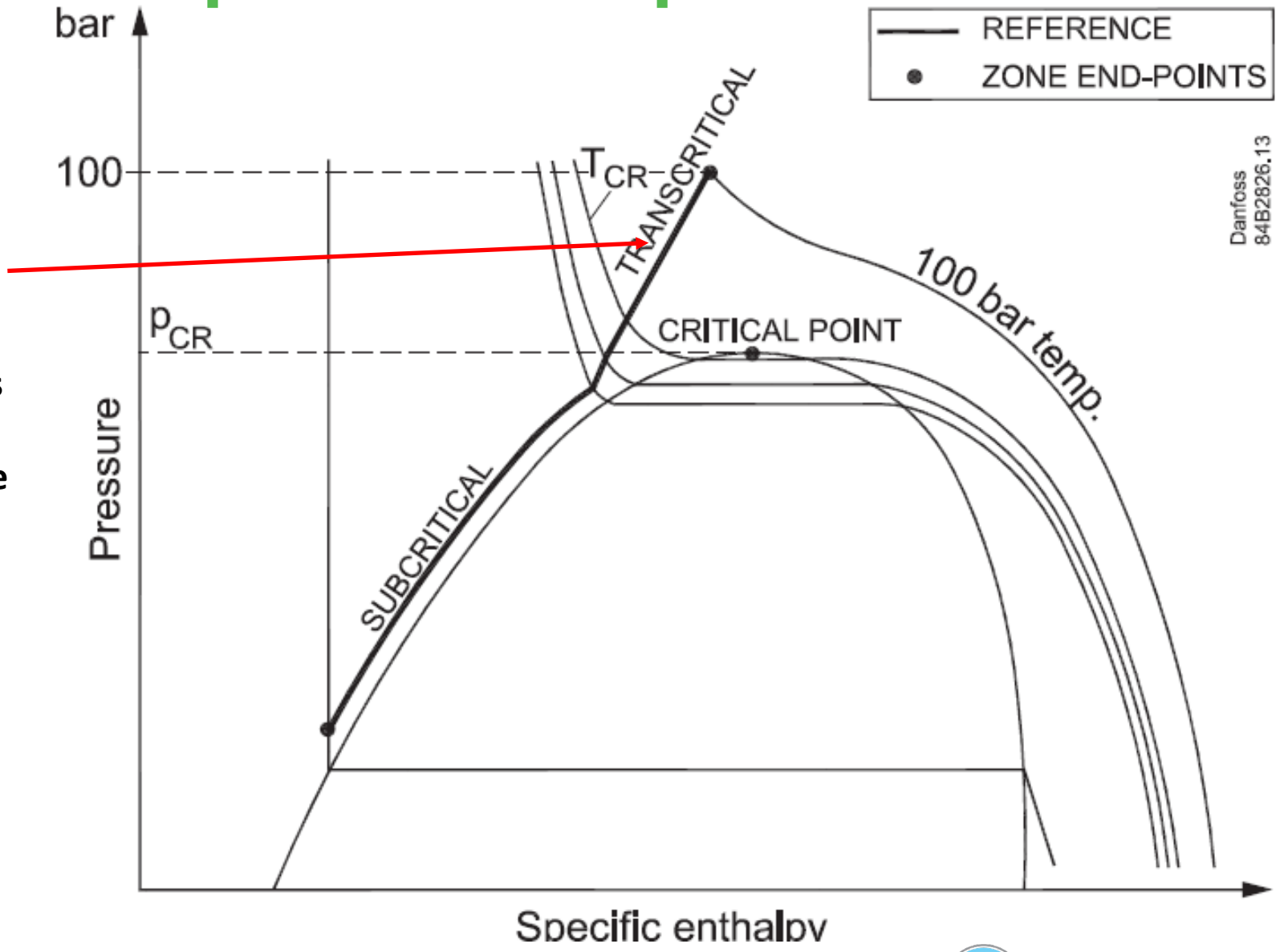
Subcritical Operation



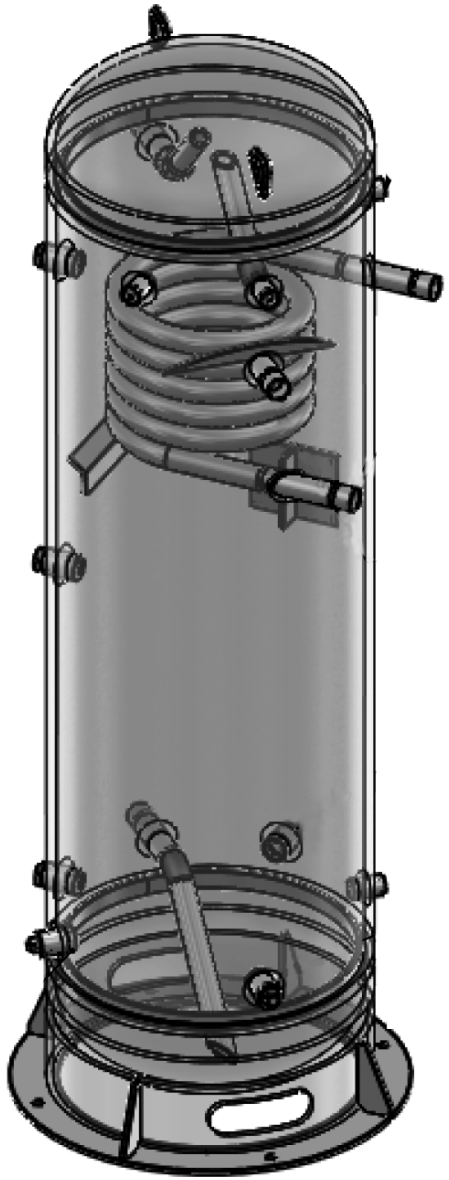
3-5^{0} of Subcooling.
Set point is set inside EKC-326A

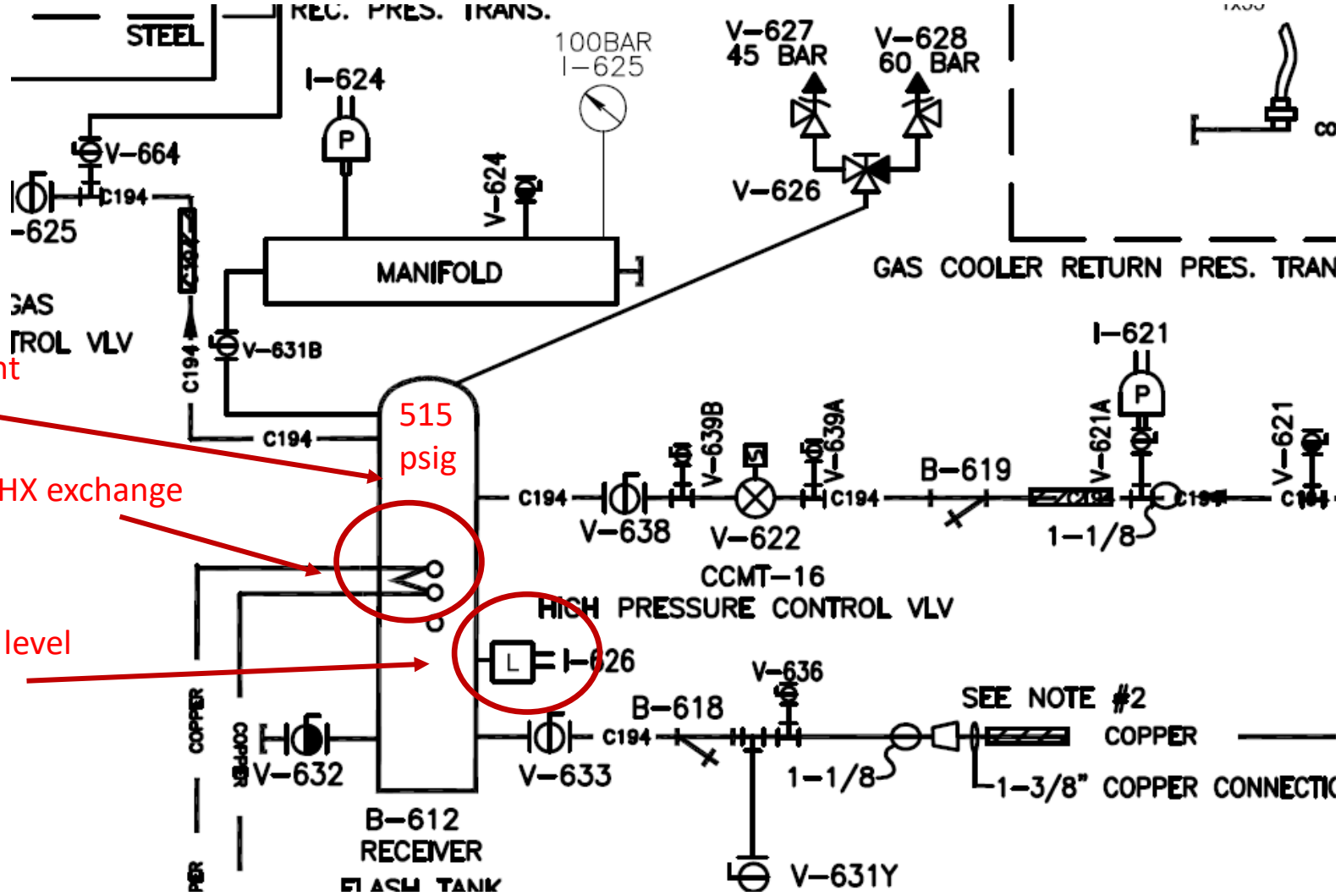
Supercritical Operation

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

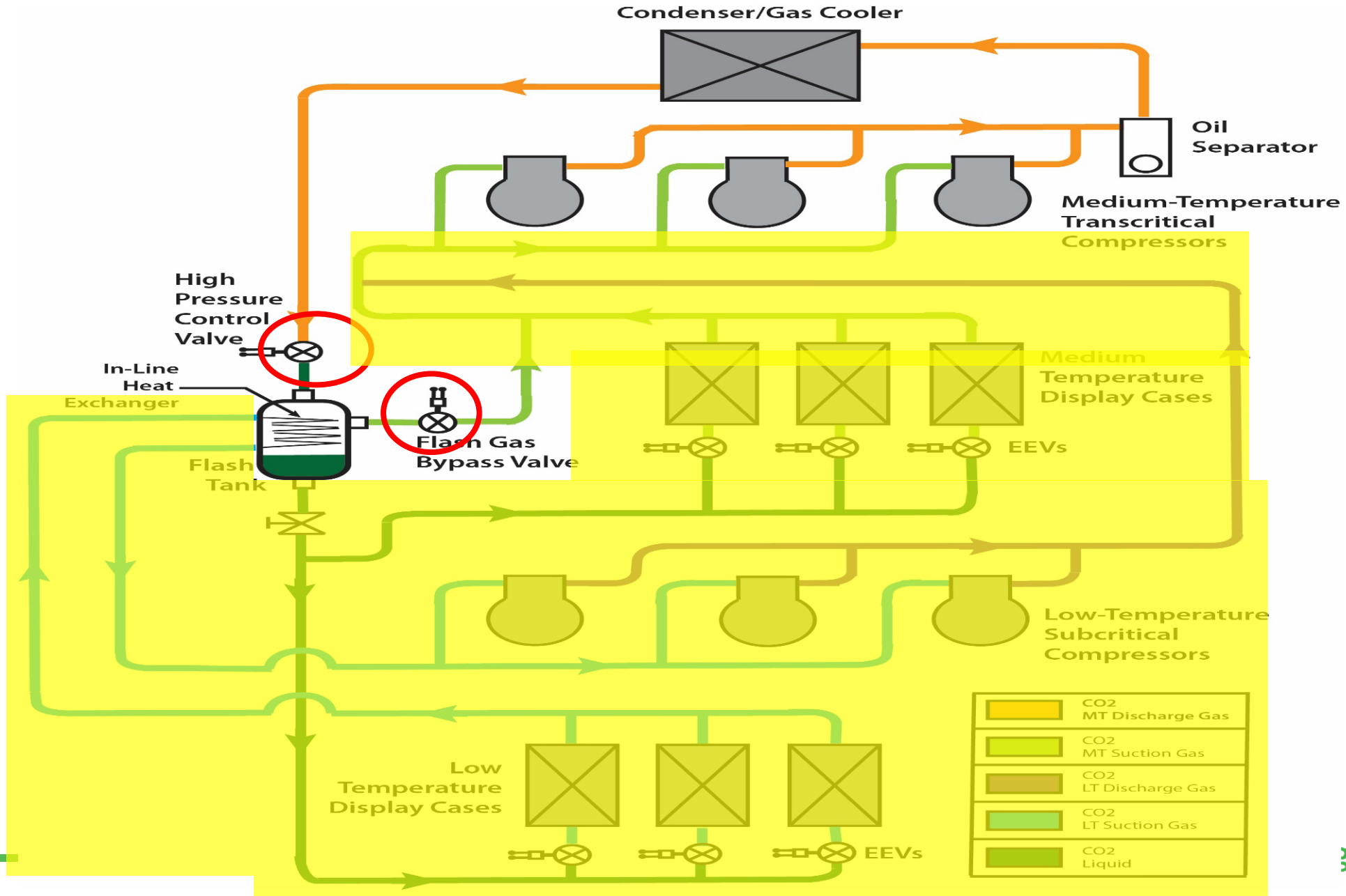


Booster Medium/Low Temperature Flash Tank





Advansor CO2 Booster System Diagram



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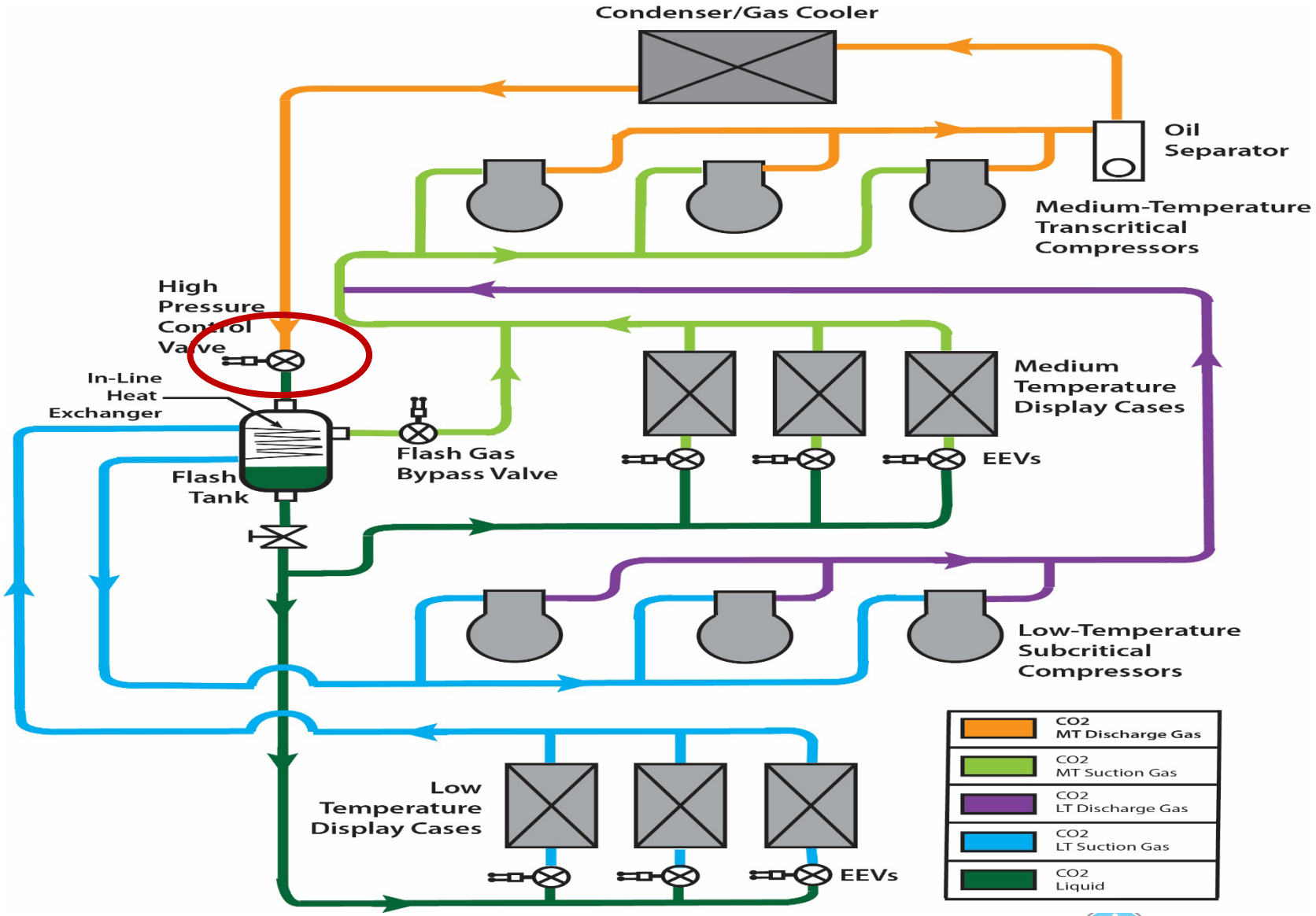
Danfoss ICMT High Pressure Control Valve

Not The Magic Valve

High Pressure Control Valve



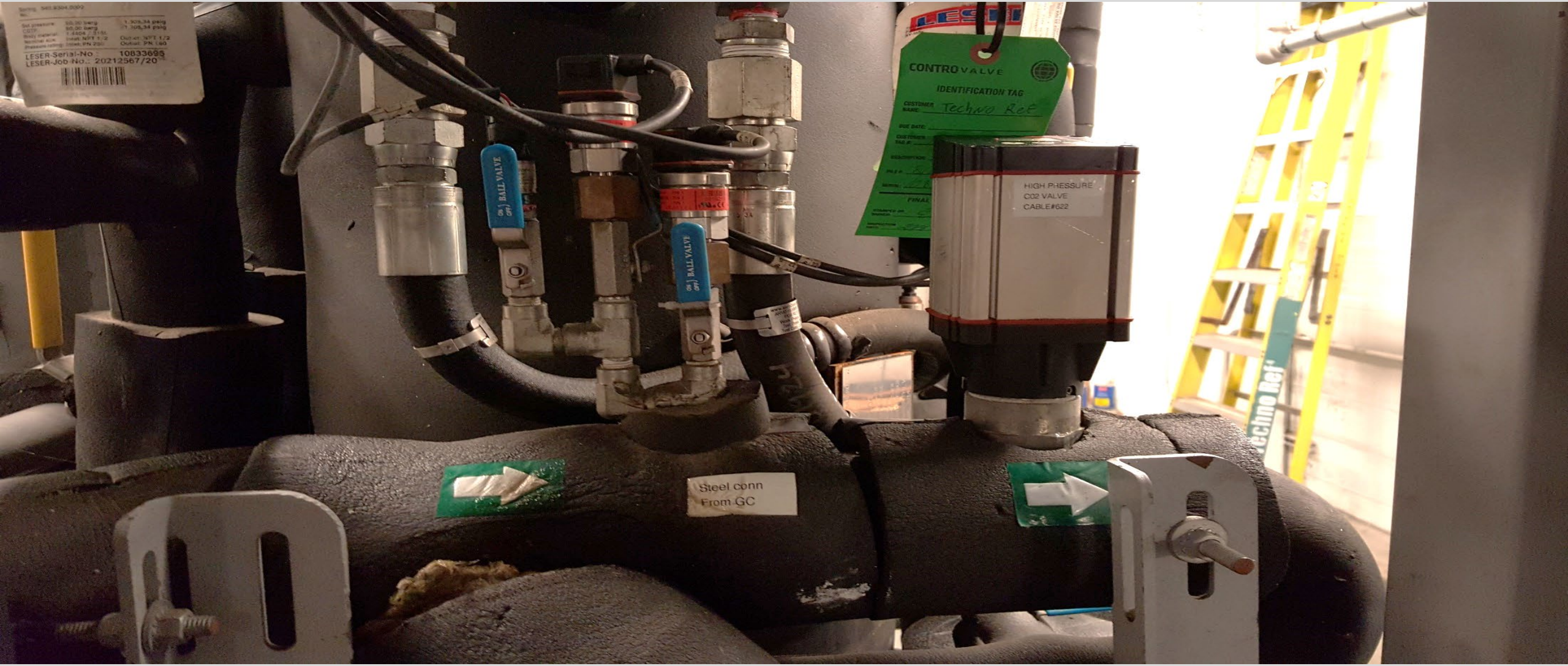
High Pressure Control Valve

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

High Pressure Control Valve

High Pressure Control Valve (ICMT)

High Pressure Control Valve (ICMT)



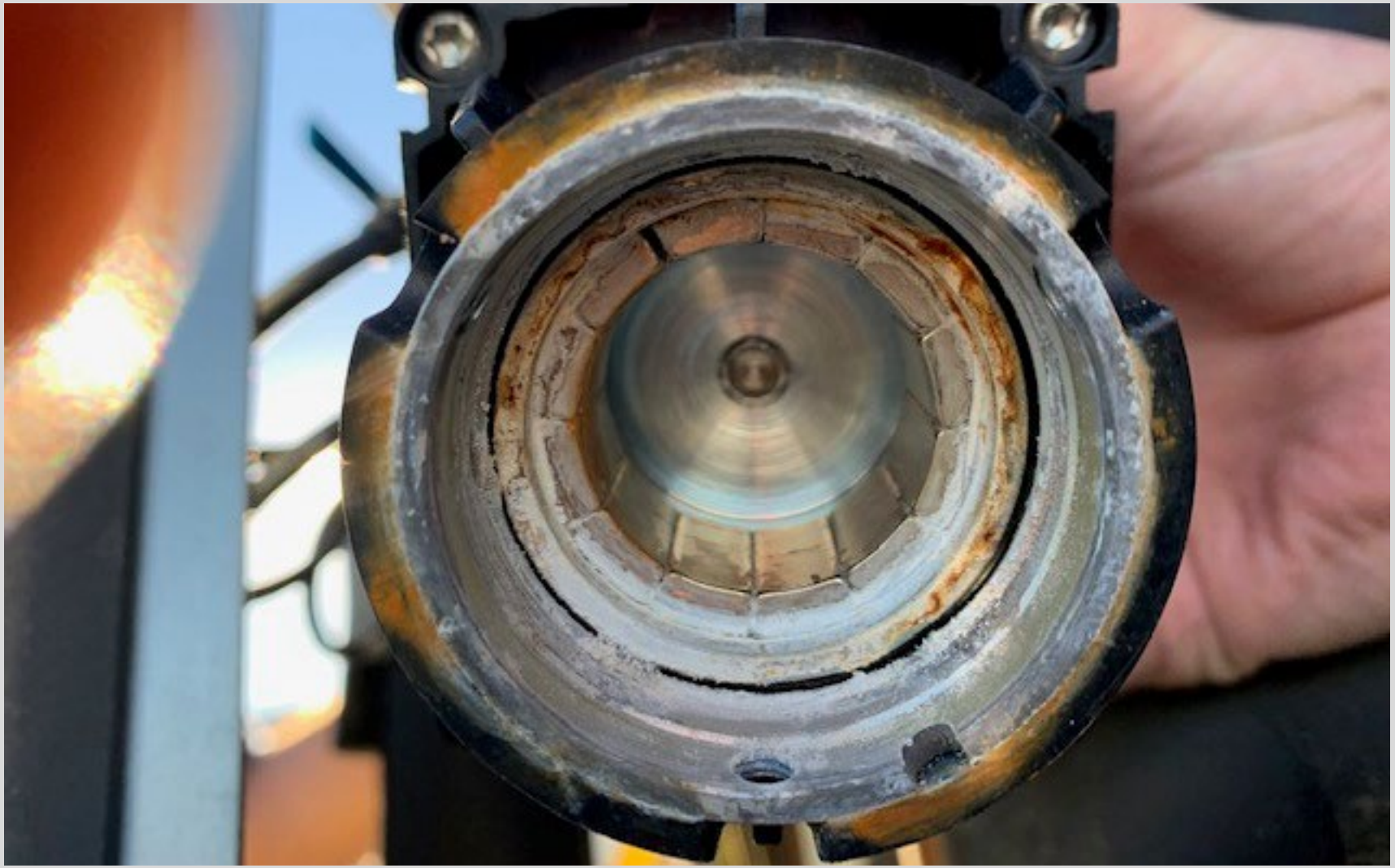
High Pressure Control Valve (ICMT)

High Pressure Control Valve (ICMT)

High Pressure Control Valve ICMTS

ICMT Valve Bad Gap

ICMT Actuator

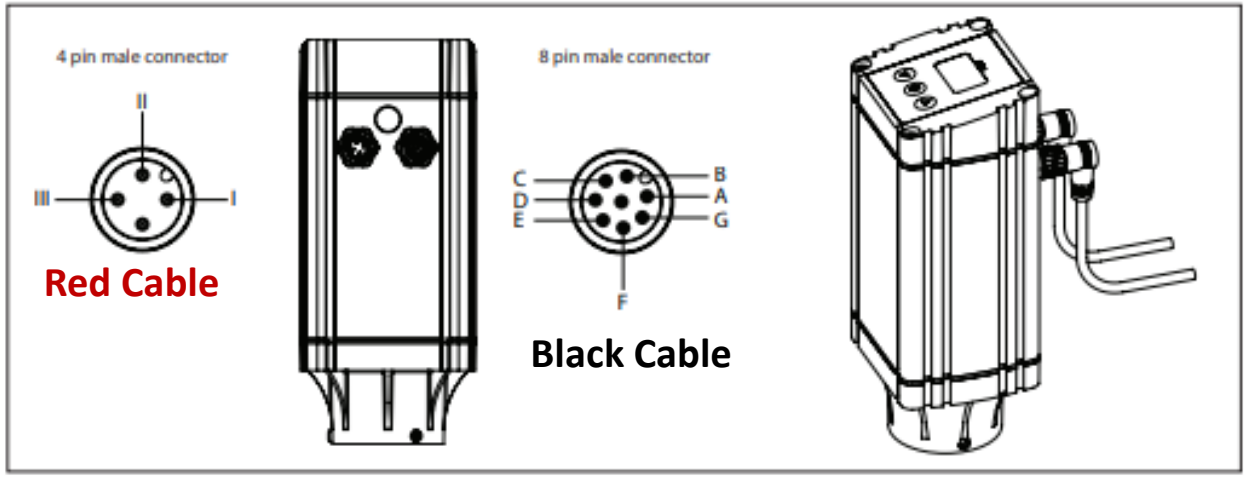


High Pressure Control Valve

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	Digital Ouput
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*	

Power connector/cable (3 wires)

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

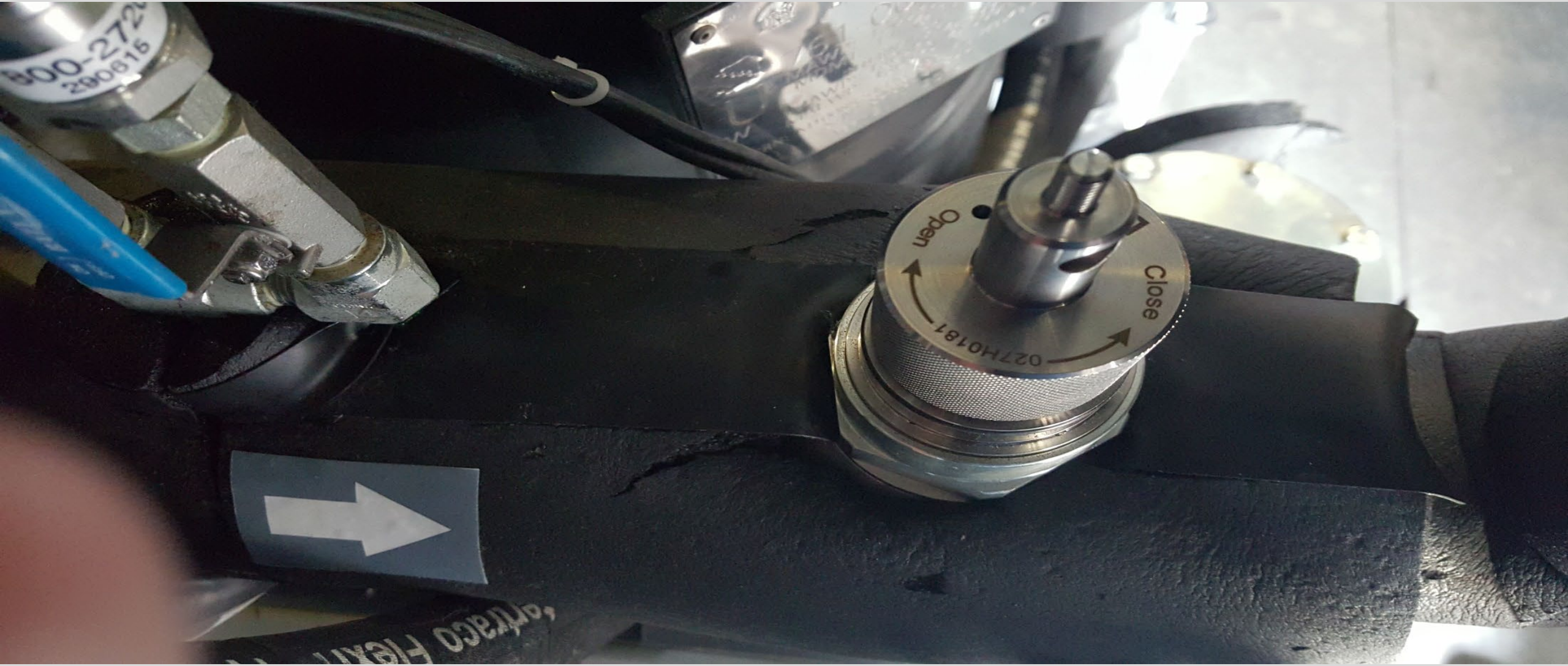
High Pressure Control Valve Alarms

Alarms

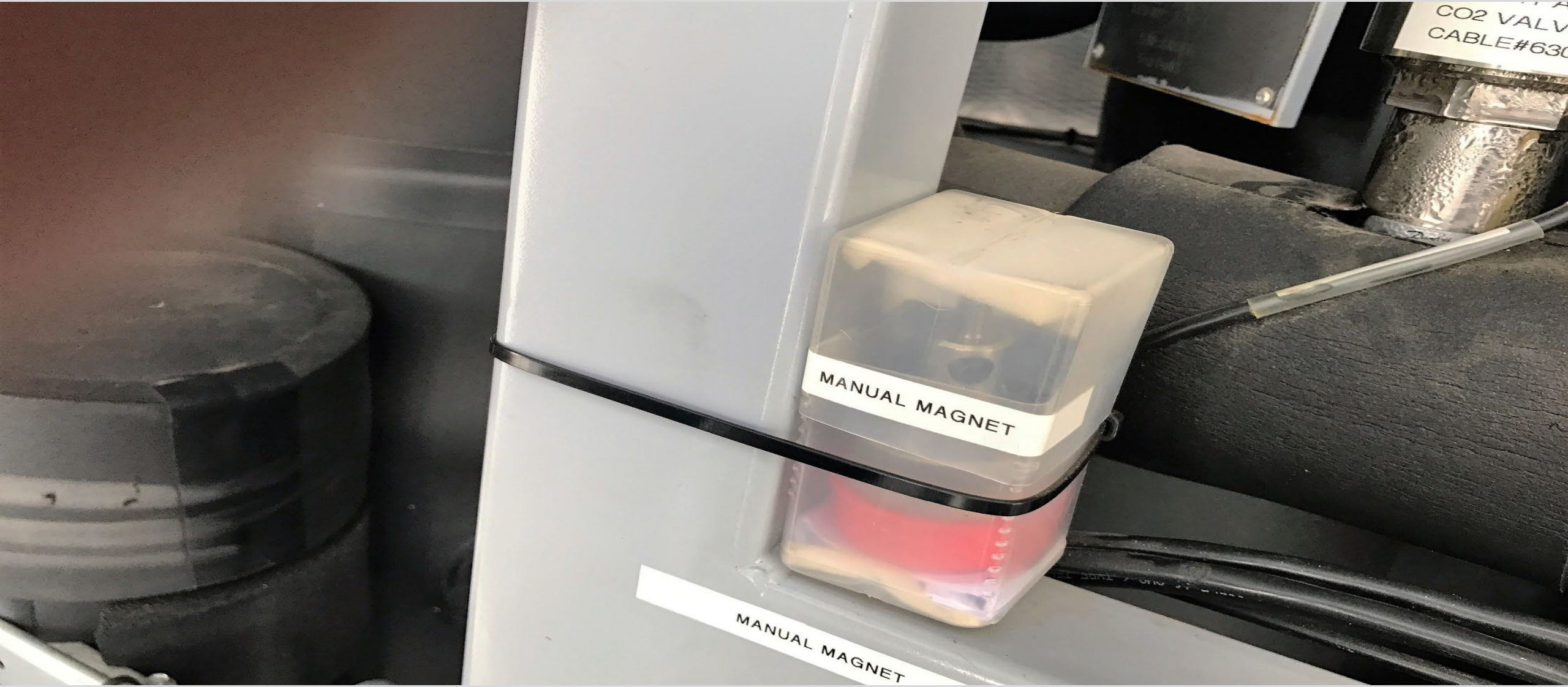
Description	ICAD alarm text	Definition of event	Comments
No Valve type selected	**A1**	Alarm ON	At start-up **A1** will be displayed until parameter **¡26** is set
Controller fault	**A2**	Alarm ON	Internal fault inside electronics. Carry out: 1) Power OFF and Power ON If A2 still active. 2) Make a Reset to factory setting If A2 still active. Return ICAD to Danfoss
Analog input error	**A3**	Alarm ON	Not active if **¡01** = 2, or **¡02** = 2 When **¡03** = 1 and AI A > 22 mA When **¡03** = 2 and AI A > 22 mA or AI A < 2 mA When **¡03** = 3 and AI A > 12 V When **¡03** = 4 and AI A > 12 V or AI A < 1 V
Low voltage of fail safe Supply	**A4**	Alarm ON	If 5 V < fail safe supply <18 V. Enabled by **¡08**
Check supply to ICAD	**A5**	Alarm ON	If supply voltage < 18 V
Calibration extended failed	**A6**	Alarm ON	Check valve type selected. Check presence of foreign debris inside ICM valve
Thermal overload	**A8**	Alarm ON	ICAD stepper motor temperature too high
Valve locked	**A9**	Alarm ON	Only active if i16 = 1 If the ICM valve is locked for more than 15 seconds (unable to reach its requested position) A9 will flashin display. A9 alarm can only be reset by Power OFF/ON of ICAD

High Pressure Control Valve Manual Operation

High Pressure Control Valve Manual Operation



Magnet for High Pressure Control Valve



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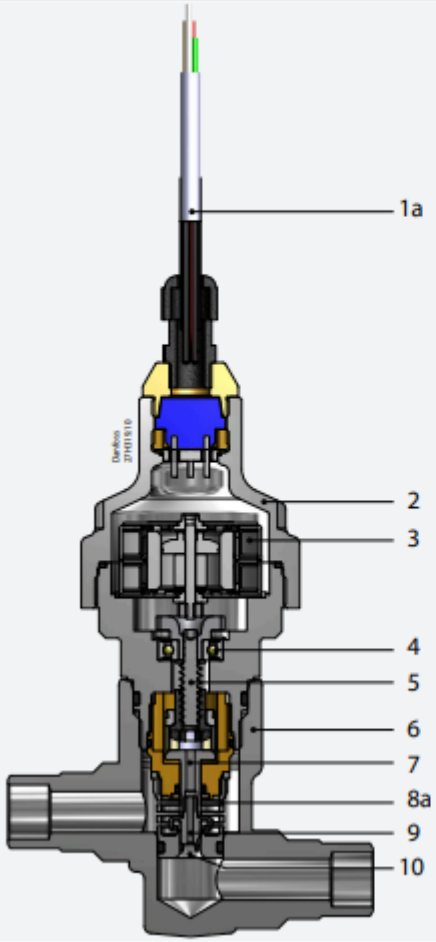
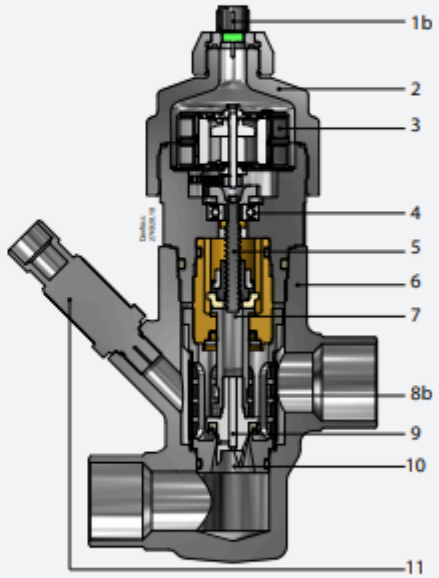
Danfoss CCMT Bipolar Stepper Valve

Danfoss CCMT High Pressure Control Valve

CCMT Bipolar Stepper Valve

Design and materials

Table 8: Design and materials

CCMT 2 - CCMT 8	CCMT 16 - CCMT 42
	

1a	Cable with M12 male connector
1b	M12 connector
2	Actuator housing
3	Stepper motor
4	Ball bearing
5	Spindle
6	Valve housing
7	Balance piston

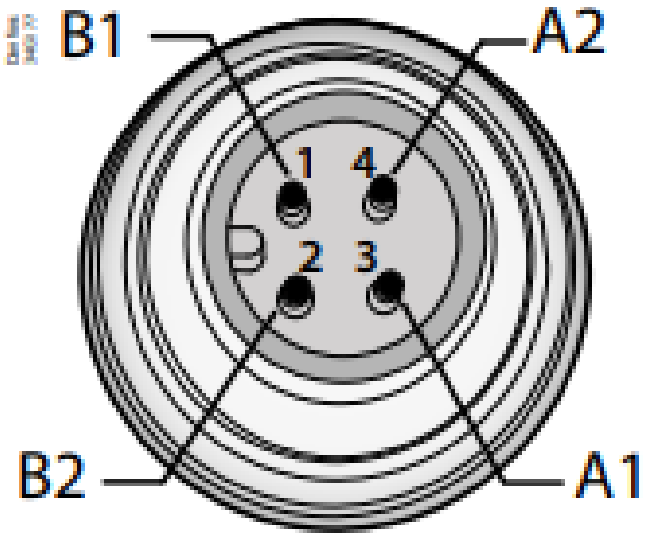
8a	Strainer
8b	Filter
9	Valve cone
10	Nozzle
11	Pressure transmitter (not included in CCMT 16 - CCMT 42 without integrated pressure transmitter)

Table 4: Electrical data

Features	Description	
Parameter	CCMT 2 – CCMT 8	CCMT 16 - CCMT 42
Stepper motor type	Bi-polar - permanent magnet	Bi-polar - permanent magnet
Motor enclosure	IP 67	IP 67
Step mode	2 phase full step, microstepping (recomended)	2 phase full step, microstepping (recomended)
Phase resistance	52 Ω ±10%	29 Ω ±10%
Phase inductance	85 mH	36.7 mH
Phase current	Using chopper drive: 100 mA RMS -4 % +15 %	Using chopper drive: 300 mA RMS -4 % +15 %
Holding current	Voltage driver: Depends on application. Current controller: Full current allowed	Not needed.
Duty cycle	100% duty cycle is allowed / 20% recommended	100% duty cycle is allowed / 20% recommended
Max. total power	Voltage drive: 5.5 W Current drive: 1.3 W (UL: NEC class 2)	Voltage drive: 10W Current drive: 2.8 W
Step rate	Chopper current drive: Max. 300 steps/sec. *(Recomended step rate: 200 steps/ sec.)* Constant voltage drive: Max. 150 steps/sec.	Chopper current drive: Max. 300 steps/sec. *(Recomended step rate: 200 steps/ sec.)* Constant voltage drive: Max. 150 steps/sec.
Total full steps	CCMT 2 , 4 and 8: 1100 steps	CCMT 16 : 800, CCMT 24 : 1400, CCMT 30 : 2300 and CCMT 42 : 2200
Full travel time	CCMT 2, 4 and 8: 5 sec. *(at 220 steps/sec.)*	CCMT 16 : 4 sec., CCMT 24 : 7 sec. CCMT 30 : 11.5 sec and CCMT 42 : 11 sec.*(at 200 steps/sec.)*
Reference position	Overdriving against full close position	Overdriving against full close position
Overdrive in close position	Max. 10% of total full steps	Max. 10% of total full steps and maximum one overdrive performed per hour.
Overdrive in open position	Not Allowed	Not Allowed
Electrical connection	M12 male connector with 0.3 m / 1 ft long cable *(4 wire: 0.5 mm2 / 20 AWG)*	Integrated M12 male connector
Compatible controllers	EKE 1A, EKE 1B, EKE 1C, EKC 313, EKC 326A , AK-XM 208C	EKE 1A, EKE 1B, EKE 1C, AK-XM 208C

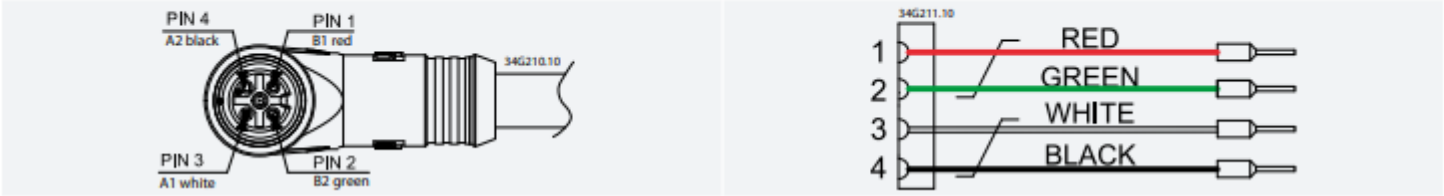
CCMT Cable Connection

Figure 2: CCMT valve



Connections

Table 9: Connections



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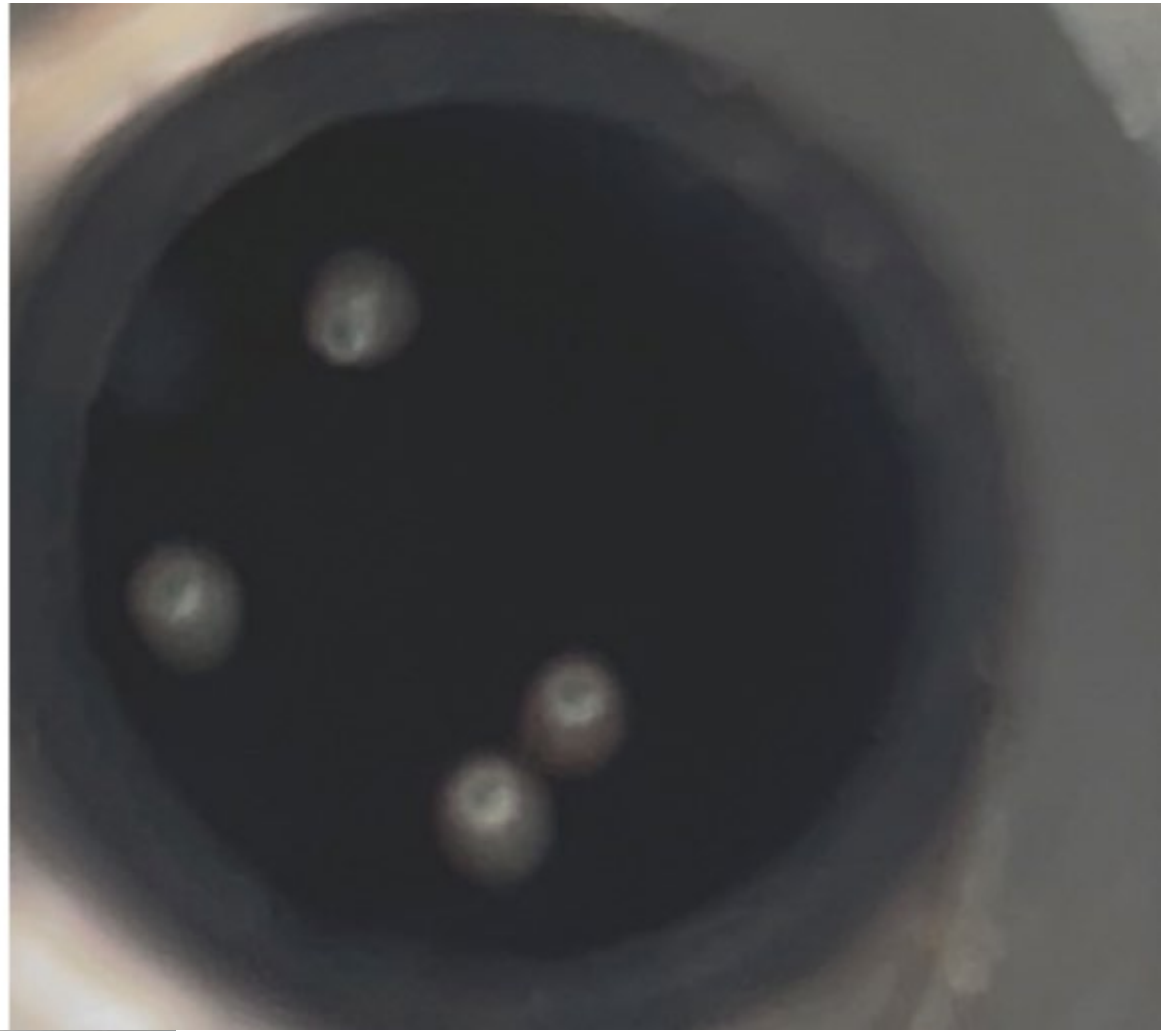
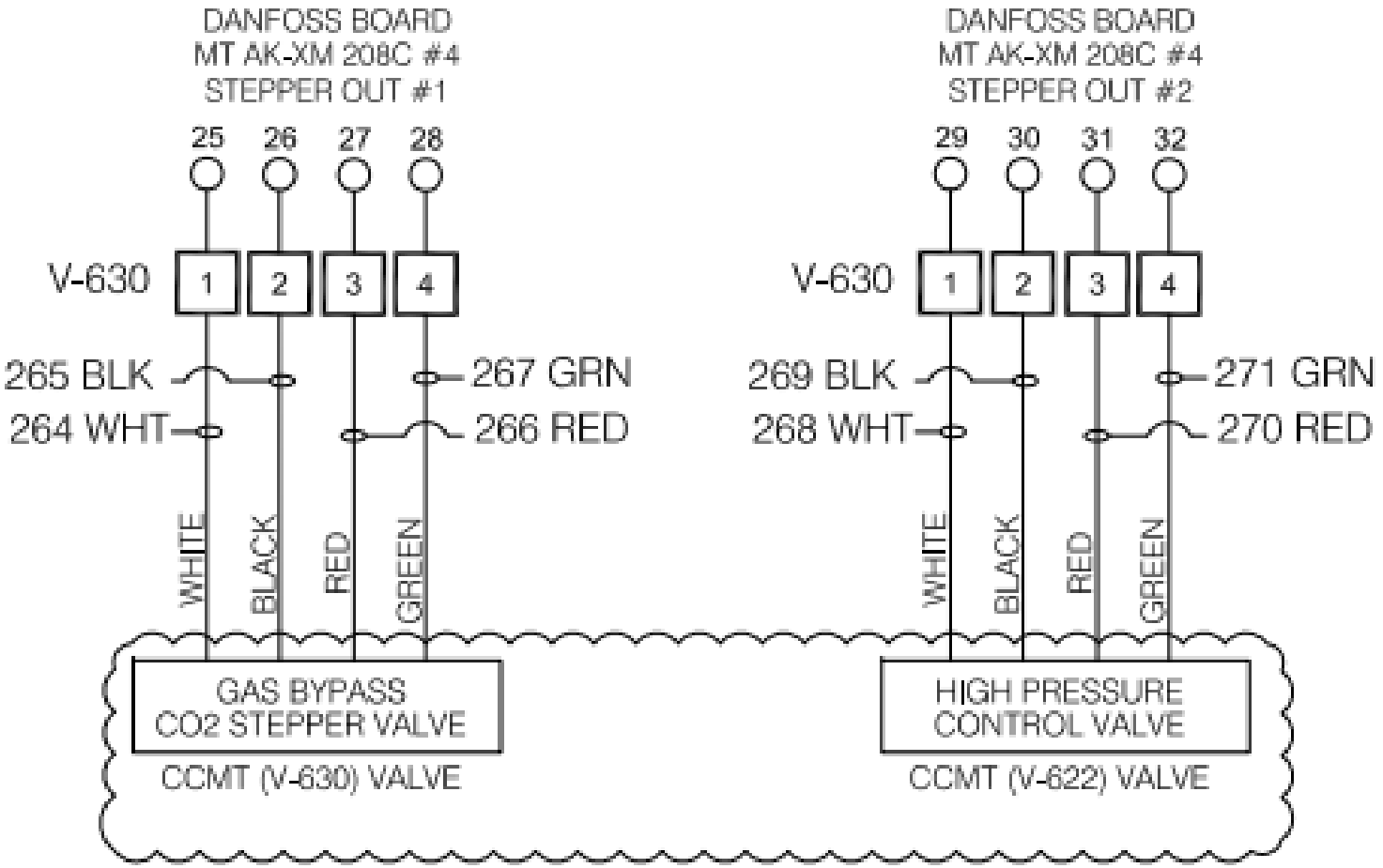
This CCMT Dosen’t Work



HPC Valve and Gas Bypass Wiring



Danfoss CCMT High Pressure Control Valve

CCMT Spare Parts

Accessories

Spareparts

Table 12: Spareparts

Type	Description	Single pack	Code no.
Gasket	O-ring spare part kit for CCM / CCMT 2 - CCMT 42	1	027H7230

Packard cable for MBS 8250 pressure transmitter

Table 13: Packard cable for MBS 8250 pressure transmitter

Type	Description	Industrial pack	Code no.
Packard cable	10 m / 32.8 ft cable for MBS 8250 pressure transmitter	14	064G0910
		1	064G0950

Ordering

Table 14: Ordering

Cable	Cable length (L)	Insulation	Packing format	Code no.
PVC - black	2 + 0.089 m / 6.6 + 0.3 ft	SR-PVC	Single pack	034G7073
	8 + 0.3 m / 26.2 +1 ft	SR-PVC	Single pack	034G7074

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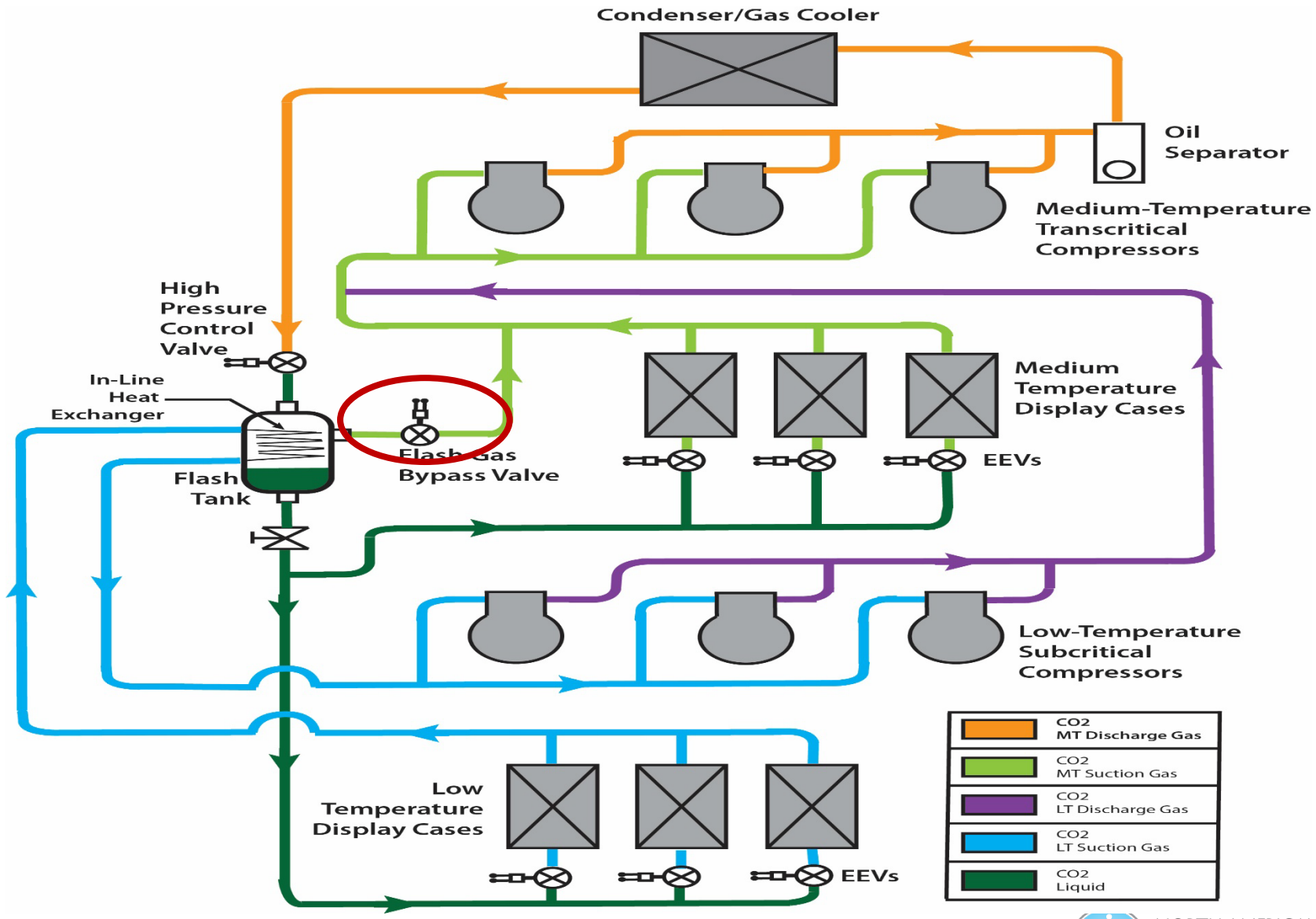
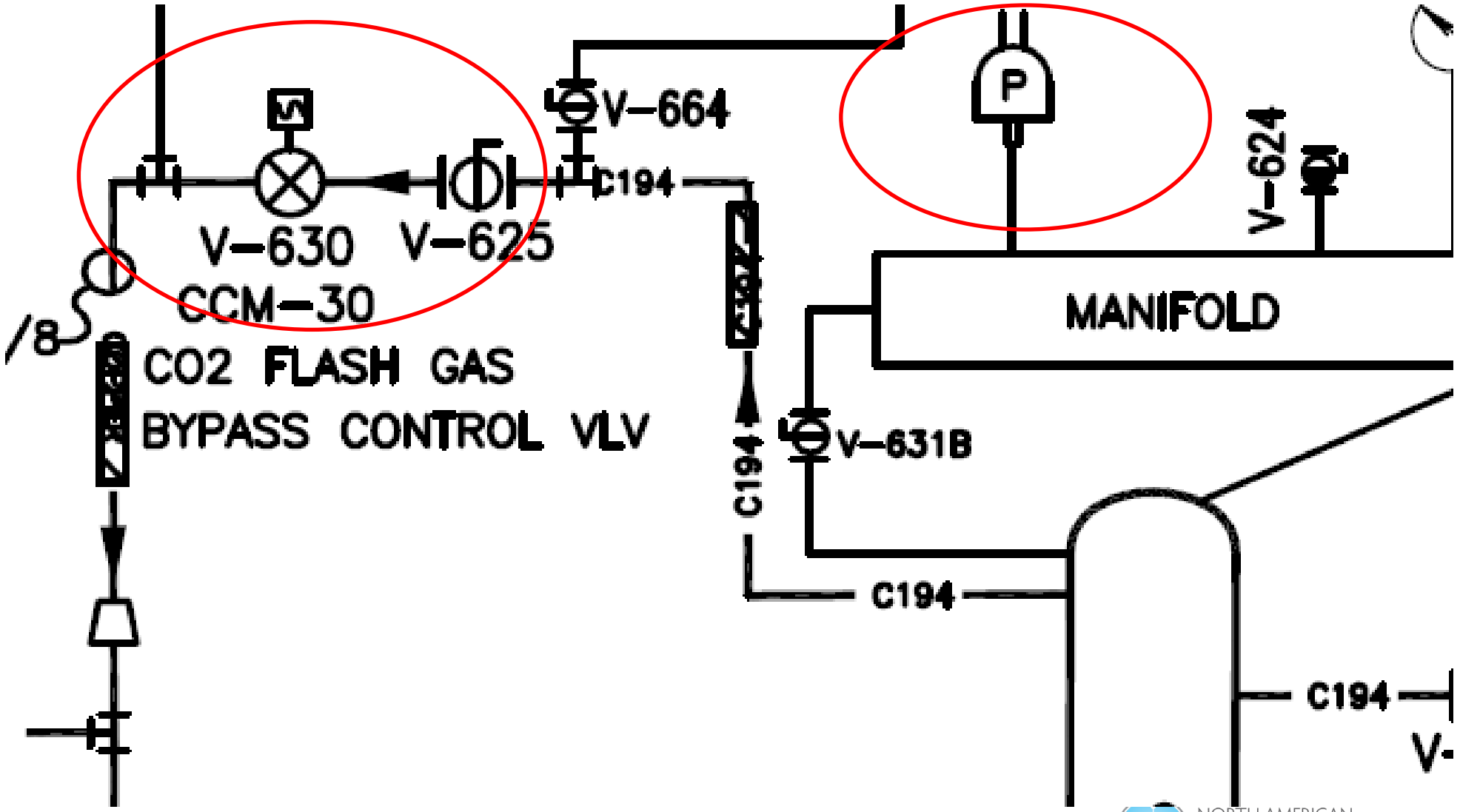
Flash Gas Bypass Valve

Flash Gas Bypass Valve (CCM)



Flash Gas Bypass Valve (CCM-30)



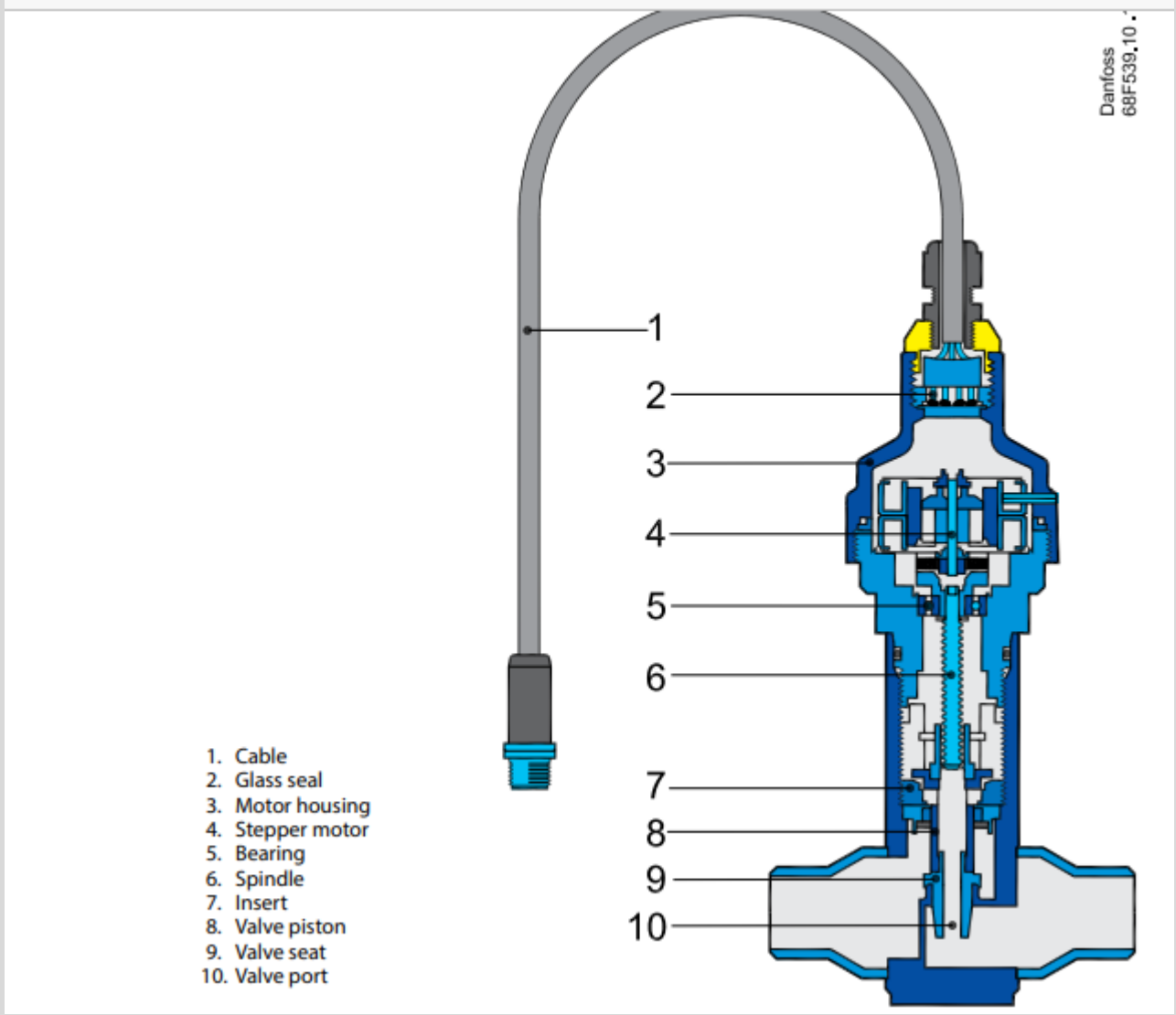
Flash Gas Bypass Valve (CCMT)

- BI-Polar Low pressure expansion motor valve

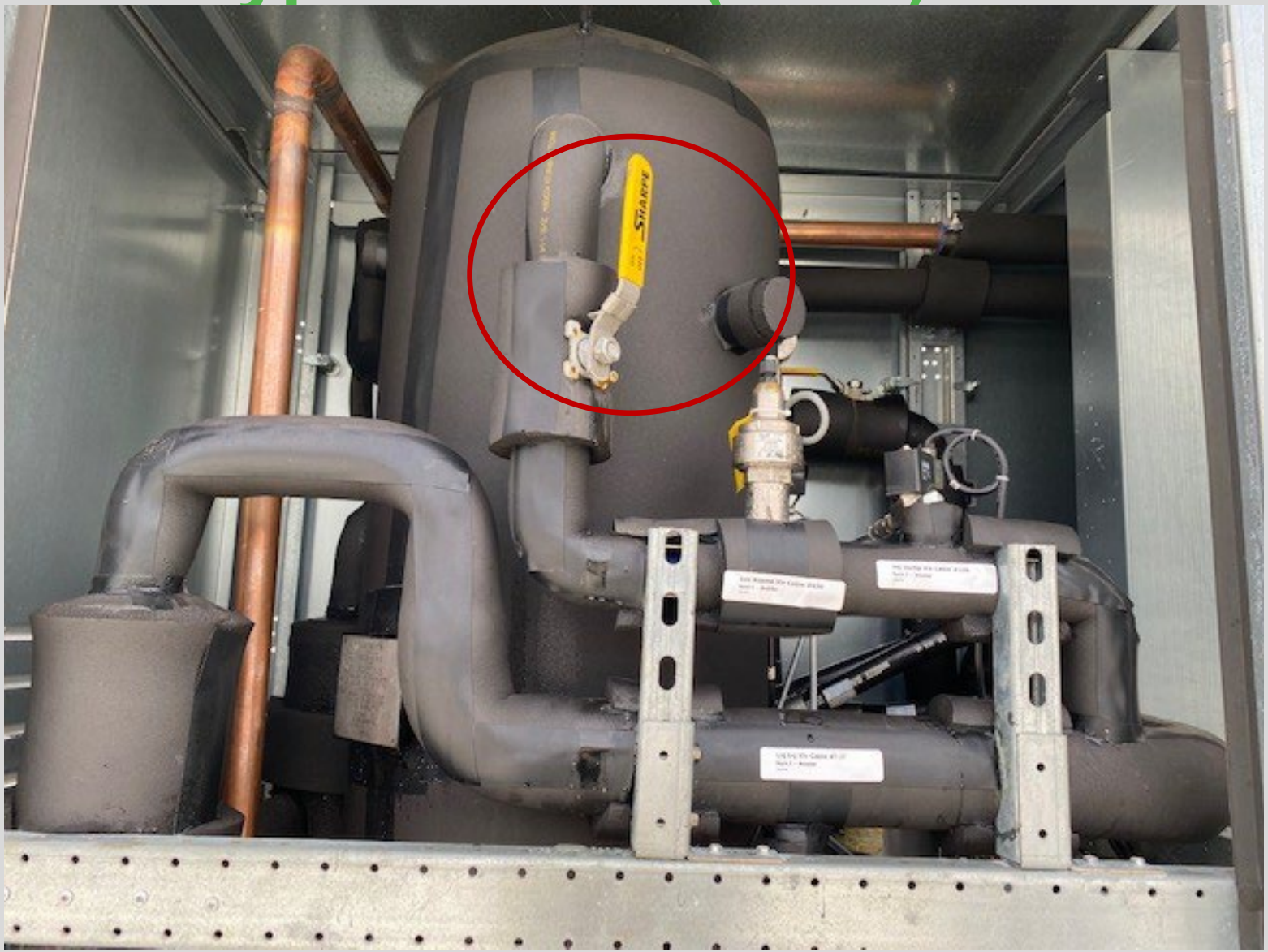
- Functions:
- Controls the Pressure in the flash tank to 35.5 bar (515 psig or 35.2^{0}F

- Maximum working pressure: PS 90 bar

Flash Gas Bypass Valve (CCM)



Flash Gas Bypass Valve (CCM) Isolation Valve



Flash Gas Bypass Valve (CCMT)

Flash Gas Bypass in Parallel

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Questions/Comments