

# Natural Refrigerant Training Summit

Building a Sustainable Workforce

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## CO<sub>2</sub> Component Overview With S3C Case Control Introduction

Jon Grable

Parker Hannifin, Sporlan Division



NORTH AMERICAN  
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Refrigeration  
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# Natural Refrigerant Training Summit

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# North American Sustainable Refrigeration Council (NASRC)

**Mission** Create sustainable future for supermarket refrigeration by removing barriers to natural refrigerant adoption

➤ **501c3**  
Non-Profit Organization

➤ **150+**  
Members

➤ **51,000+**  
Food Retail Locations

## Goals

- **Build sustainable workforce**
- Increase funding options
- Increase education & awareness

## Natural Refrigerants

Carbon Dioxide  
R744

Propane  
R290

Ammonia  
R717

# Need help? Look for NASRC staff!



**Danielle Wright**  
Executive Director



**Morgan Smith**  
Program & Communications Director



**Jeanne Ackerman**  
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# Before we get started...

- Please make sure you sign in by the door
- To receive an electronic certificate for this training:
  - Complete the survey at the end of the session
  - Share your name and email at the end of the survey



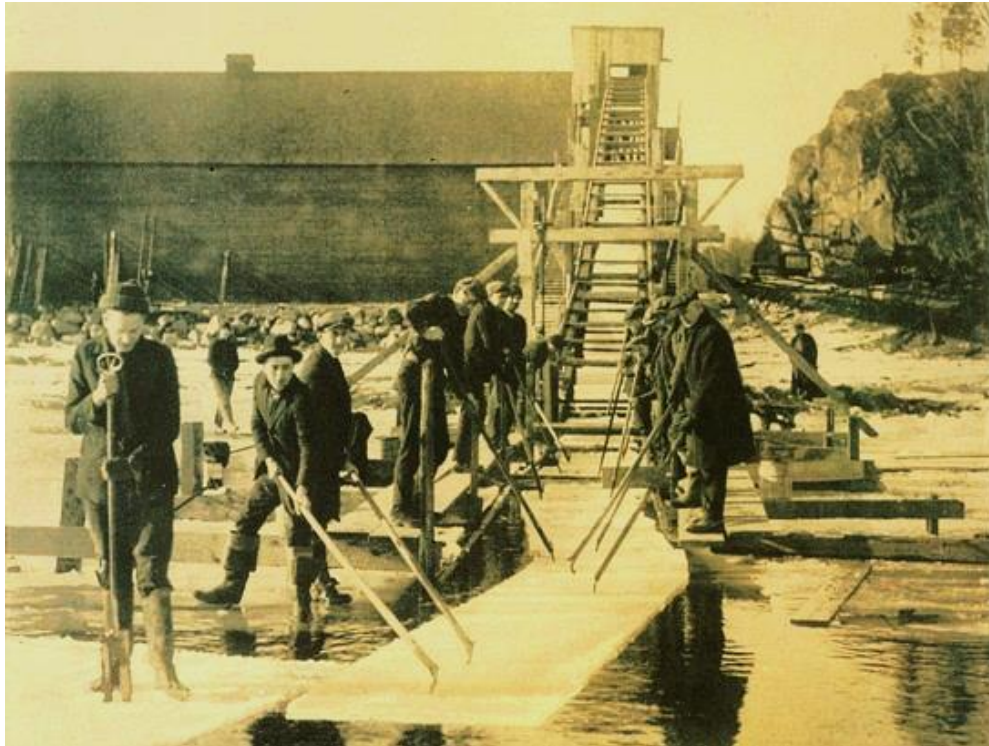
# Presenter



**Jon Grable**  
Territory Manager  
[jonathan.grable@parker.com](mailto:jonathan.grable@parker.com)



# Refrigeration History





# Ice Box – Predecessor to the Refrigerator



Block ice was delivered daily and placed in the ice box.



# The Term Ton Relates to Ice

The cooling produced by melting 1 ton of ice in a day  
Described as **1 Ton of Refrigeration**



**Equal to 288,000 BTU/day = 12,000 BTU/hr**

# Grocery Stores are Essential for Food

- Approximately 50,000 existing stores in the U.S. and Canada
- 1K to 2K new builds every year to meet demand
- Millions of \$\$\$ in lost product, due to improper temperatures and equipment malfunctions or monitoring



# Business Trends

- Online Ordering
- Curbside Delivery
- Home Delivery
- In-garage Delivery
- Grab & Go
- Mobile Scan & Go
- Instore Restaurants & Bars
- Reusable Packaging & Containers





# Design & Work Force Trends

- Lower GWP refrigerants are mandated
- New store platforms
- Metering devices/electronics
- Tech labor force

# What is AWEF?

## Annual Walk-In Energy Factor (AWEF)

- An energy factor mandated by the Department of Energy (DOE)
- All walk-in equipment of 3000 ft<sup>2</sup> or less must conform to this new requirement
- Affects Thermostatic Expansion Valve (TEV) and Electric Expansion Valve (EEV) sizing

**Change is Here!**

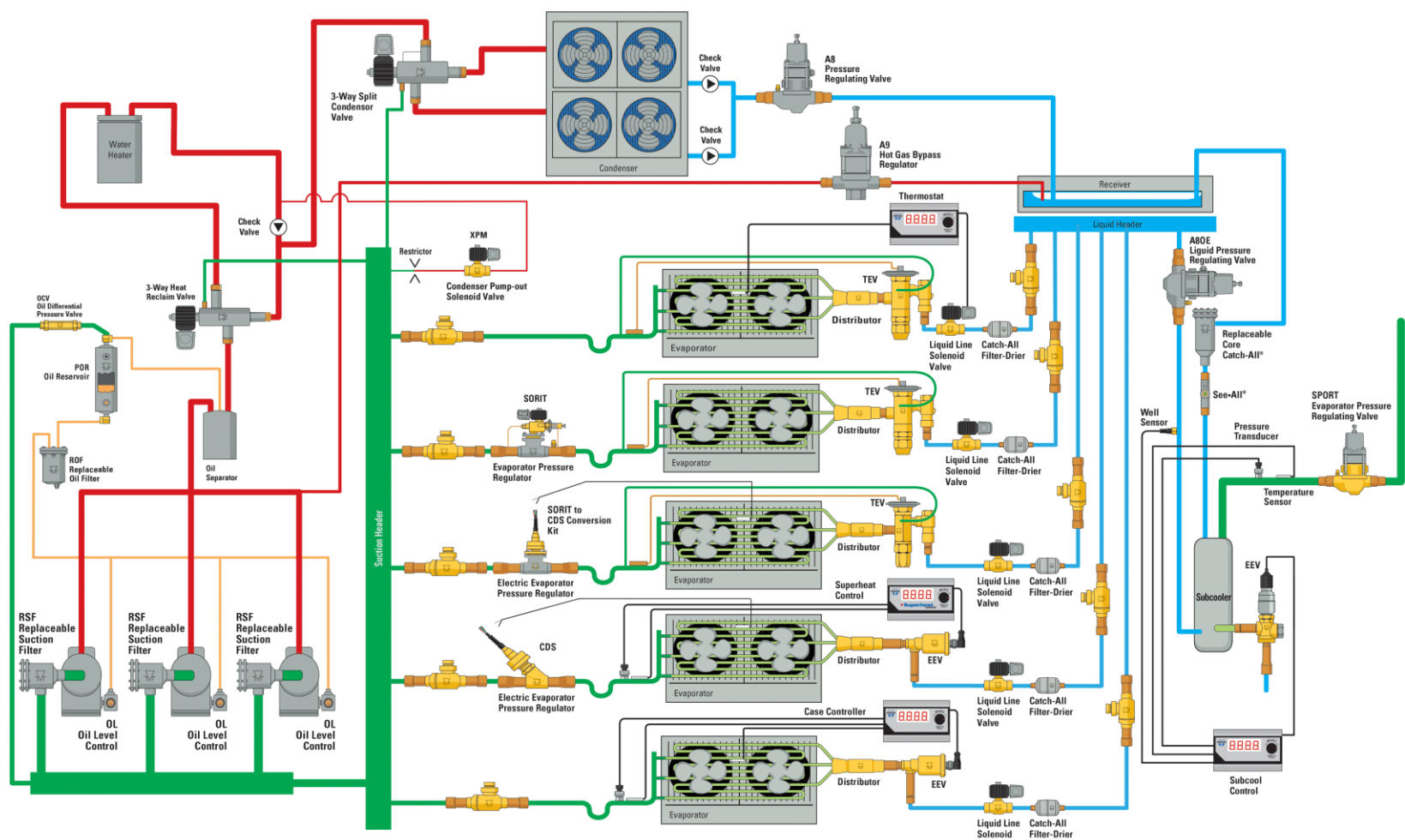
# Supermarket of the Future

## What will supermarkets look like in 5, 10, and 15 years?

- Increased efficiency
- Fewer refrigerant leaks
- More electronics!
- New low-GWP refrigerants
- Maybe using propane
- Maybe using CO<sub>2</sub>

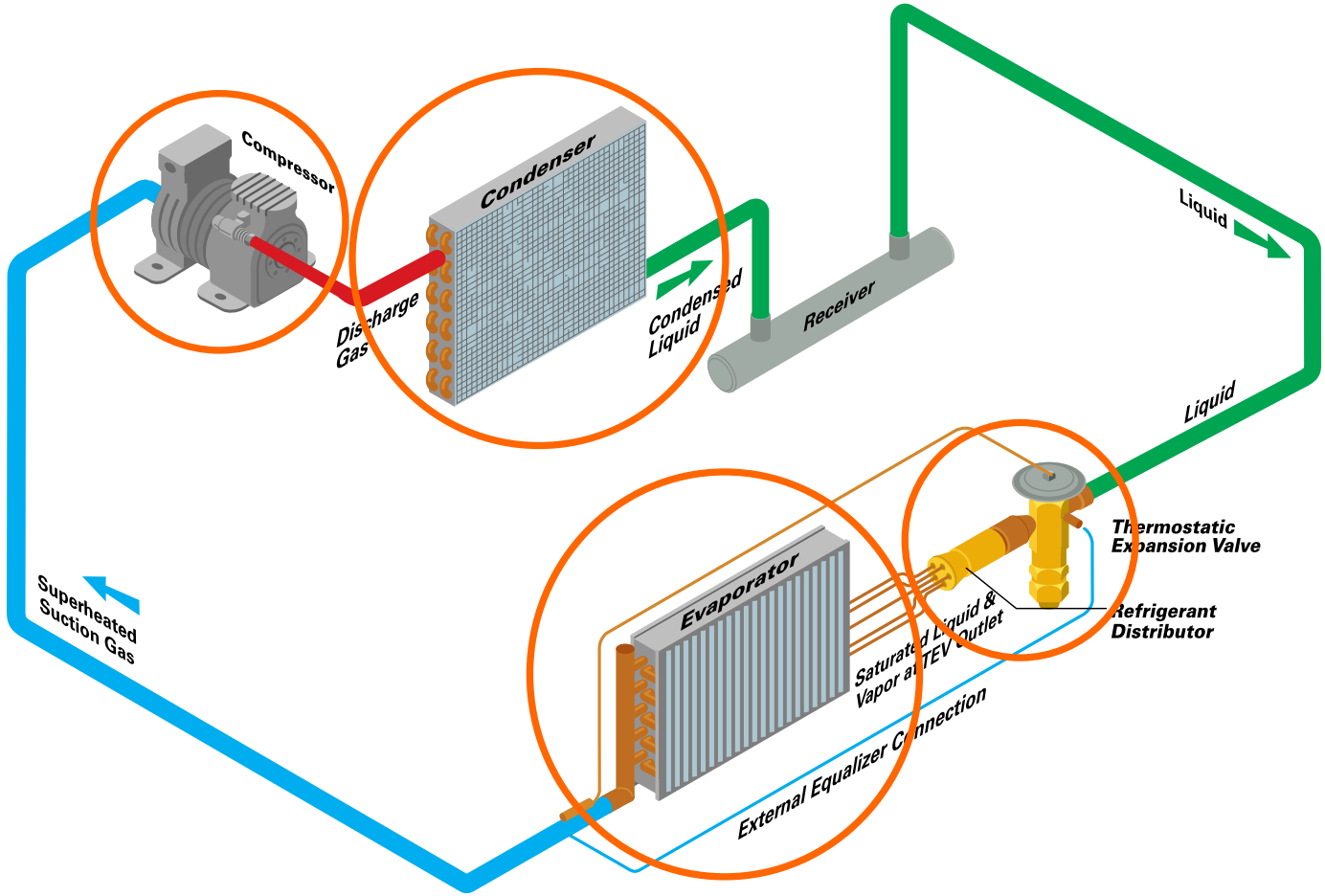


# DX Systems – Multiplex Racks

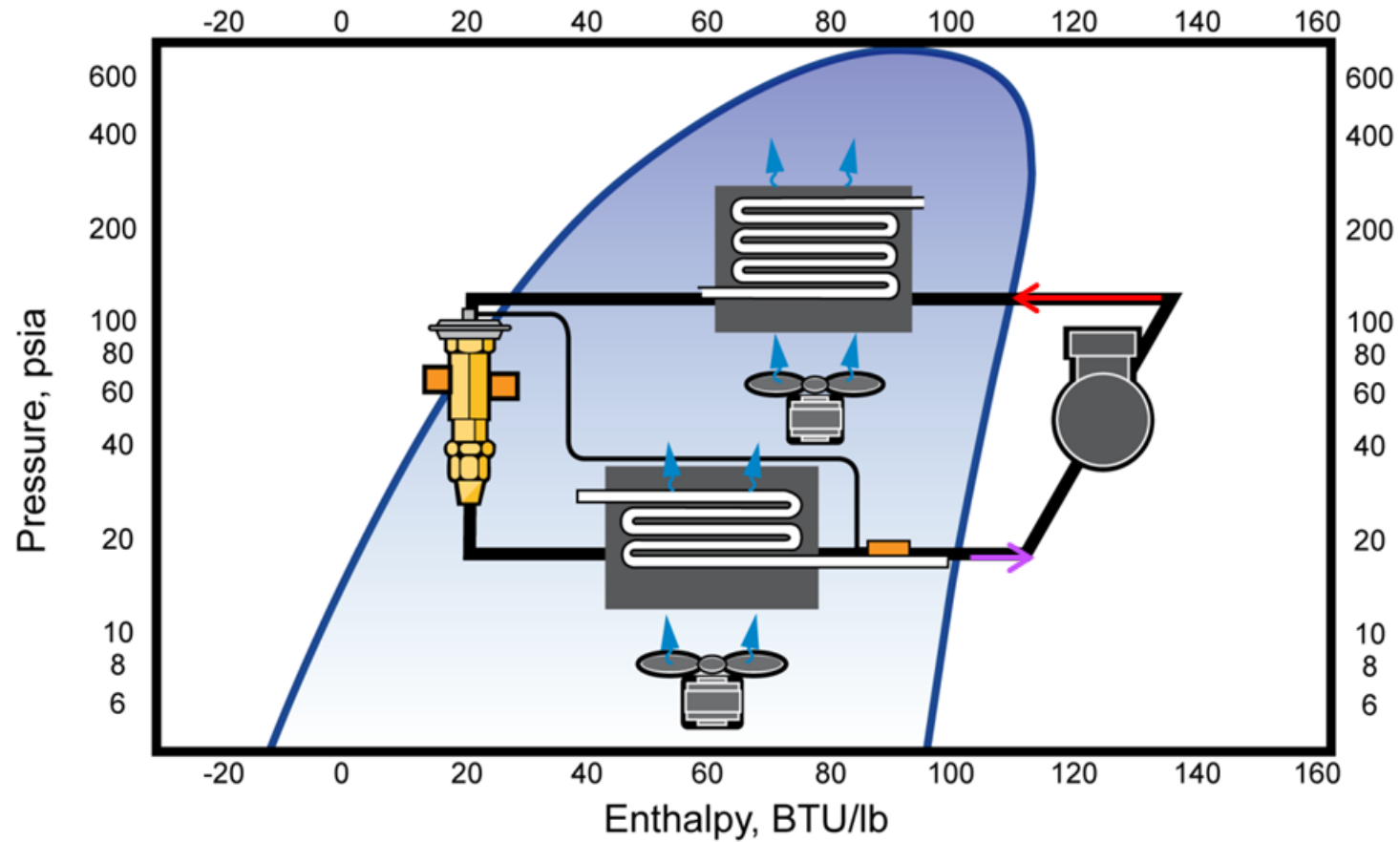




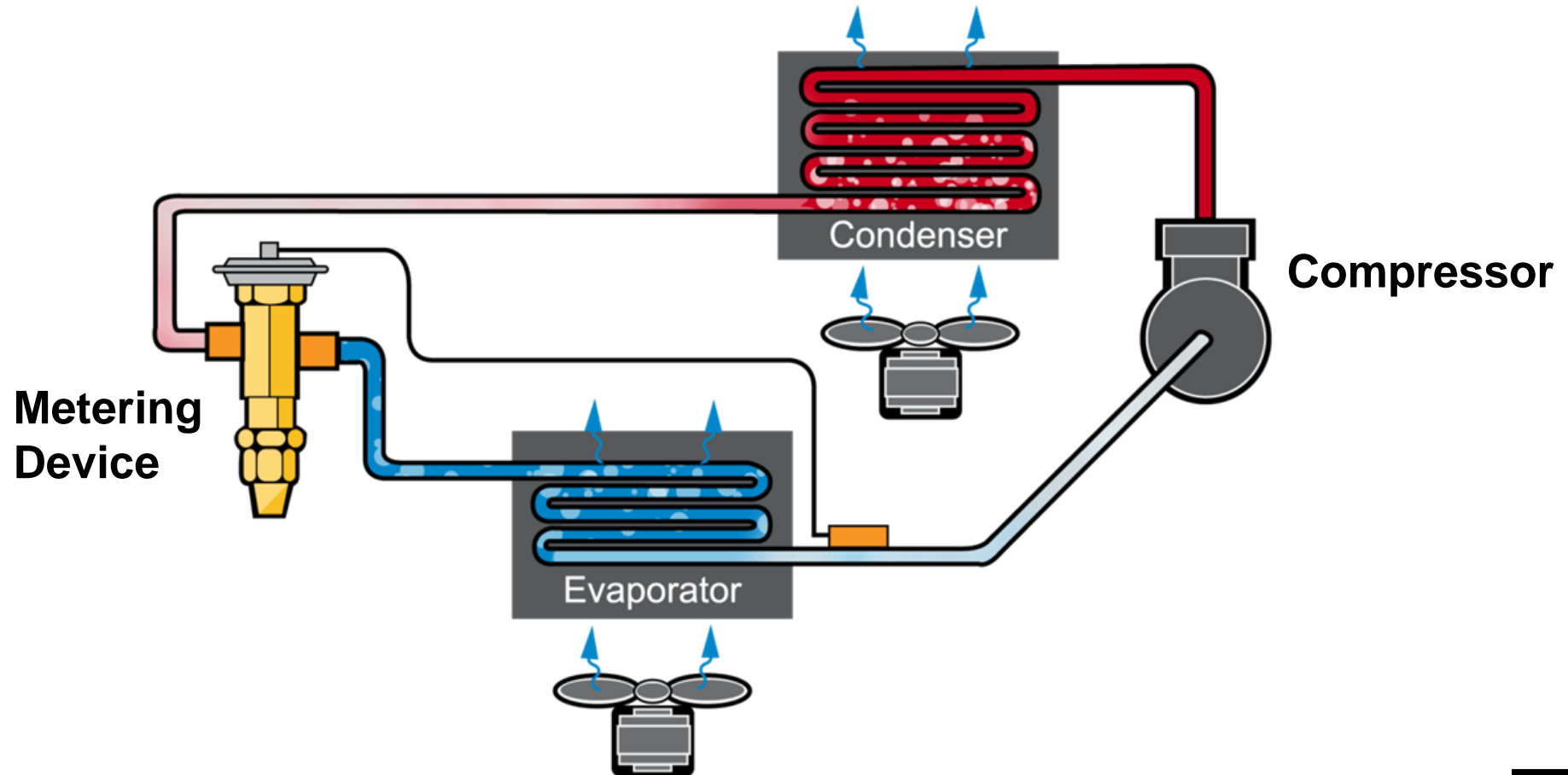
# Basic Refrigeration System Components



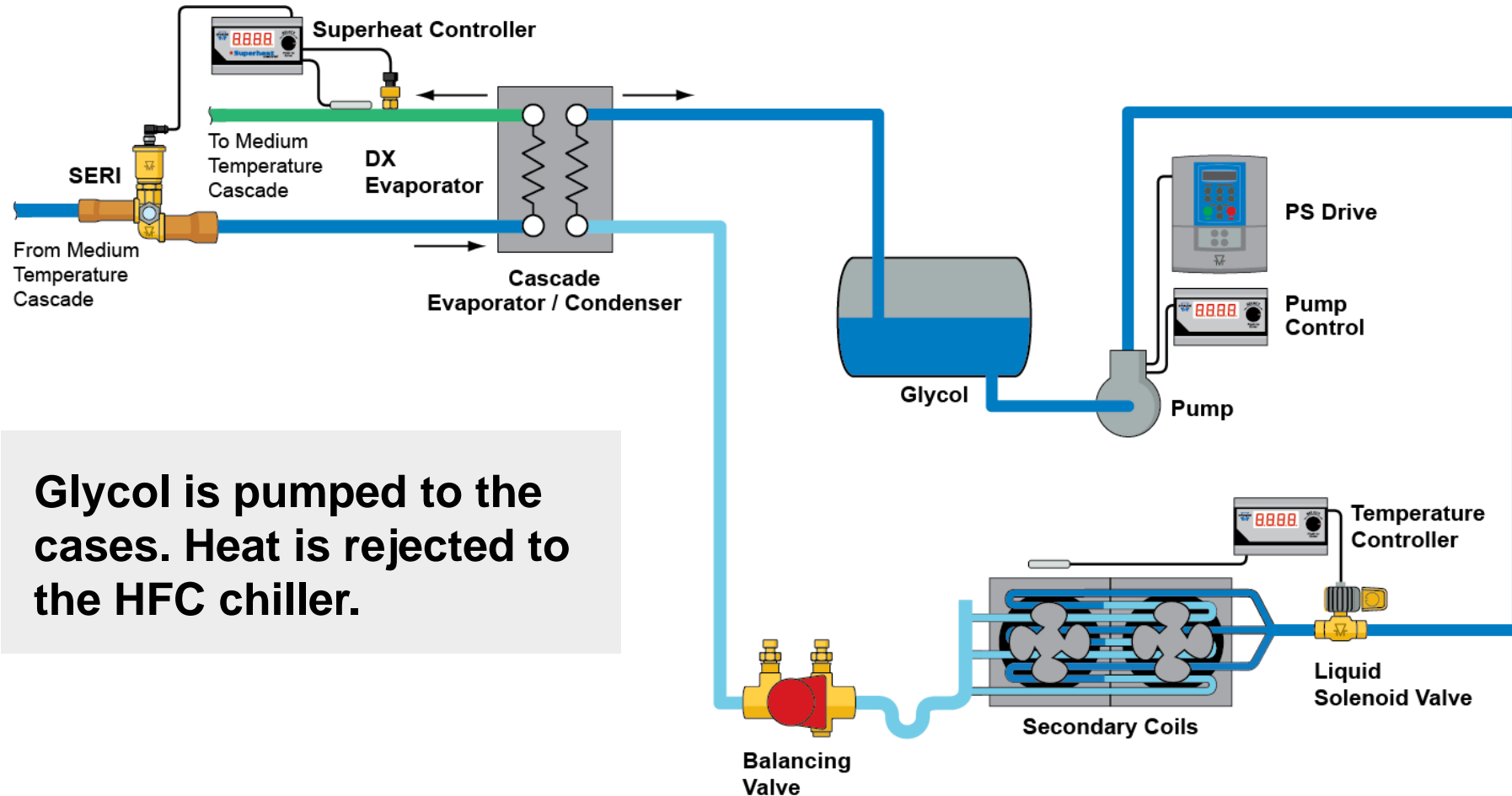
# Vapor Compression Cycle



# The Vapor Compression Refrigeration Cycle



# Glycol Systems



**Glycol is pumped to the cases. Heat is rejected to the HFC chiller.**



# CO<sub>2</sub> Systems R744

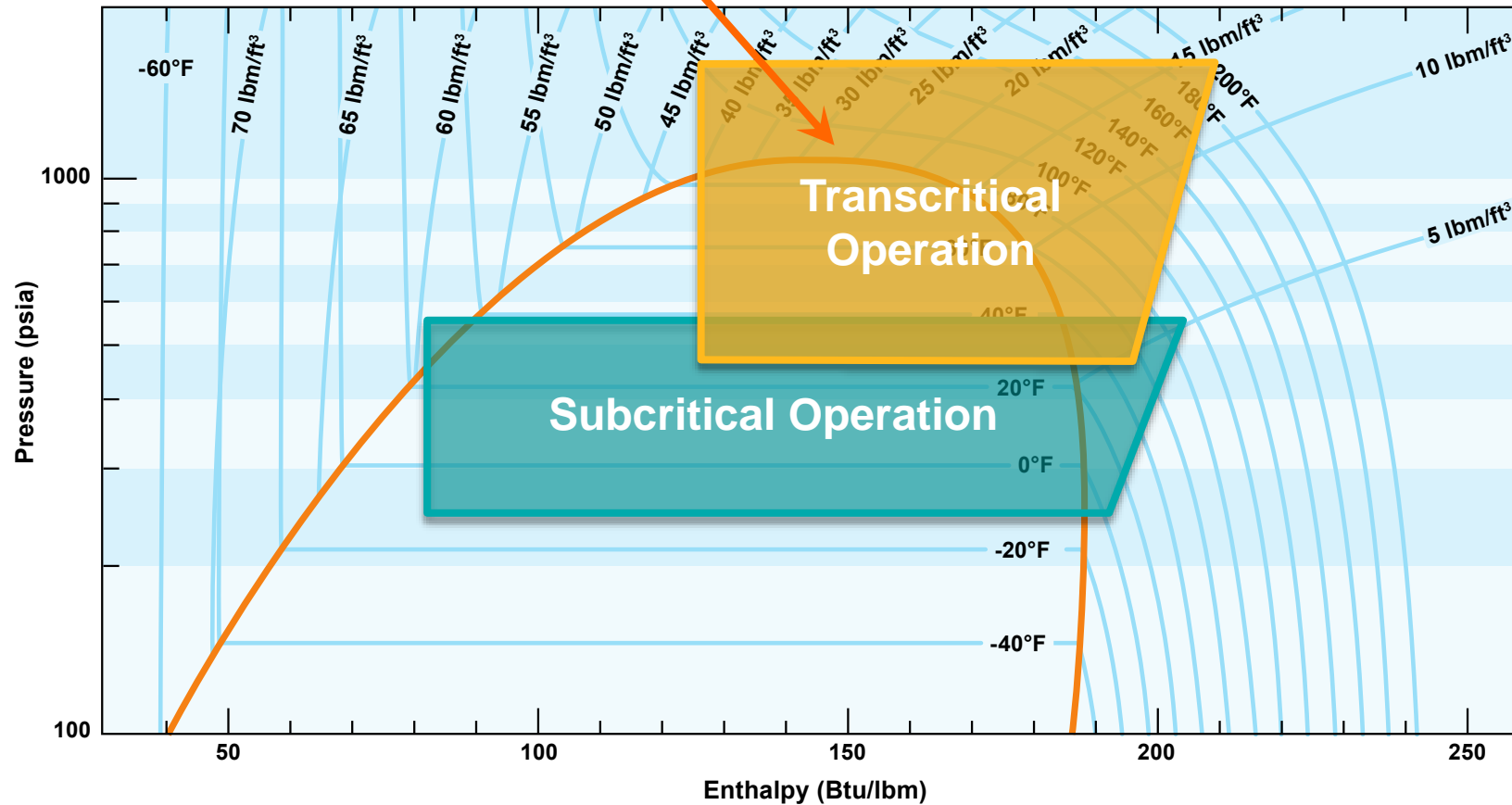
- Liquid Overfeed
  - Subcritical CO<sub>2</sub>
  - Transcritical CO<sub>2</sub>
- } *HFC refrigerant used to keep pressures manageable*

## Saturated Suction

	Temperature (°F)	Pressure (psig)
	-40	131
	-35	146
	-30	163
	-25	181
LT	-20	200
	-15	221
	-10	243
	-5	266
	0	291
	5	318
	10	346
MT	15	376
	20	407
	25	441
	30	476

# CO<sub>2</sub> Cycle Overview

Critical Point: 87.9°F / 1070 psia



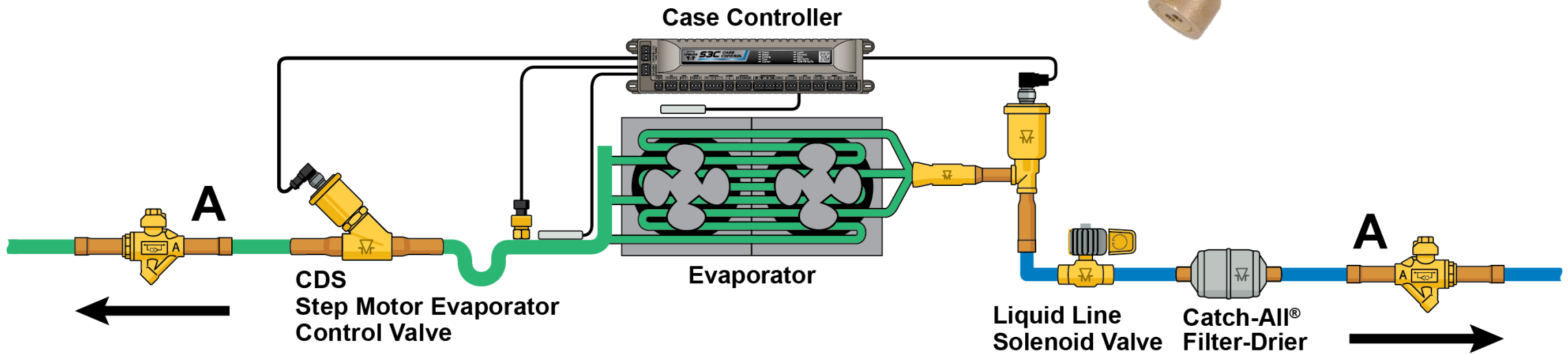
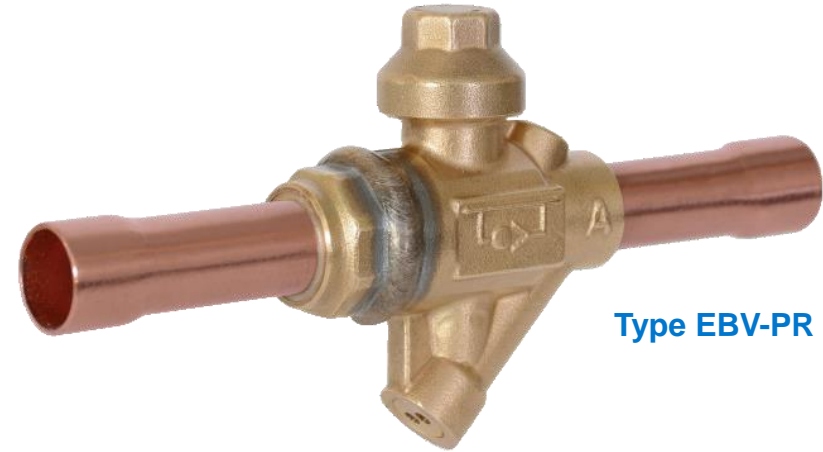
# CO<sub>2</sub> Safety

- Pressures can rise quickly if power is lost
- Pressure relief valves and safety precautions are needed



# CO<sub>2</sub> Safety

## Combination Ball Valve and Safety Relief Check Valve



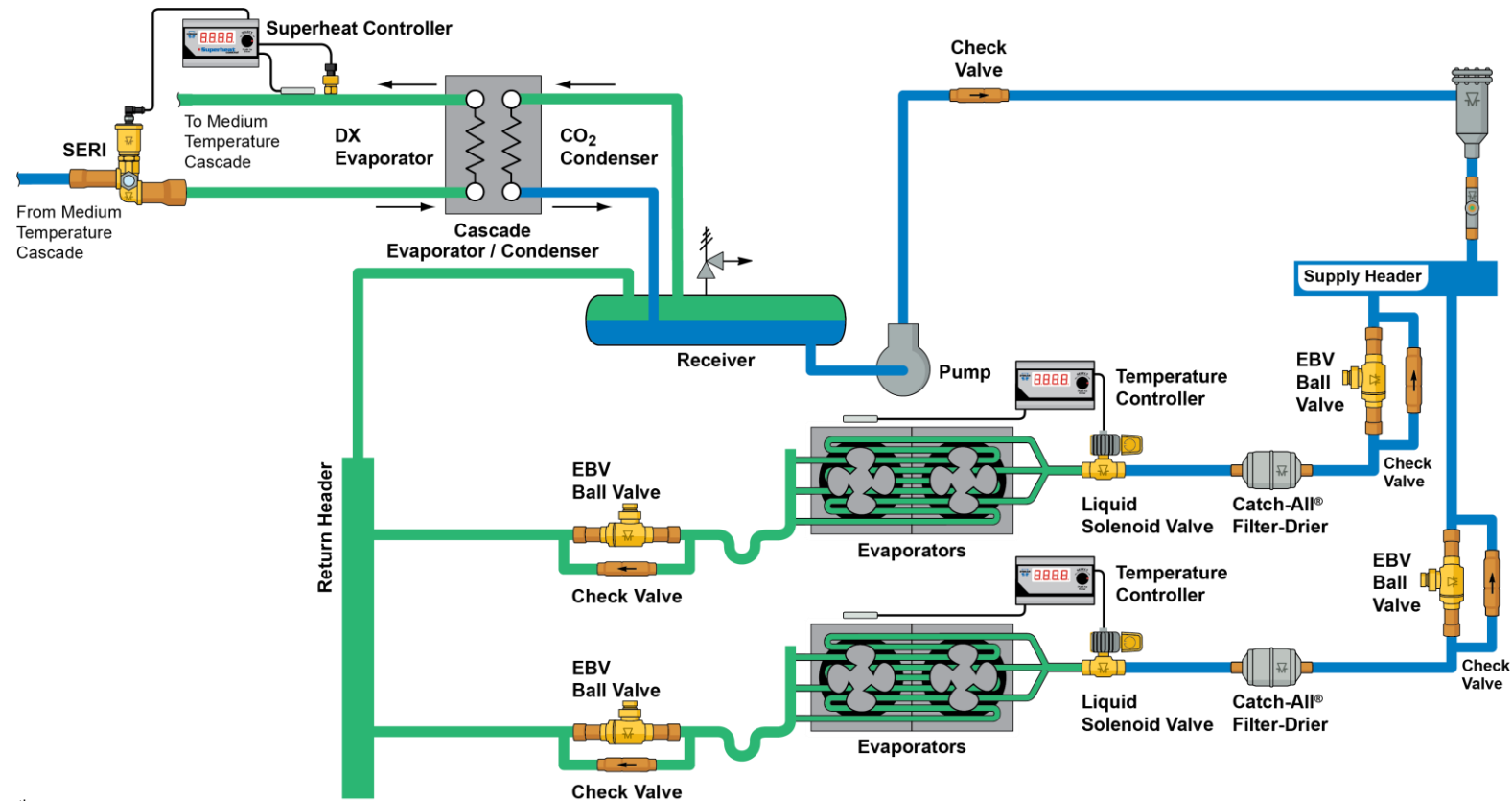
# Why CO<sub>2</sub>?

- **Refrigerant reduction**
  - Total HFC charge reduced from 2,500 lbs. to 600 lbs. or lower
  - CO<sub>2</sub> is relatively inexpensive
- **Fast pull down and stable temperature control**
  - High heat transfer coefficient
- **Piping installation is less expensive**
  - Small pipe diameters
- **Energy reduction over Glycol secondary systems**
  - Phase change occurs in the evaporator coil vs. a temperature change in glycol
  - Energy consumption close to DX HFC



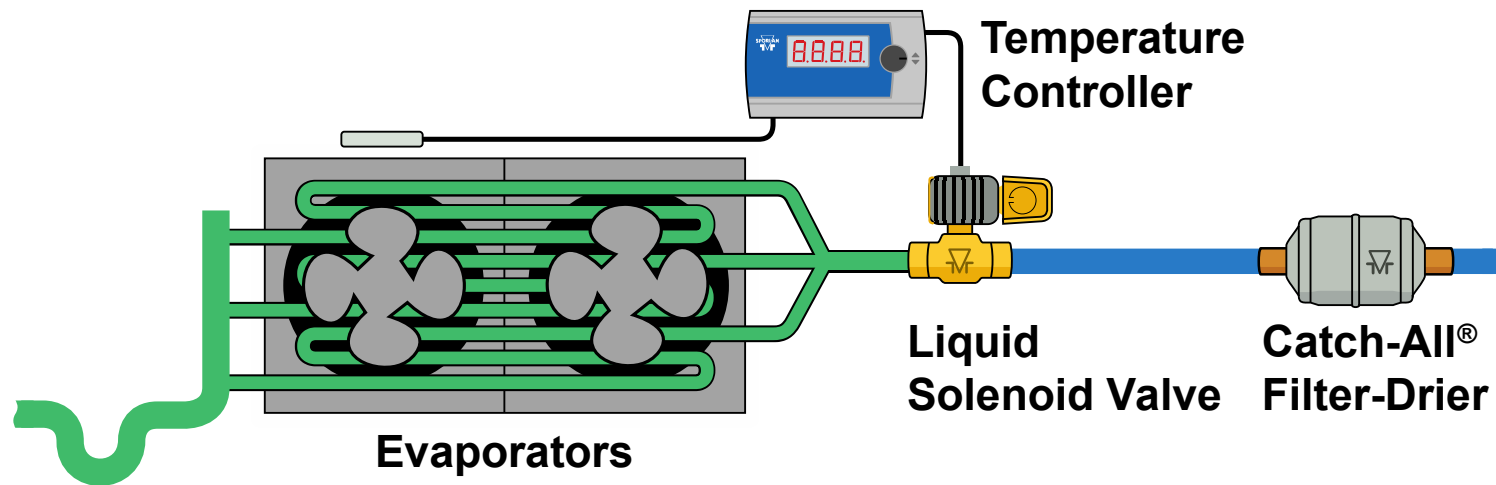
# Subcritical Secondary CO<sub>2</sub>

## Liquid Overfeed Secondary System Schematic For low and/or medium temperature applications

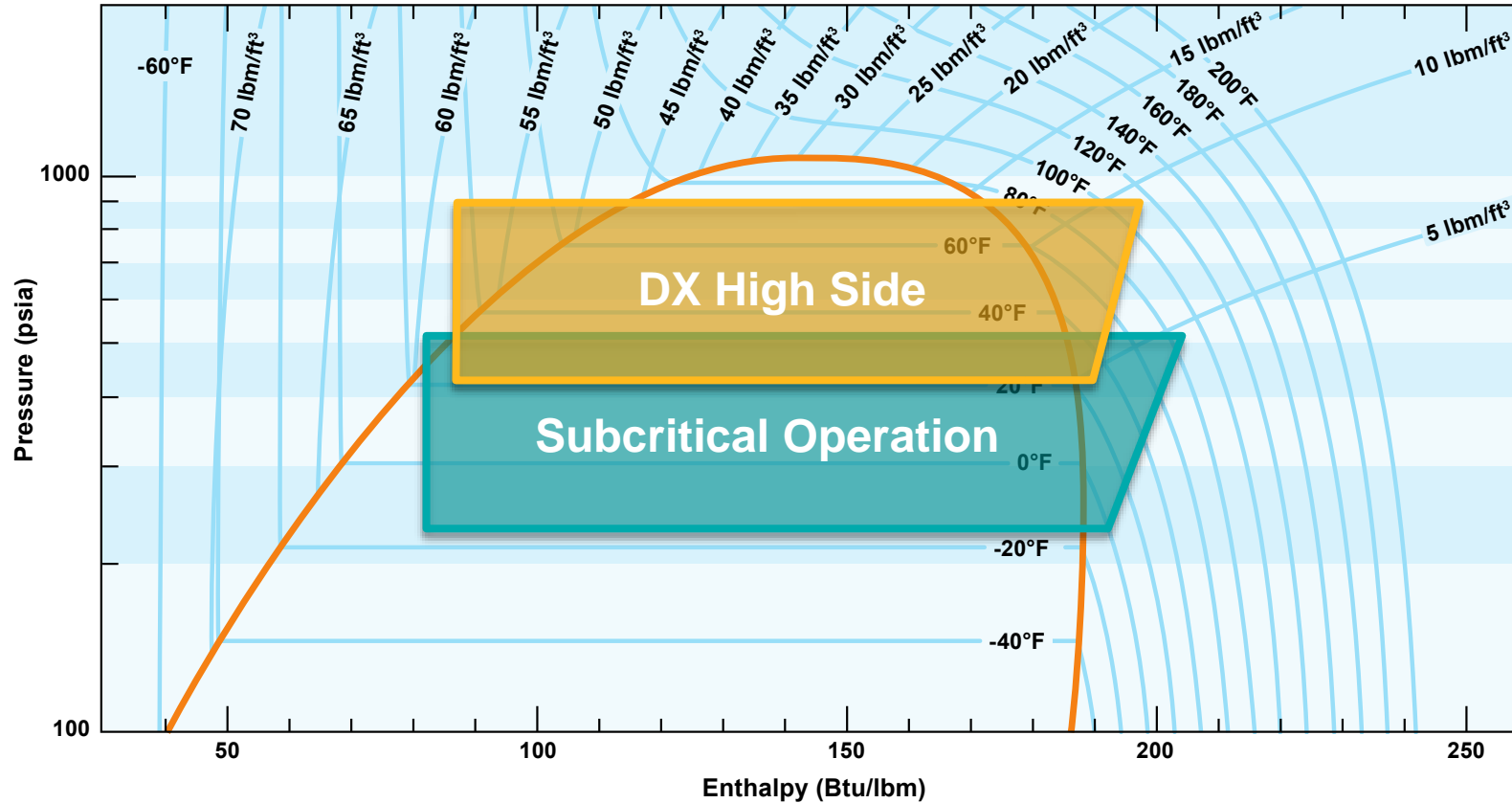


# XSP Solenoid for CO<sub>2</sub> Liquid Overfeed

- Tight seating required at low pressure differential
- Ensures closure during defrost
- Valve rated for MOPD (50 psid) and MRP (700 psi)



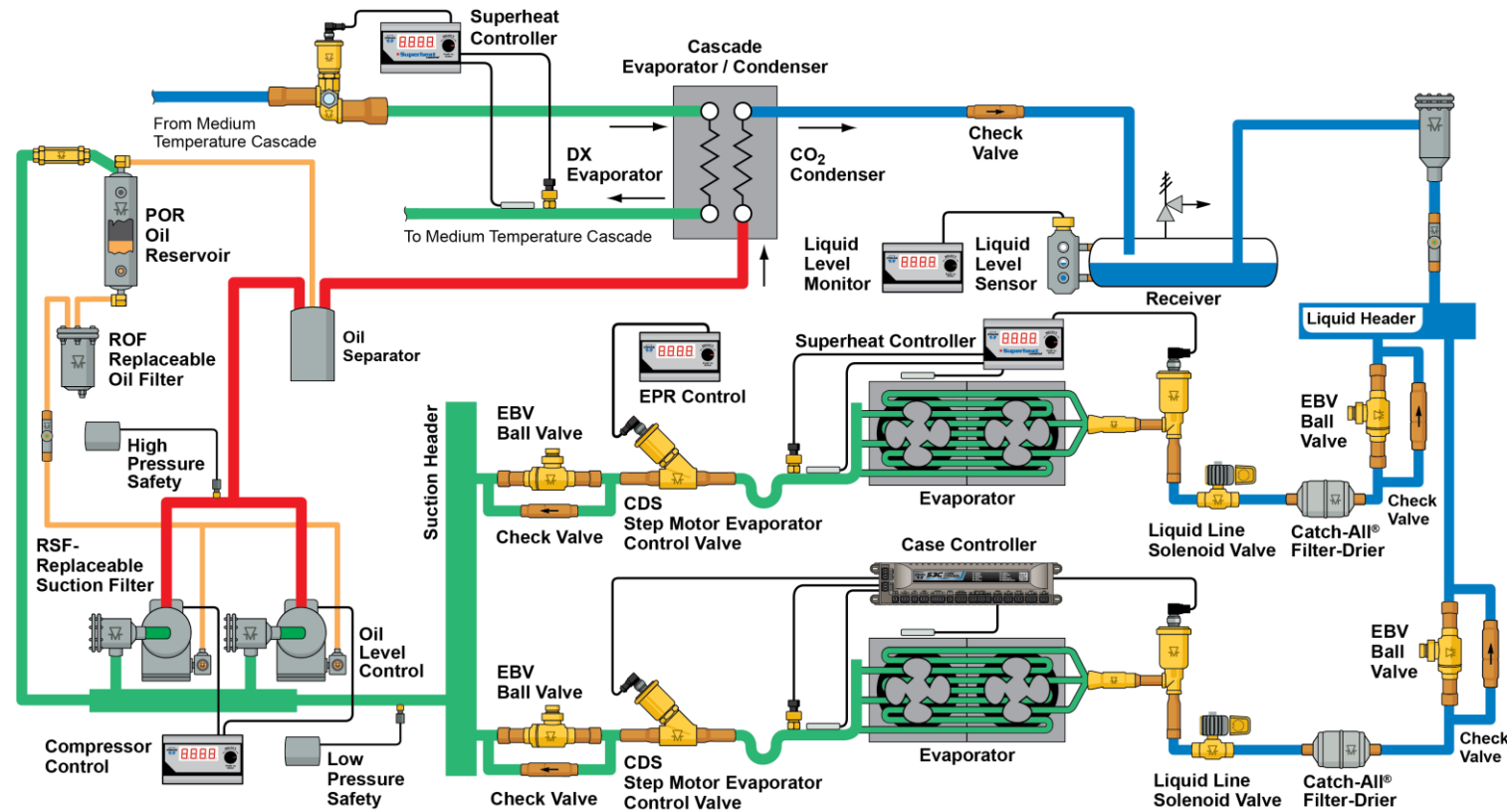
# CO<sub>2</sub> PH Diagram – Cascade



DX high side graphically shows HFC cooling of the CO<sub>2</sub> loop.  
Properties for HFC are not comparable to CO<sub>2</sub>.

# Subcritical CO<sub>2</sub>

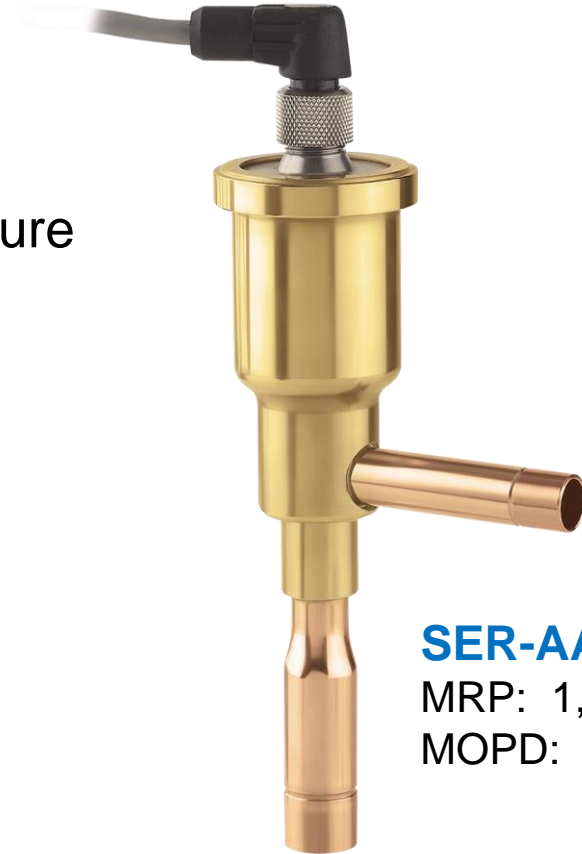
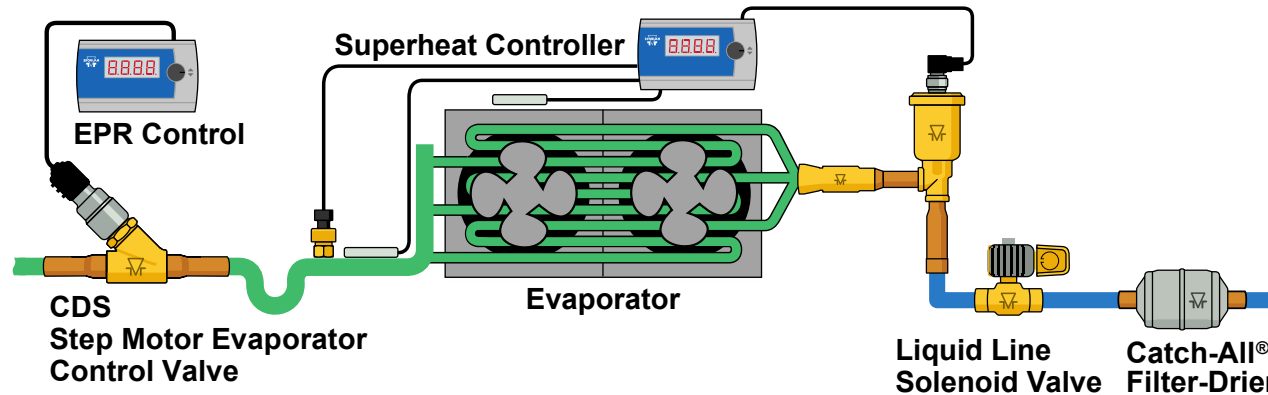
## Cascade System Schematic - For low temperature applications



# Controlling Subcritical CO<sub>2</sub>

## Electric Expansion Valves

- High resolution allows precise superheat control
- Designs may use EEVs to control discharge air temperature
- Consider MRP and MOPD limitations

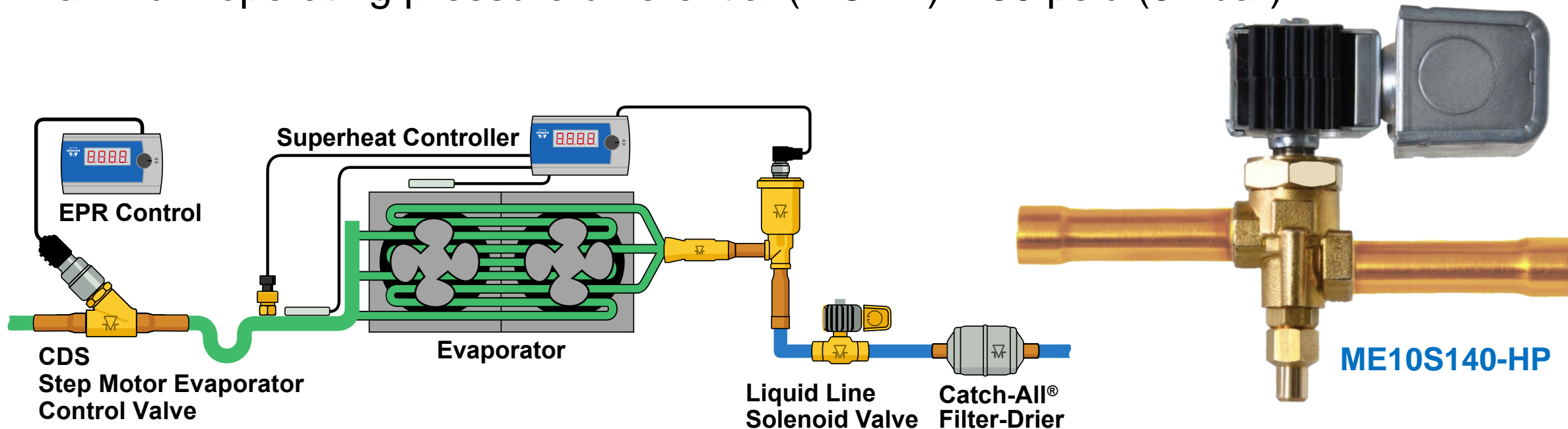


**SER-AA, -A**  
MRP: 1,015 psi  
MOPD: 580 psid



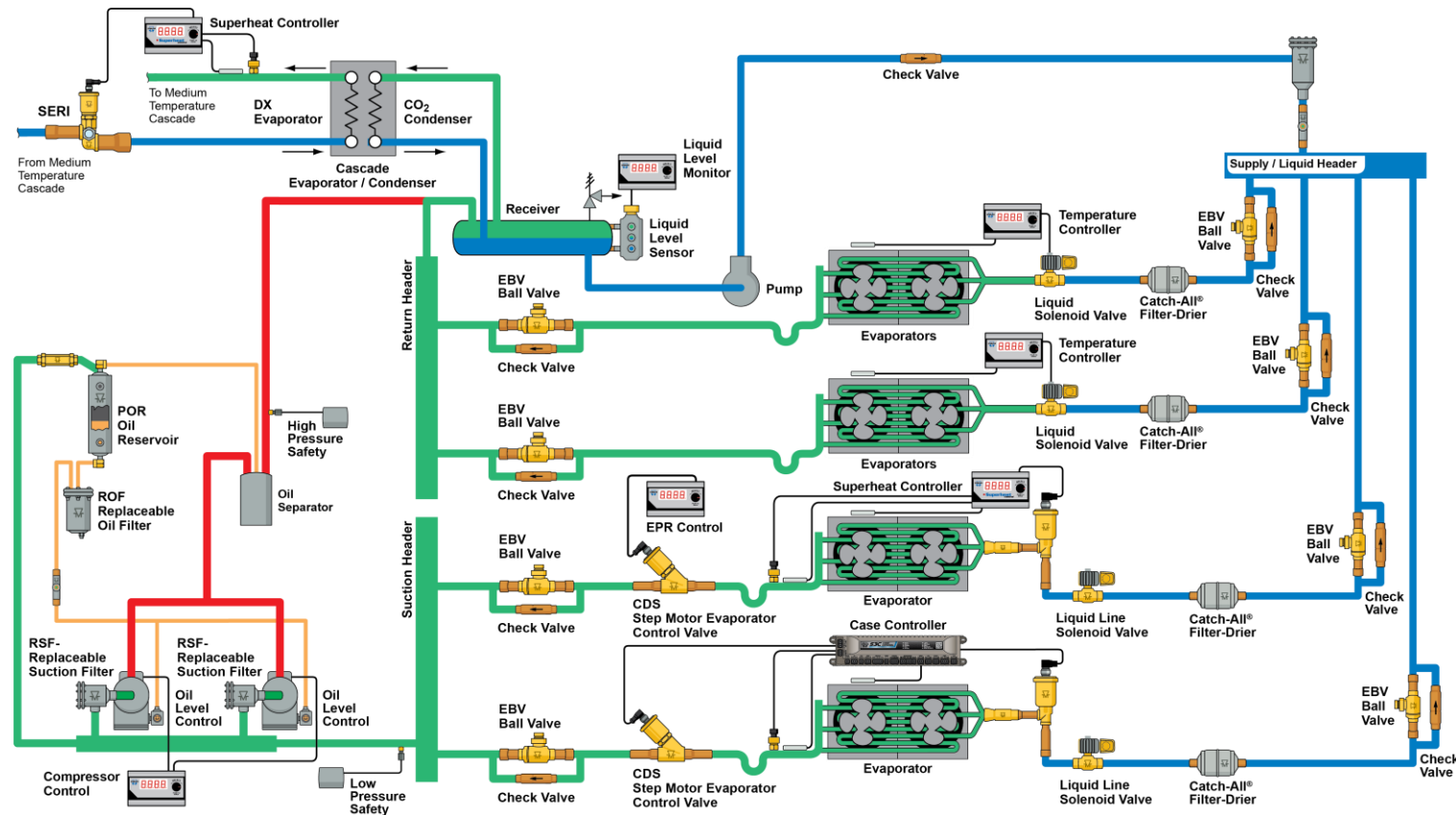
# Subcritical CO<sub>2</sub> Solenoid Valves (-HP)

- Maximum rated pressure (MRP): 700 psi (48bar)
- Maximum operating pressure differential (MOPD): 450 psid (31 bar)



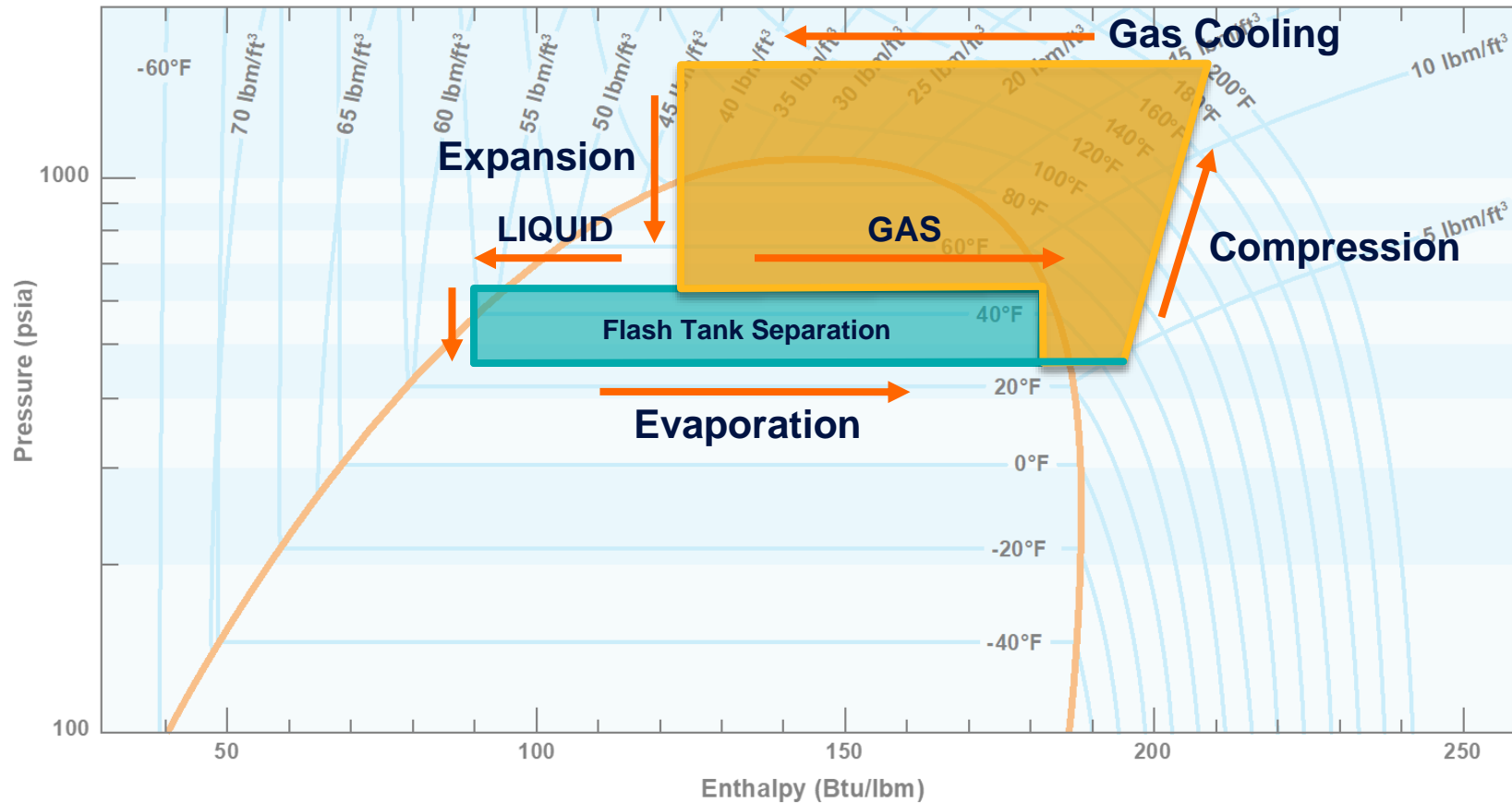
# Combined Subcritical CO<sub>2</sub>

## For Low and Medium Temperature Applications

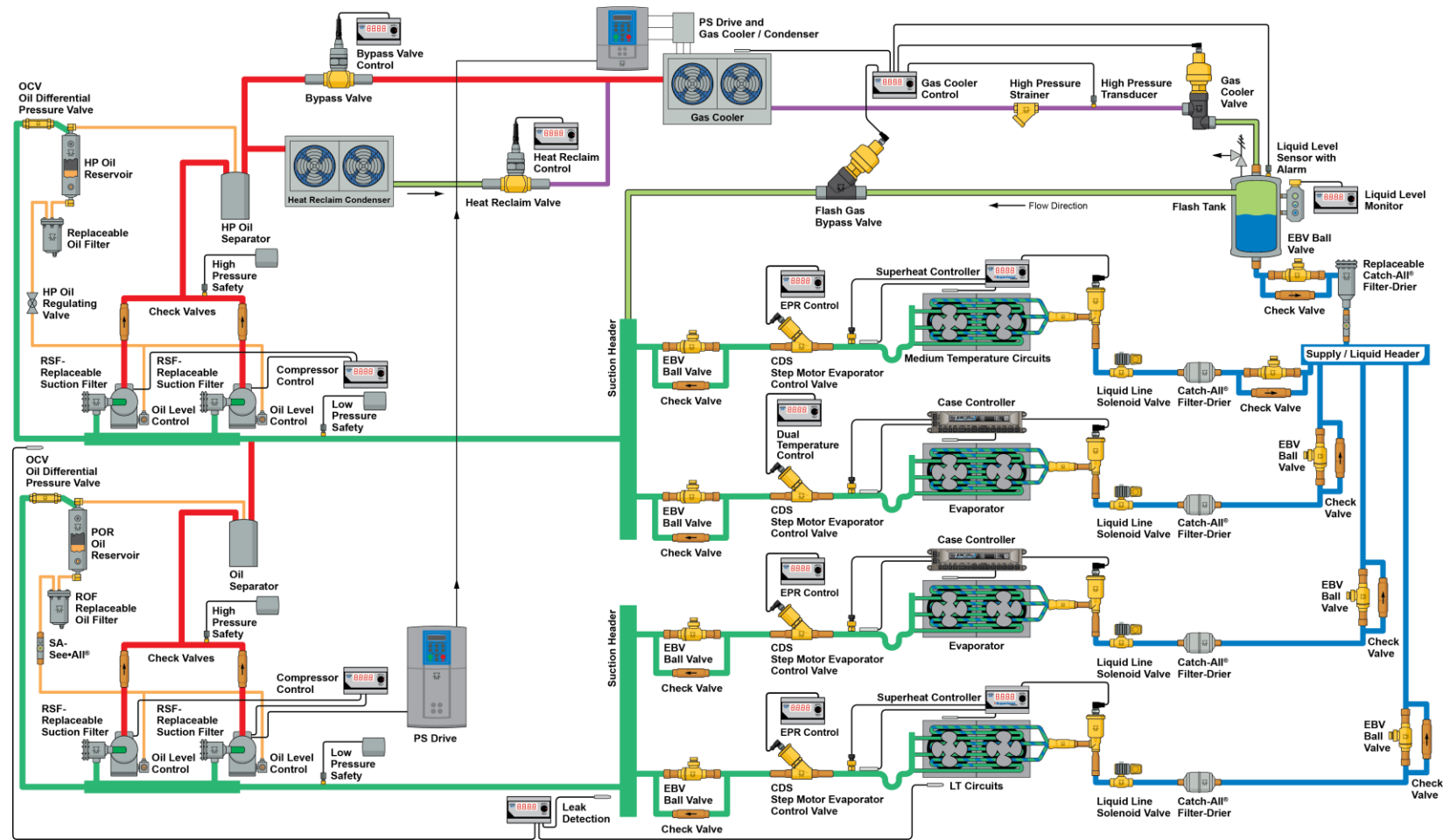


# CO<sub>2</sub> PH Diagram

## Transcritical Operation

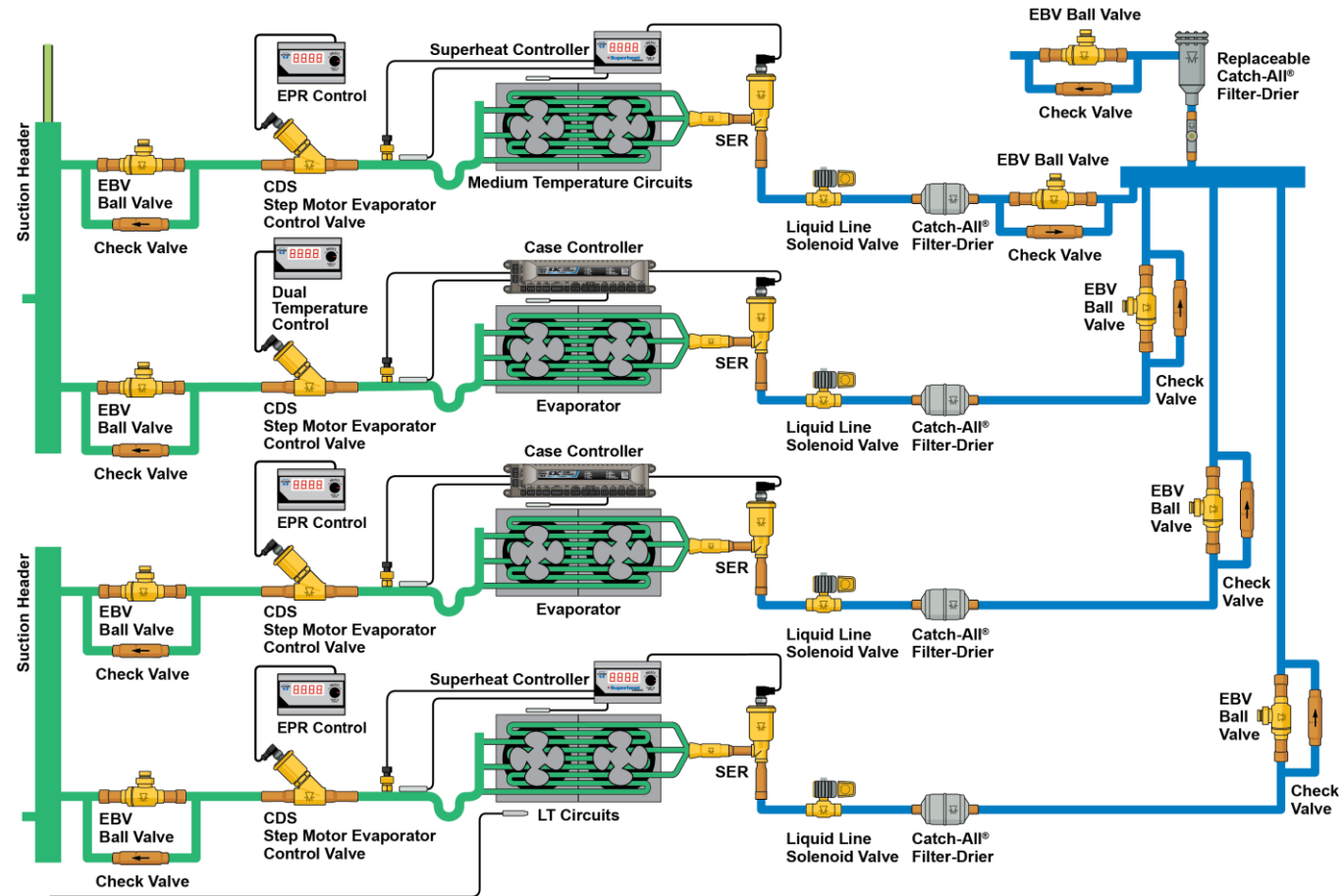


# Transcritical CO<sub>2</sub>



# Transcritical CO<sub>2</sub>

## Subcritical CO<sub>2</sub> DX Operation

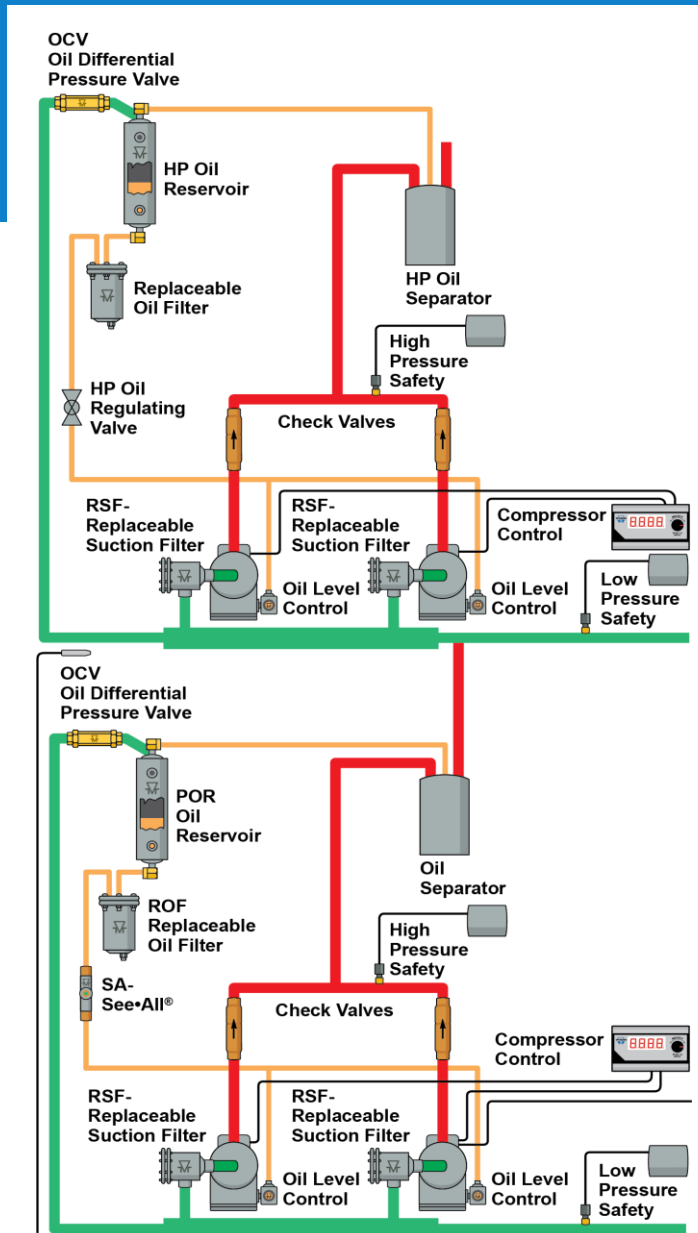




# Transcritical CO<sub>2</sub>

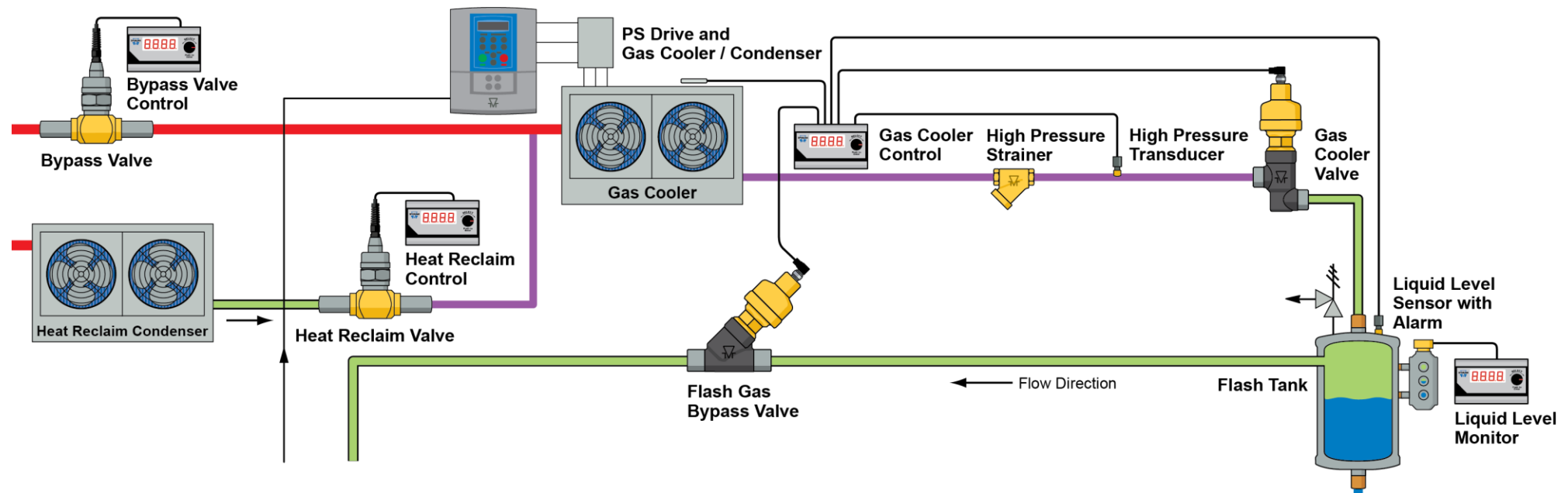
## Compound Compression

- LT suction gas is compressed and discharged into MT suction header
- MT suction is compressed to gas cooler pressure

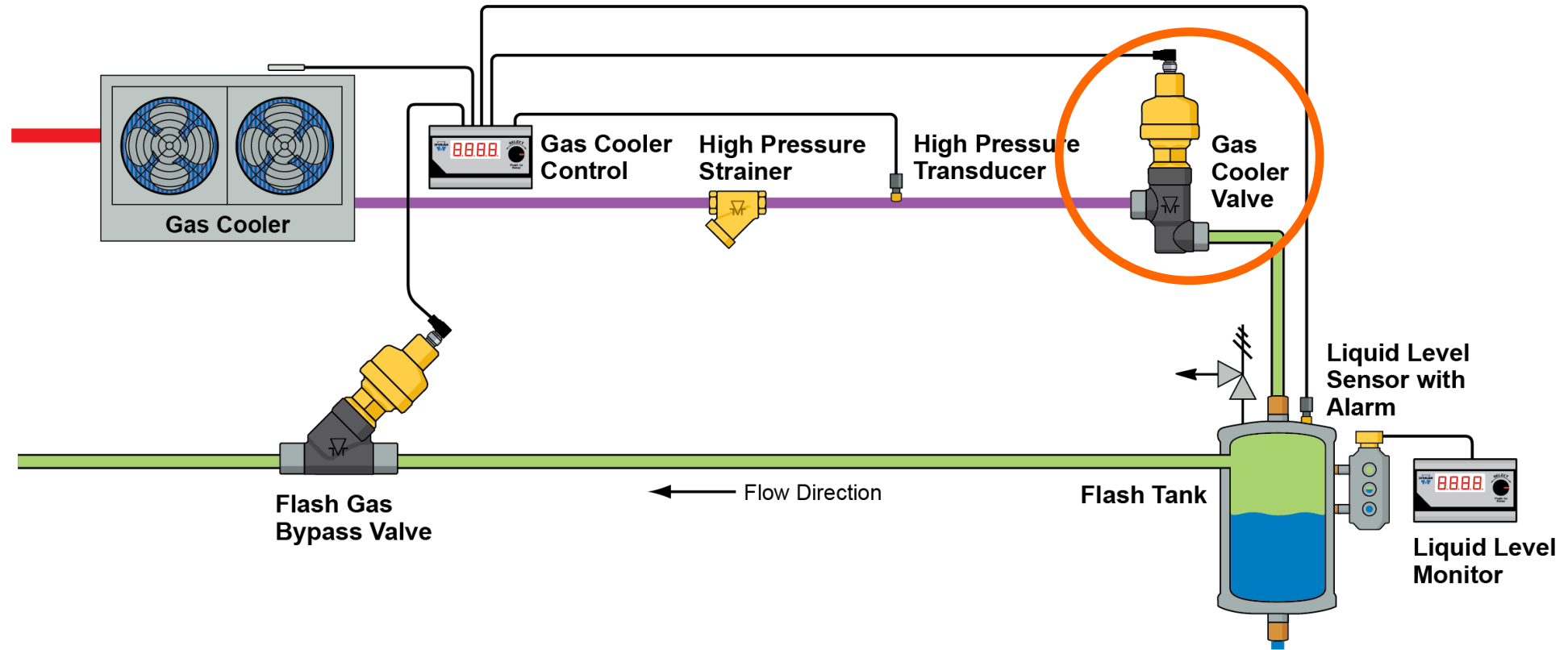


# Transcritical CO<sub>2</sub>

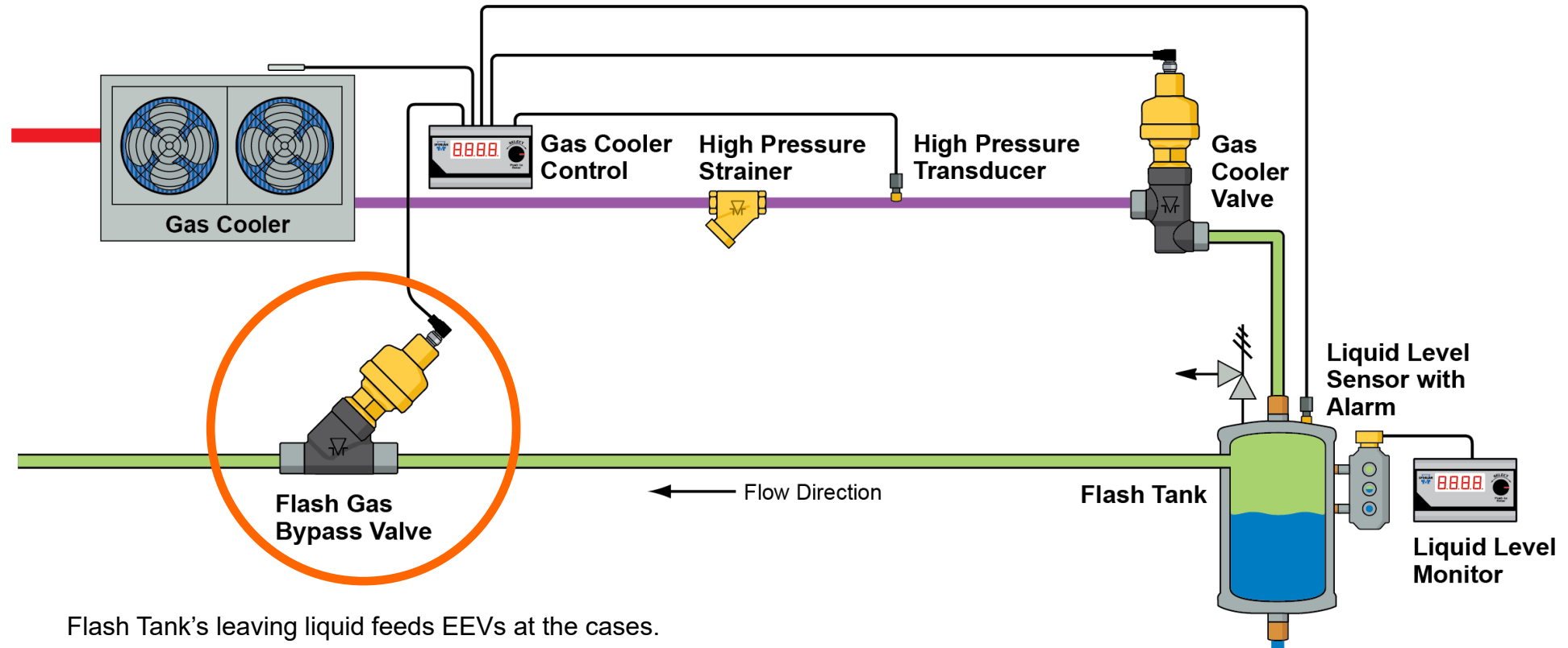
## Gas Cooler Configuration



# Transcritical CO<sub>2</sub> Flow Control



# Transcritical CO<sub>2</sub> Flow Controls



# Transcritical CO<sub>2</sub> Flow Controls

## Sporlan Transcritical CO<sub>2</sub> Valves

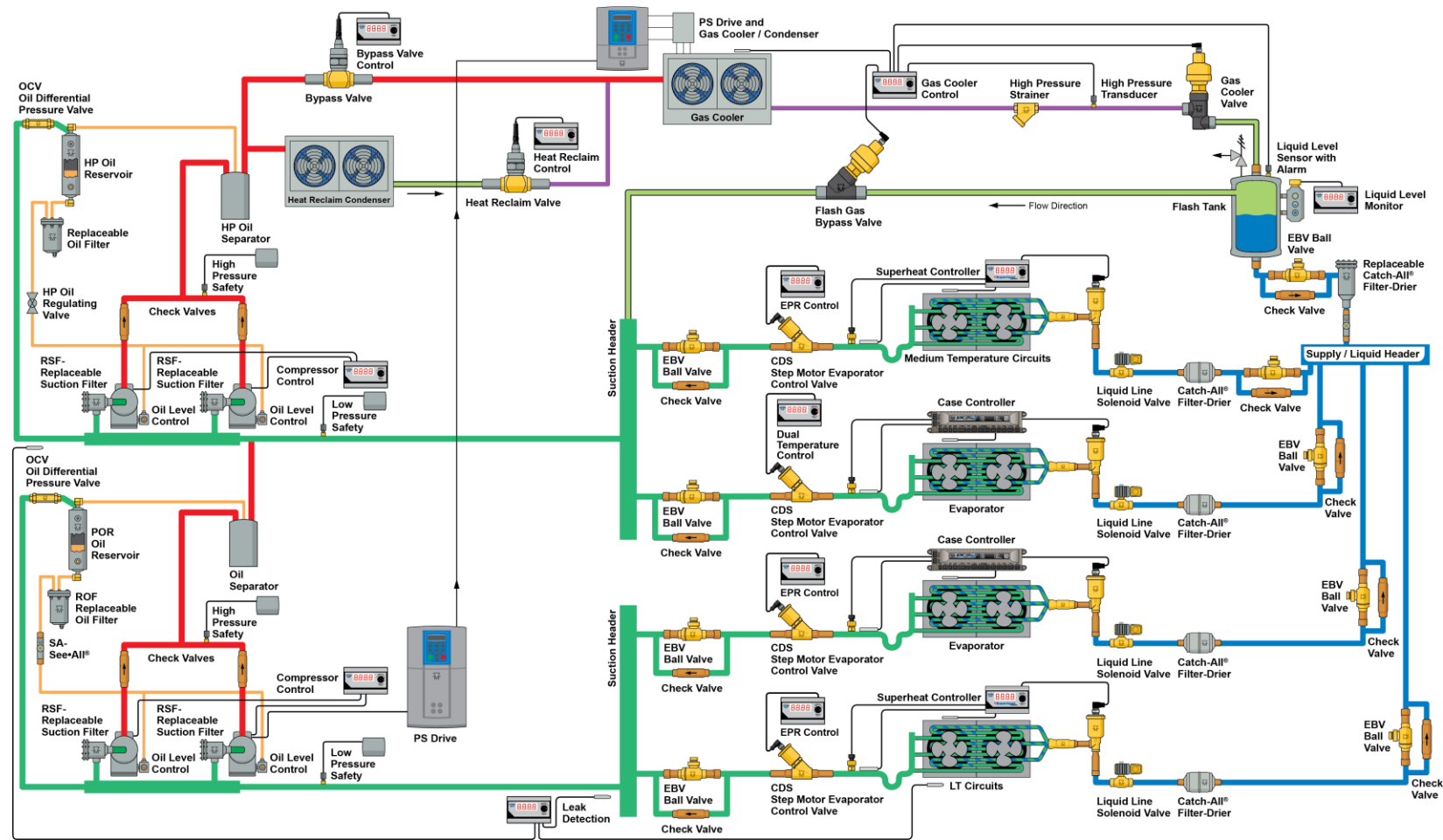
Gas Cooler  
Valve



Flash Gas  
Bypass Valve



# Transcritical CO<sub>2</sub>





# Supermarket Industry Trends

## Expect More:

- Alternative refrigerants
- Changes to store refrigeration specifications
- Changes to regulations
- Electronics

The Supermarkets of the future are  
coming.....*Are Here!* 

# S3C Introduction



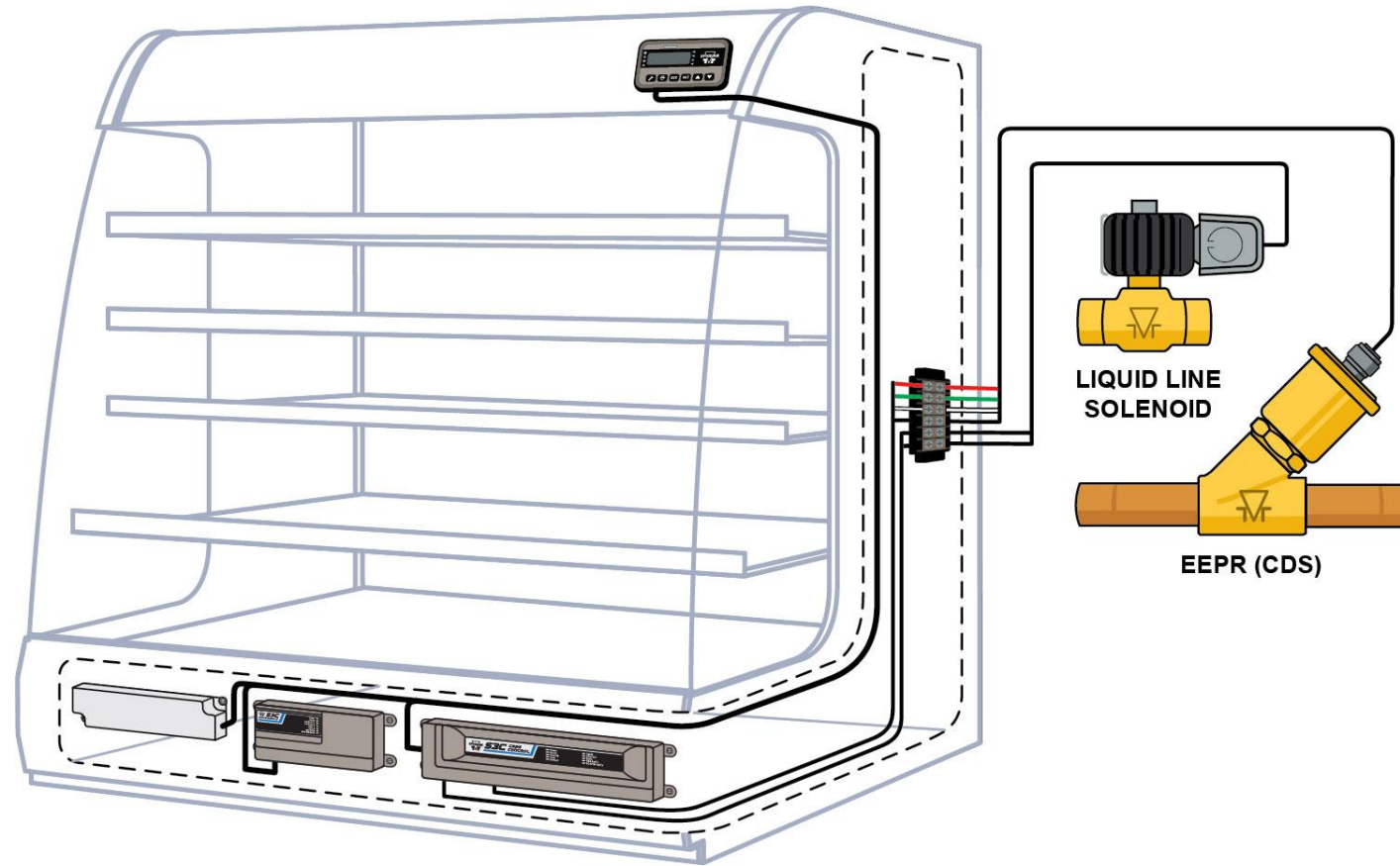
## **S3C** CASE CONTROL

- **SAFETY**  
Food Safety
- **SERVICE**  
Diagnostics Tools
- **SECURITY**  
Fail-safe and stand-alone control mechanisms

# Accelerated Case Delivery



# Mounting and Wiring

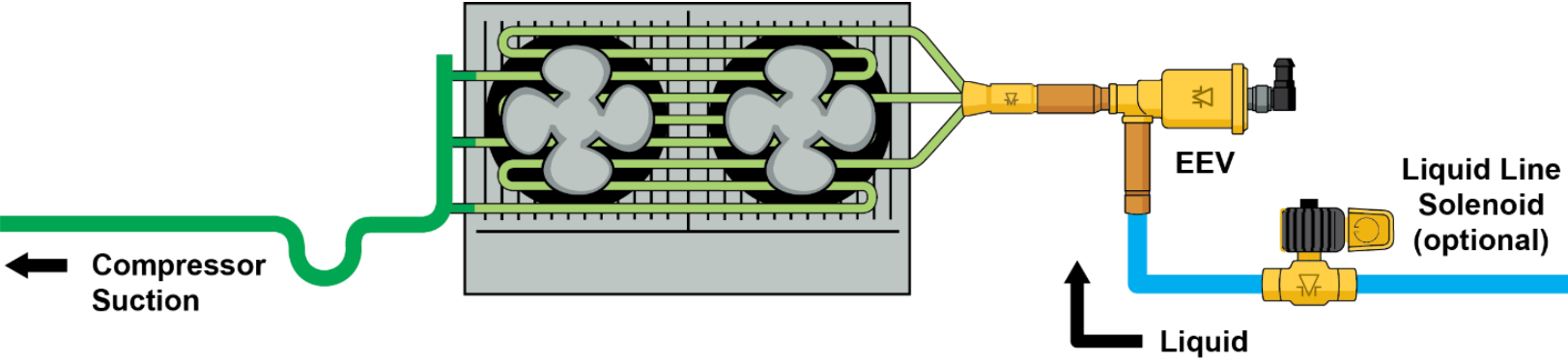


# S3C Controls

- **Case Control (S3C) Valve Module (VM)**  
Mount in a rain-tight protected location using either a flange or din rail
- **Display Module (DM)**  
Mount in an indoor location, near the case, but outside of the refrigerated space

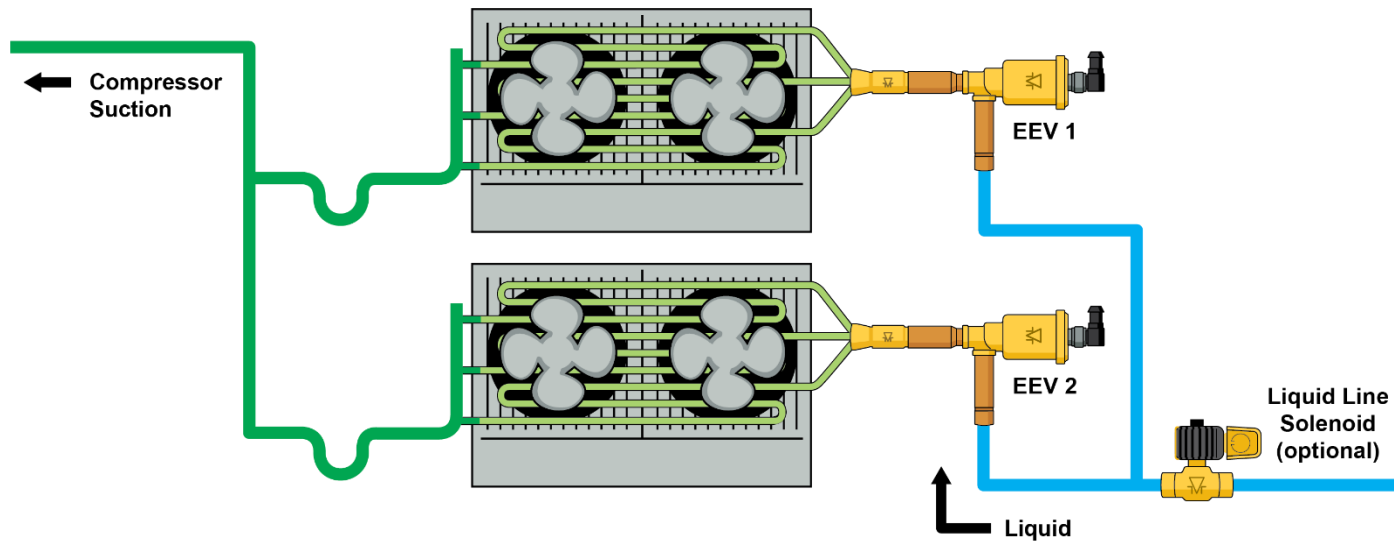


# EEV and Control

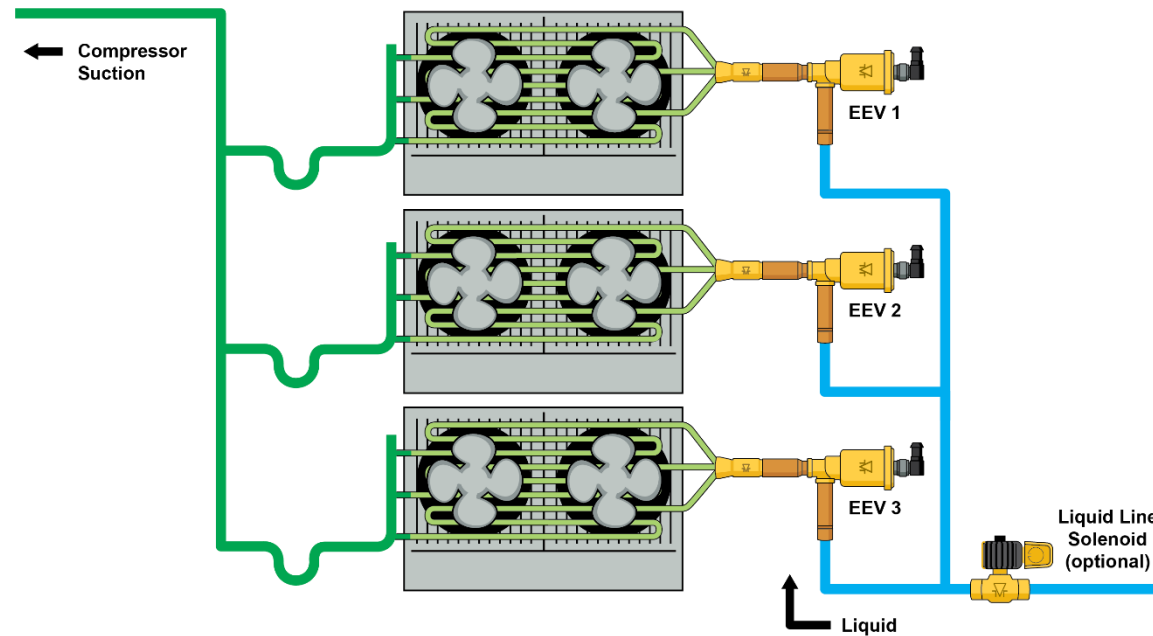




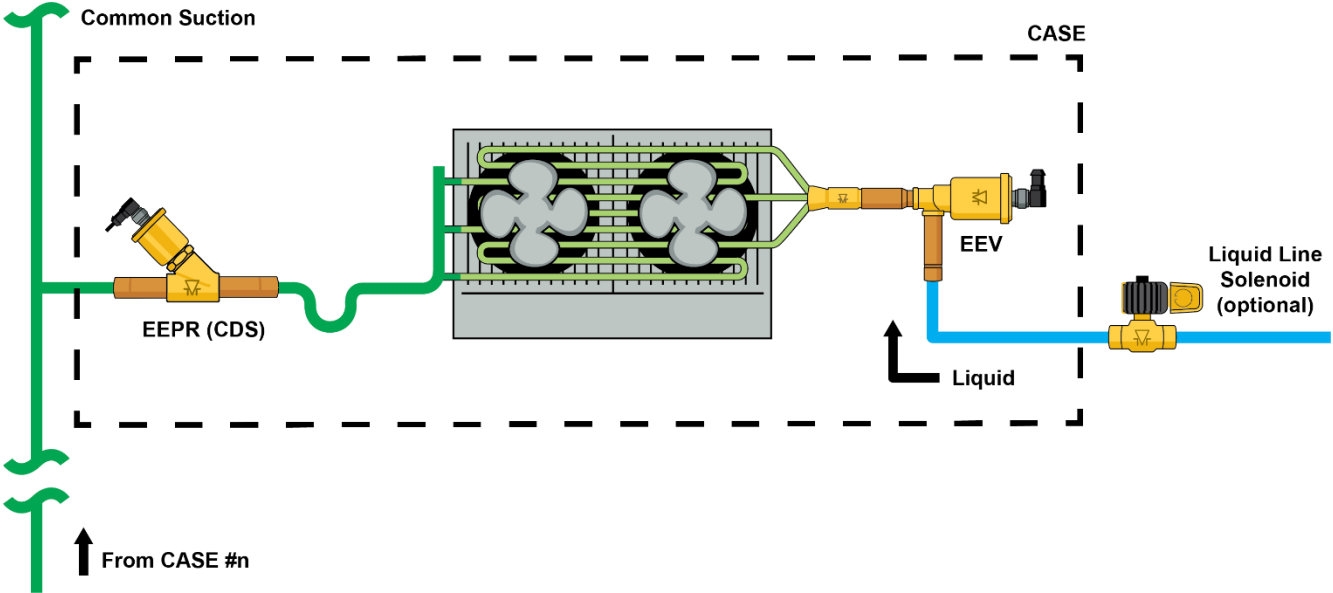
# 2 EEVs and Control



# 3 EEVs and Control



# EEV, EEPR and Control



# S3C Case Controls - Overview

## Three Primary Components

- Main Case Controller
- Valve Module (for additional electric valves)
- Display Module



## UNIQUE CASE CONTROL SOLUTION

- Refrigeration Control
- Line-up Control
- Data Interface/Integration
- Energy Efficiency
- Serviceability
- OEM/BAS Integration



**WARNING:** Use caution when working around high voltage components. Safety covers should be used for personal safety on high voltage panels.

# Case Controller

- Interfaces with EMS
- Drives EEVs & EEPs
- Controls onboard relays
  - Defrosts
  - Lights
  - Fans
  - Anti-sweats

S3C Case Control



Valve Module



Bluetooth®  
Display Module

# Controller Overview

## Power Supply

### Input

- 100 to 240 VAC @ 1.2A 50/60 HZ

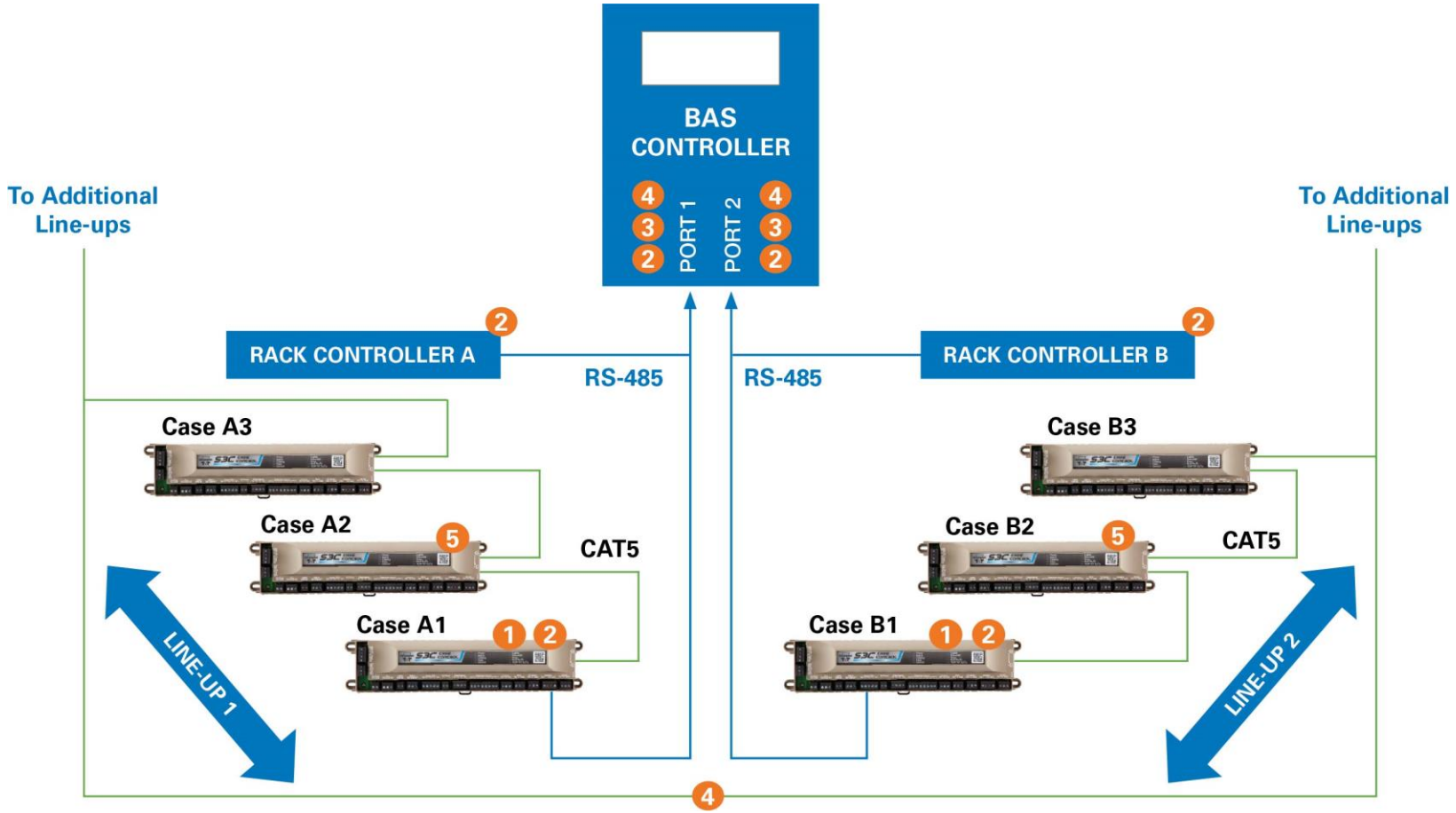
### Output

- 24VDC @ 2.5A



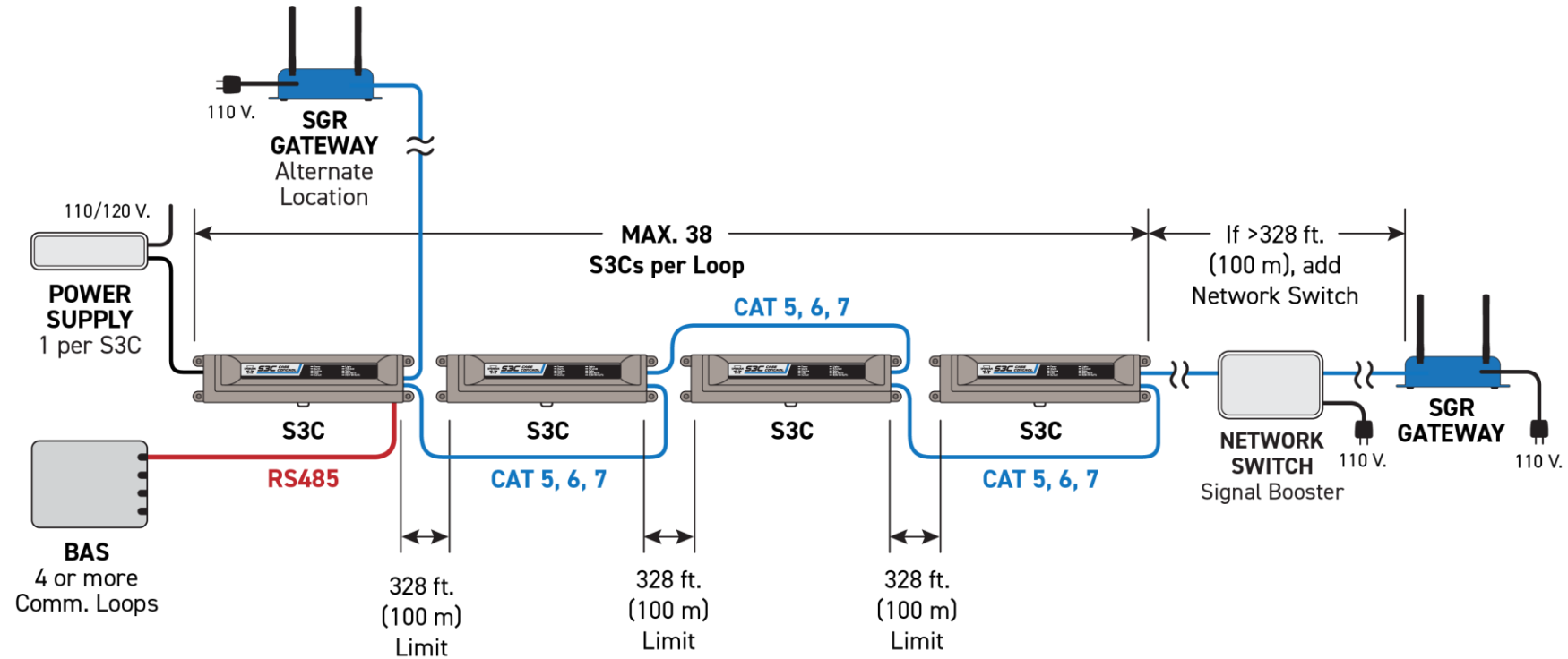


# BAS Integration



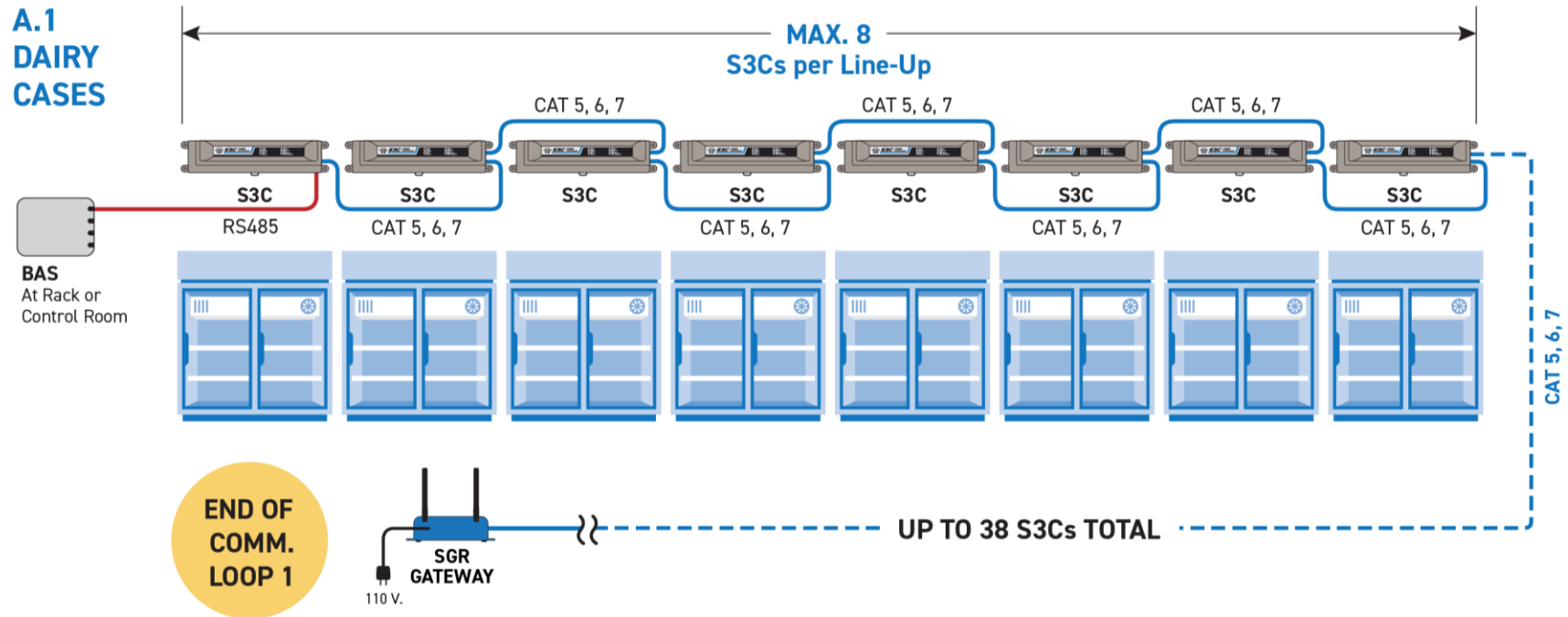
# The Communication Loop

## Components

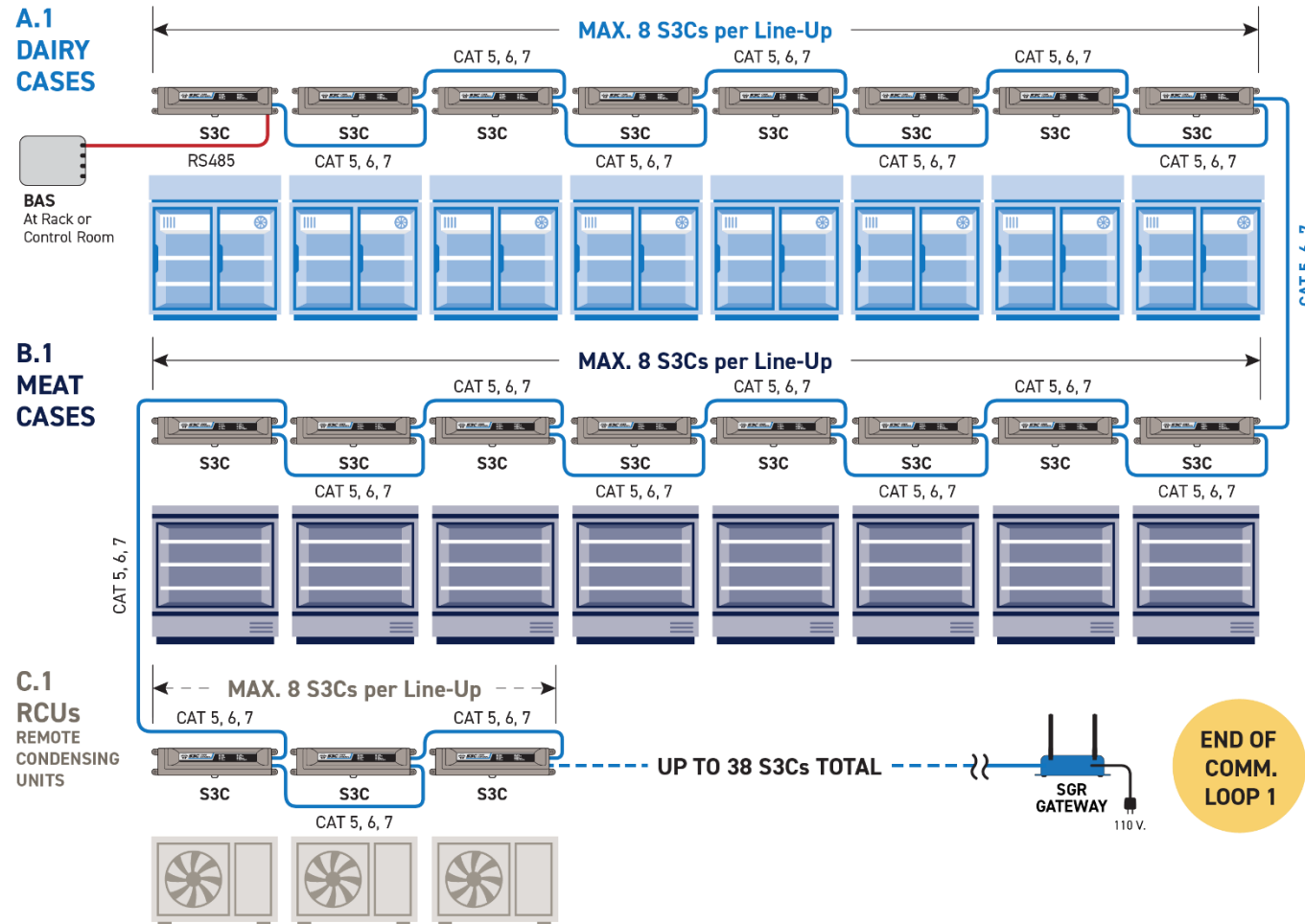


# The Line-Up

## Example



# The Communication Loop and the Line-Up



# Gateway

## MULTI-TECH



Front



Back



Top

# Gateway

## VANTRON



Front



Back



Top



# Gateway

- 2 models are being shipped to customers

## MULTI-TECH



Front



Back



Top

## VANTRON



Front

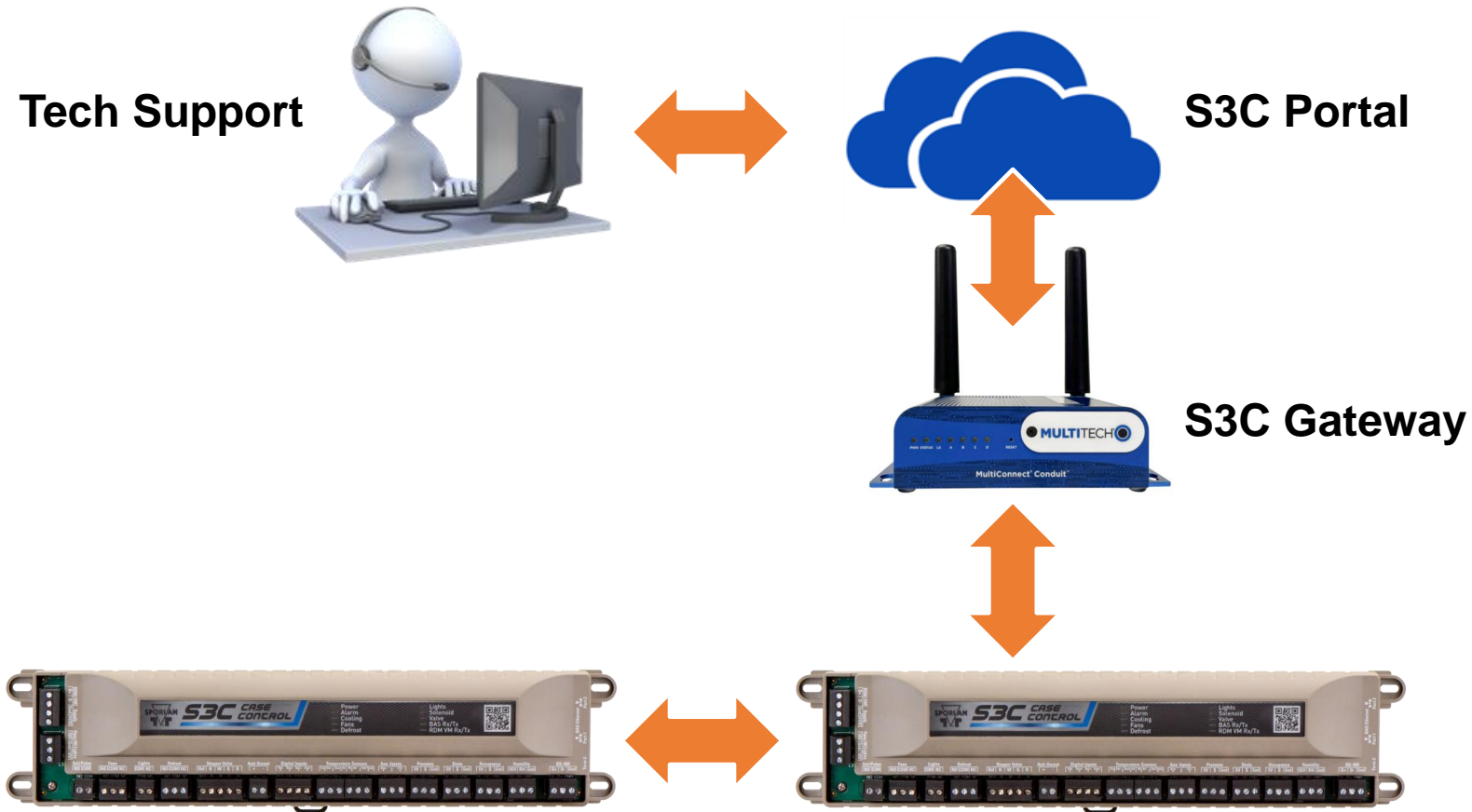


Back



Top

# Gateway Portal



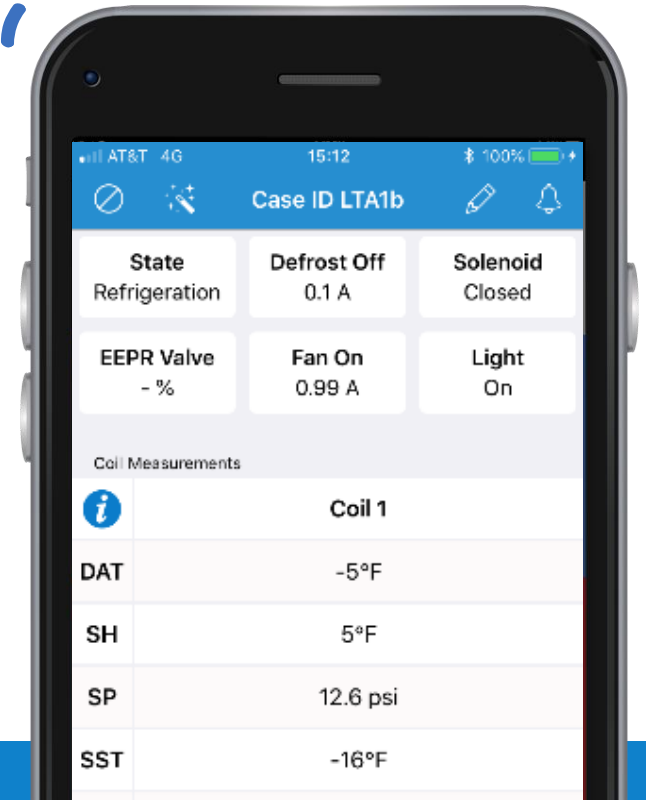
# Wireless Access Sporlan Tech Check App

- **iOS App**

- View current operational values
- Graphing
- View / Override selected readings and outputs (with a timeout)



*Tech Check  
Mobile App*



# Controller Overview

- Temperature Control
- Superheat Control
- EEPN Control
- Fan Control
- Defrost Control
- Liquid Line Solenoid Valve Control
- Lighting Control
- Dual Temp. Case Control



- Data Interface
- Local User Interface
- Diagnostics
- Fail Safe Operation

# Virtual Engineer

## SIZING AND SELECTION TOOL

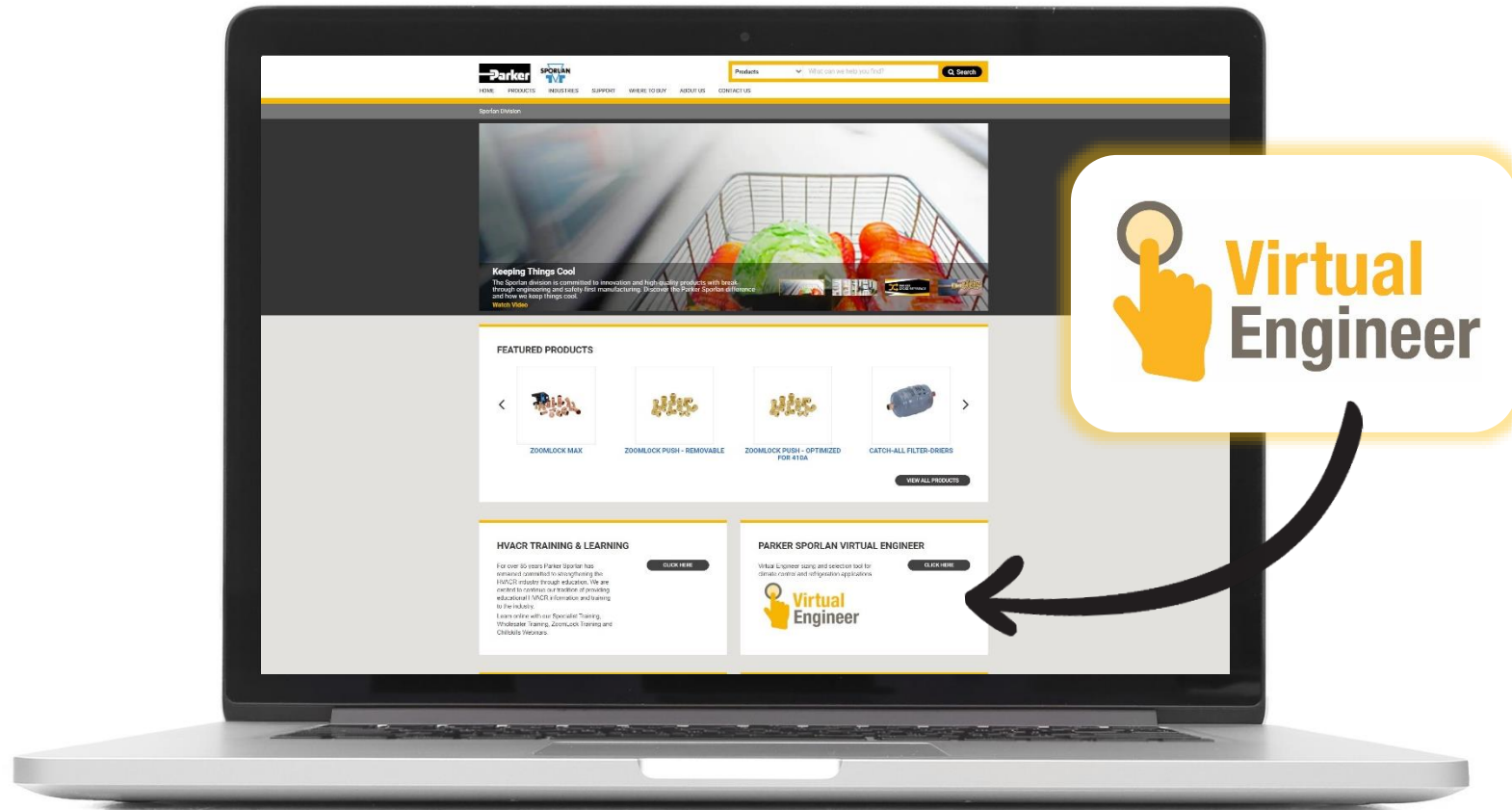


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**Virtual Engineer Selection Program**  
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# Virtual Engineer SIZING AND SELECTION TOOL

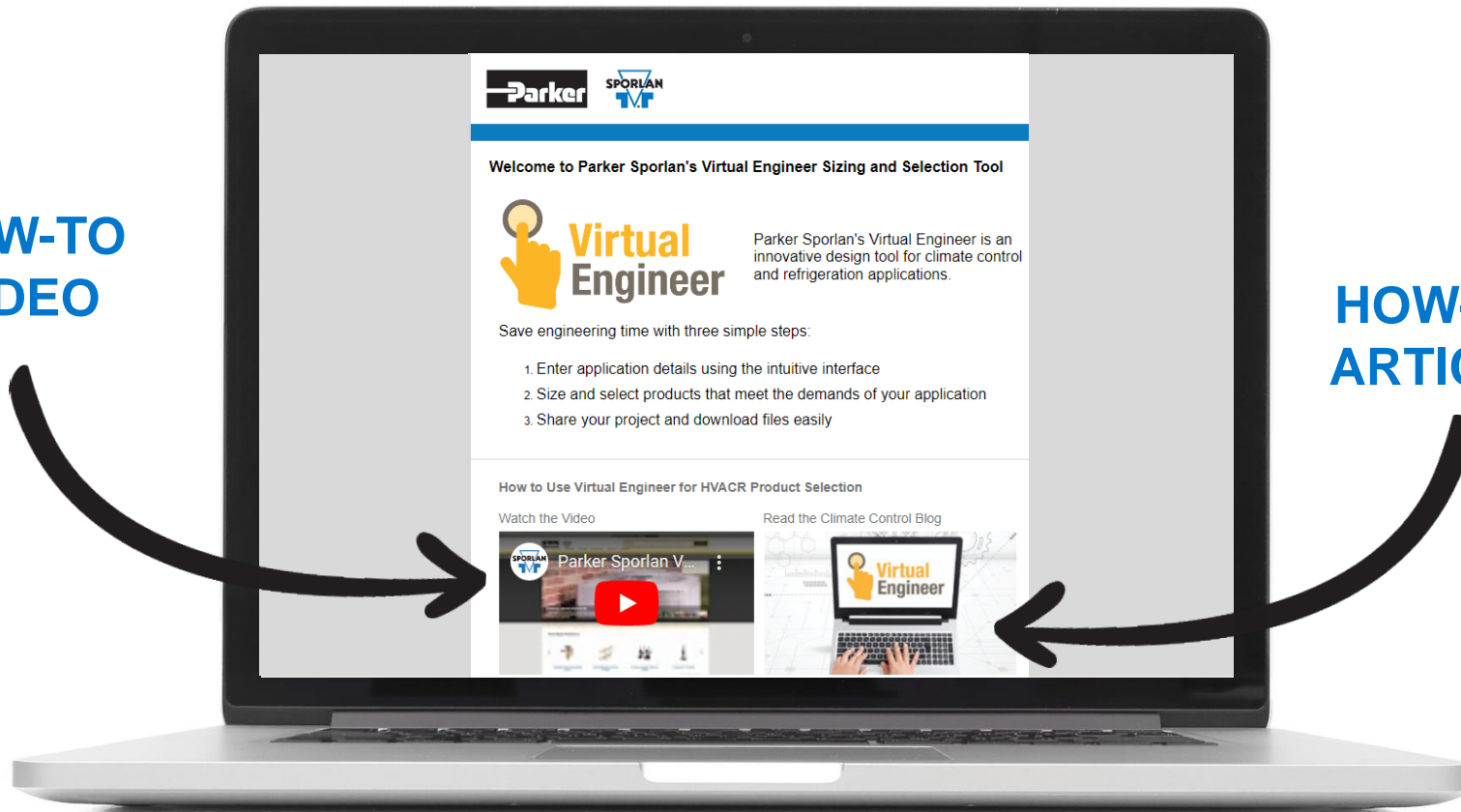
Sporlan.com



# Virtual Engineer

## SIZING AND SELECTION TOOL

HOW-TO  
VIDEO



HOW-TO  
ARTICLE



# Sporlan Teaching Materials

**Solenoid Valves**  
Installation and Servicing Instructions  
November 2011 / BULLETIN 30-11

**12 Solutions for Fixing Common TEV Problems**  
FORM 10-143

**Thermostatic Expansion Valves**  
Theory of Operation, Application, and Selection  
March 2011 / BULLETIN 10-7

**CONTAMINANT CONTROL WITH THE Catch-All**  
WHY CHEMICAL CONTAMINATION OCCURS

**Using P-T Analysis As A Service Tool**  
Manufacturers of refrigerants, controls, and other suppliers distribute hundreds of thousands of pressure-temperature charts to the trade every year. It should be indicated to find a service technician who could not put their hands on a pressure-temperature chart or application of a minute's notice.

**S3C CASE CONTROL**  
Installation and Operation Instructions  
DECEMBER 2017 / BULLETIN 100-90-9-1

**Electric Expansion Valves**  
SER, SERI, SEHI  
Apr 17 17 / Bulletin 100-29

**P-T Chart Features:**

- Refrigerants 134a, 404A, 407A, 507, 744 - CO<sub>2</sub>
- Instructions for determining superheat
- Systematic Analysis
- Handy pocket size
- Android / IOS Mobile

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Sporlan TechTalks



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2. Provide your name and email at the end of the survey

**Please Note:** *You will not receive a certificate unless you share your name on the survey form.*

## CO<sub>2</sub> Component Overview With S3C Case Control Introduction

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Parker Hannifin, Sporlan Division