

Natural Refrigerant Training Summit

Building a Sustainable Workforce

CO₂ Component Overview With S3C Case Control Introduction

Jim Jansen

Parker Hannifin, Sporlan Division



NORTH AMERICAN
Sustainable
Refrigeration
Council



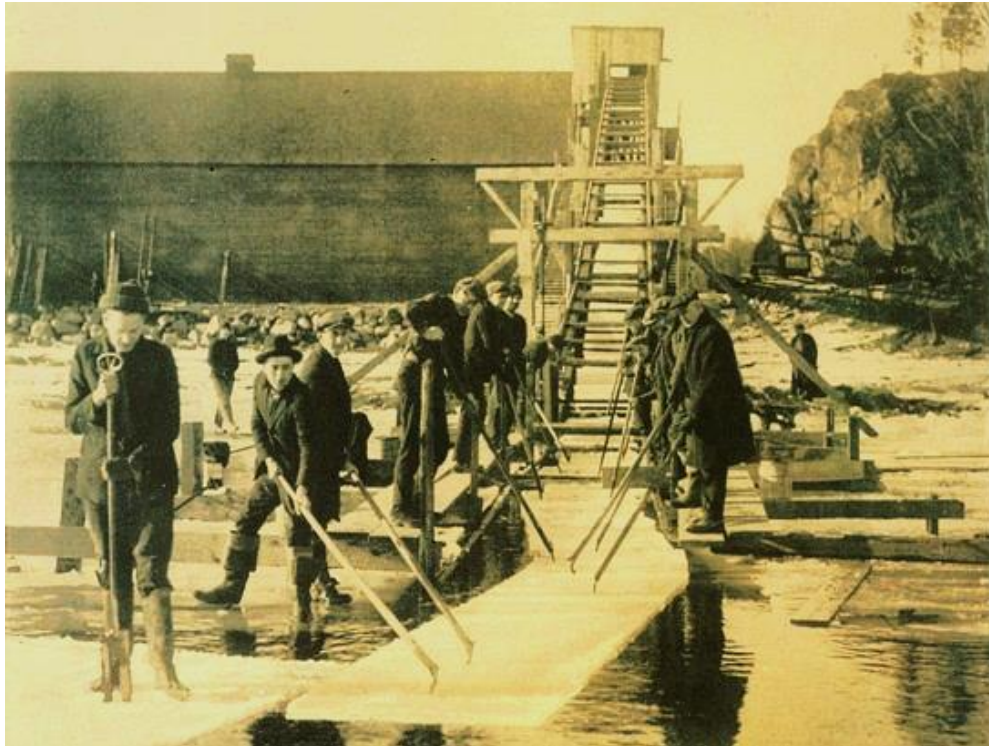
NORTH AMERICAN
Sustainable
Refrigeration
Council

Presenter



Jim Jansen
Senior Application Engineer
JLJansen@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



End Users / Supermarket Chains

Wegmans



Bashas'



Walmart



King Kullen
America's First Supermarket



BROOKSHIRE'S

Schnucks



Supermarket OEMs

HUSSMANN[®]



SOUTHERN
CaseArts

SOURCE
Refrigeration & HVAC, Inc.

Hill PHOENIX
E X C E L L E N C E TM



KYSOR  **WARREN**[®]

HEATCRAFT[®]
Refrigeration Products

TYLER

truwe[®]

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 ft² or less must conform to this new requirement
- Affects Thermostatic Expansion Valve (TEV) and Electric Expansion Valve (EEV) sizing

Change is Here!

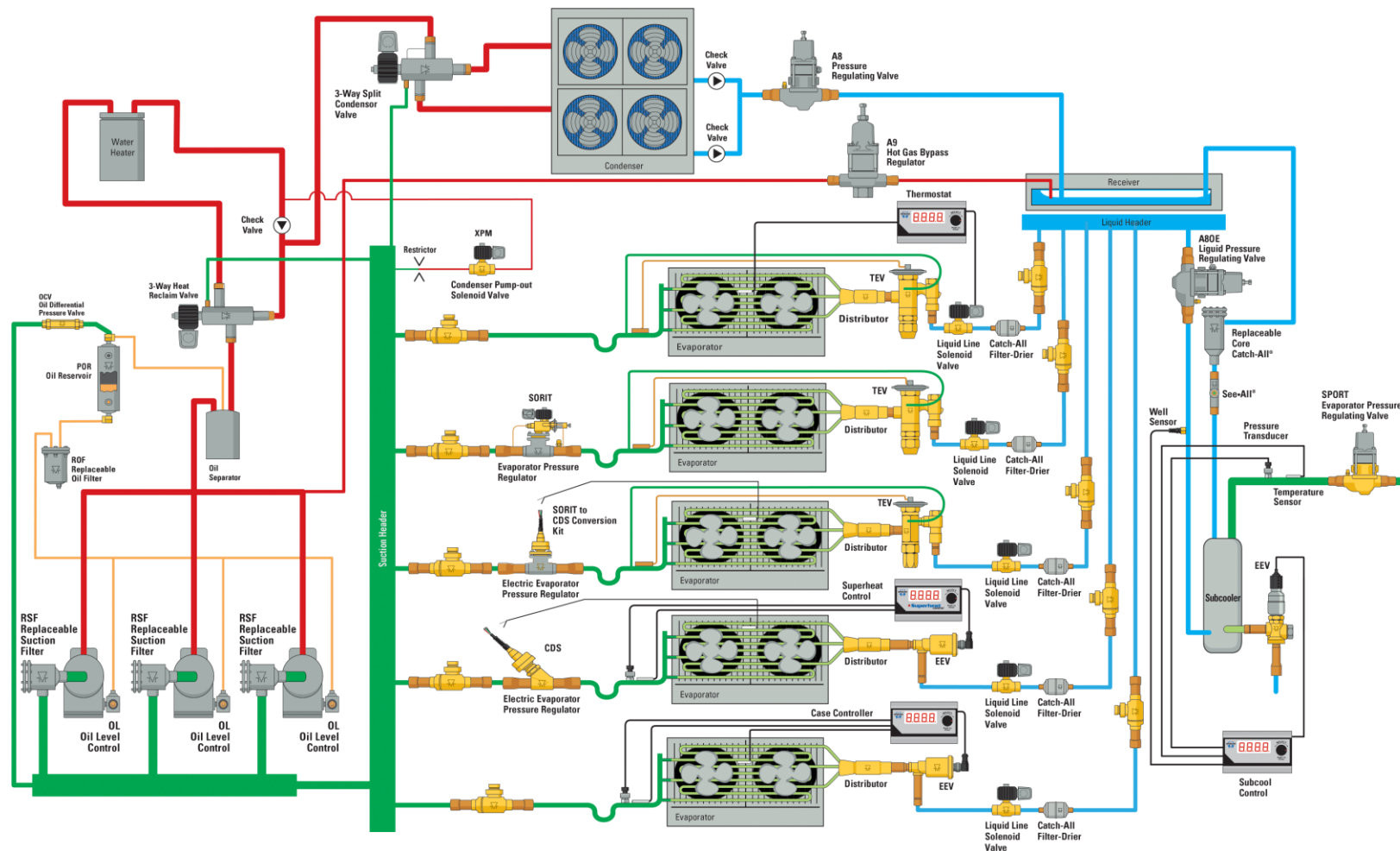
Supermarket of the Future

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

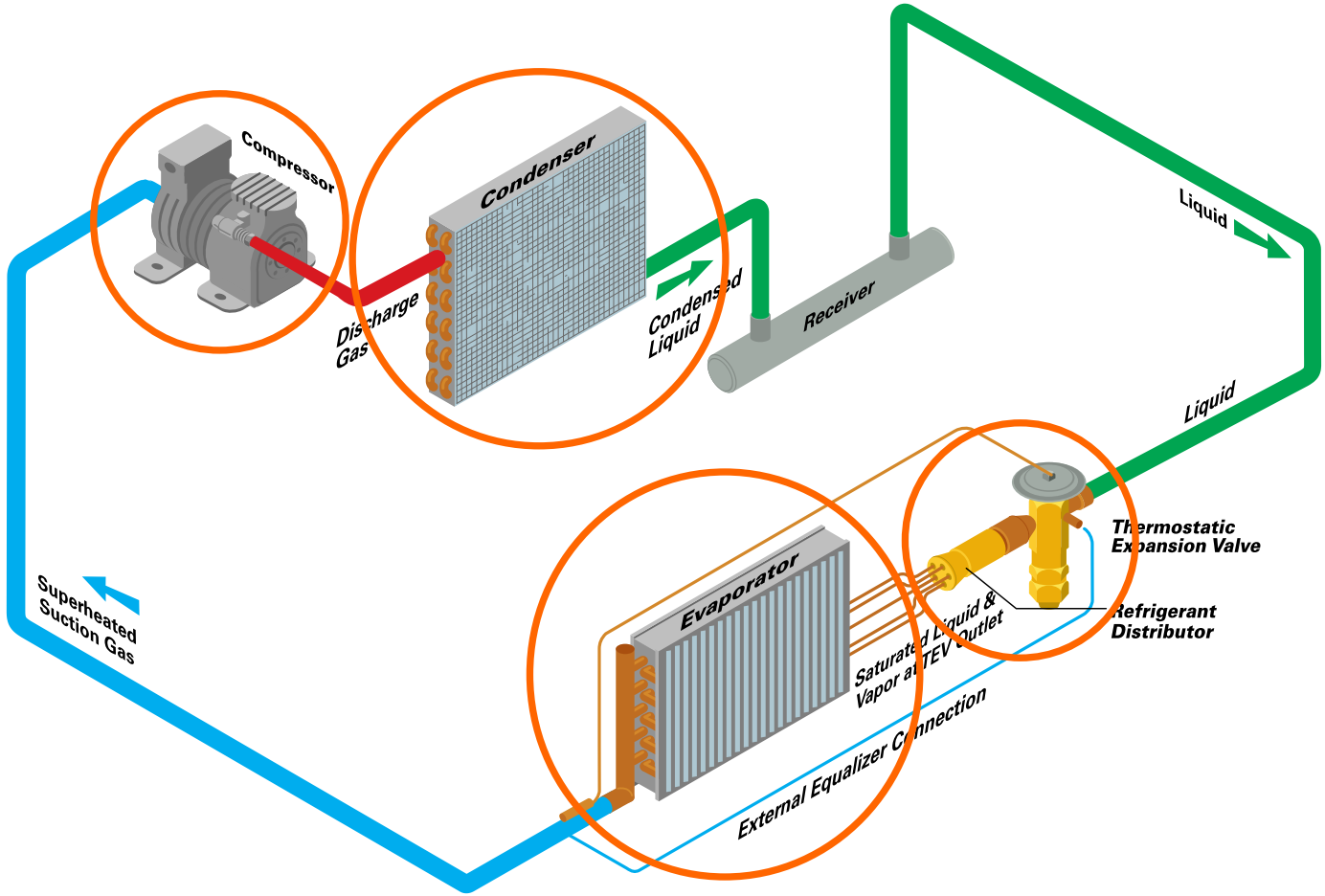
- Increased efficiency
- Fewer refrigerant leaks
- More electronics!
- New low-GWP refrigerants
- Maybe using propane
- Maybe using CO₂



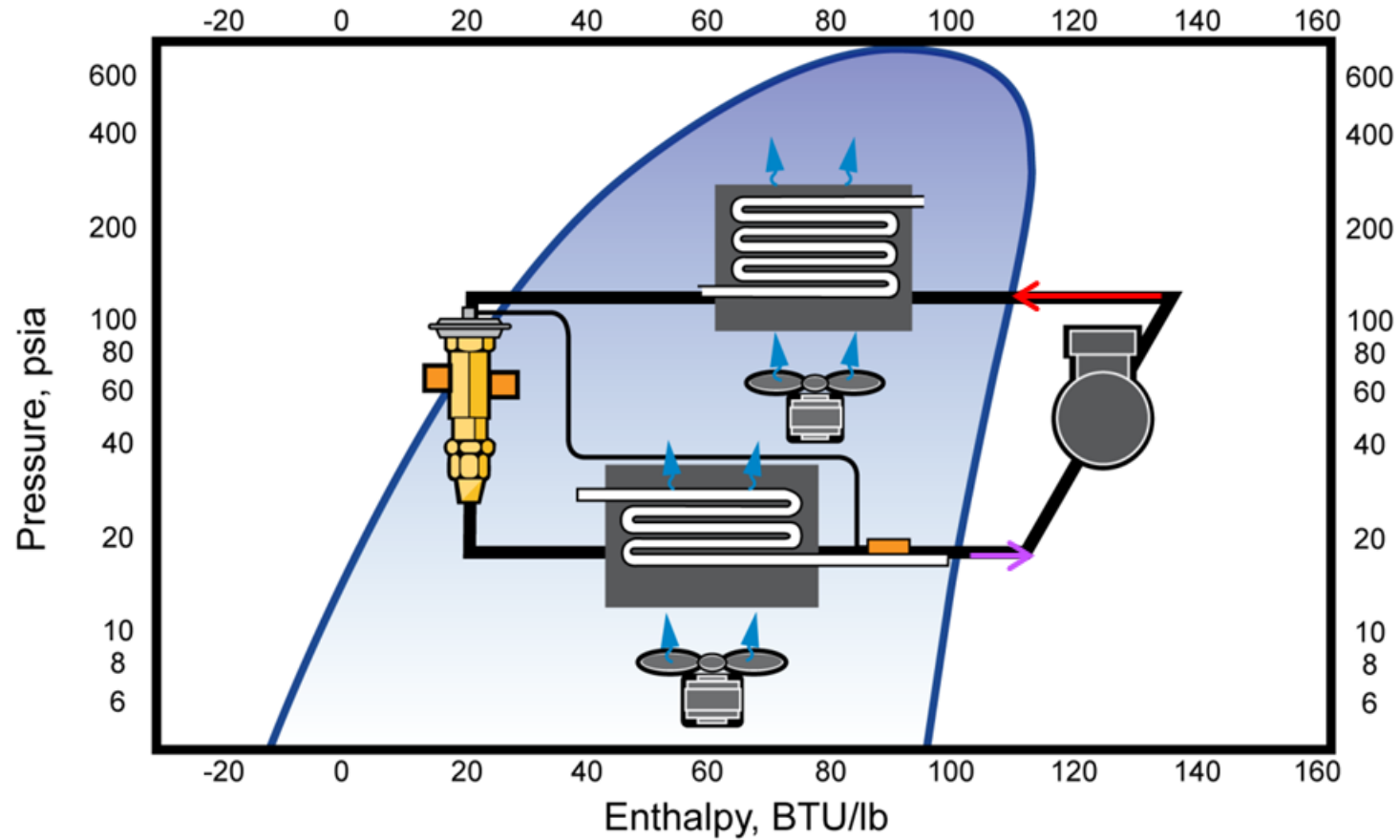
DX Systems – Multiplex Racks



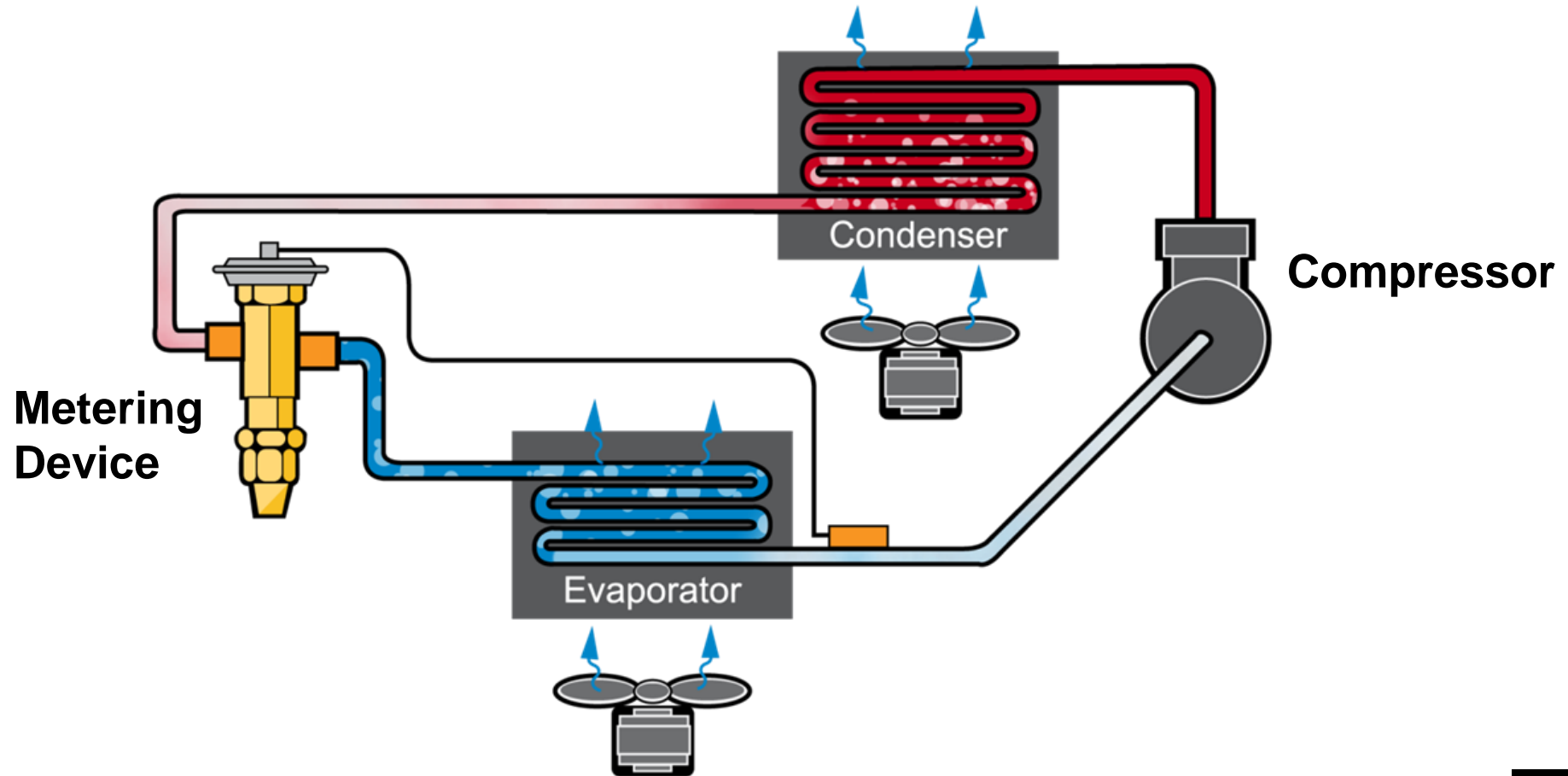
Basic Refrigeration System Components



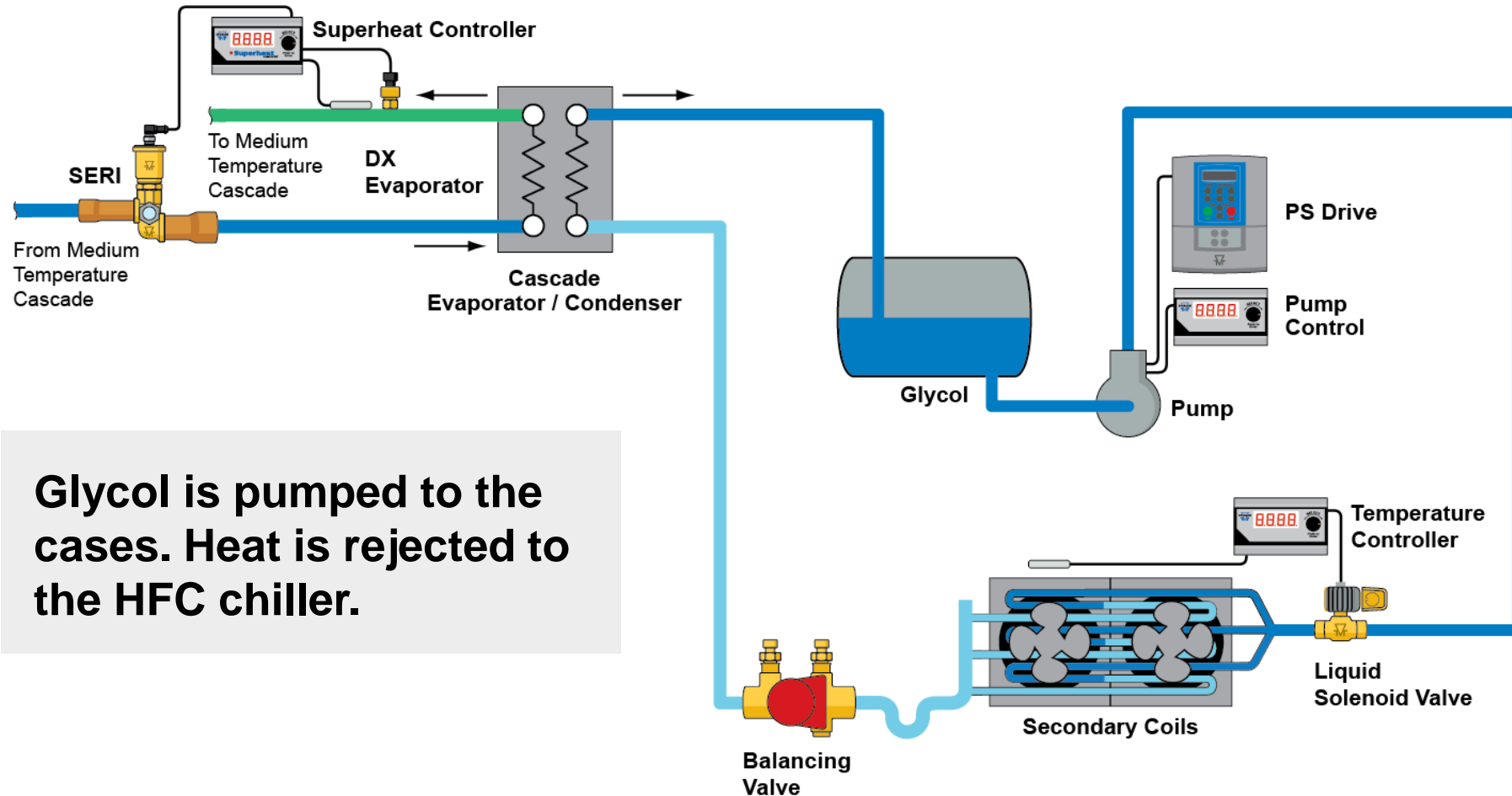
Vapor Compression Cycle



The Vapor Compression Refrigeration Cycle



Glycol Systems



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

CO₂ Systems R744

- Liquid Overfeed
 - Subcritical CO₂
 - Transcritical CO₂
- } *HFC refrigerant used to keep pressures manageable*

Saturated Suction

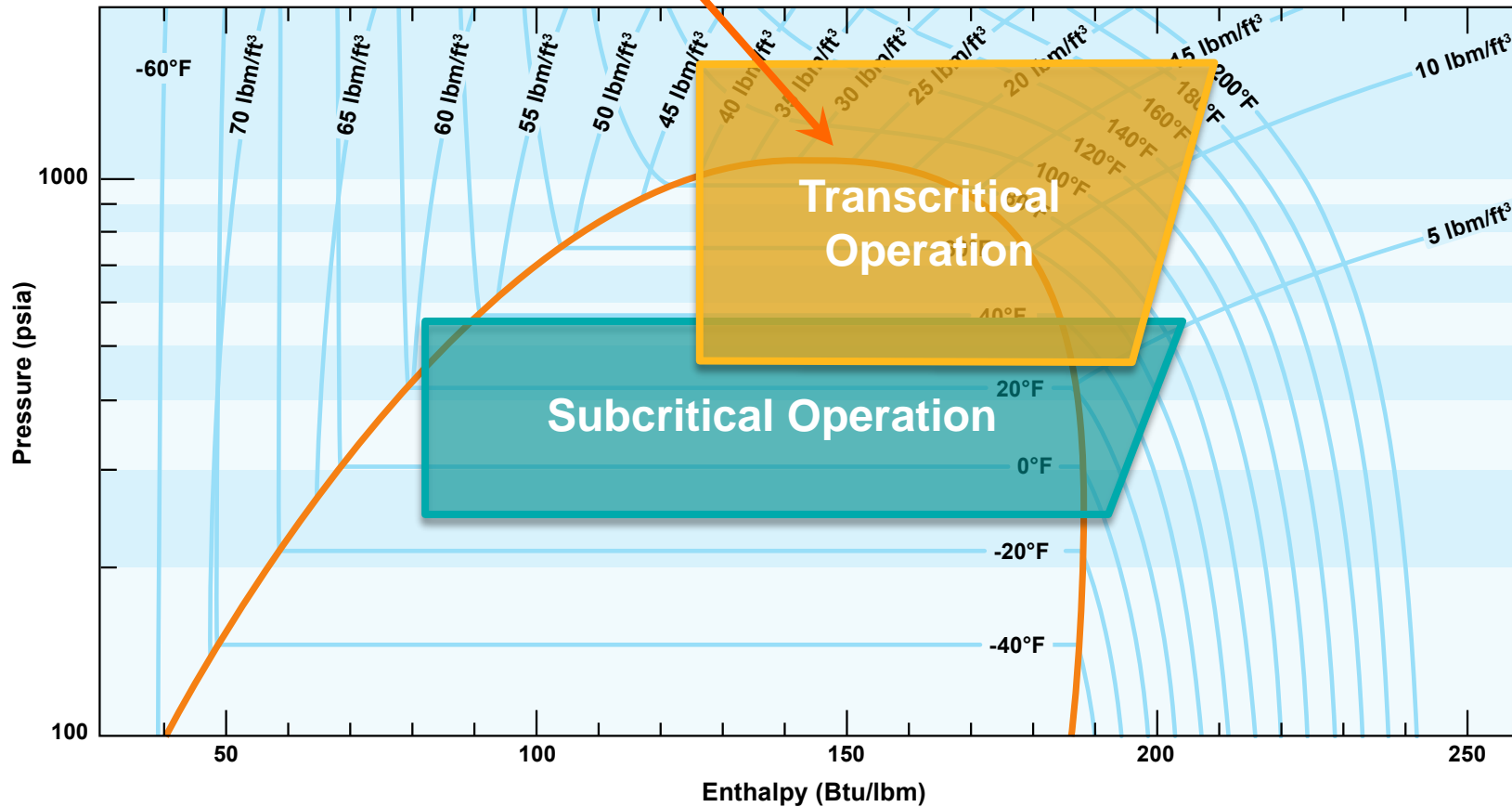
Temperature (°F)	Pressure (psig)
-40	131
-35	146
-30	163
-25	181
-20	200
-15	221
-10	243
-5	266
0	291
5	318
10	346
15	376
20	407
25	441
30	476

LT

MT

CO₂ Cycle Overview

Critical Point: 87.9°F / 1070 psia



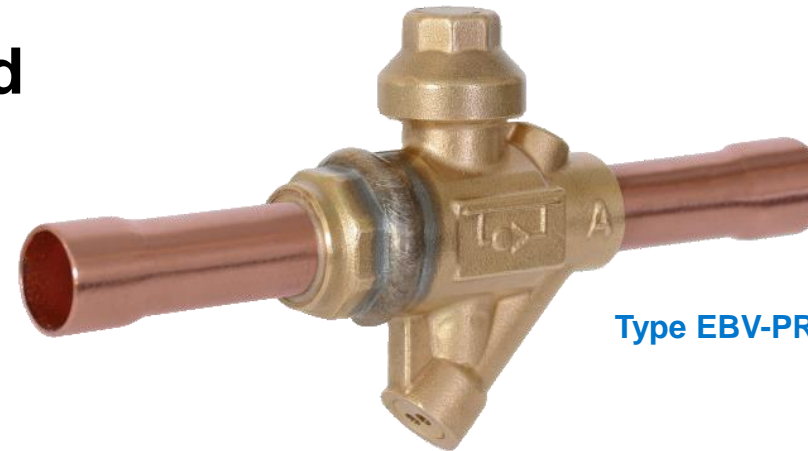
CO₂ Safety

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

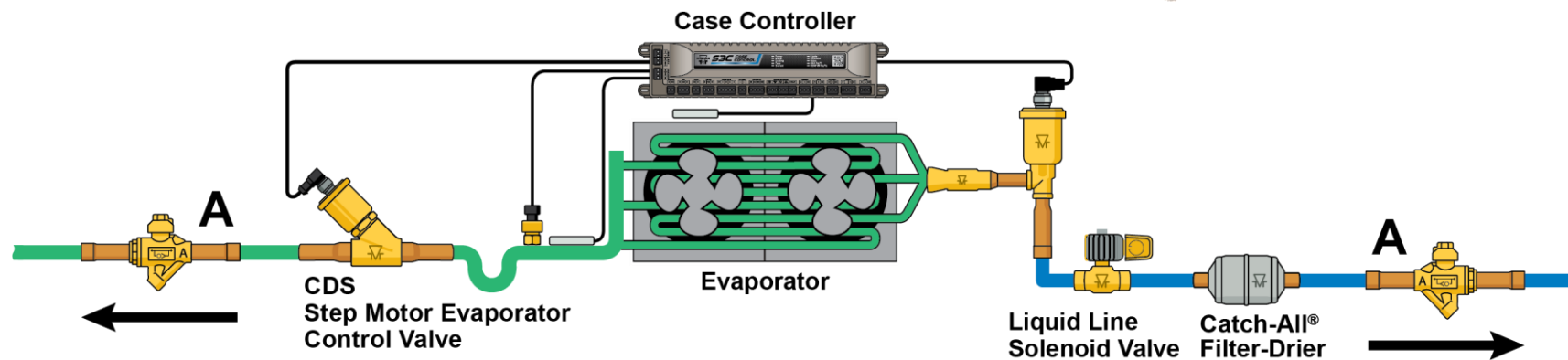


CO₂ Safety

Combination Ball Valve and Safety Relief Check Valve



Type EBV-PR

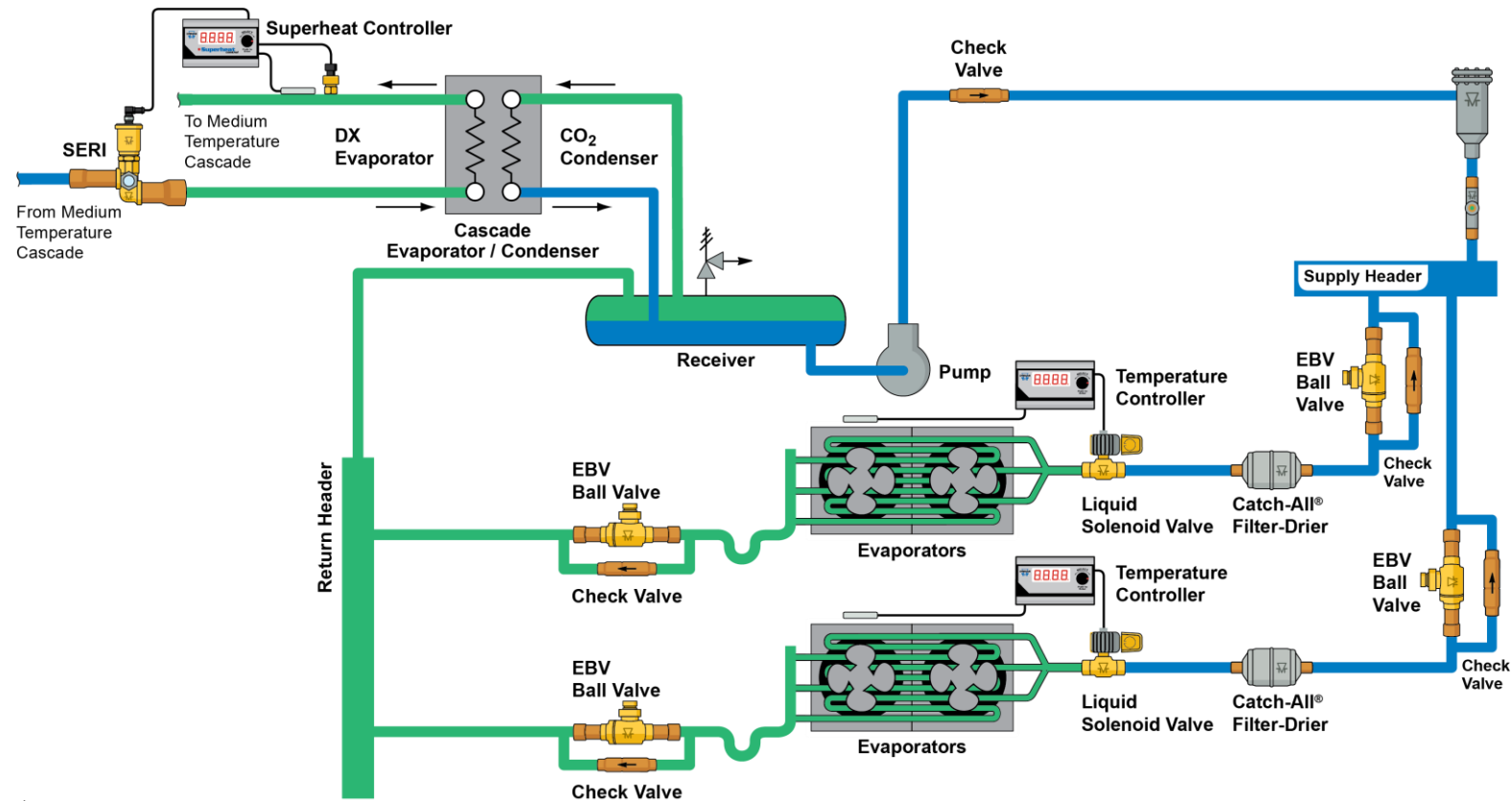


Why CO₂?

- **Refrigerant reduction**
 - Total HFC charge reduced from 2,500 lbs. to 600 lbs. or lower
 - CO₂ 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

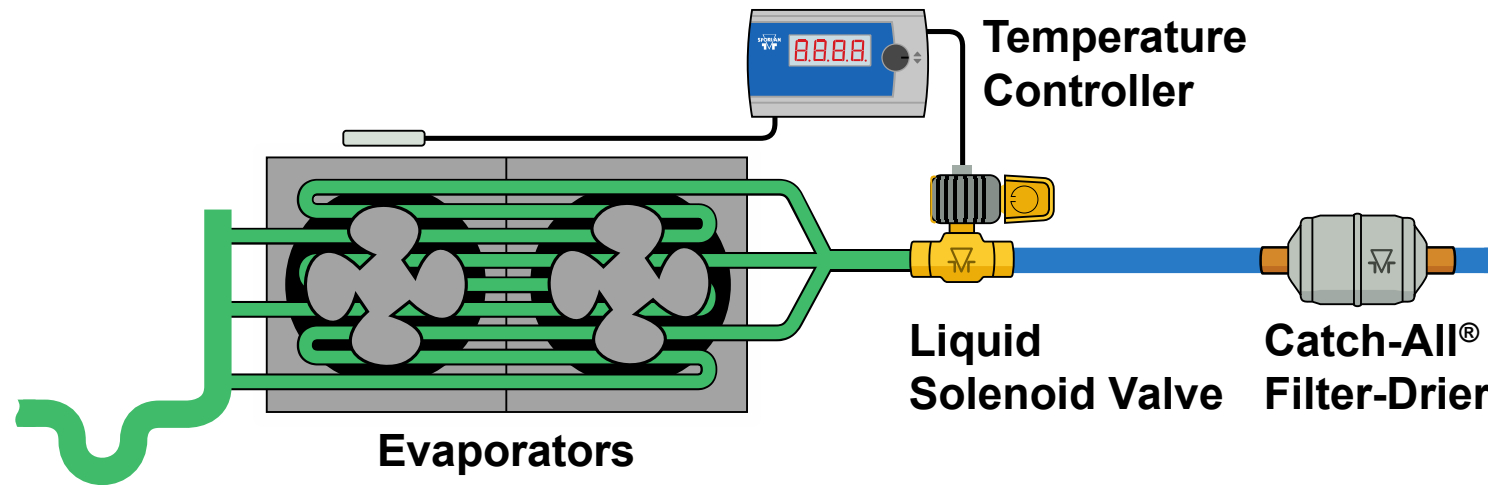
Subcritical Secondary CO₂

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

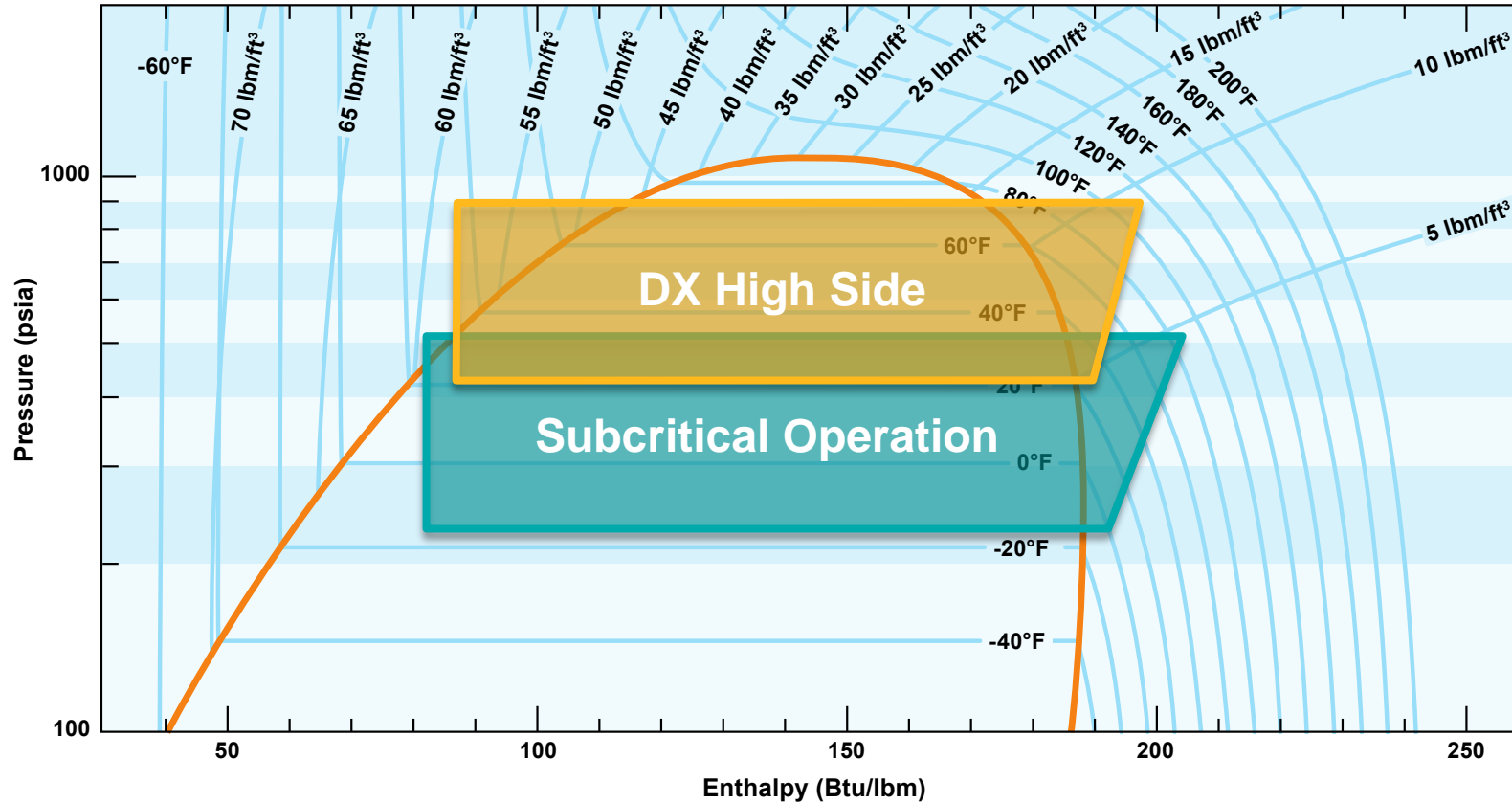


XSP Solenoid for CO₂ Liquid Overfeed

- Tight seating required at low pressure differential
- Ensures closure during defrost
- Valve rated for MOPD (50 to 300 psid) and MRP (700 psig)



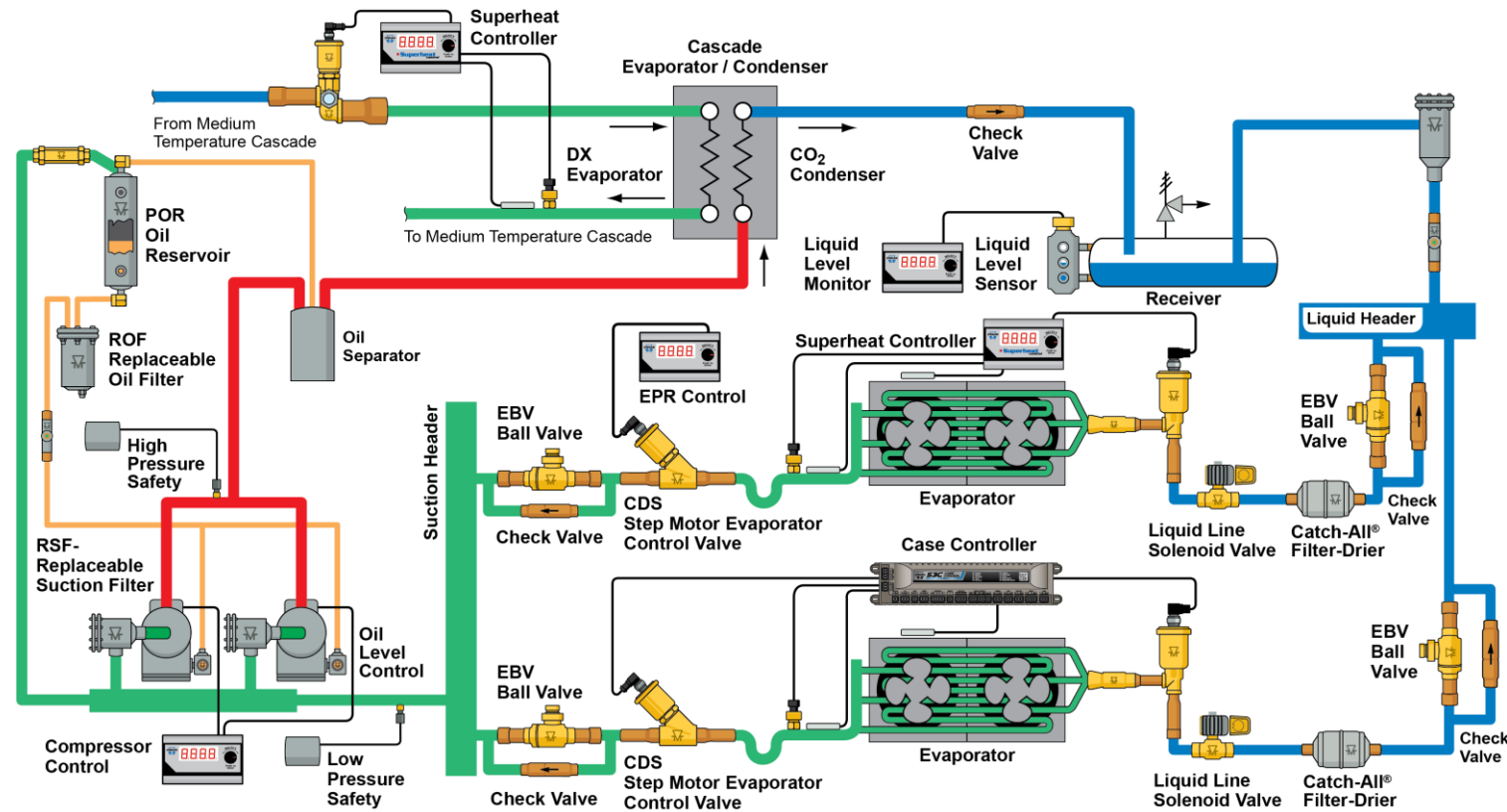
CO₂ PH Diagram – Cascade



DX high side graphically shows HFC cooling of the CO₂ loop.
Properties for HFC are not comparable to CO₂.

Subcritical CO₂

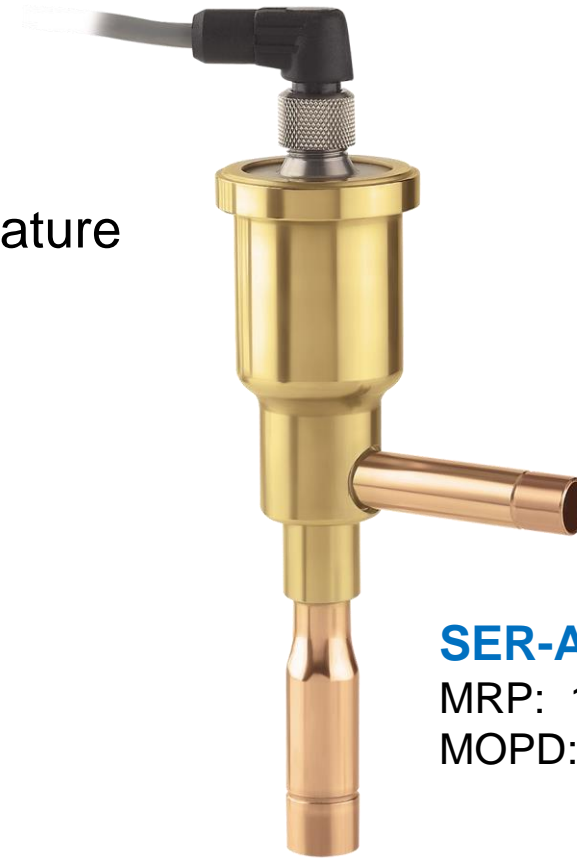
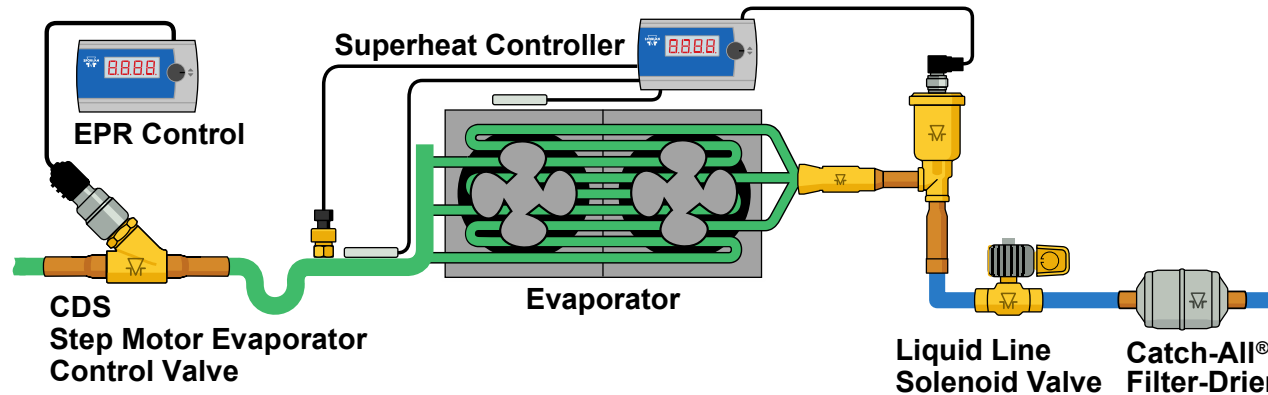
Cascade System Schematic - For low temperature applications



Controlling Subcritical CO₂

Electric Expansion Valves

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



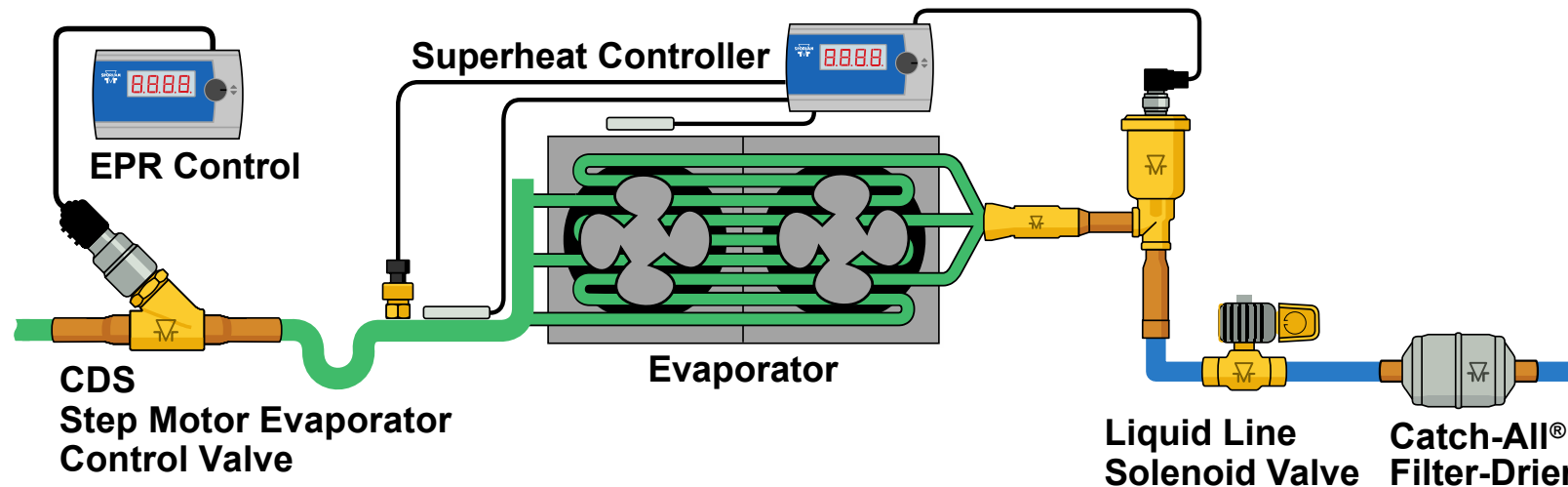
SER-AA, -A

MRP: 1,015 psi (70 Bar)

MOPD: 580 psid

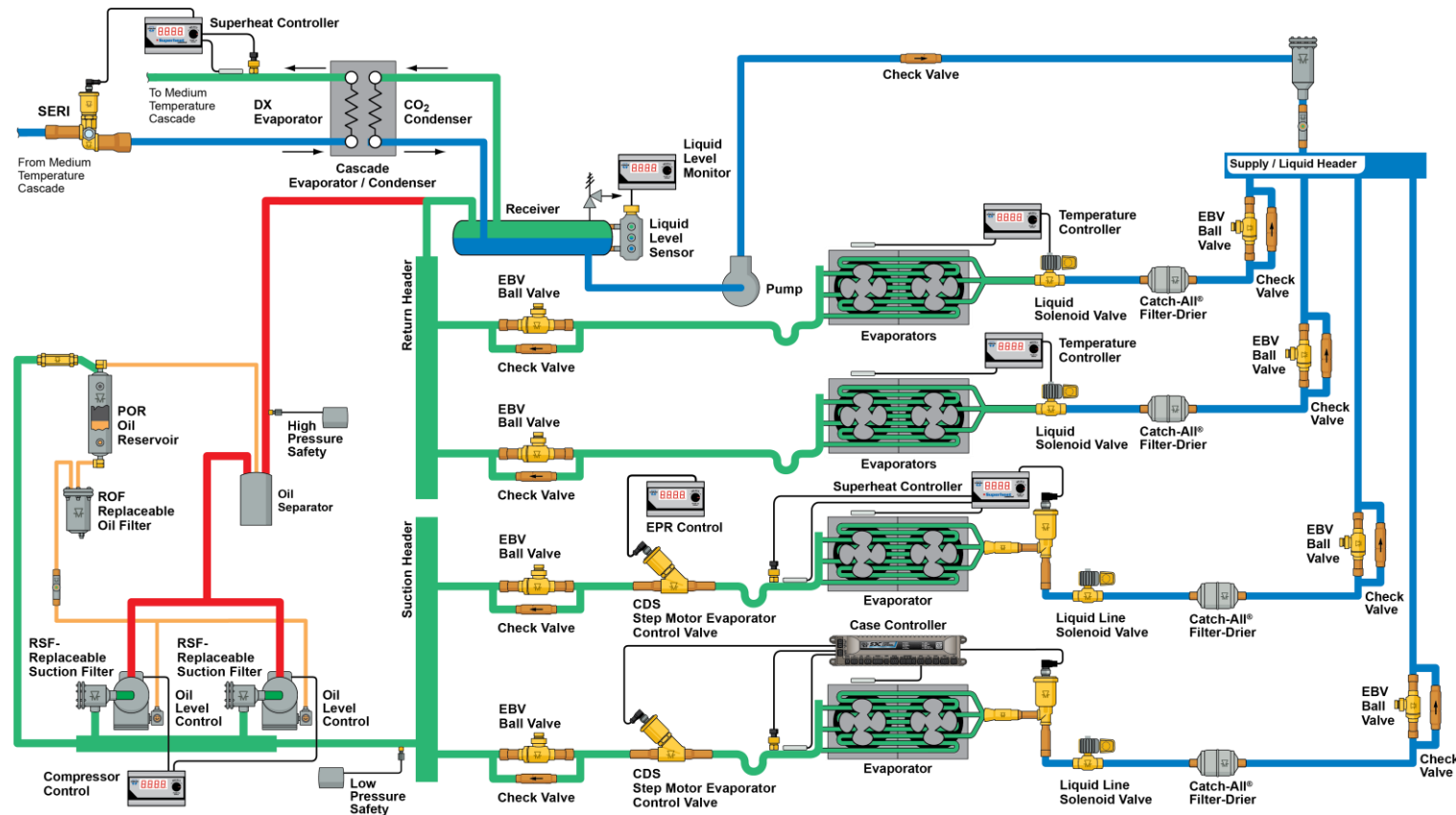
Subcritical CO₂ Solenoid Valves (-HP)

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



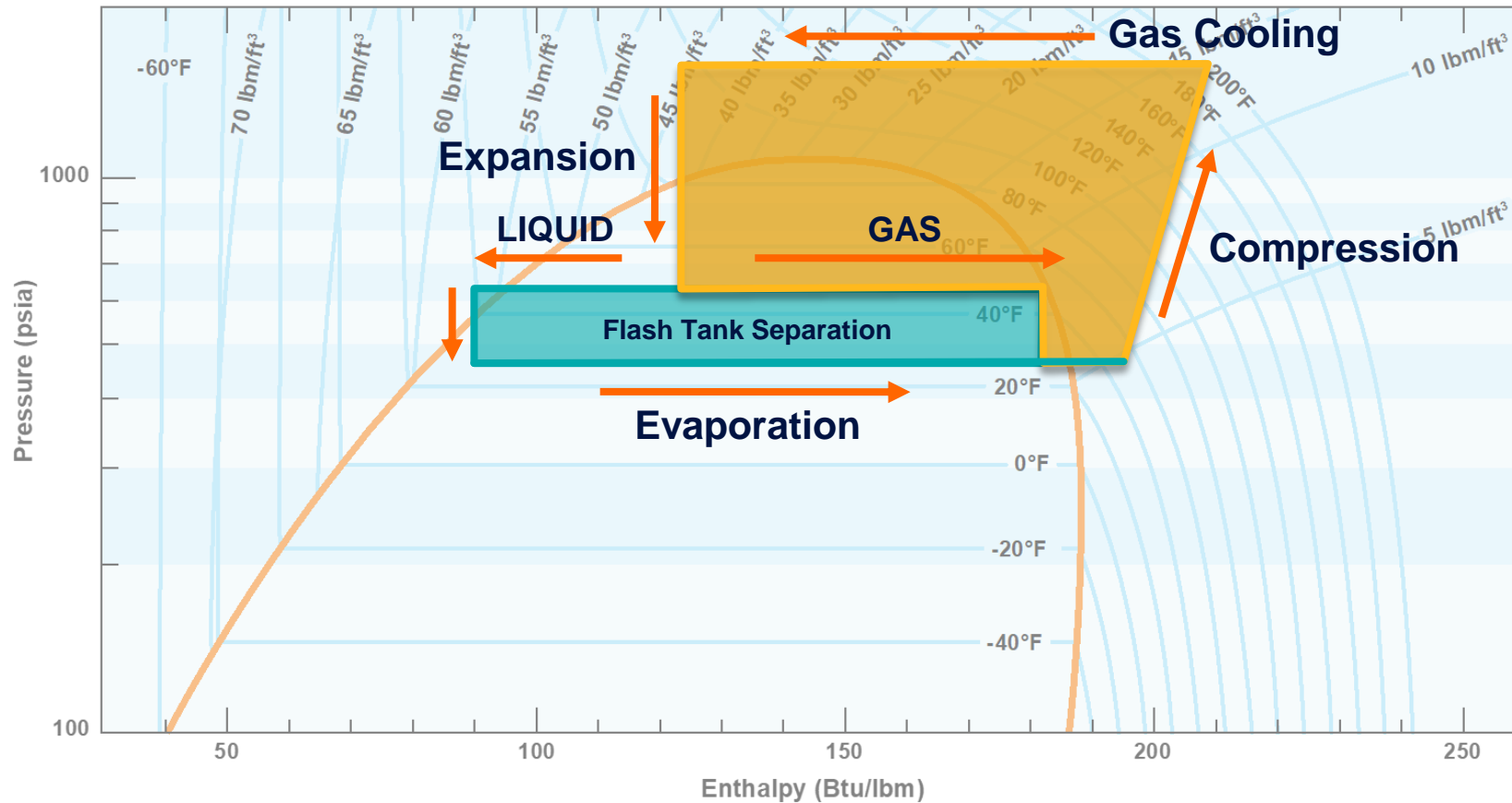
Combined Subcritical CO₂

For Low and Medium Temperature Applications

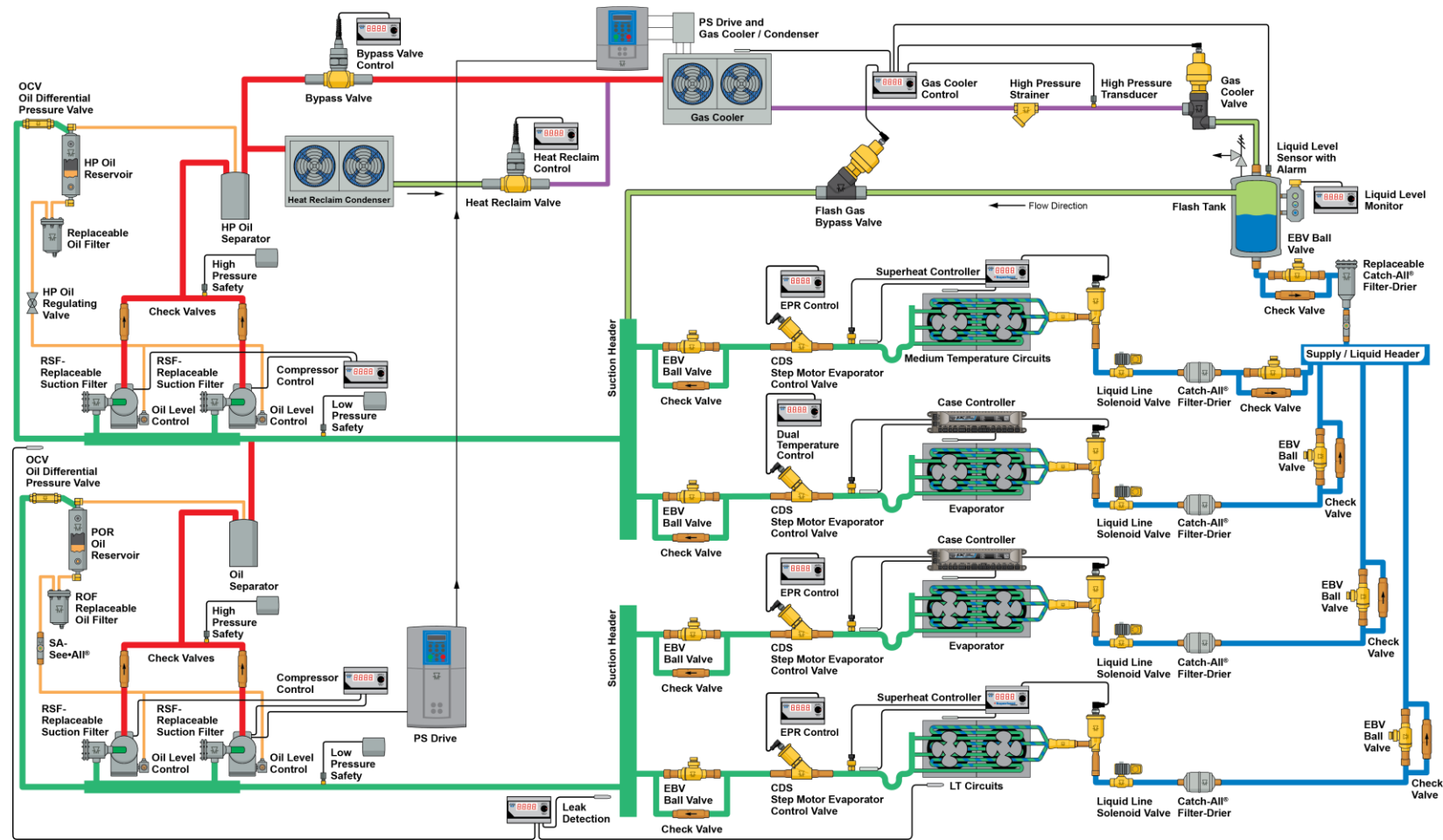


CO₂ PH Diagram

Transcritical Operation

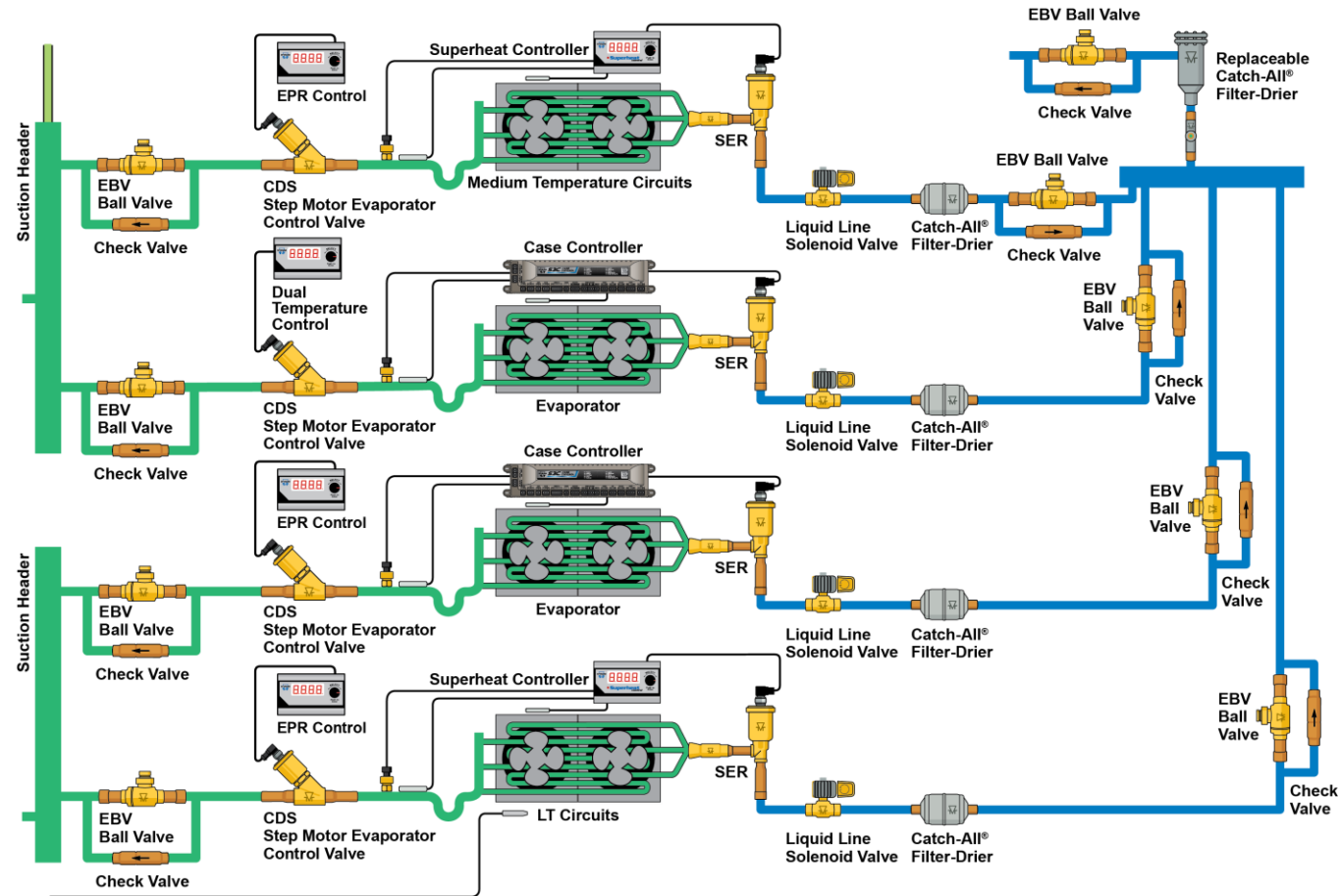


Transcritical CO₂



Transcritical CO₂

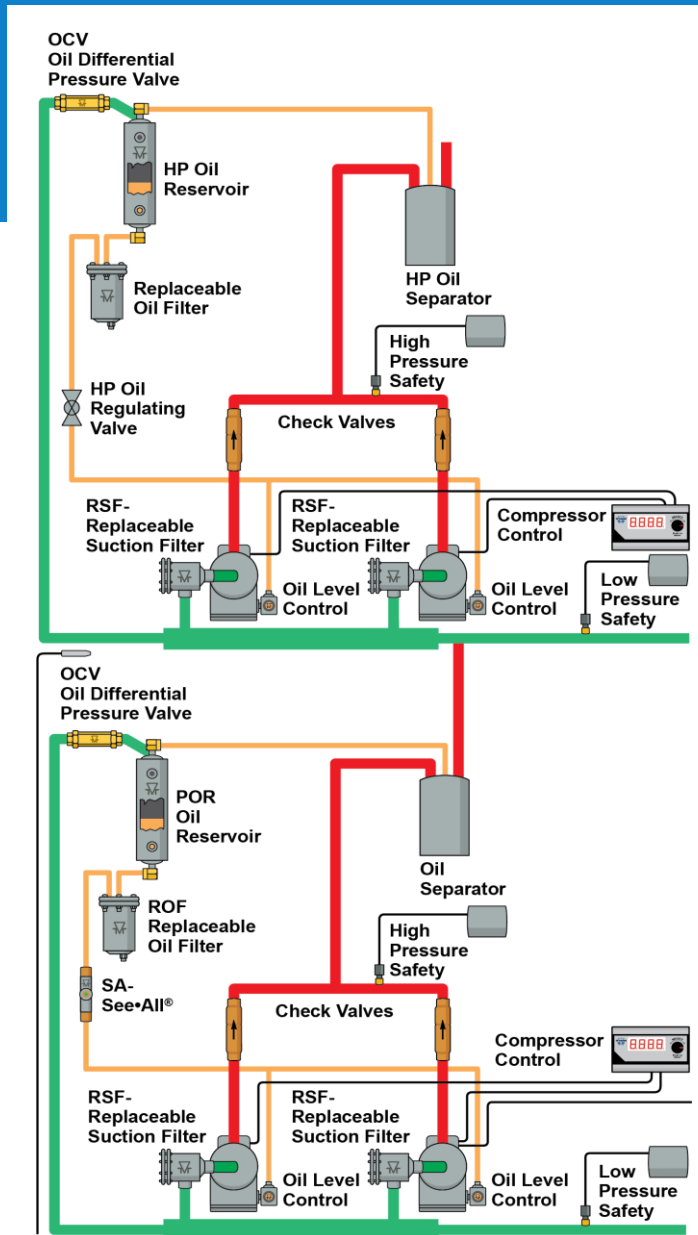
Subcritical CO₂ DX Operation



Transcritical CO₂

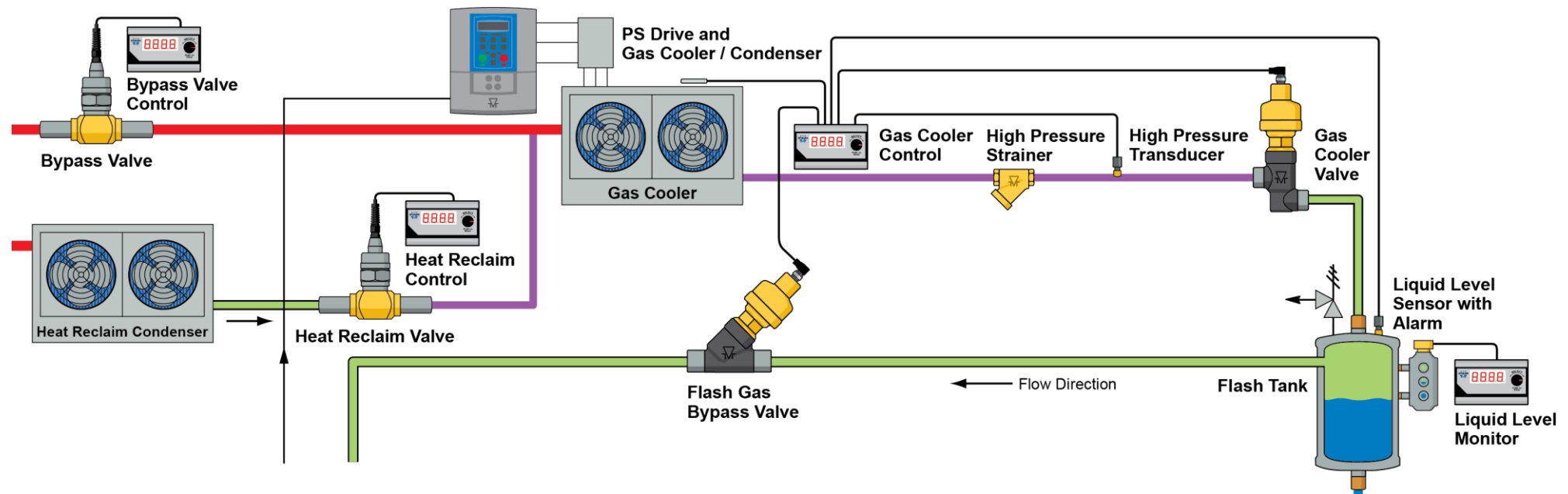
Compound Compression

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

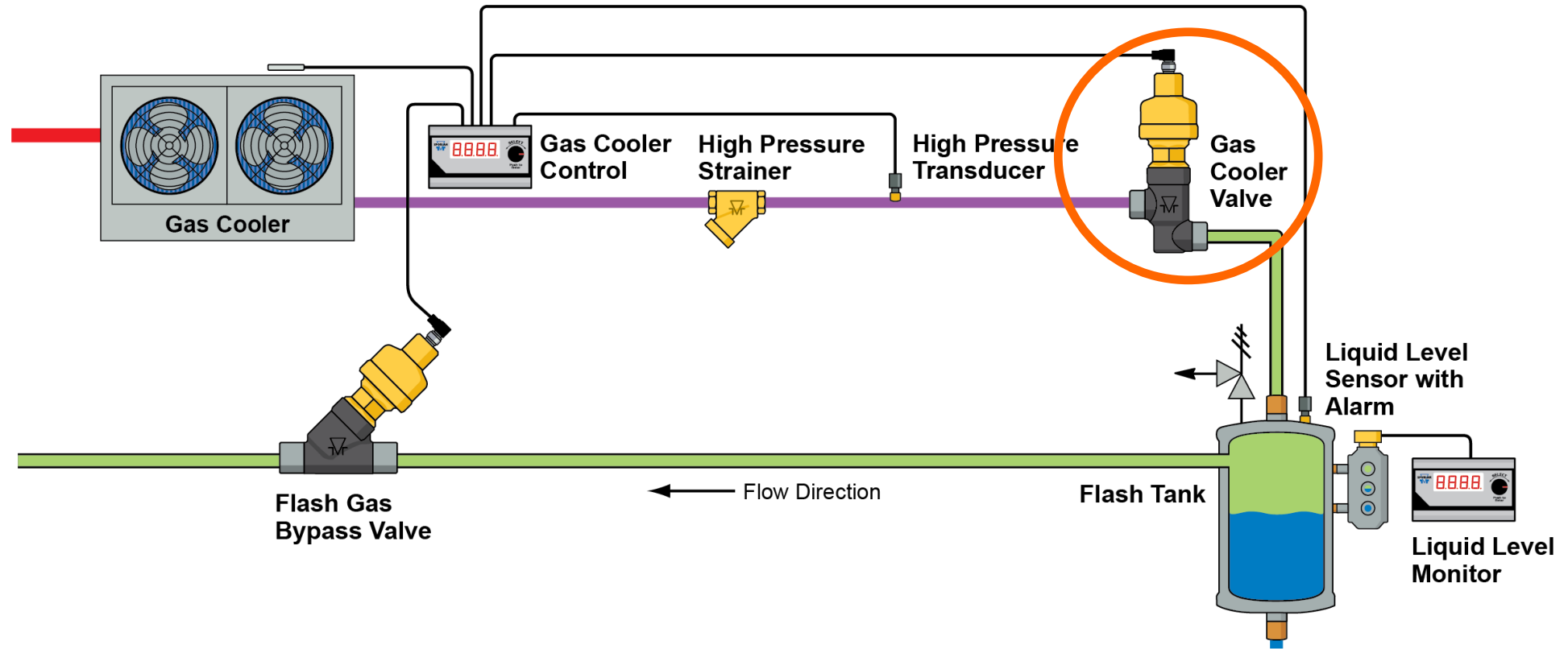


Transcritical CO₂

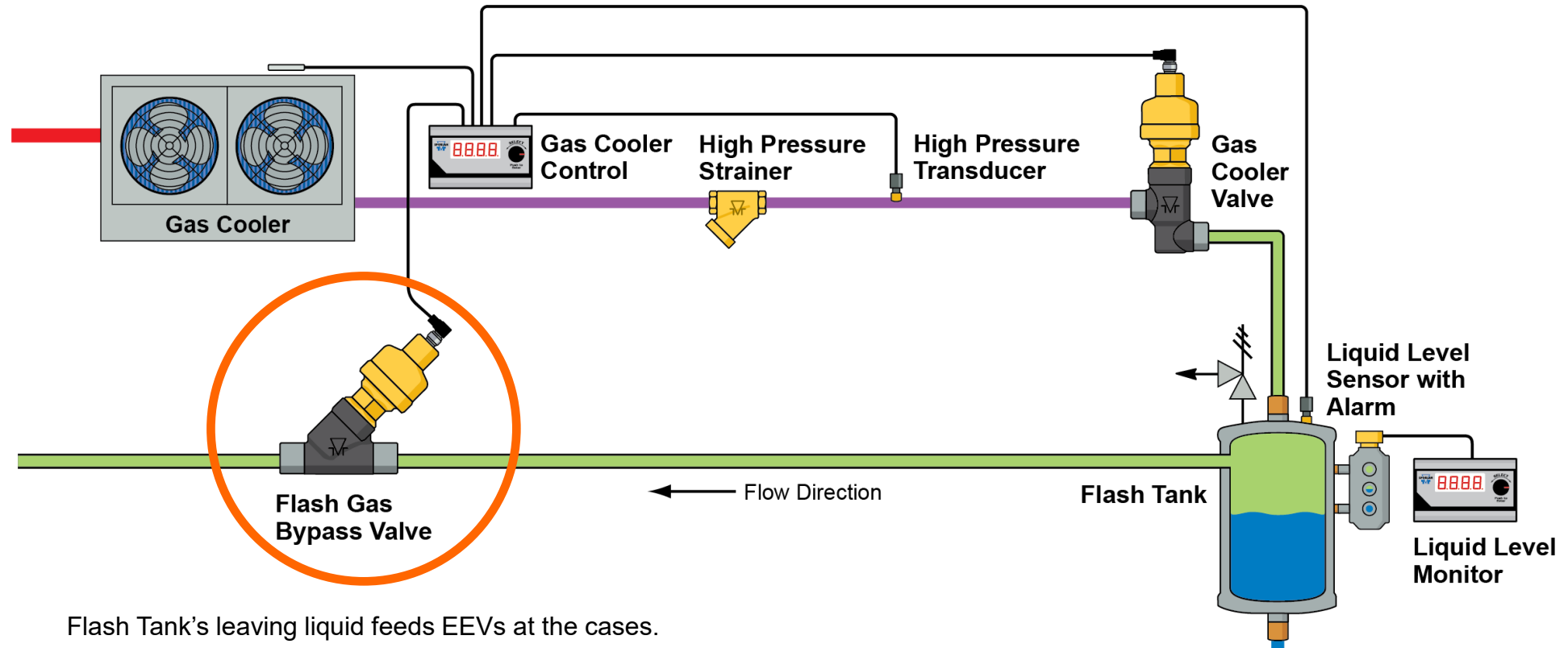
Gas Cooler Configuration



Transcritical CO₂ Flow Control



Transcritical CO₂ Flow Controls



Transcritical CO₂ Flow Controls

Sporlan Transcritical CO₂ Valves

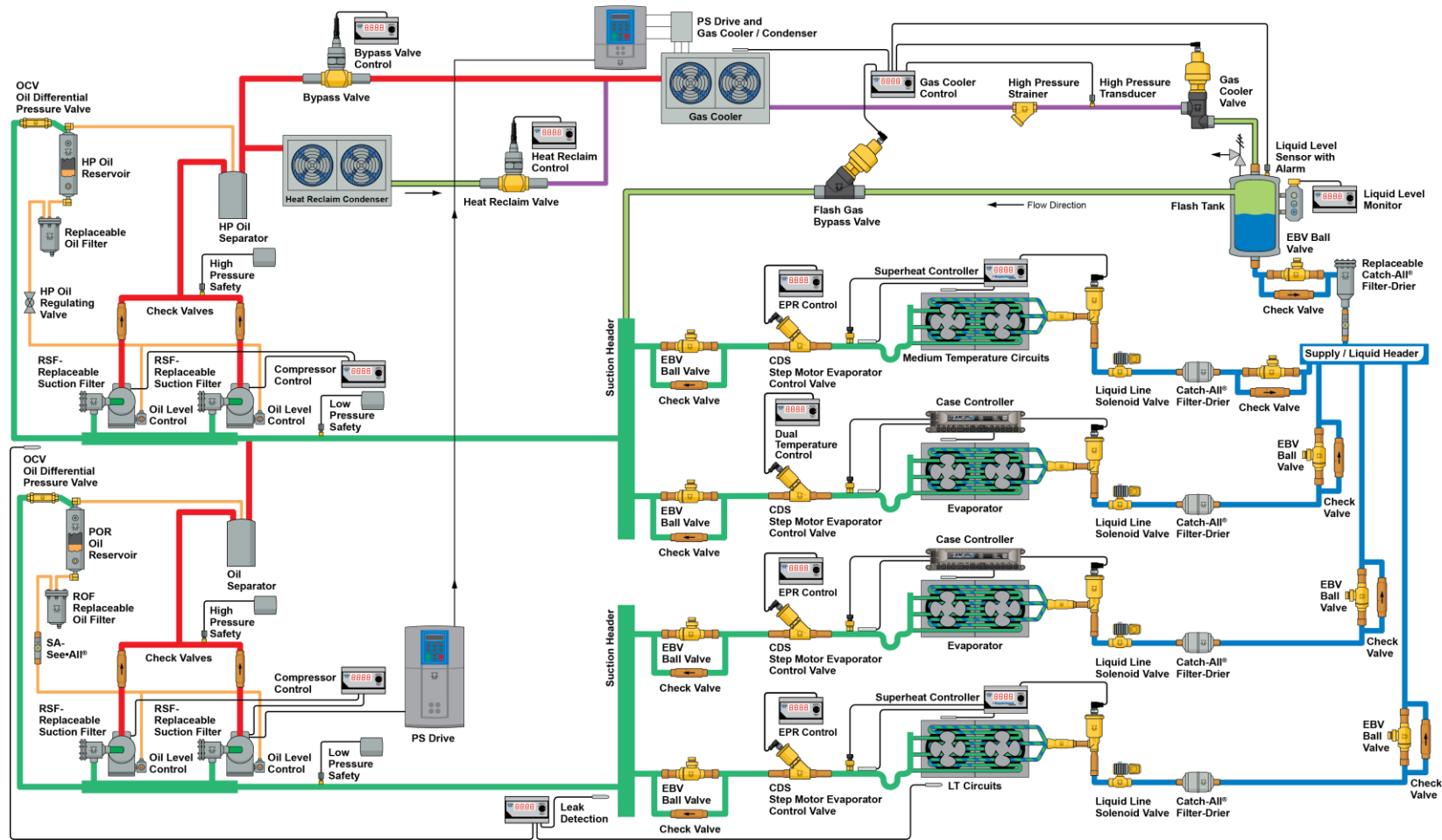
Gas Cooler
Valve



Flash Gas
Bypass Valve



Transcritical CO₂



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



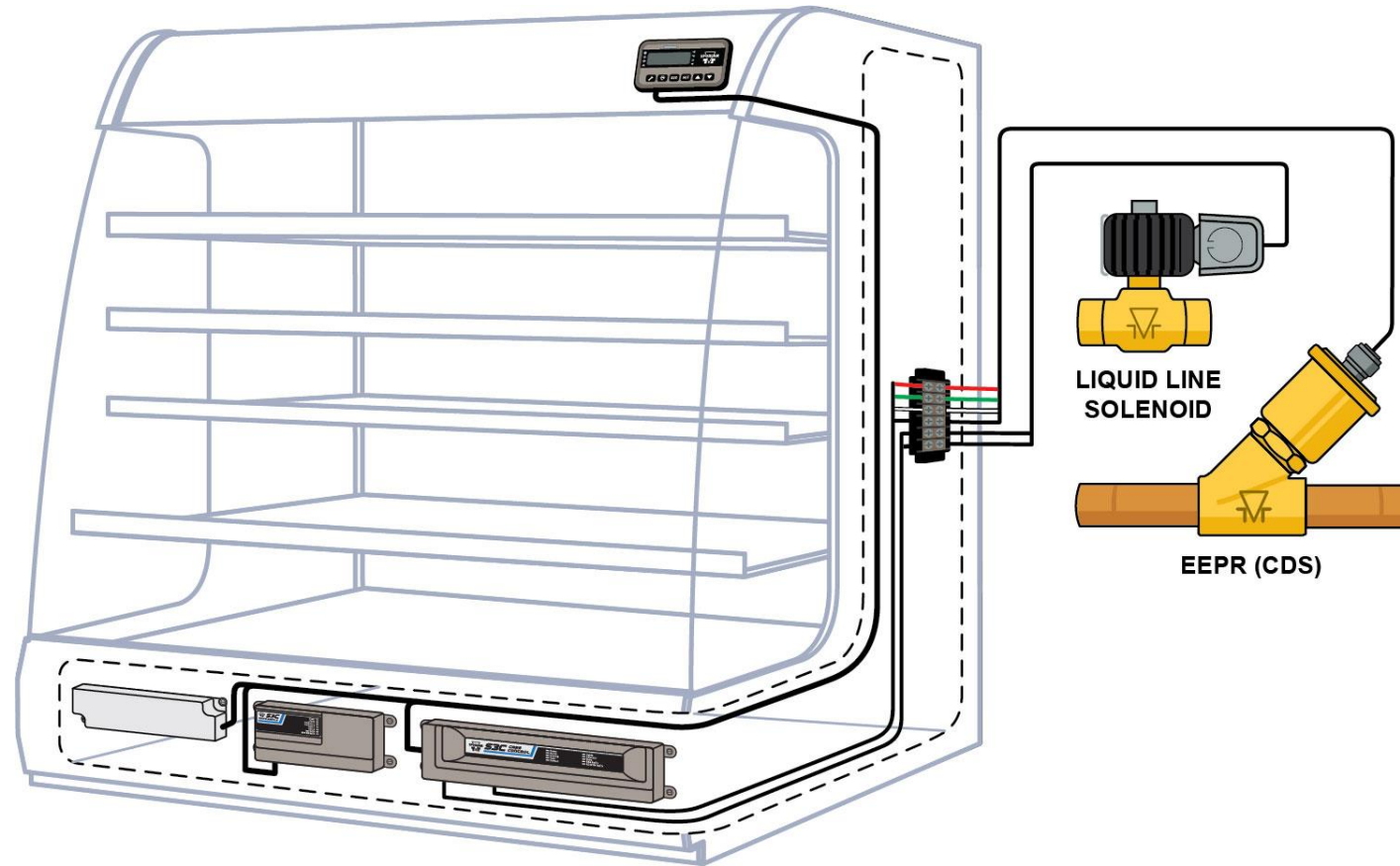
S3C CASE CONTROL

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

Accelerated Case Delivery



Mounting and Wiring

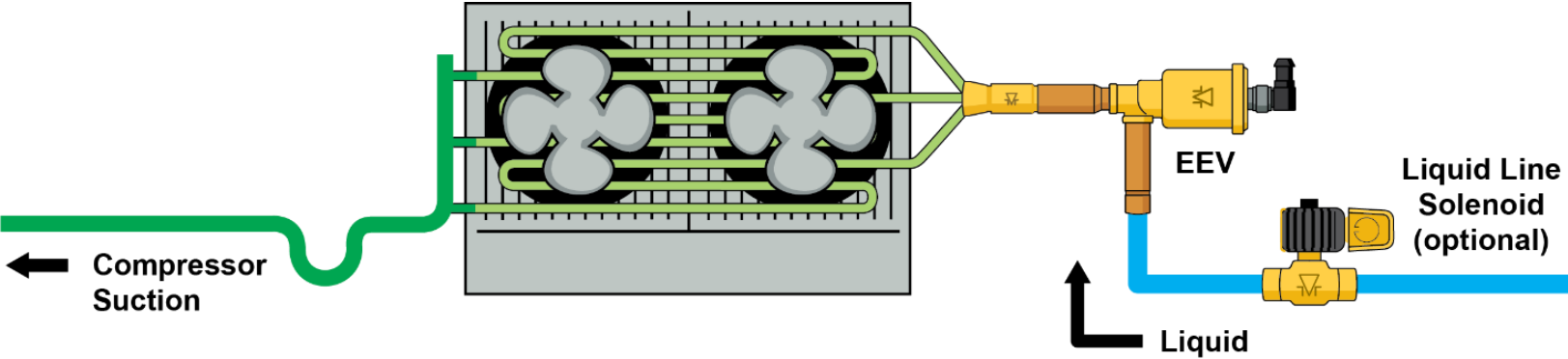


S3C Controls

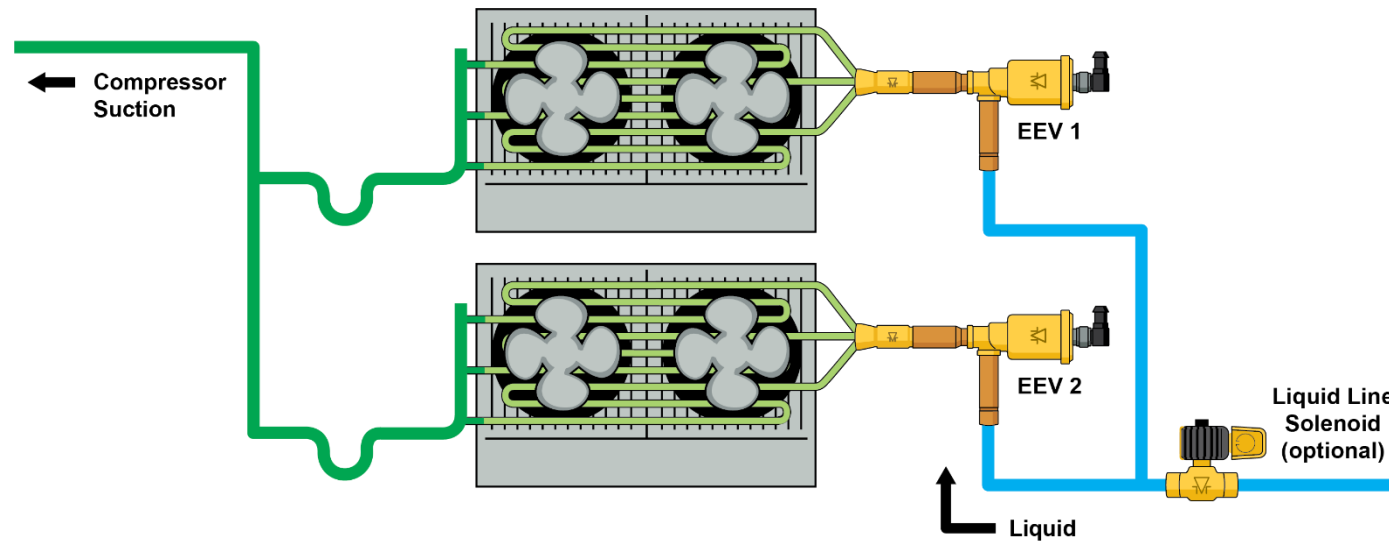
- **Case Control (S3C) Valve Module (VM)**
Mount in a rain-tight protected location using either a flange or din rail
- **Display Module (DM)**
Mount in an indoor location, near the case, but outside of the refrigerated space



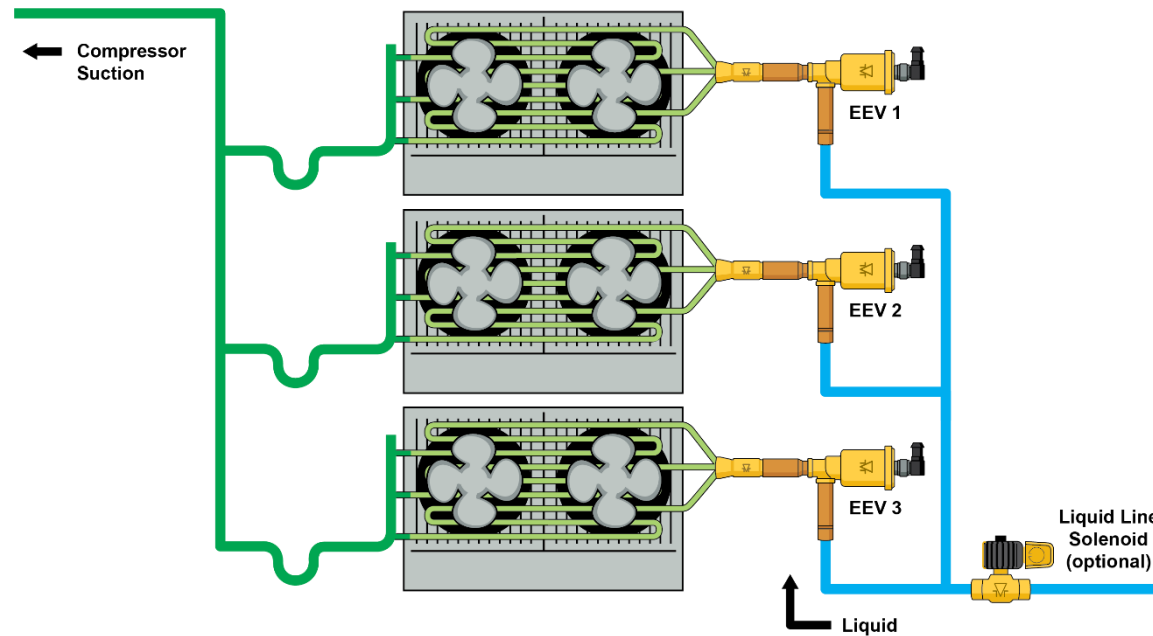
EEV and Control



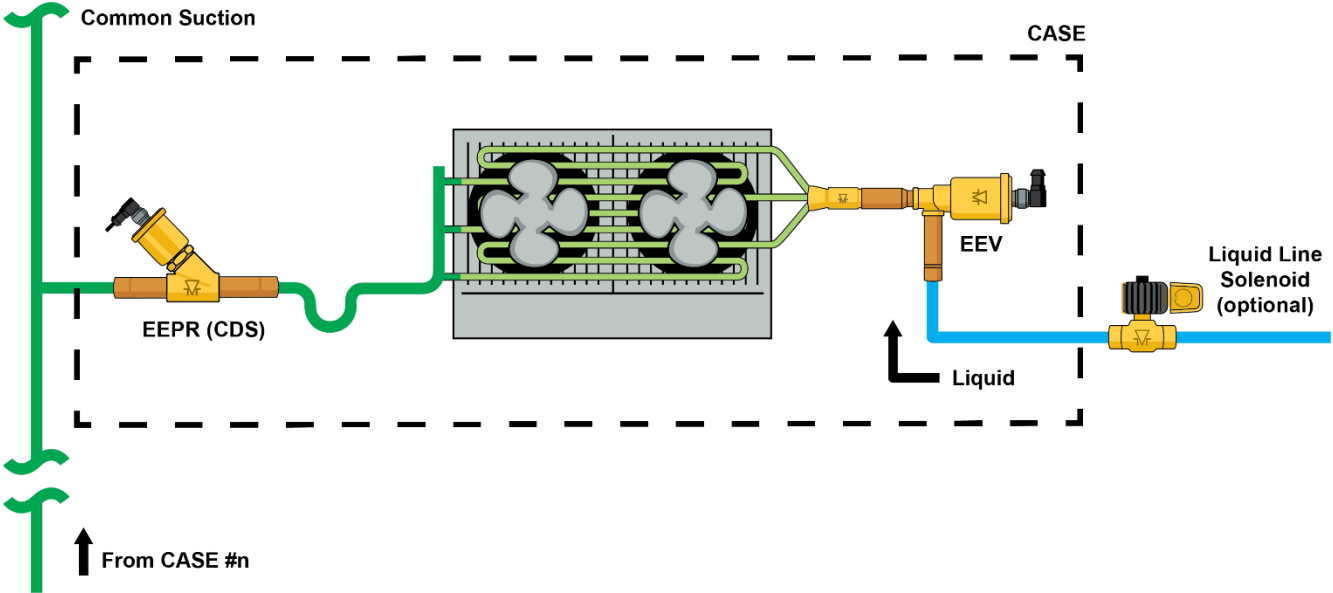
2 EEVs and Control



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



Controller Overview

Power Supply

Input

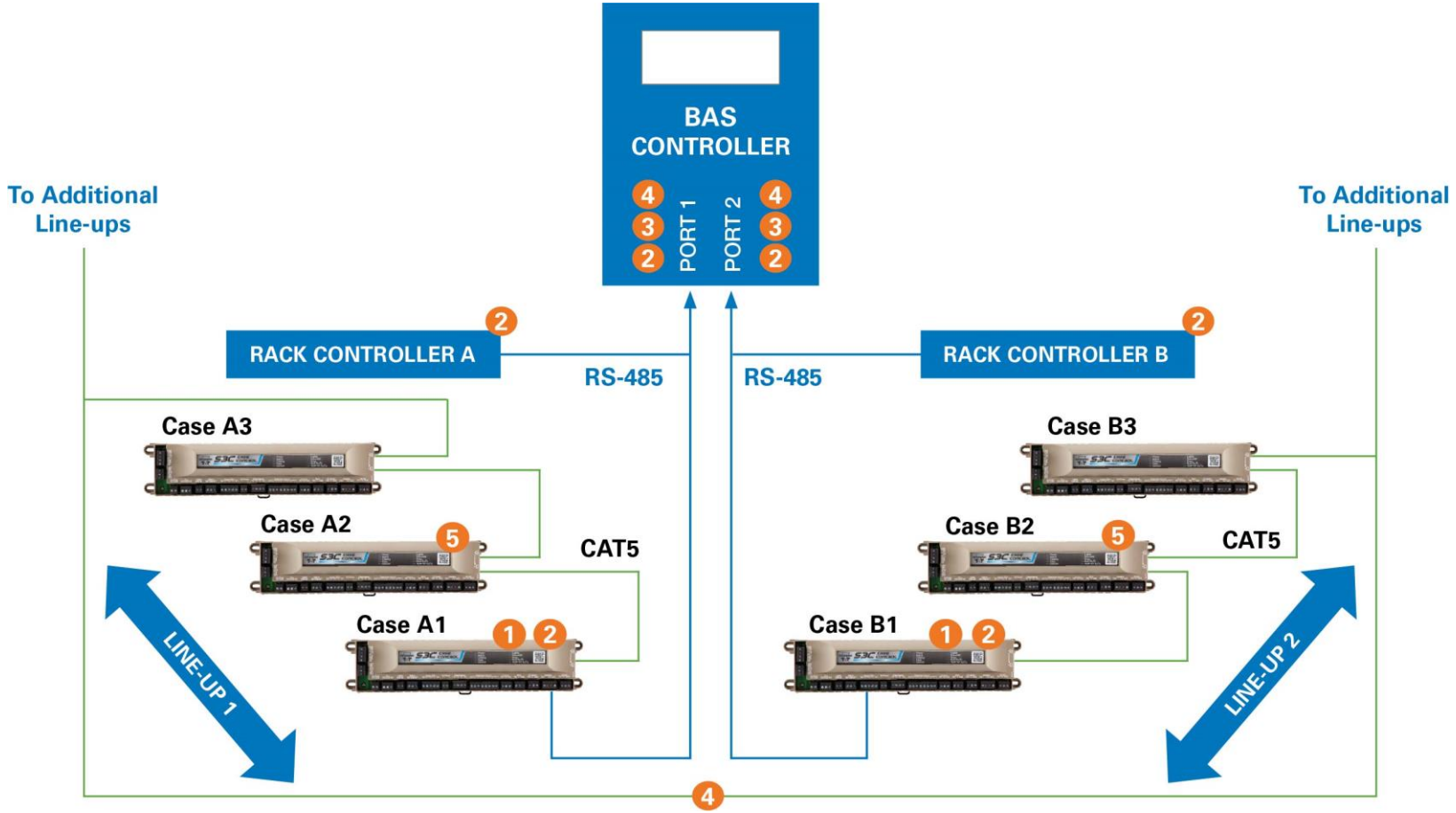
- 100 to 240 VAC @ 1.2A 50/60 HZ

Output

- 24VDC @ 2.5A

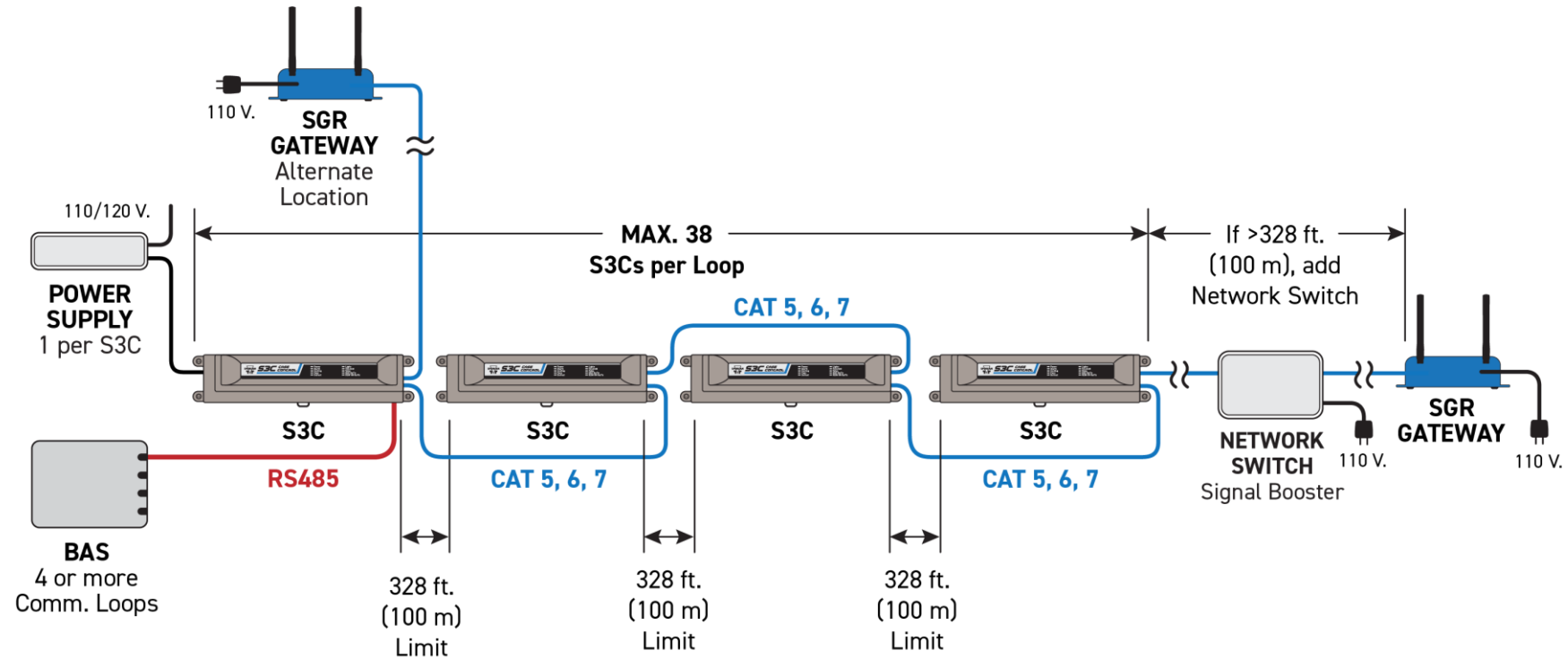


BAS Integration



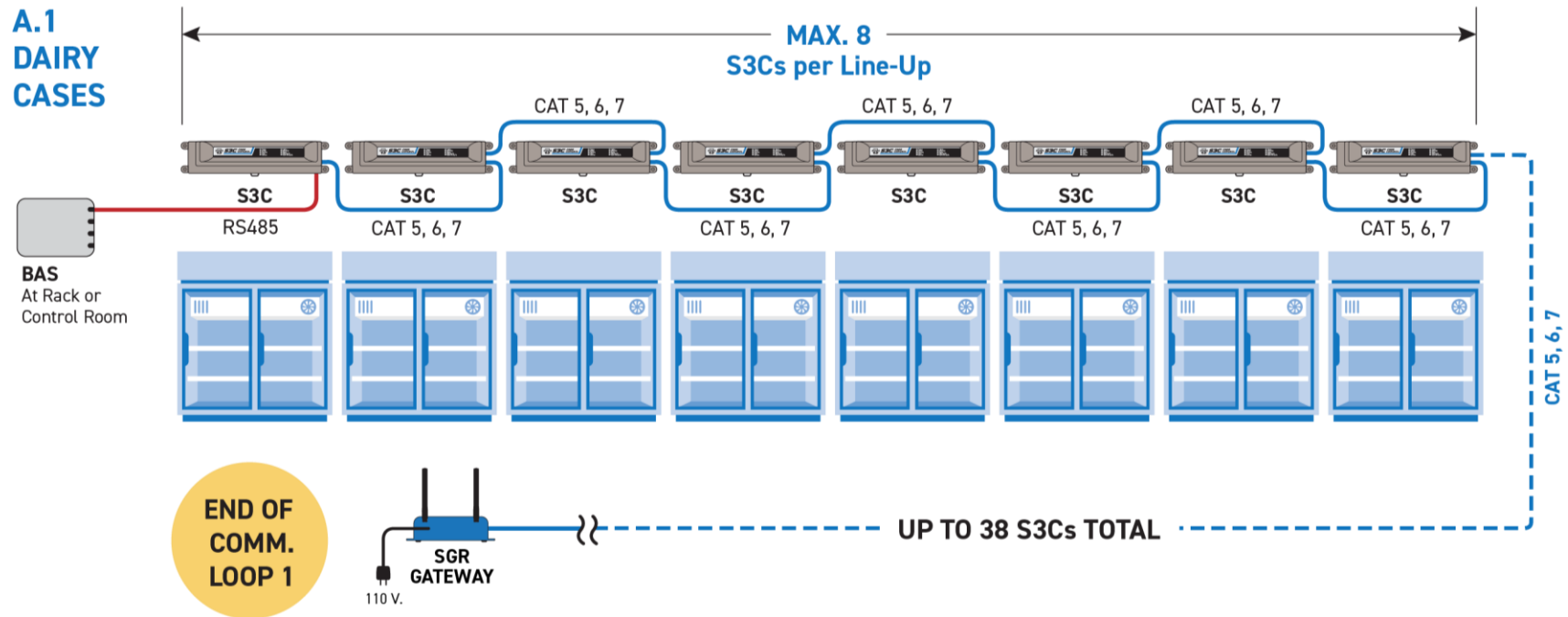
The Communication Loop

Components

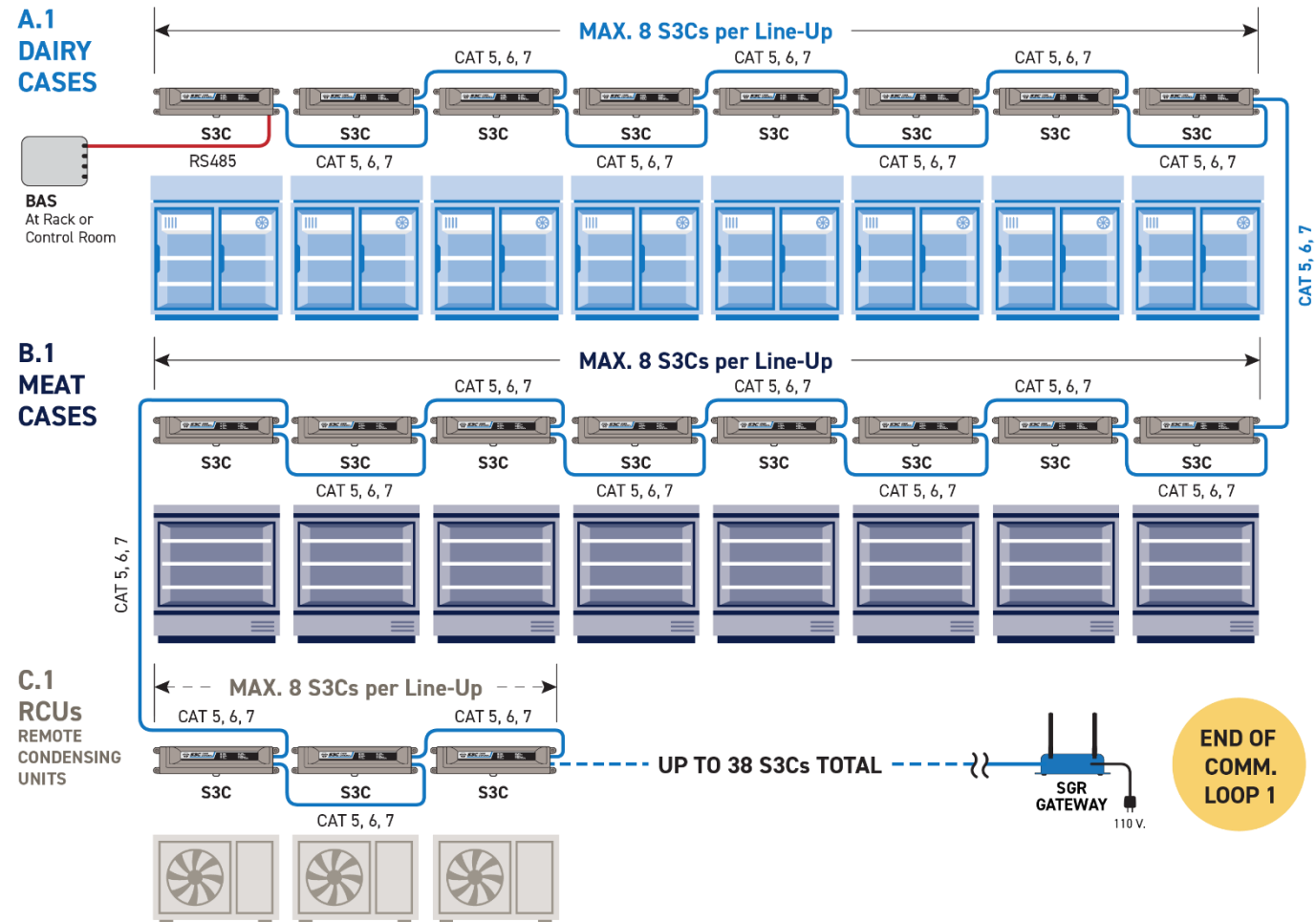


The Line-Up

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

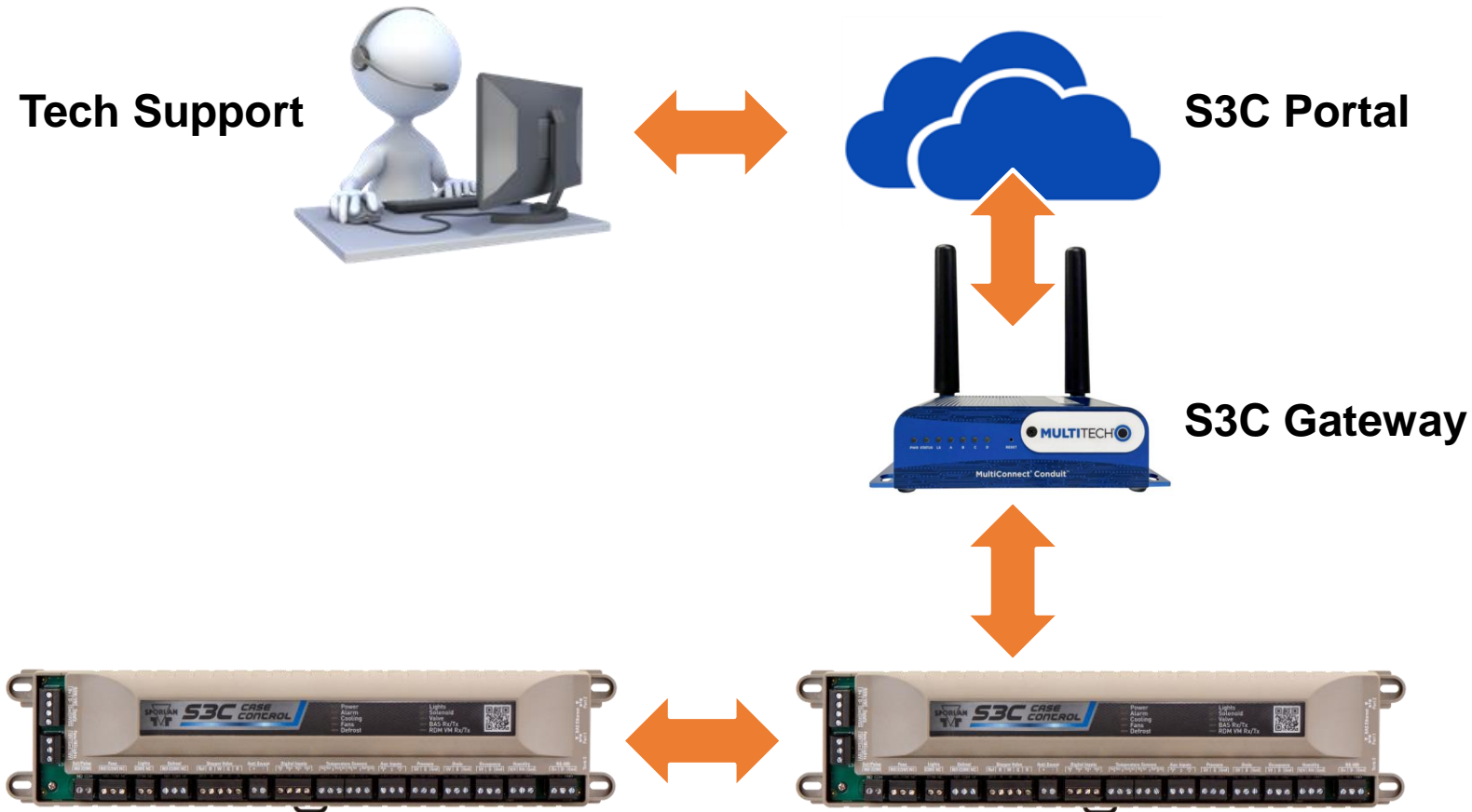


Back



Top

Gateway Portal



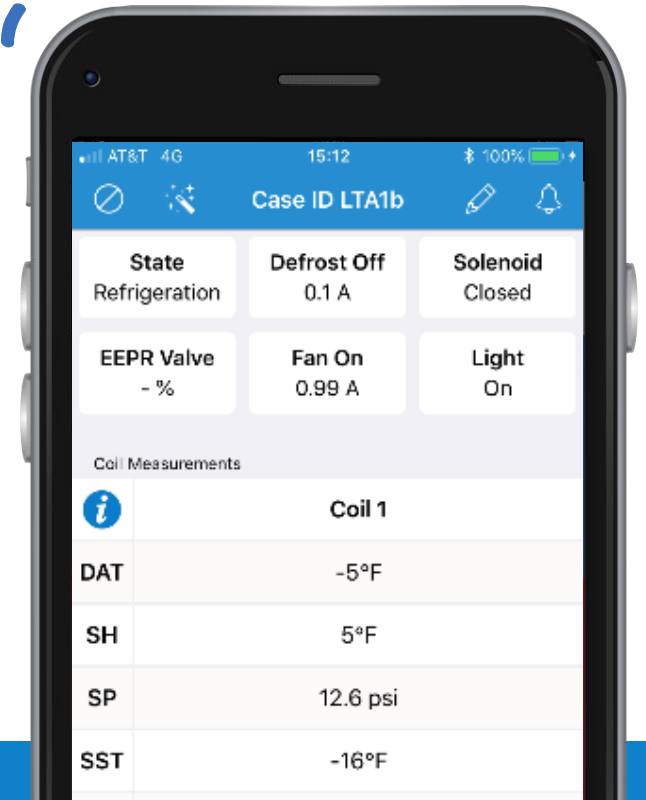
Wireless Access Sporlan Tech Check App

- **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



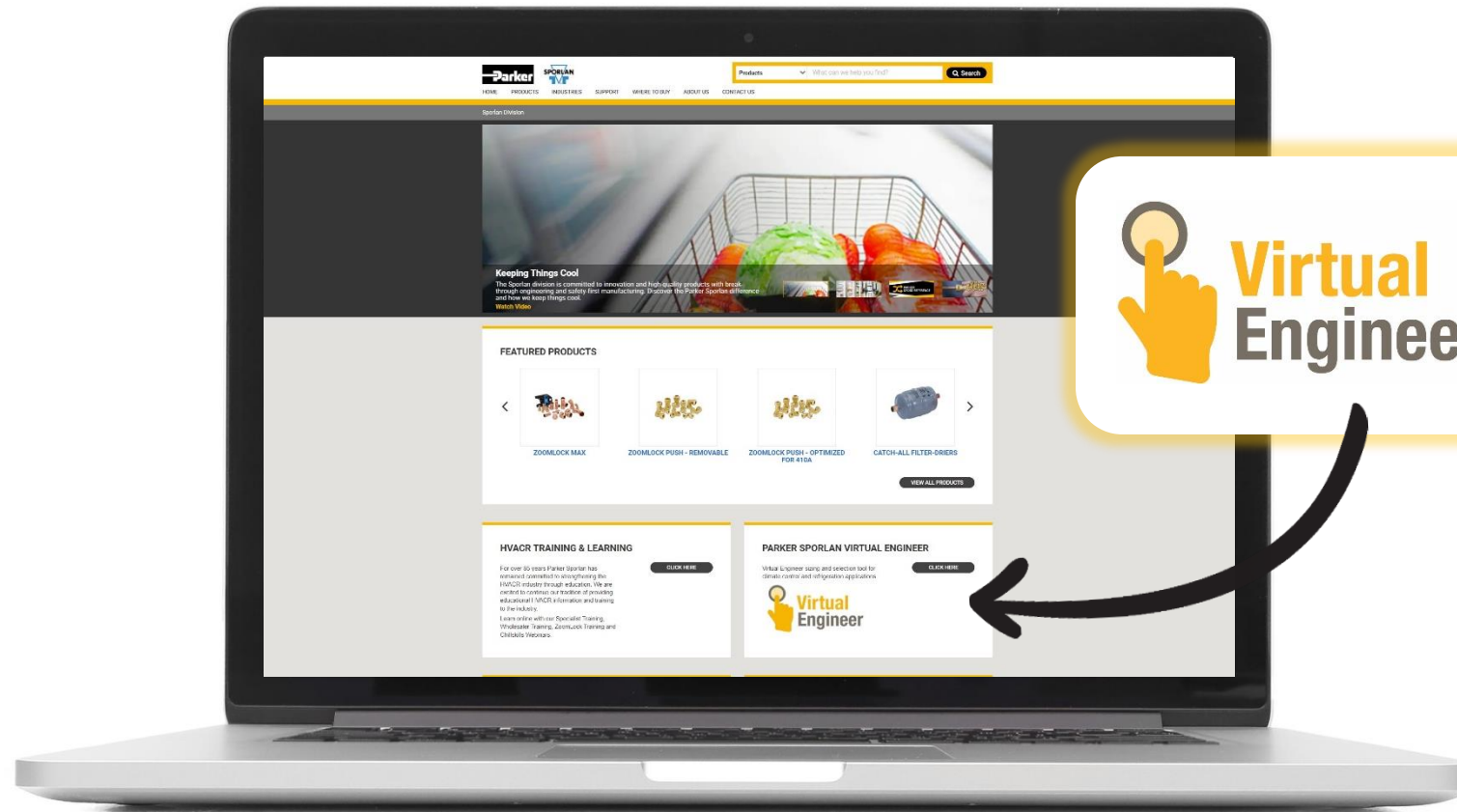
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TO ACCESS
VIRTUAL ENGINEER**

Virtual Engineer Selection Program
<http://solutions.parker.com/SporlanVirtualEngineer>

Virtual Engineer

SIZING AND SELECTION TOOL

Sporlan.com



Virtual Engineer

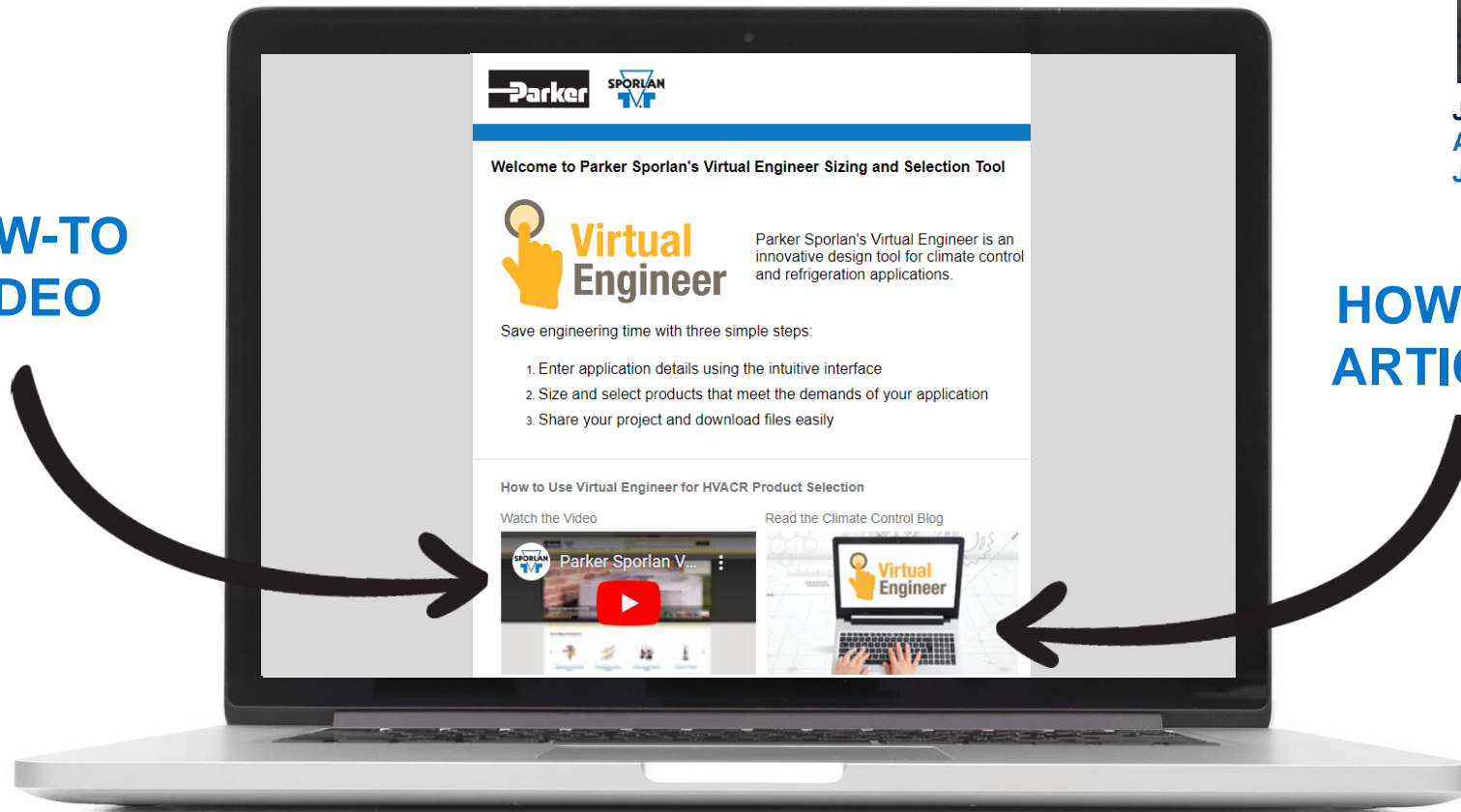
SIZING AND SELECTION TOOL



Jason Forshee
Application Engineer
Jason.Forshee@parker.com

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 OCCURS

53C CASE CONTROL
Installation and Operation Instructions
DECEMBER 2017 / BULLETIN 110-90-9-1

Using P-T Analysis As A Service Tool

Electric Expansion Valves
SER, SERI, SEHI
Apr 17 17 / Bulletin 110-29

P-T Chart Features:

- Refrigerants 134a, 404a, 407a, 507, 744 - CO₂
- Instructions for determining superheat
- Systematic Analysis
- Handy pocket size
- Android / IOS Mobile

Possible Causes:

- 1. Low side
- 2. High side
- 3. Low refrigerant charge
- 4. Dirty or restricted
- 5. High refrigerant charge
- 6. High pressure
- 7. High pressure
- 8. High pressure
- 9. High pressure
- 10. High pressure
- 11. High pressure
- 12. High pressure

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