



solutions for asia
natural refrigerants

3-5 February 2015 in Tokyo

***Controls designed to help improve
CO2 system pressure stability***

Abel Gnanakumar

Director- Refrigeration Marketing (Asia)

Emerson Climate Technologies

Key Areas for CO2 Refrigeration Development

Discuss Today

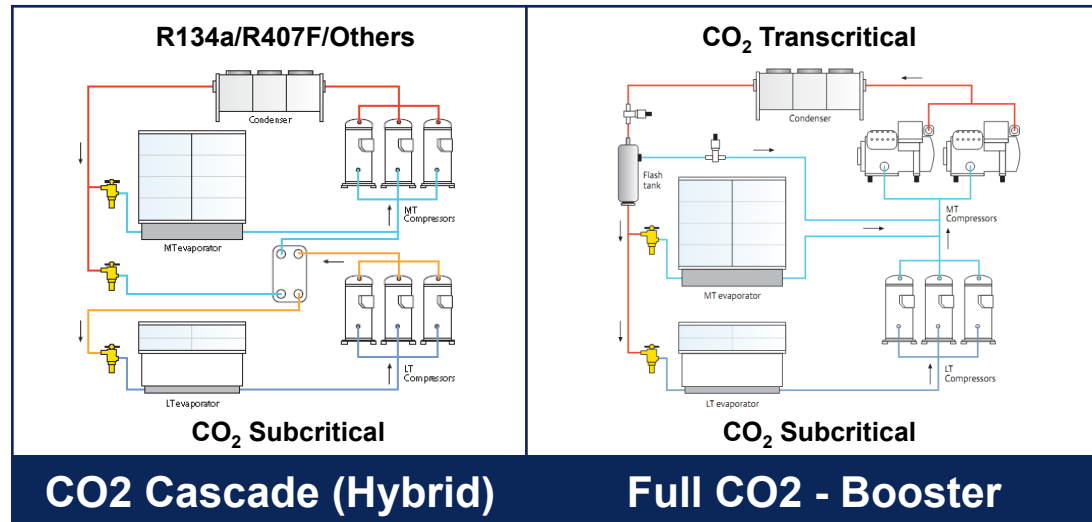
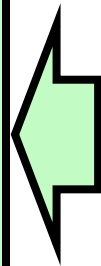
CO2 System Pressure Optimization Through

a

- Improving Flash Tank Pressure Stability

b

- Evaporator Pressure/temperature Stability



1

System Initial Cost

2

Innovation / Sustainable Performance

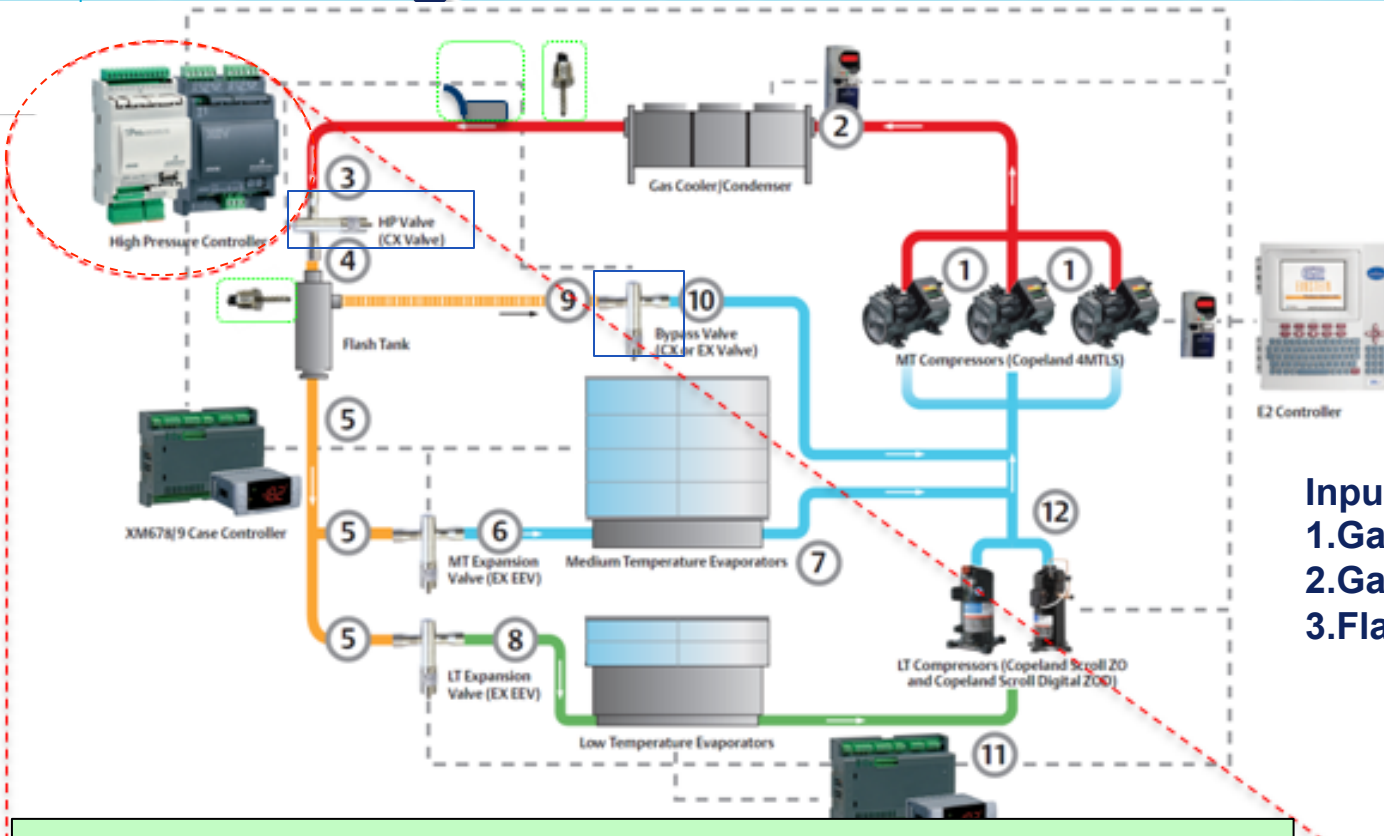
3

System Resilience

4

System Compactness & Sound

CO2 High Pressure Controller



Inputs

- 1. Gas Cooler Out Pressure
- 2. Gas Cooler Out Temp.
- 3. Flash Tank Pressure

Subcritical Operation

- Maintains Subcooling In Condenser

Transcritical Operation

- Ignores Subcooling Control & Controls Gas Cooler Pressure

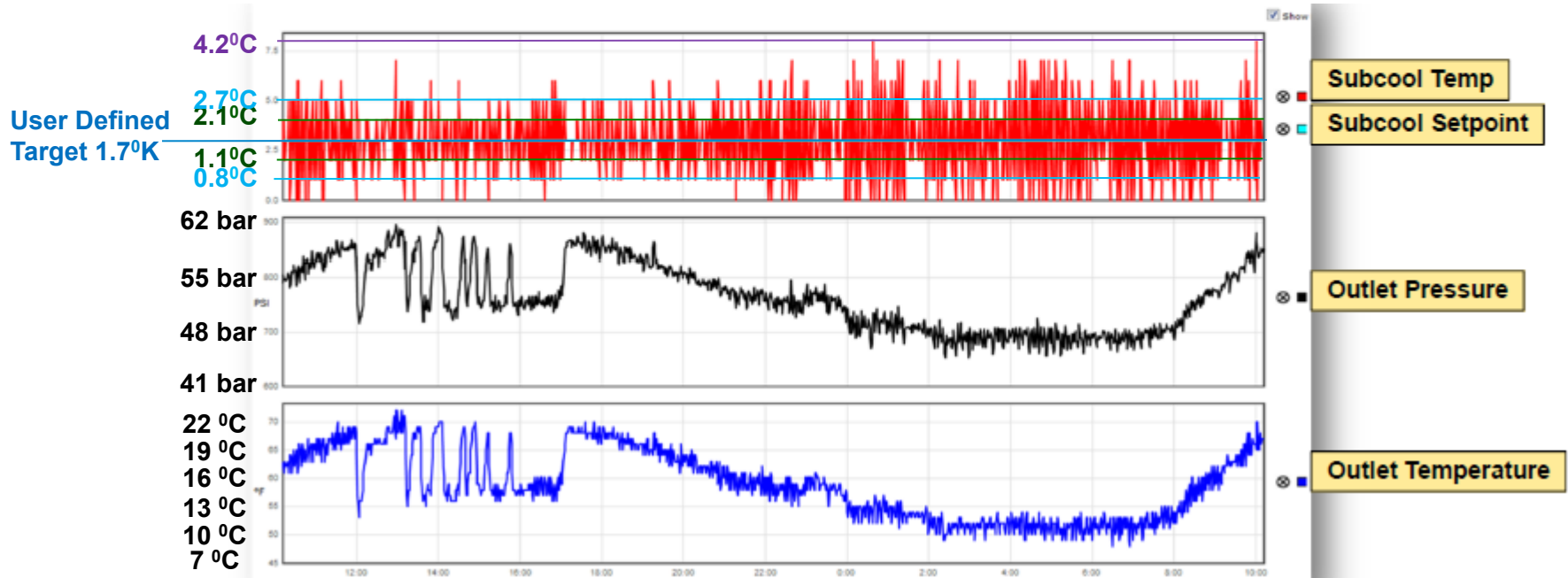
Transient Operation

- Hard Switch In Either Sub or Transcritical To Avoid Effects Of Rapid CO2 Density Change Zone

Controller Operation At Subcritical Condition

Controller Targets To Maintain Sub Cooling At The Outlet Of The Gas Cooler To An User Defined Set point

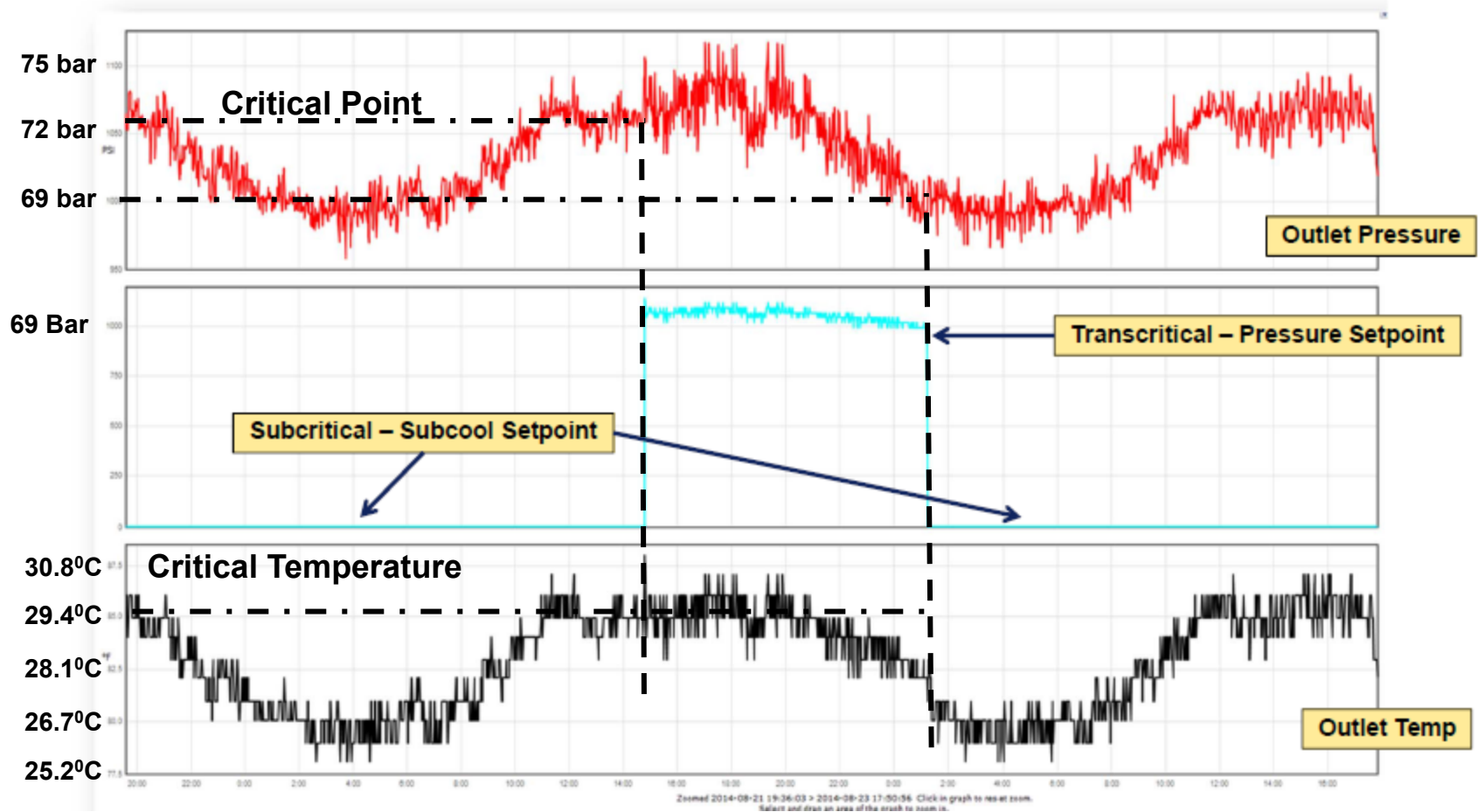
- User Defined Set Point Is 1.7K,
 - Maintaining With In Band Of +0.4 & -0.6 ~60% Of Time
 - Maintaining With In Band Of +1 & -0.9 ~25% Of Time
 - Maintaining With In Band Of +2.5 & -2.5 ~15% Of Time



a

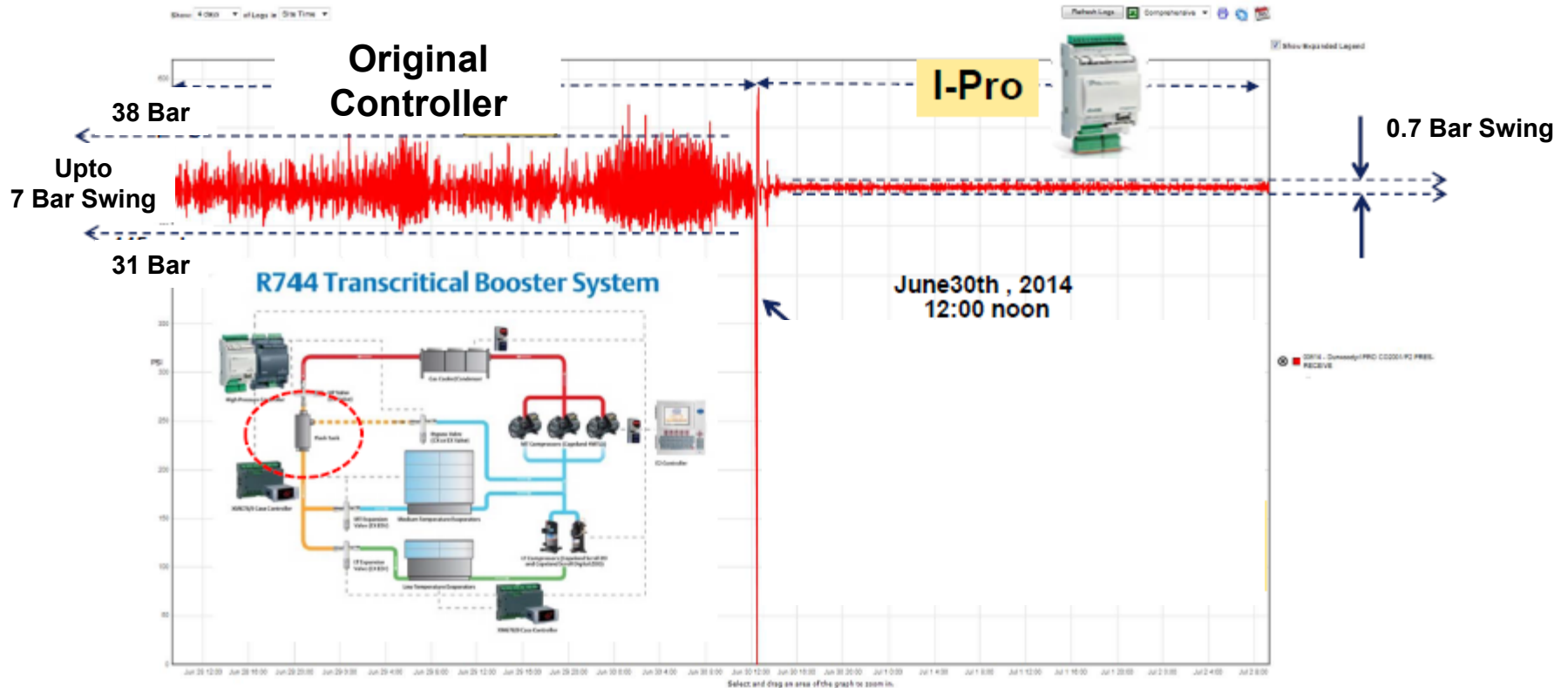
Hard Switch Between Trans & Subcritical, Avoids System Destabilization At Rapid Density Change Zone

Improving Flash Tank Pressure Stability



Improvement In Flash Tank Pressure

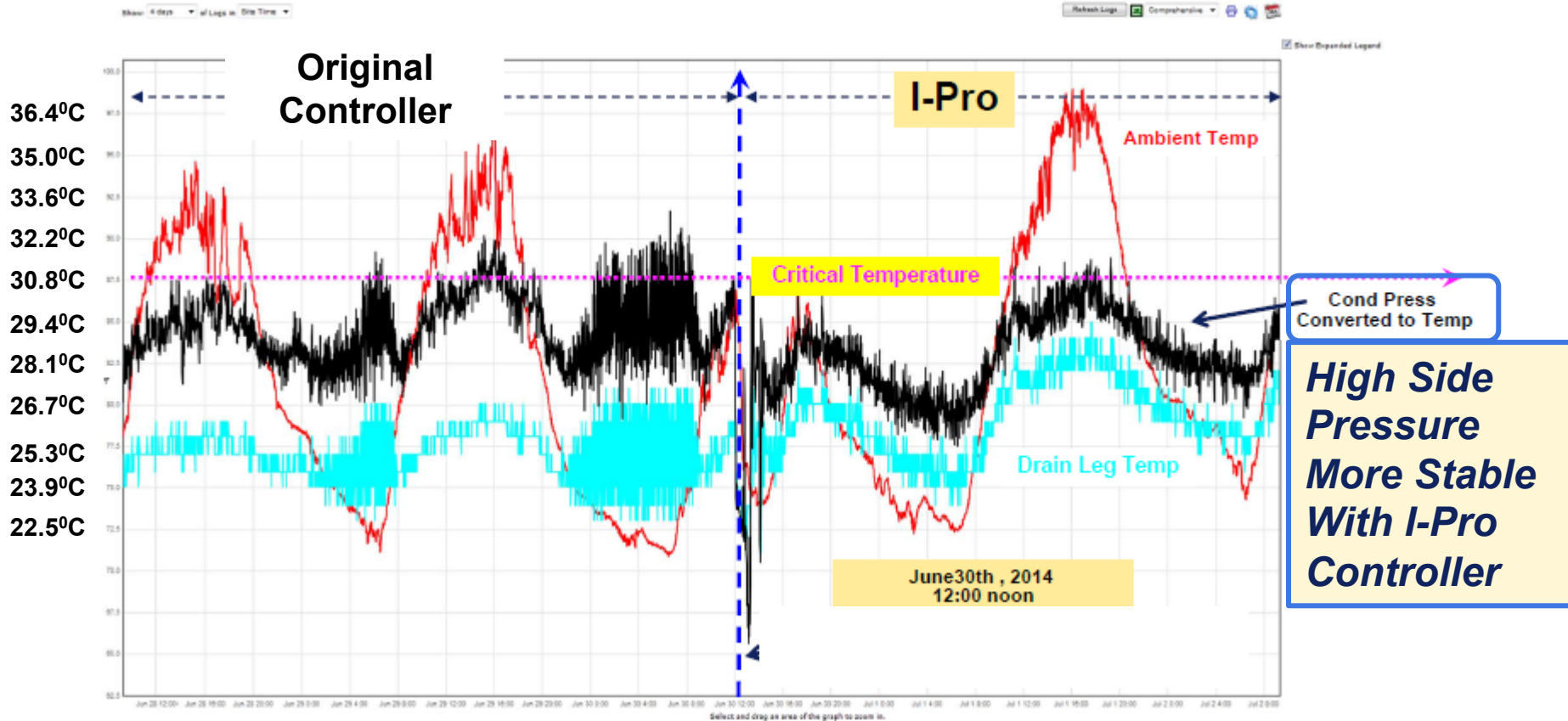
Flash Tank Pressure Trace In A Supermarket Site



Stable Flash Tank Pressure Helps EEV Stable Operation, Stable Pressure

a

Comparison Of Ambient, Condensing Temp And Sub-Cooled Liquid Temperature



Evaporator Expansion Valve Control

- Discussion Based On PWM Modulation Expansion Valve
 - Valve Modulates In Fully Open And Fully Close Positions In a Cycle Time
 - (Example In 6 Seconds Cycle Time)
 - 100% PWM : 6 Sec On/ 0 Sec Off
 - 50% PWM : 3 Sec On/ 3 Sec Off
 - 0% PWM : 0 Sec On/ 6 Sec Off
- In Conventional Control Method
 - EXV PWM Is Decided By Target Super Heat
- In Continuous Control Mode
 - EXV PWM Is Decided By Target Super Heat & Case Temperature
- In Continuous Mode Because Of Two Control Points, Controller Knows The Capacity Need And Does Not Go Often To 0% PWM.
 - Able To Maintain A More Steady Case Temperature And Pressure

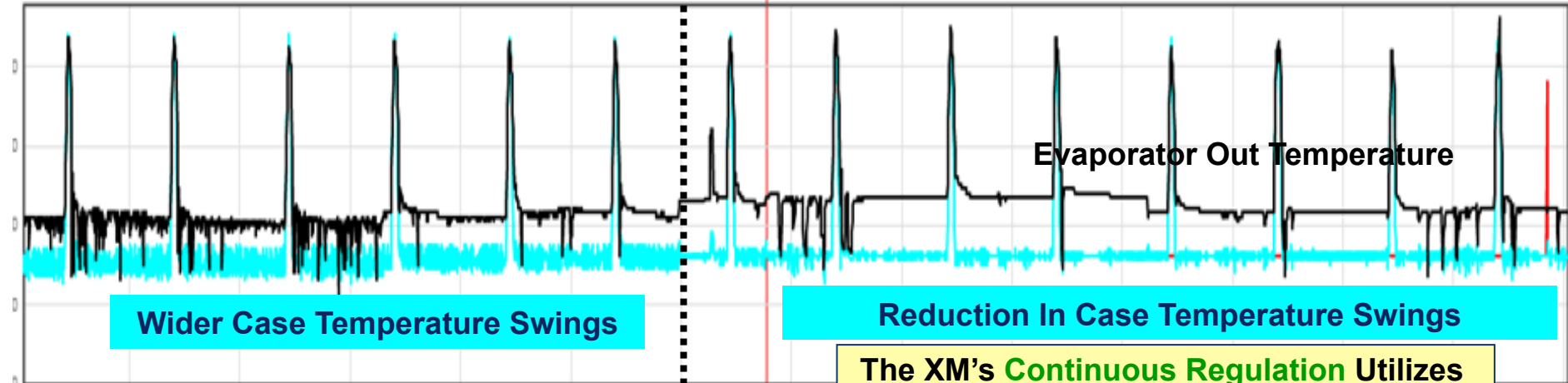


b

Continuous Regulation Mode In EXV Improves Evaporator Out Pressure

Conventional

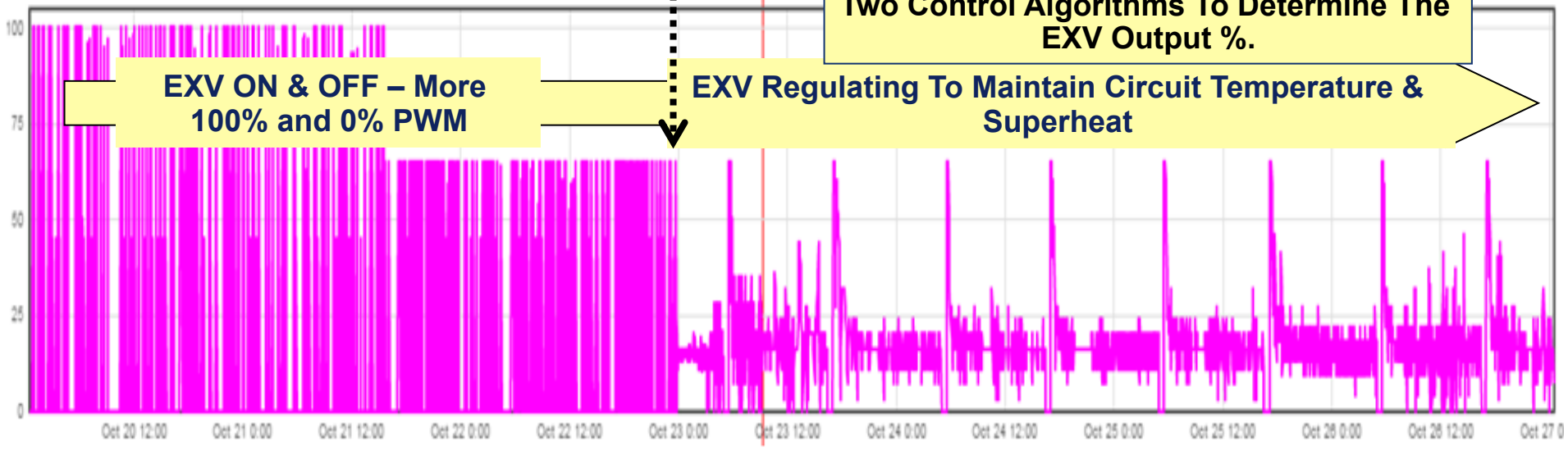
Continuous Mode



The XM's **Continuous Regulation** Utilizes Two Control Algorithms To Determine The EXV Output %.

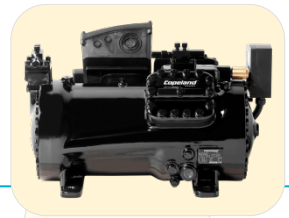
EXV ON & OFF – More 100% and 0% PWM

EXV Regulating To Maintain Circuit Temperature & Superheat



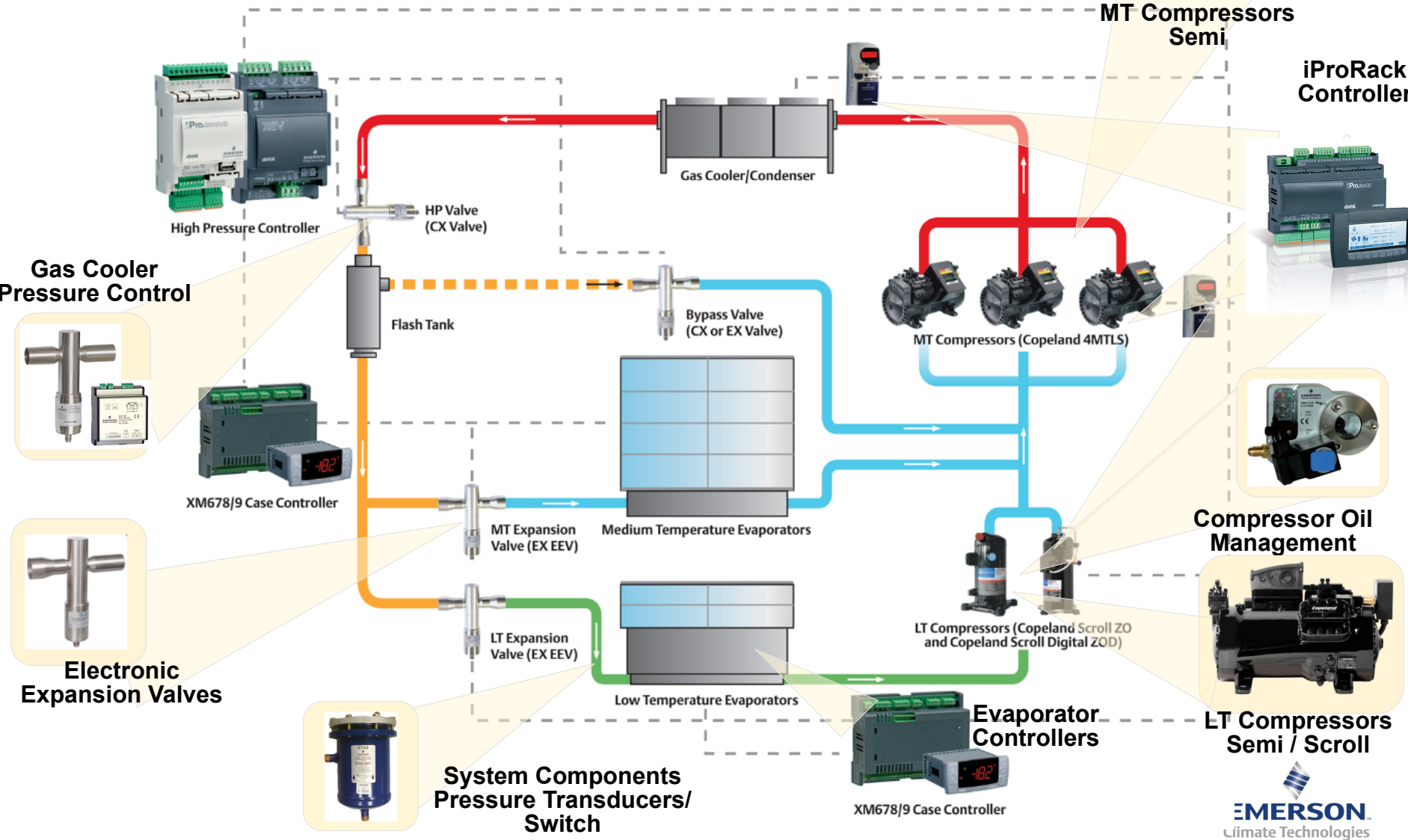
Widely Used In Australia In CO2 Stores Since 2013

Emerson Has Become A Unique Provider Of Complete CO2 Solutions



MT Compressors Semi

iProRack Controller



Gas Cooler Pressure Control



Electronic Expansion Valves



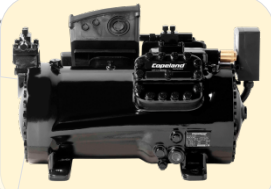
System Components Pressure Transducers/Switch



Compressor Oil Management



LT Compressors Semi / Scroll



MT Compressors (Copeland 4MTLS)

LT Compressors (Copeland Scroll Z0 and Copeland Scroll Digital Z0D)



Evaporator Controllers



High Pressure Controller



XM678/9 Case Controller



System Components Pressure Transducers/Switch



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Thank you very much!