



P E C I™

Energy for Change™

Supermarket Commissioning

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Agenda

- Supermarket Overview
- Functional Testing / Commissioning
- Energy Commissioning
- Commissioning Persistence

Why Commissioning?

- Potential for energy savings / energy cost avoidance
- Optimize equipment operation
 - Extend equipment life
 - Reduce maintenance costs
 - Ensure quality of perishable foods

Typical Grocery Store

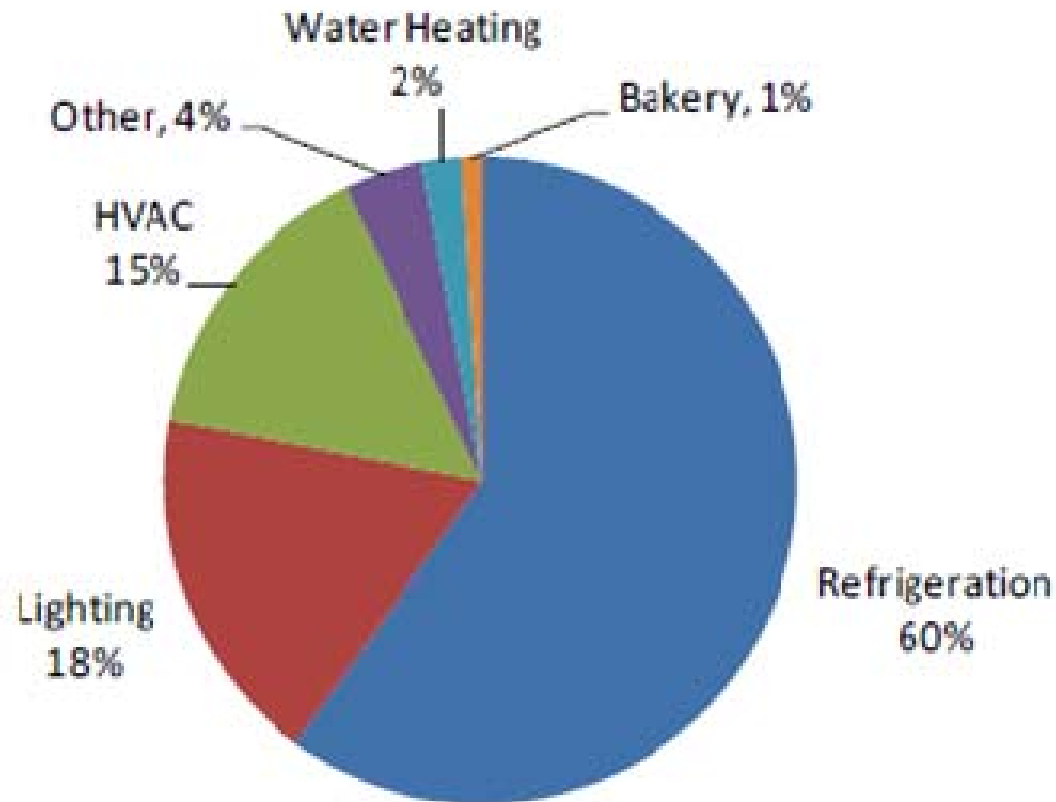


- 50,00-60,000 sq. ft
- 3,000,000 annual KWh
 - 54 KWh/sq. ft.

Store Energy Use

- 400 – 500 KW demand
- 3,000,000 annual KWh
- \$350,000 + annual electrical expenses
- National 1,000 store chain = \$350 million

Grocery Store Energy Use Profile



Source: EPA , 2007



Refrigeration Equipment

Heat Transfer Equipment

- Major Components:
 - Compressors
 - Condensers
 - Cases
 - Evaporators

Parallel Rack



Air Cooled Condenser



Display Cases



Storage Box Evaporator Coil



Typical Store

- 4 parallel racks
 - 16-30 compressors
- 4 condensers
 - 30- 50 horsepower
- 145 refrigerated cases
 - 500 – 600 fan motors
- 15 storage box evaporators
 - 40 - 50 fan motors

Control Valves



Evaporator Pressure Regulator

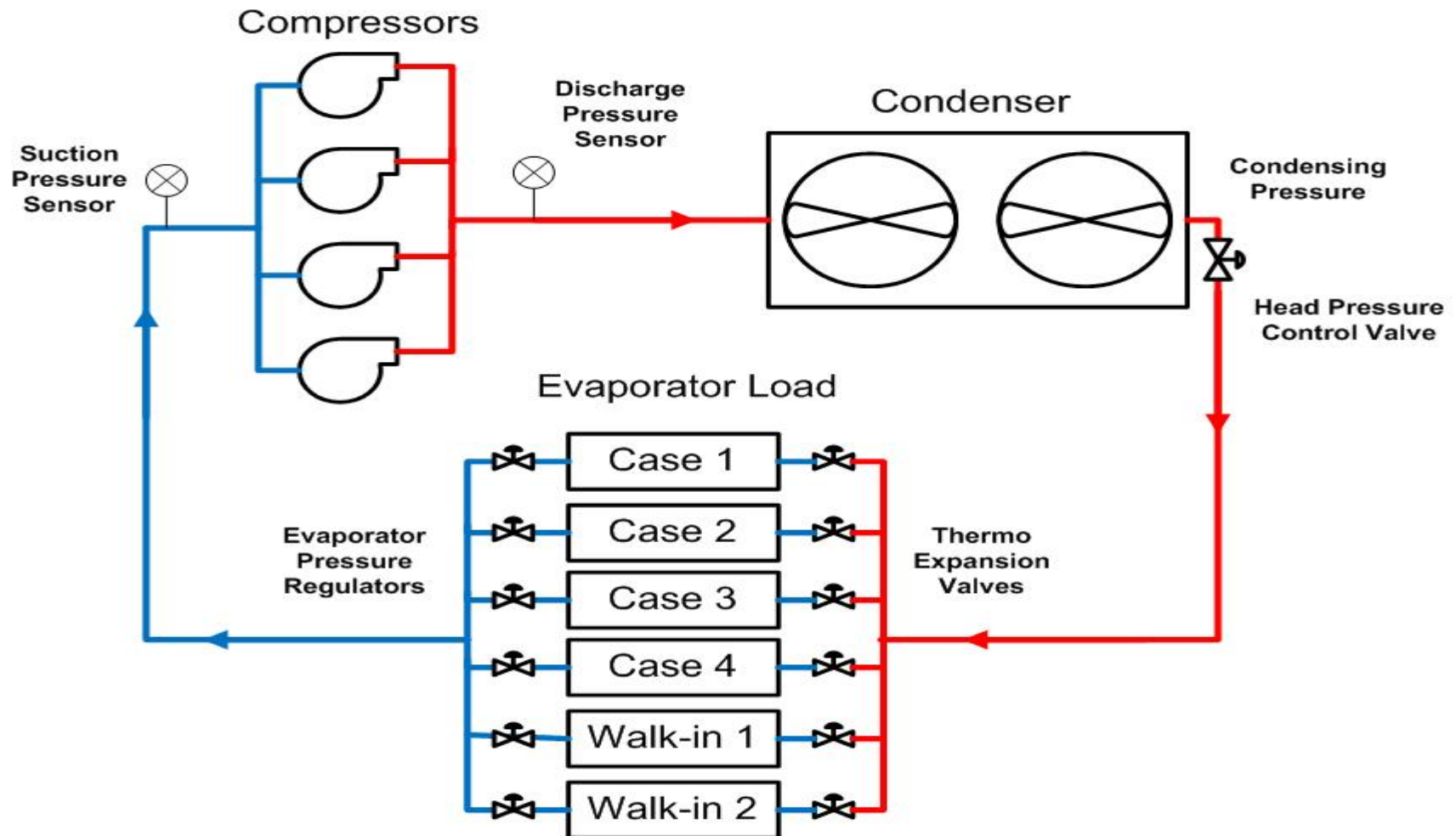


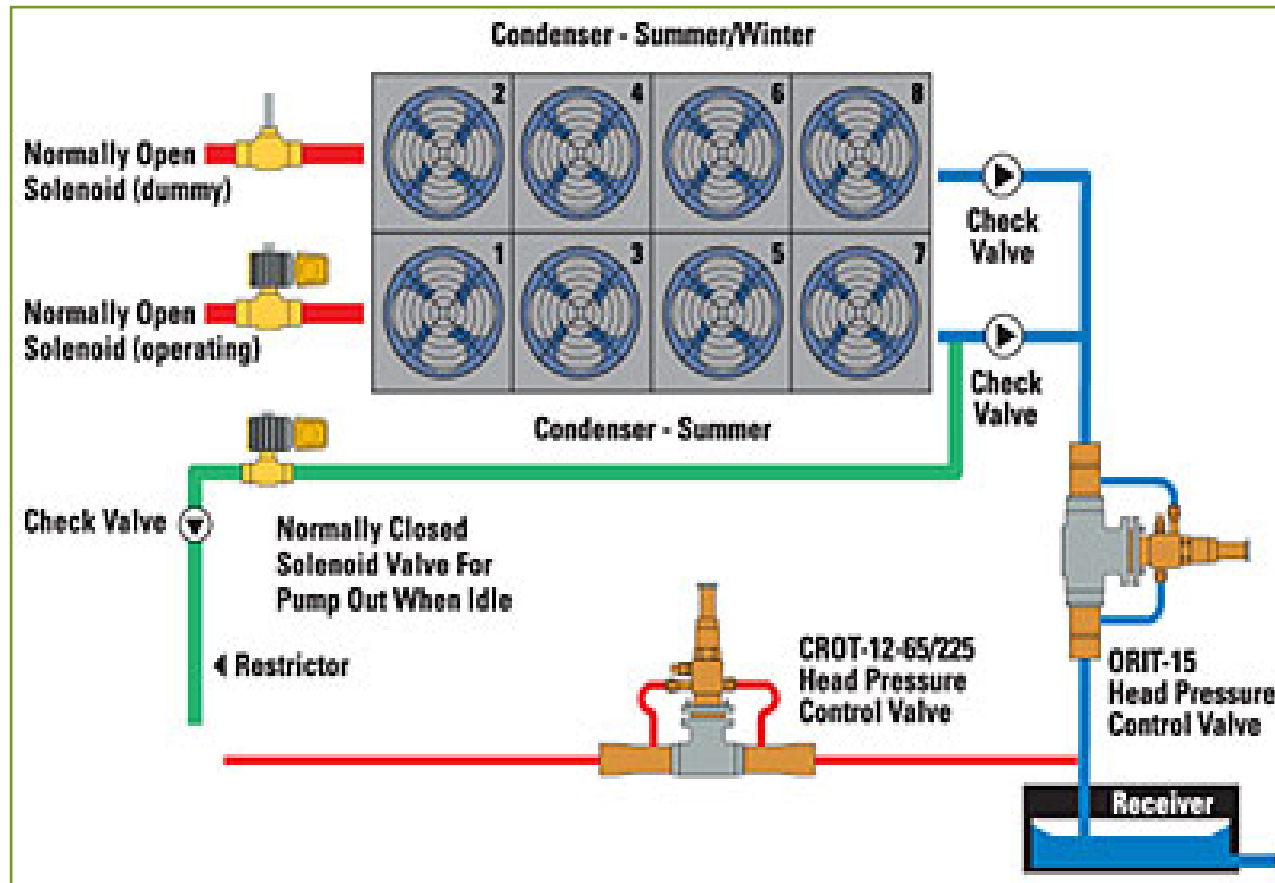
Thermo Expansion Valve

Head Pressure Control Valve
(Condenser flooding valve)



Piping Schematic





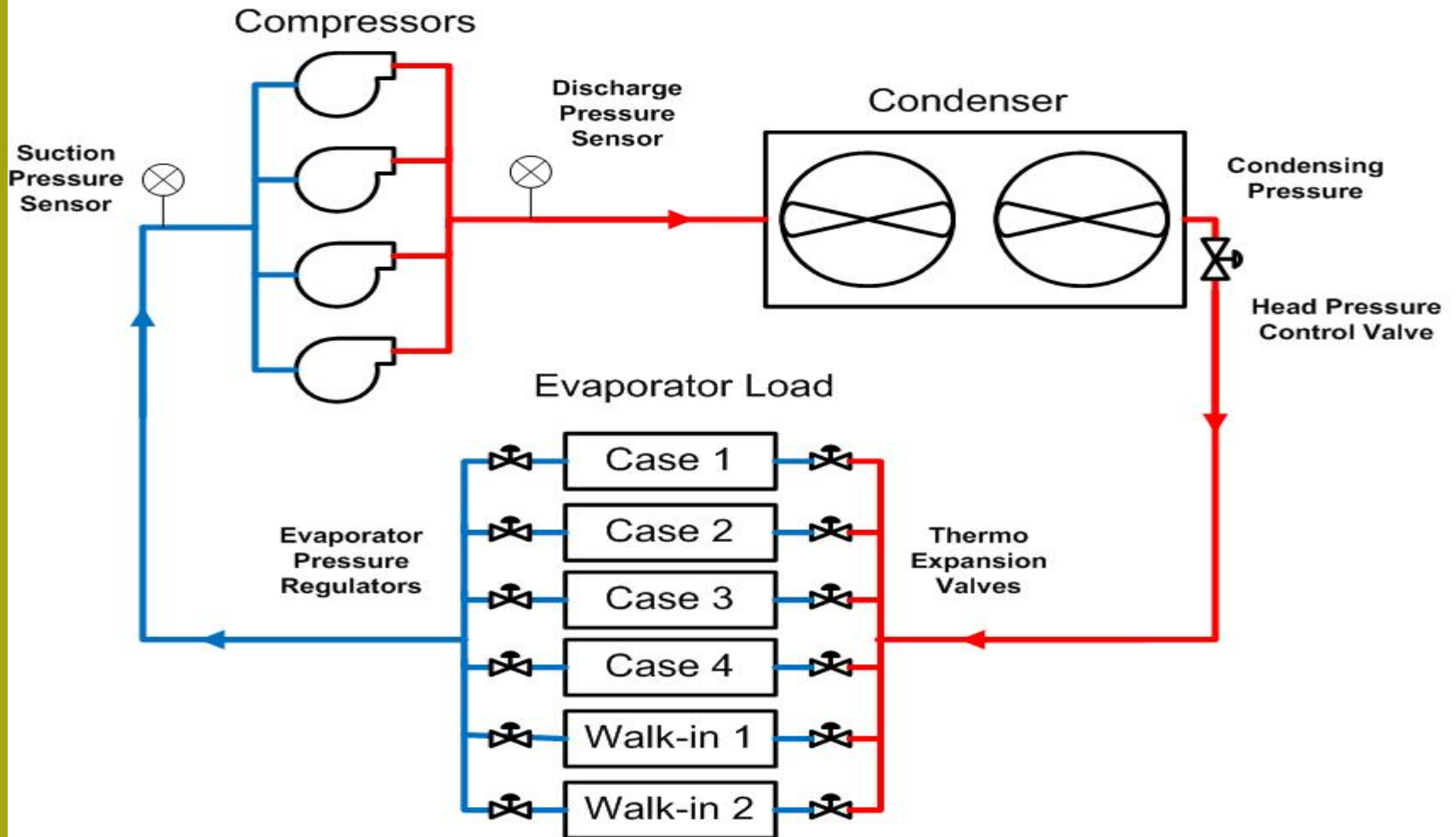
Typical Store

- Thermo expansion valves: 160
- Head pressure control valves: 4
- Evaporator pressure regulator valves: 40

Energy Management System



Piping Schematic



Rack w/ EMS



Typical Store

- EMS Panels: 4-5
- Pressure transducers : 8-10
- Temperature sensors: 160
- Dew point sensors: 2

EMS Panel

- PID algorithms for control of:
- Compressor cycling
- Discharge pressure
- Suction pressure
- Condenser fans
- Anti sweat heaters
- HVAC
- Lighting



Refrigeration System Commissioning



It Starts Here

HVAC system

Frozen Food case anti sweat heaters

Case lights

It Ends Here

Heat transfer equipment

Control valves

Energy Management System

Key HVAC Commissioning Tasks



Temperature, Dew point sensor calibration

Fresh air damper adjustment

EMS functional operation

Compressor unloader adjustment

Night setback / Blower motor night cycle

Key Anti Sweat Heater Commissioning



Verify all frozen door control

Verify fans and lights separated

EMS functional operation

Key Lighting Commissioning Tasks



Case lights TOD schedule

EMS functional operation

Compressor Power Equation

$$P_c = m_R \cdot P_s \cdot \frac{\alpha}{\alpha - 1} \cdot \frac{1}{\rho_s} \cdot \left[\left(\frac{P_d}{P_s} \right)^{\frac{\alpha - 1}{\alpha}} - 1 \right] \dots \dots \dots (1)$$

System Energy Optimization

- Reduce system energy use:
- Lower compressor compression ratio
 - lower discharge pressure
 - higher suction pressure
- Increase refrigerant density

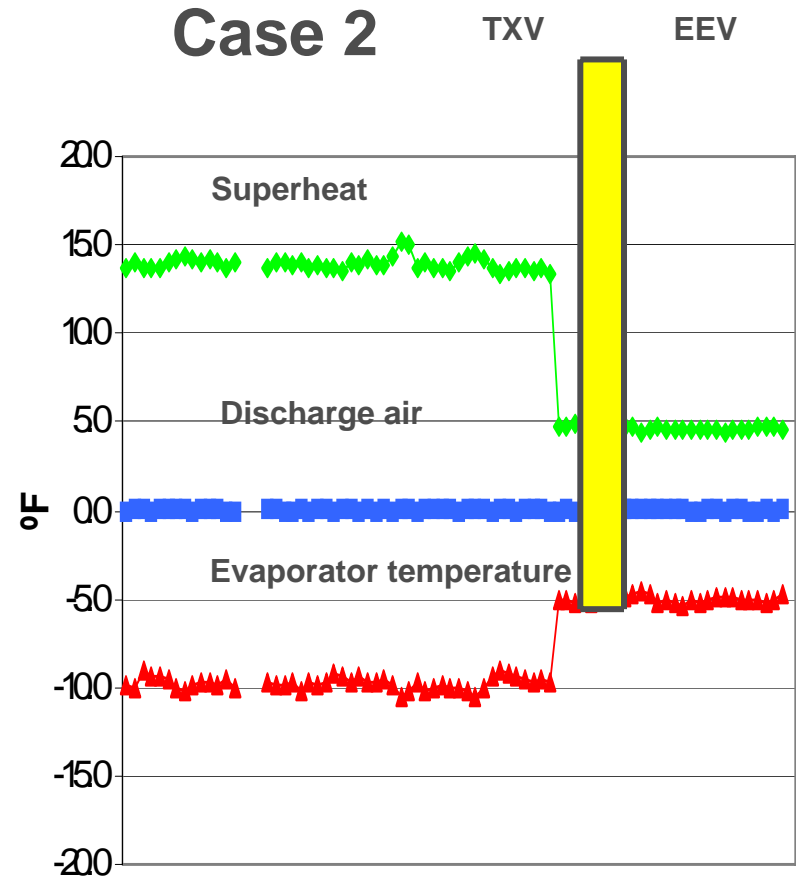
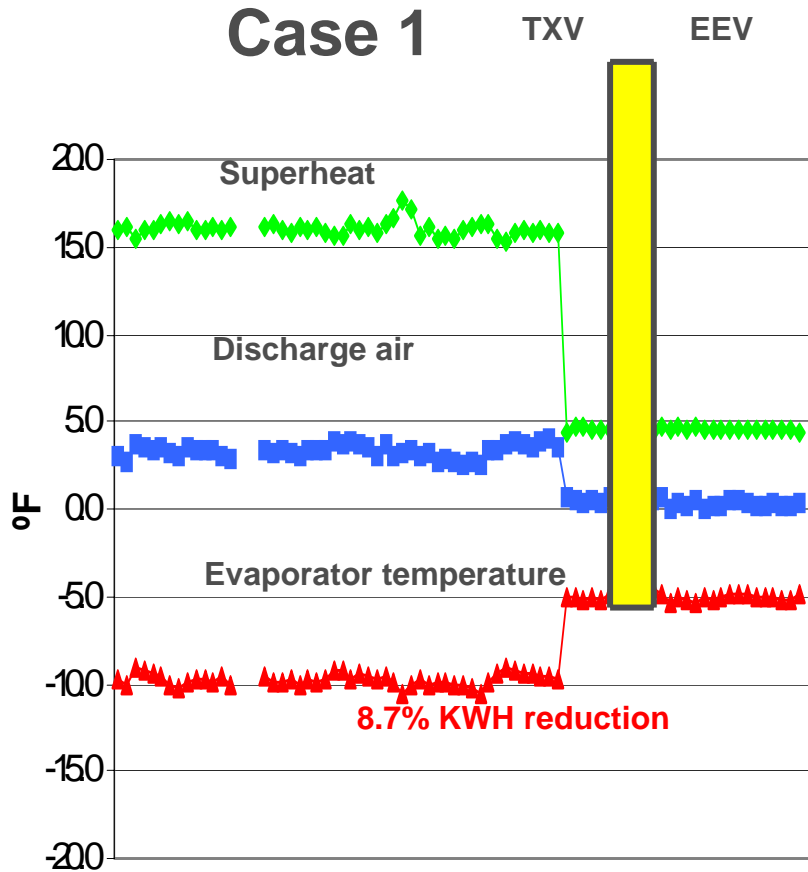
Key Refrigeration Commissioning Tasks



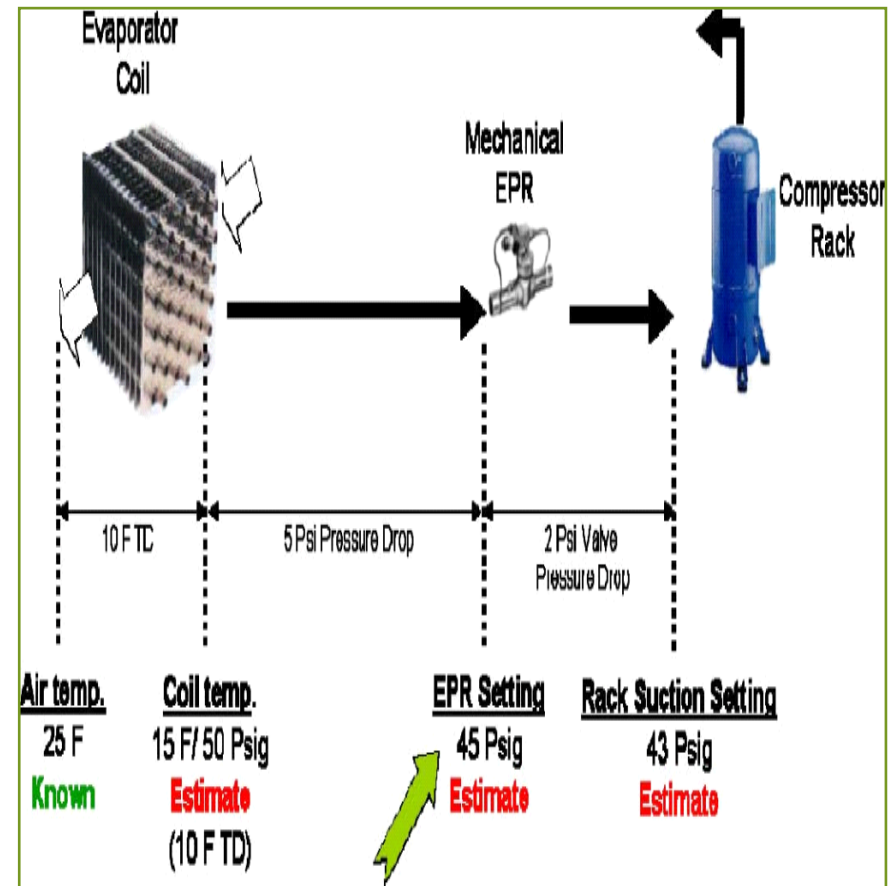
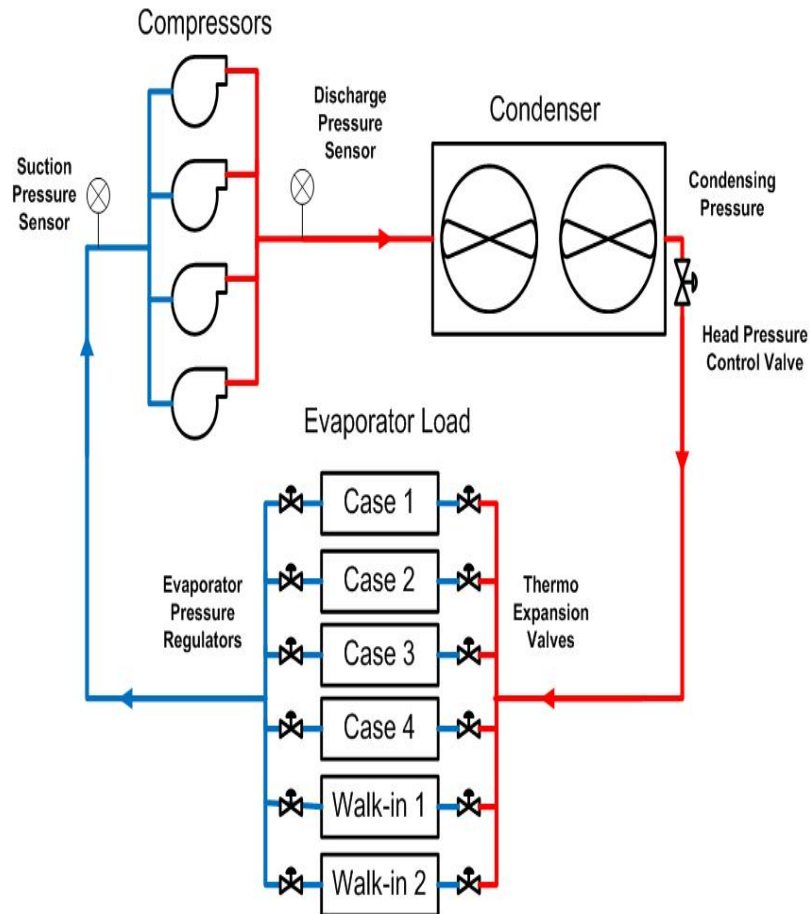
1. Calibrate sensors
2. Adjust evaporator super heats
3. Adjust EPR settings
4. Adjust condenser pressure controls
5. Program EMS for:
Floating Head Pressure / Floating Suction Pressure
6. Program suction pressure dead band for minimal compressor cycle count

Expansion valve adjustment

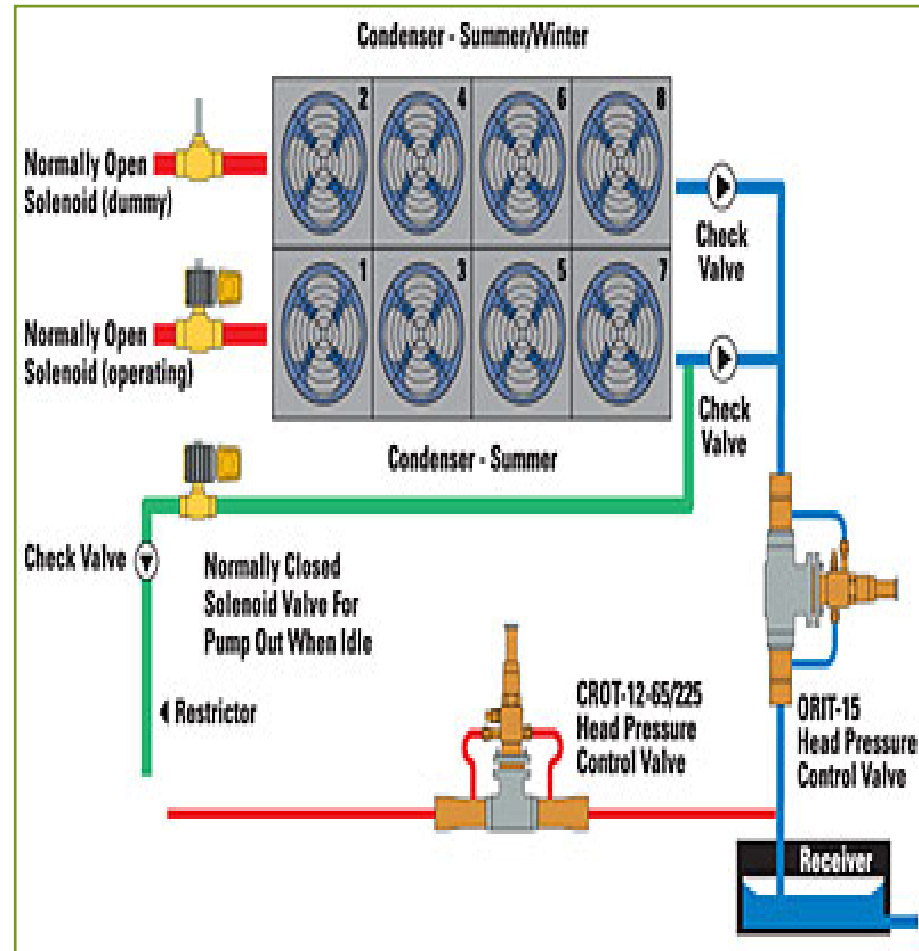
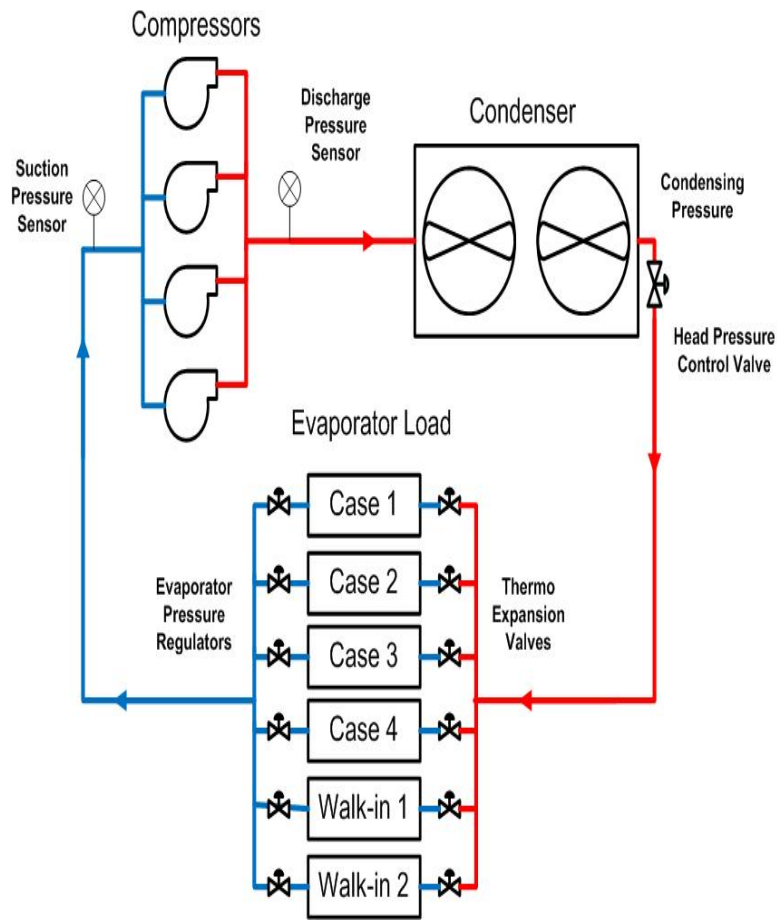
Glass Door frozen food



Suction Pressure Control Logic



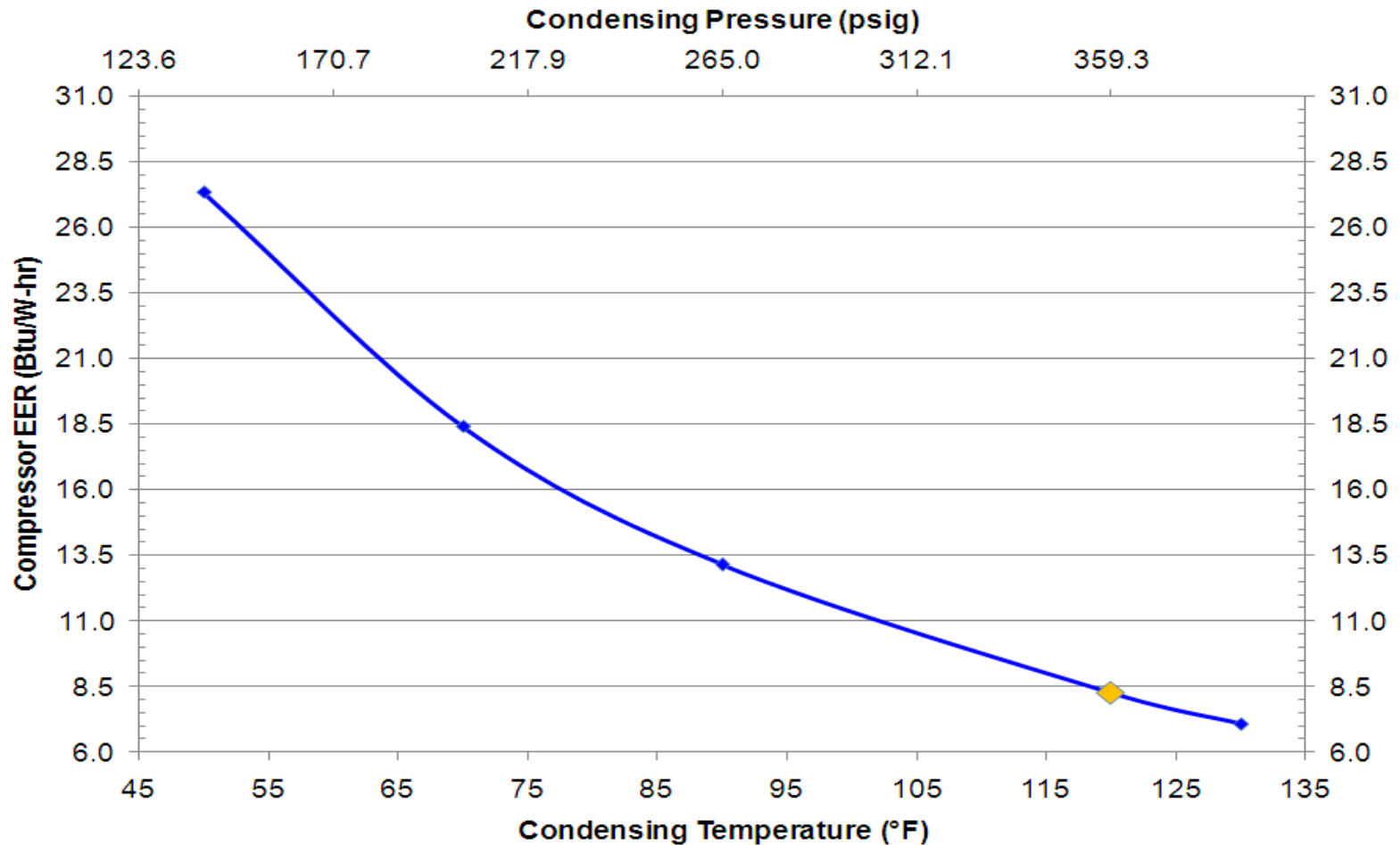
Condenser Pressure Adjustment



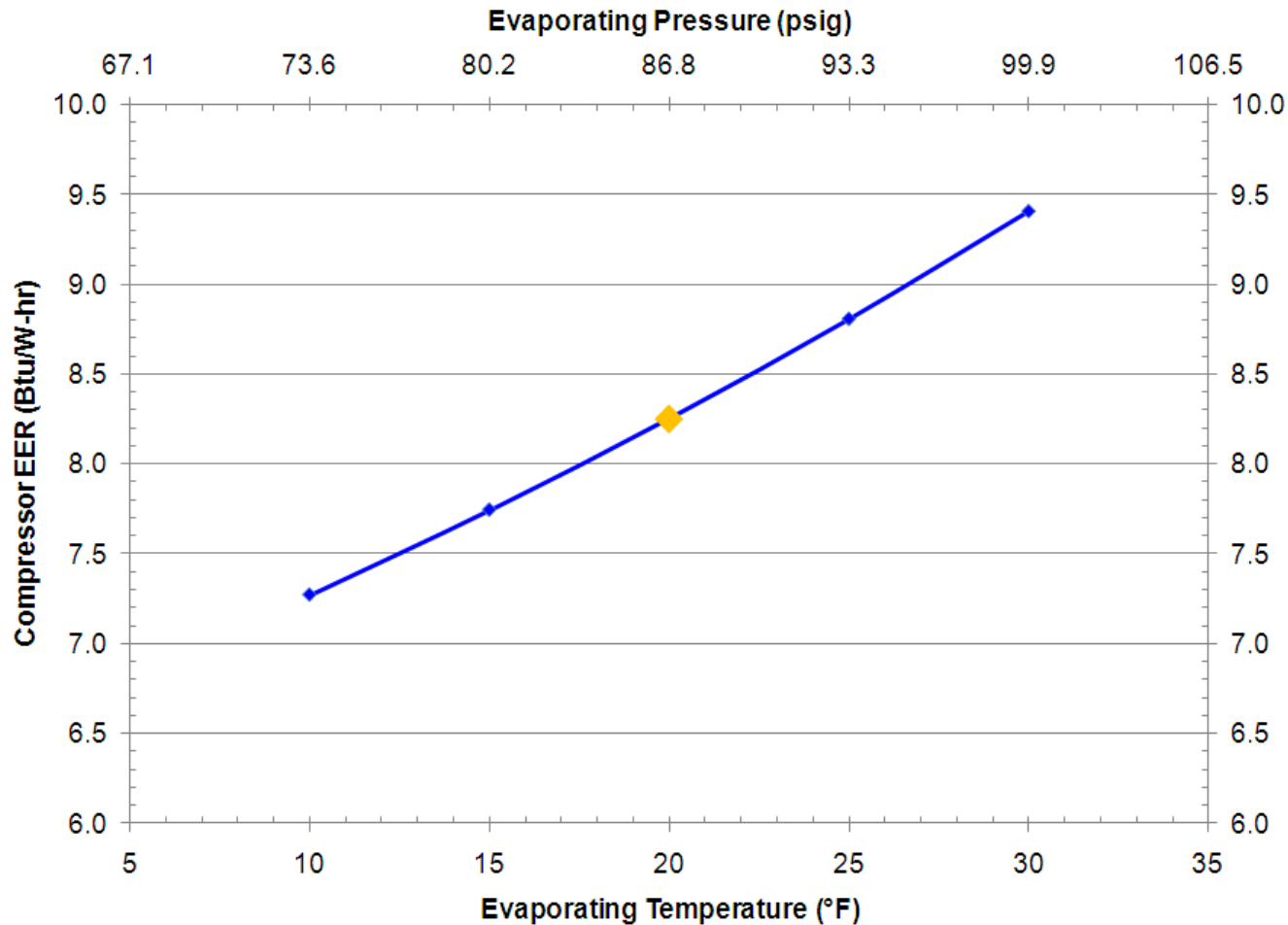
System Application Engineering

- Compressor evaporator loads based on 75 / 55
- Condensers and compressors sized for maximum case load at summer design ambients

Effects of Condensing Temp./Pressure on Compressor Efficiency



Effects Of Suction Temp/Pressure on Compressor Efficiency



Courtesy, Emerson

Floating Control Strategies

- Floating Head Pressure

Allowing system head/condensing pressure set point to float down with outside ambient temperatures

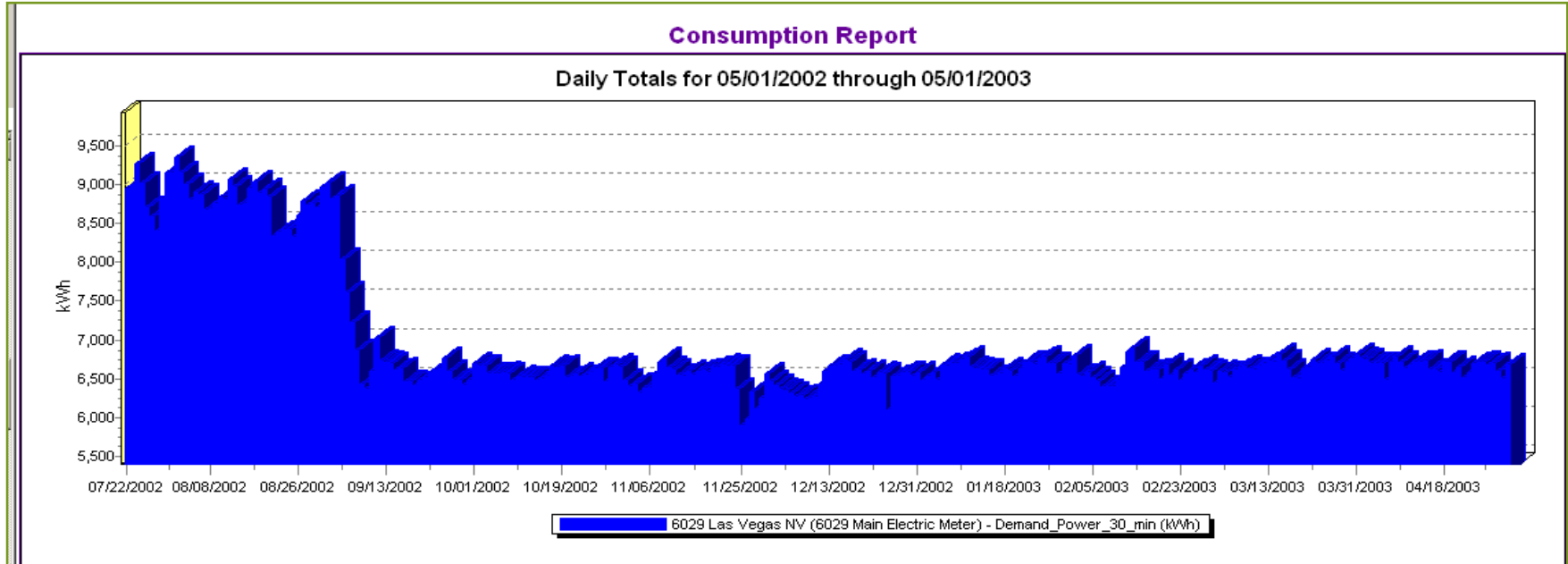
- Floating Suction Pressure

Allowing compressor suction pressure set point to float up as evaporator loads are reduced

The Value of Energy Commissioning

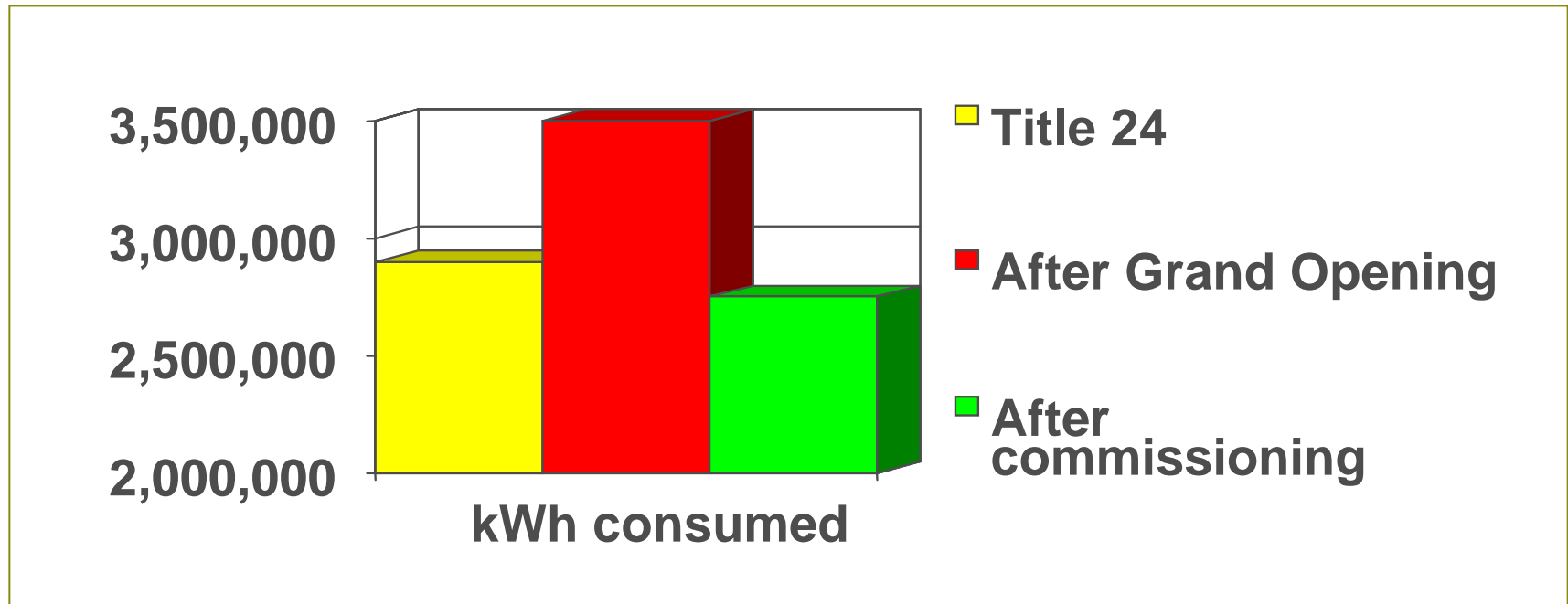


Commissioning Impacts Energy Consumption



The Value of Energy Commissioning

Case Study: Commissioning Results in Energy Savings



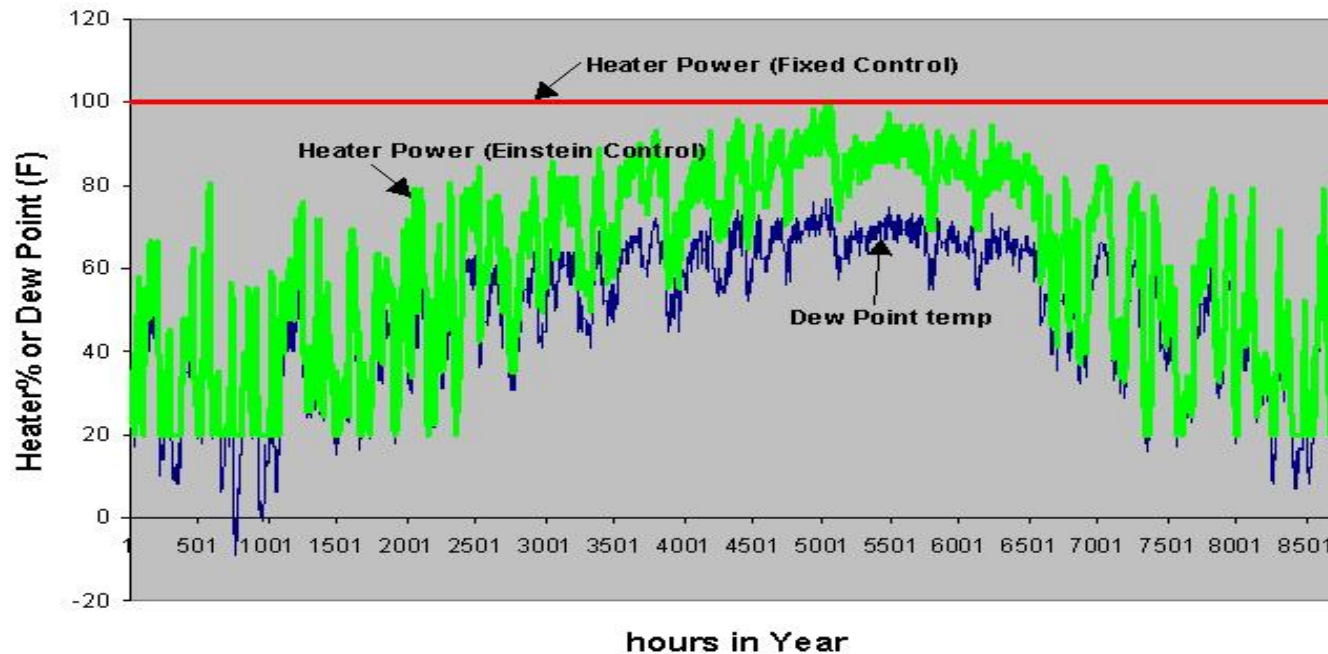
730,000 kWh @ \$.08/kWh = \$58,000/yr savings

Additional savings in maintenance costs

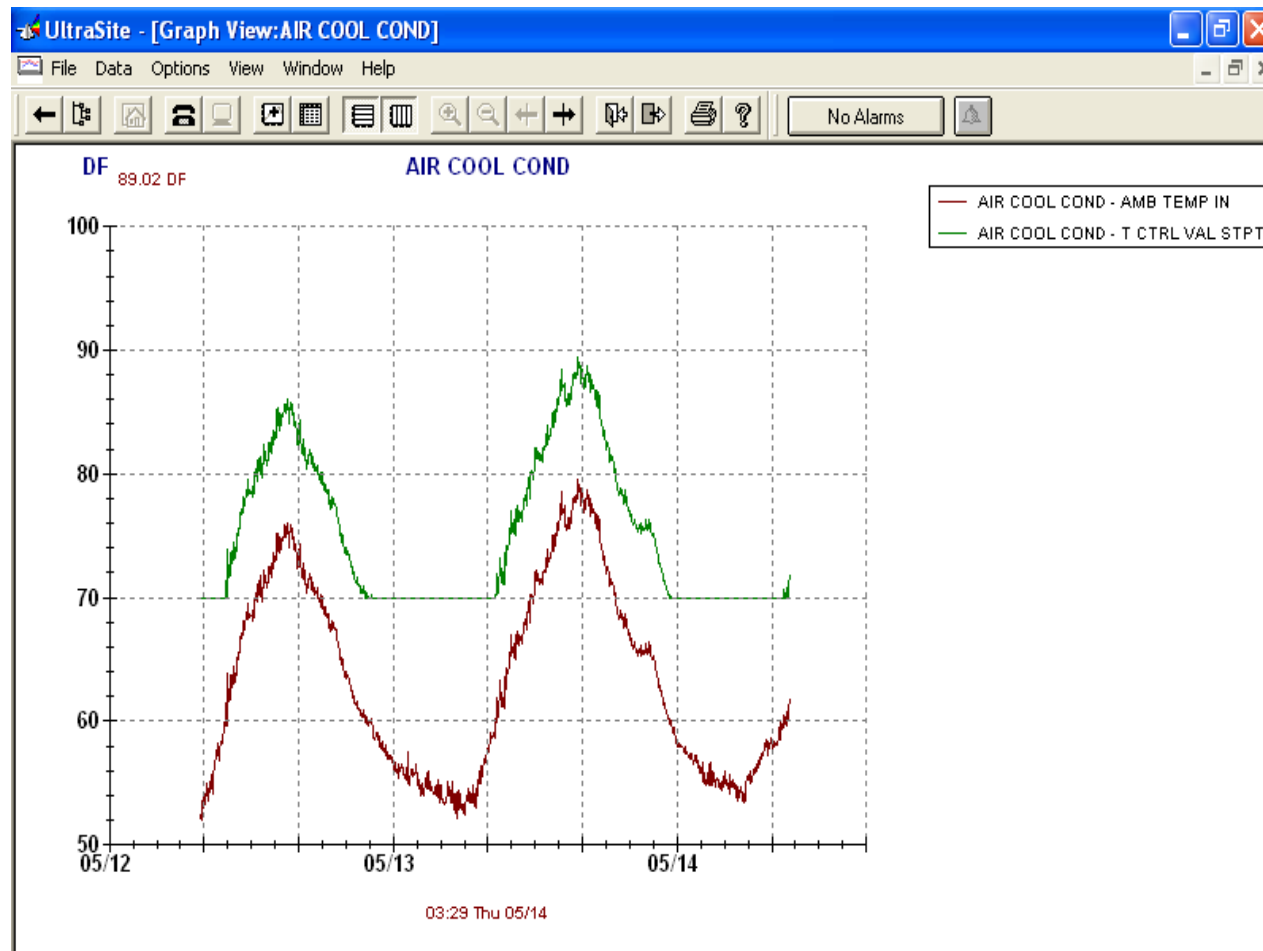
Courtesy, Albertson's

Commissioning Anti Sweats

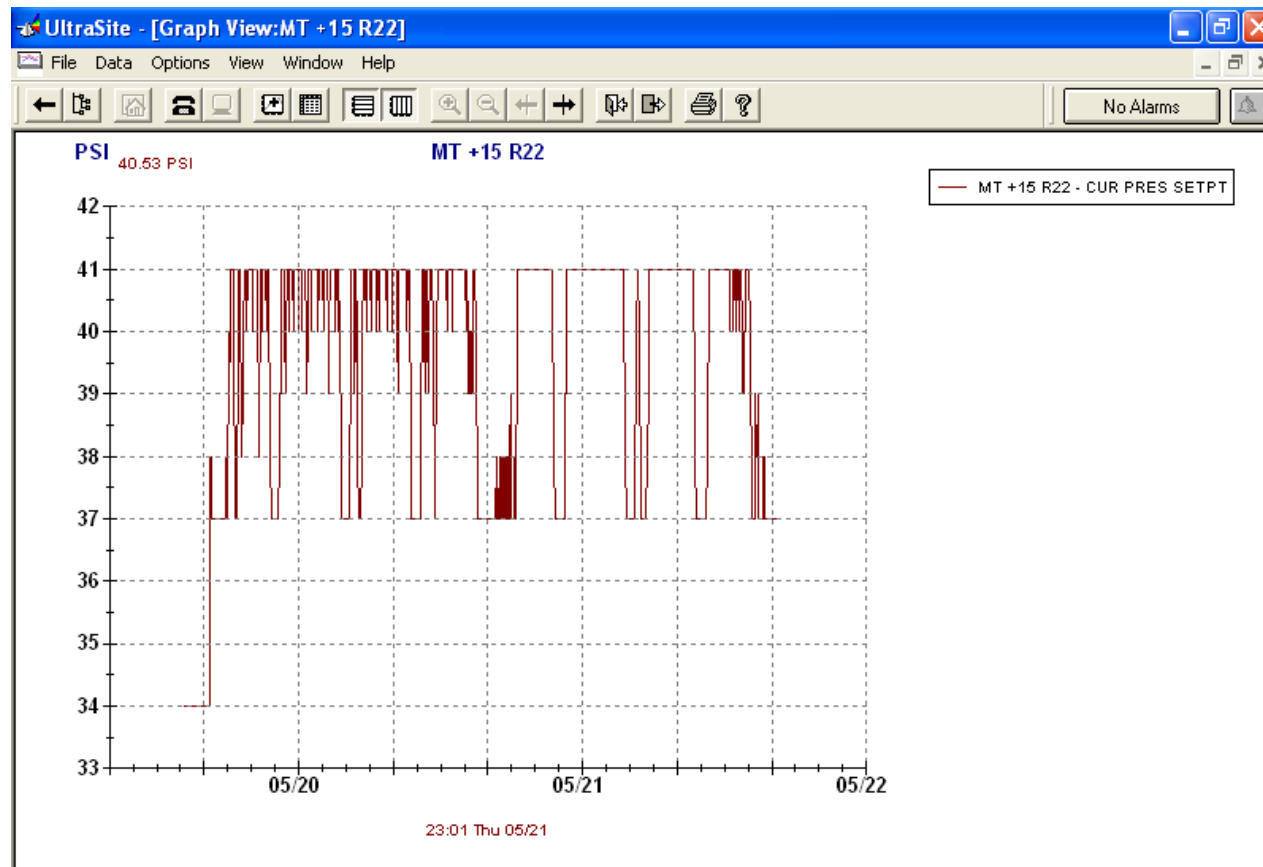
Yearly Heater Power with Einstein (kwh):	535,395
Yearly Heater Power with Fixed Heater (kwh):	876,000
% Savings (Einstein/Fixed):	38.9%



Commissioning FHP



Commissioning FSP



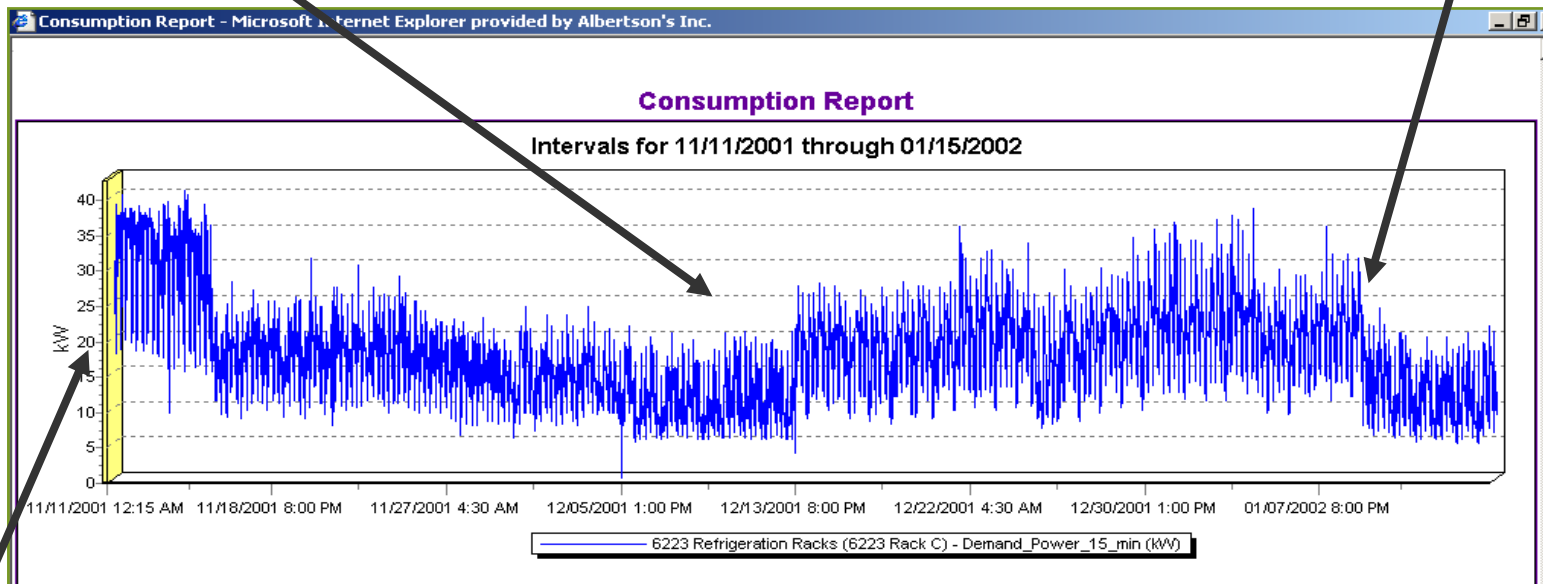
Persistence



Energy Monitoring

System Operation
Changes

System Operation
Restored!



Recommissioning

Key Takeaways

- Energy commissioning is vital for optimal refrigeration system performance
- Installation-startup-service contractors are not energy commissioning agents
- Persistence plan should be part of the commissioning package

Questions?



Thank-you

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