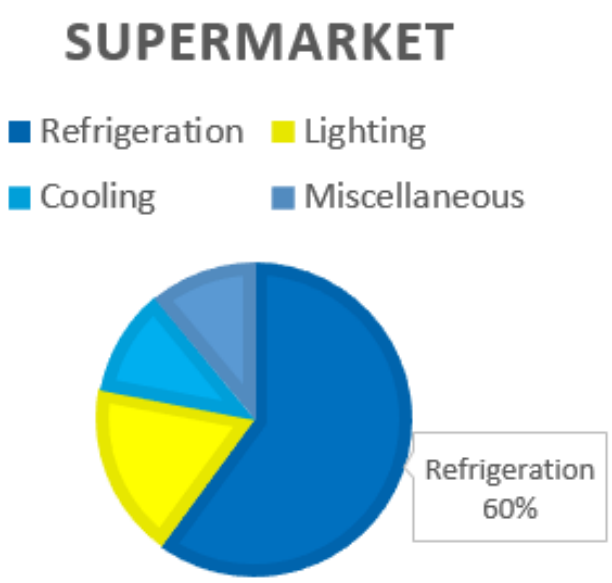
# Commercial Refrigeration Temperature & Defrost Control and Optimization

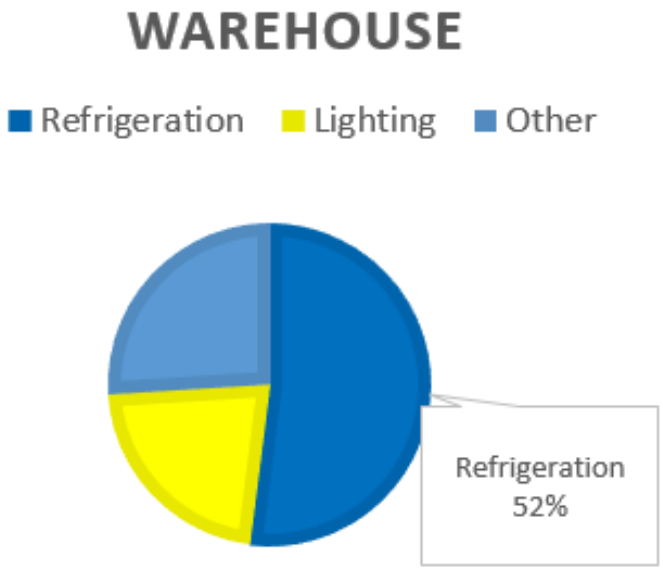
Joe Dudley

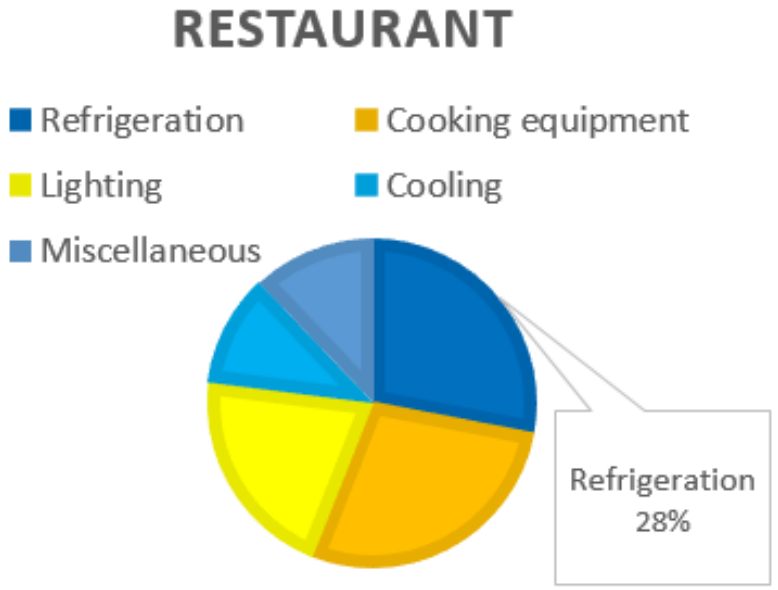
Regional Sales Manager

KE2 Therm Solutions, Inc.

# Commercial Refrigeration: The unmet energy challenge



# Traditional Temperature Controls

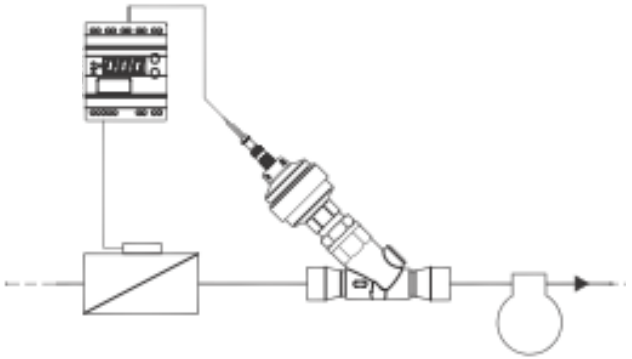
- Pressure Controls
  - Provides Indirect Temperature Control

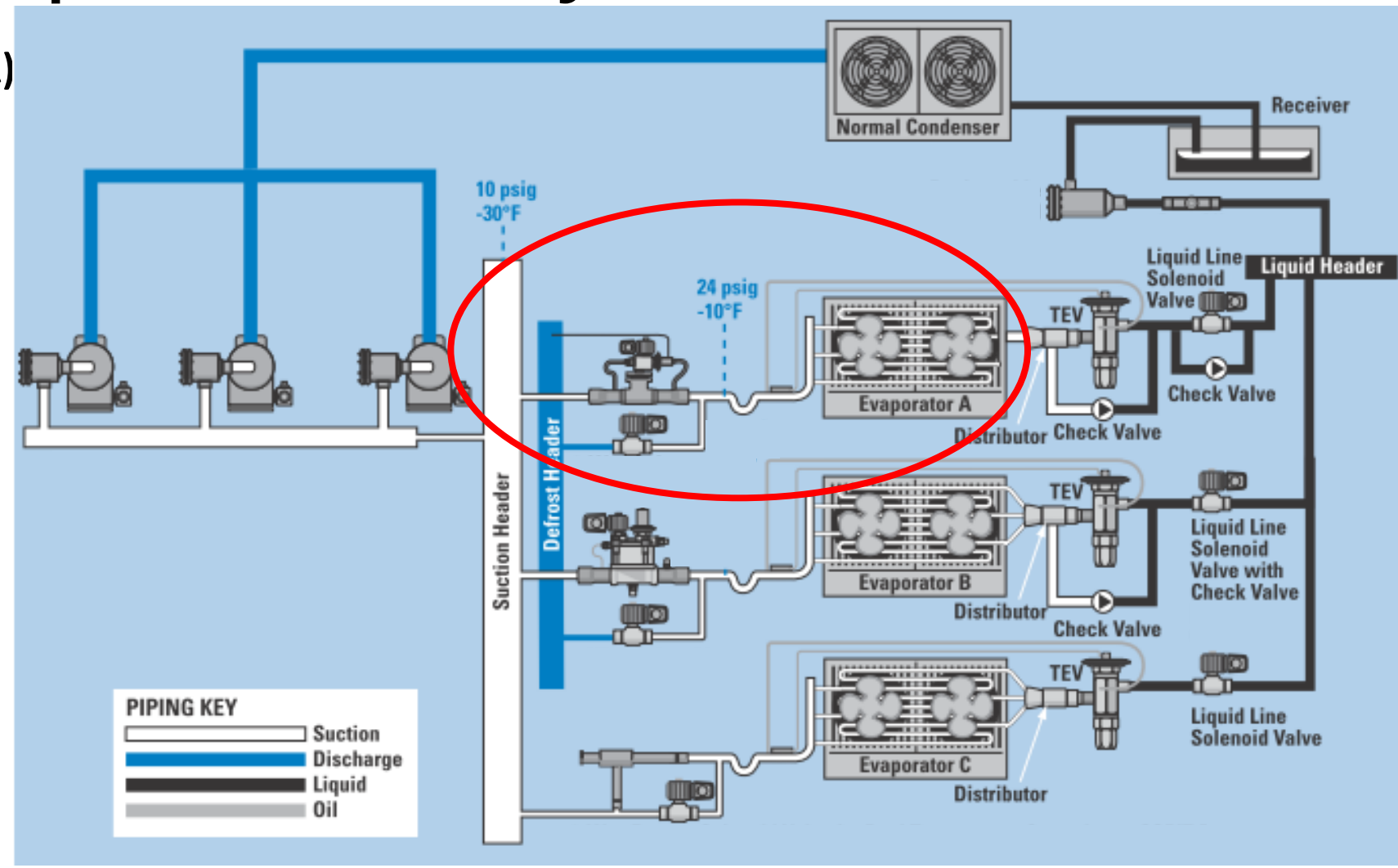

- Thermostat
  - Return/Discharge Air Temp
  - Evaporator Coil Temp
  - Product Temp

# Advanced Temperature Control
## Multiplex Rack Systems

- **Evaporator Pressure Regulator (EPR)**
  - EPR = Steady Suction P = Steady Air Temp
  - Good for stable load conditions

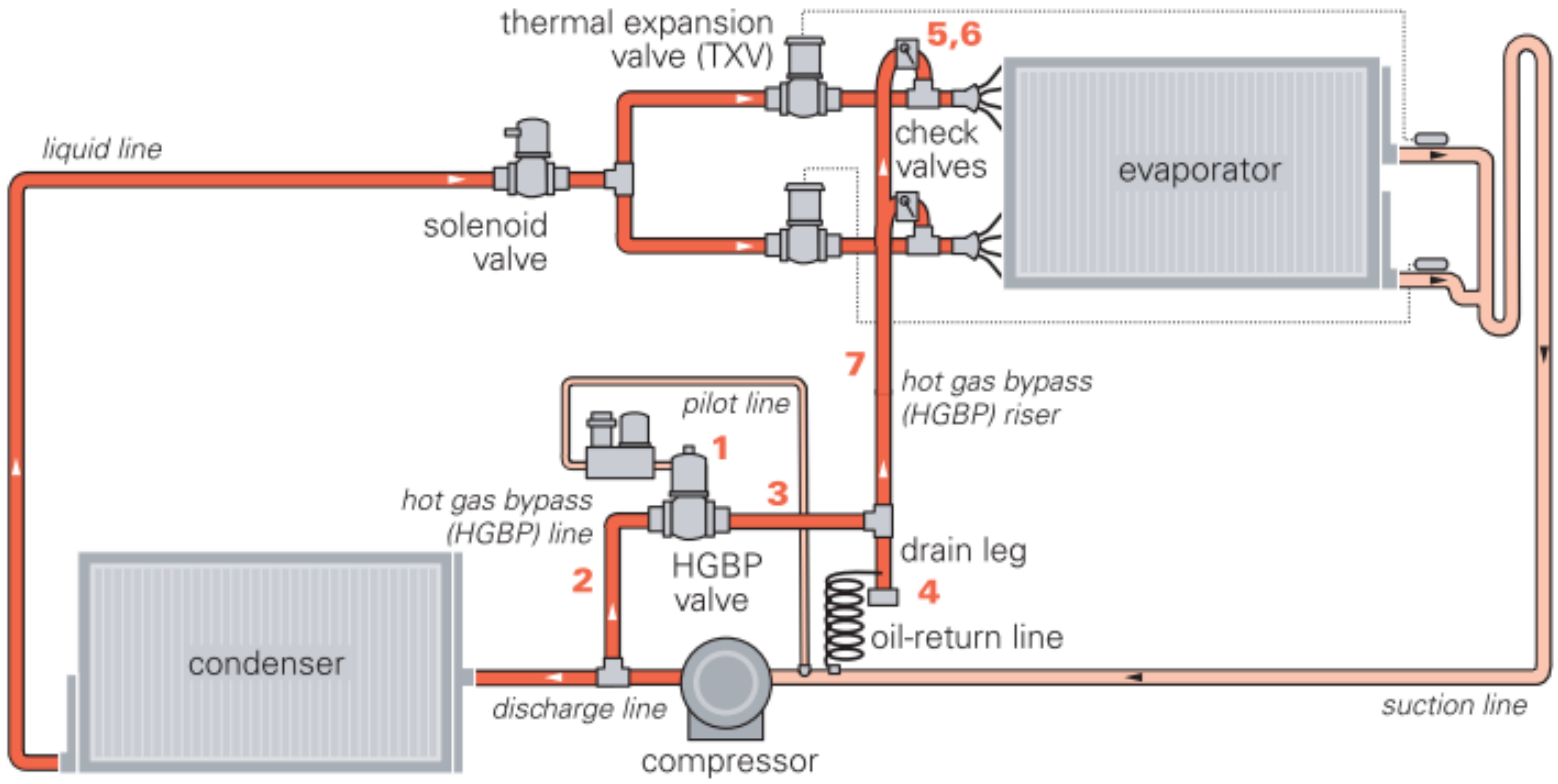
- **Electronic Suction Regulator**
  - Controlled by microprocessor controls
  - Flexible control (pressure or temp)
  - Responds to varying load conditions for improved temperature control





# Advanced Temperature Control
## Single Compressor Systems

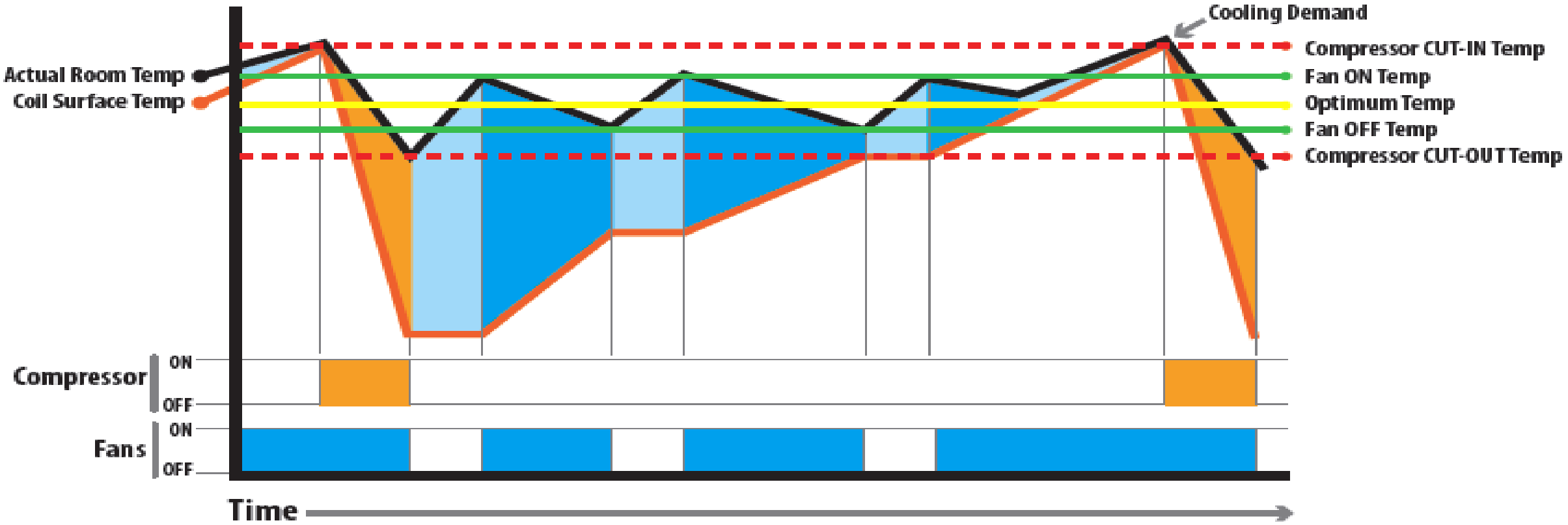
- **Hot Gas Bypass**
  - Can Provide Excellent Temperature Control
  - Comes at an Energy Penalty



# **Advanced Temperature Control**
## Single Compressor Systems

- Utilize microprocessor controls to improve overall system performance
- Reduced Room Temp Differential Between Cut-In & Cut-Out
- Compressor Short Cycle Protection (Minimum Runtime & Off-time)
- Evaporator Fan Management
  - **Variable Speed Evaporator Fans**
    - Should be part of overall system design
    - Likely requires other variable capacity components (EEVs, Variable Speed Compressor, etc.)
    - Can be cost prohibitive for smaller applications
  - **Two Speed Evaporator Fans**
    - Provides energy savings during refrigeration off-cycle
    - Typically requires specific motor design
  - **Off-Cycle Fan Management**

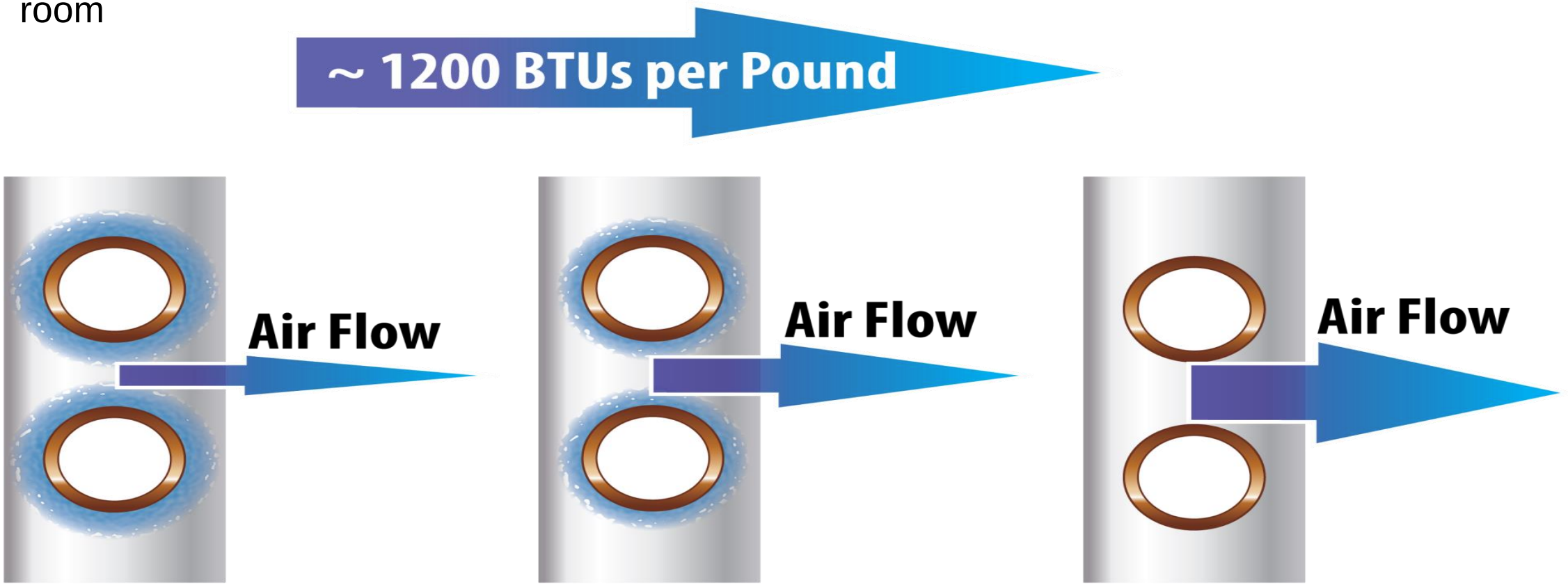
# Off-Cycle Fan Management Provides Improved Temp Control & Energy Savings




Latent energy recovery through evaporator fan cycling, compressor stays off

# Free Cooling – Latent Energy Recovery

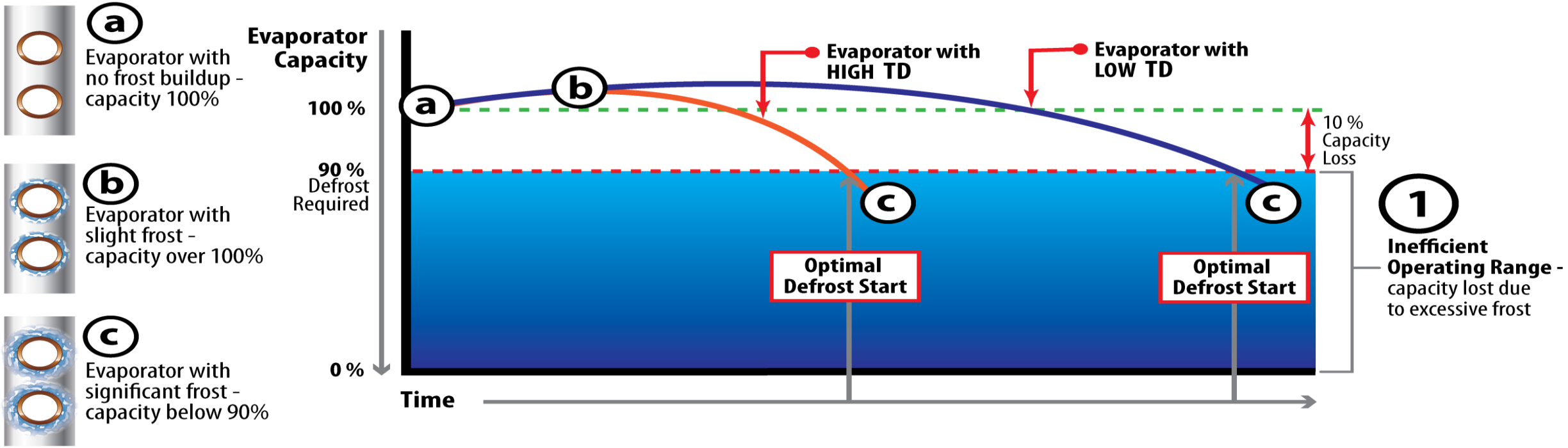
- Proper fan control during operation provides “free cooling” by sublimating frost to chill room



# Factors Affecting Frost Buildup

- Air Temp
- Humidity
- Coil Temp
  - ➢ Including variations due to refrigerant flow
- Fin Spacing
- Air movement (high velocity vs. low velocity)

## Light Frost Accumulation Improves Heat Transfer of the Coil



# Common Methods of Defrost

- Air Defrost (Off-Time)
- Hot Gas Defrost
- Electric Defrost

# Air Defrost Techniques
## (Space Temps ≈ 36°F & Above)

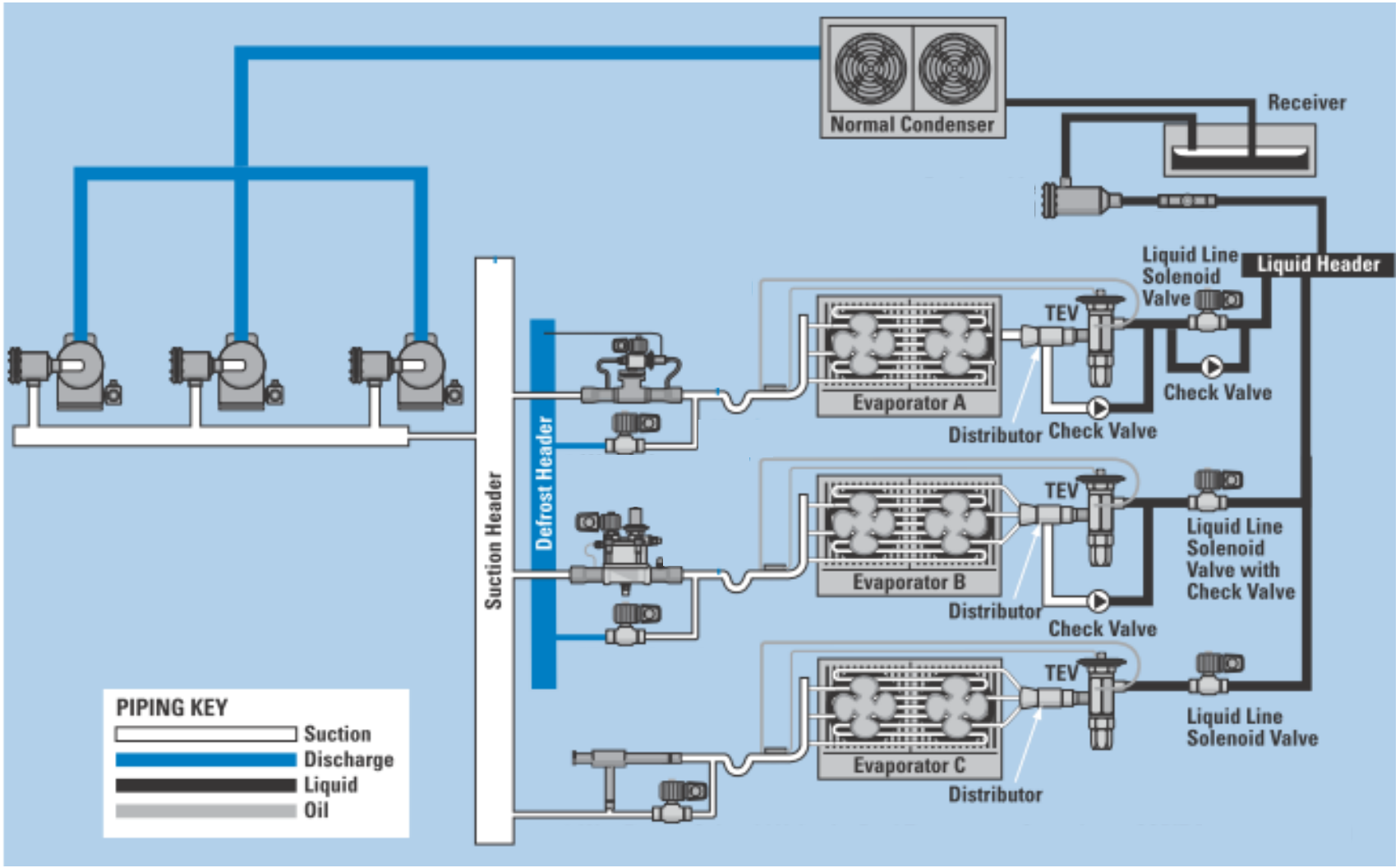
- **Natural Off-Time**
  - Requires oversized refrigeration system
  - Space Temperature control always active
  - No guarantee the coil is defrosted

- **Pressure/Temperature constant cut-in/cut-out**
  - Initiates off-cycle/defrosts in response to drop in suction temp/pressure
  - Provides indirect space temperature control
  - Does provide feedback regarding defrost effectiveness
  - Can be difficult to dial-in
  - System issues & load variations can “fool” the controls

- **Forced Defrost**
  - Independent of Temperature Control
  - Fixed Time or Temperature Terminated

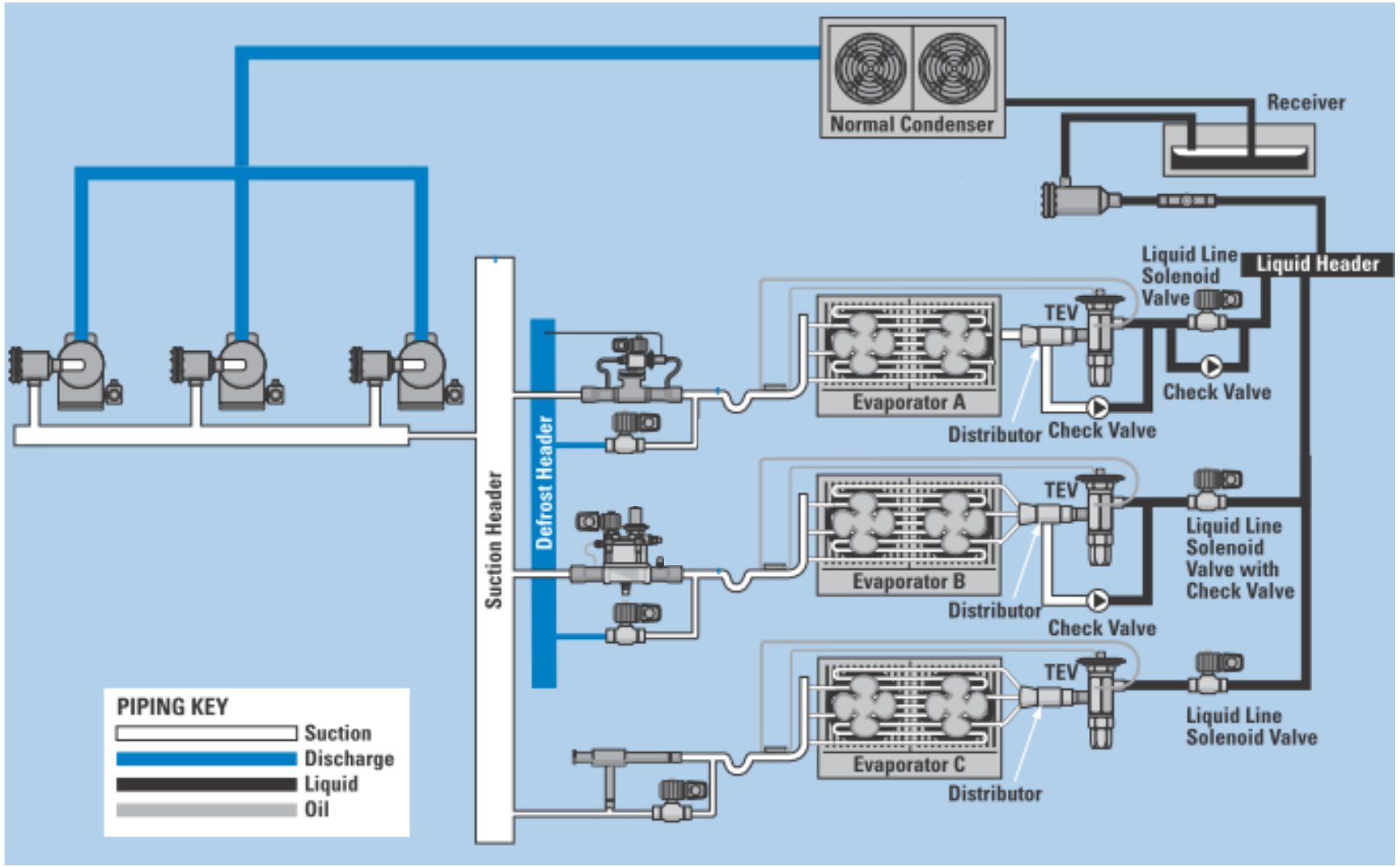
# Hot Gas Defrost

- Typically Fastest Means of Defrost
- Melts Frost from Inside-Out
- Heat is Provided by Refrigeration System
- Higher Up Front Cost for Added Piping & Controls



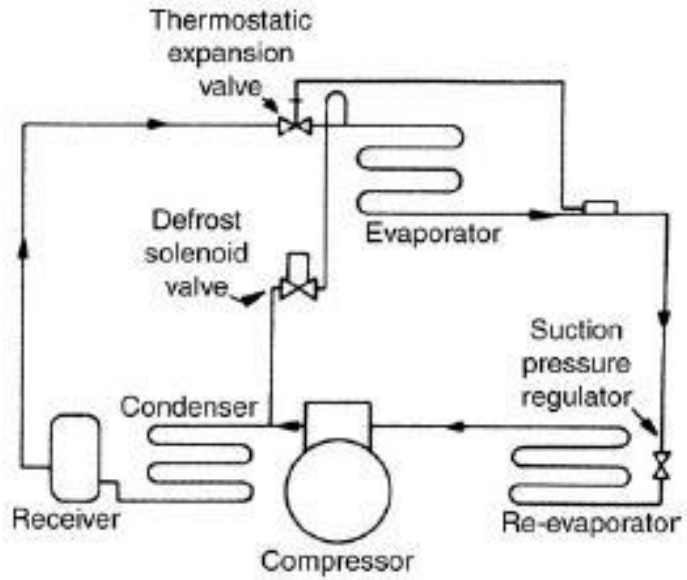
# Hot Gas Defrost Techniques

- **Reverse Flow**
  - Typically on Rack Systems
  - Hot Gas is directed from Compressor Discharge or Liquid Receiver to Outlet of Evaporator
  - Gas flows backwards through Evap and condensed liquid is directed to liquid line/header

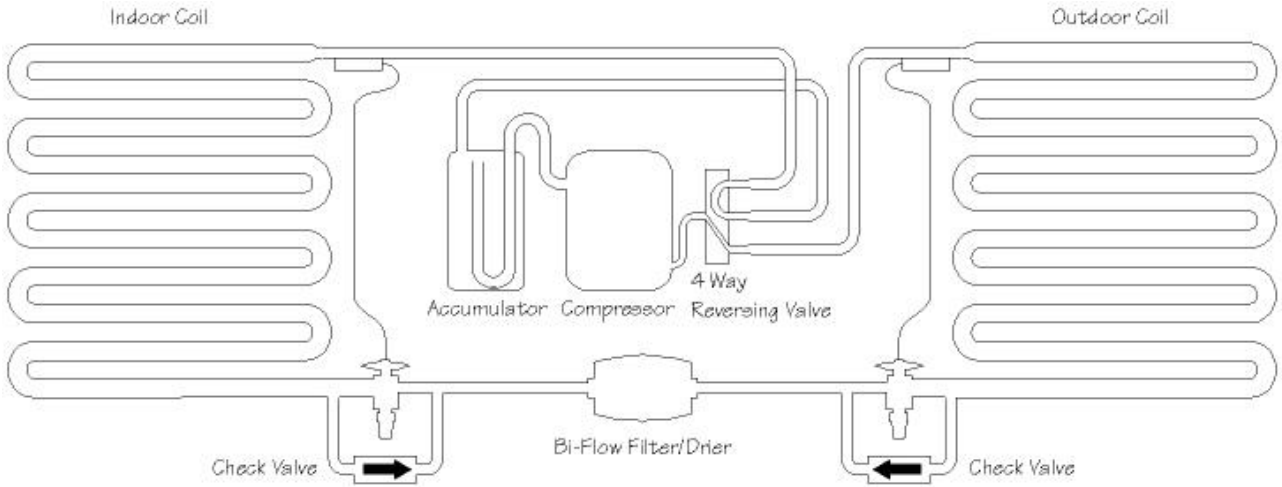


# Hot Gas Defrost Techniques

- **Three Pipe**
  - Dedicated Hot Gas line to the evaporator inlet
  - Must have a means of dealing with condensed liquid exiting the evap during defrost

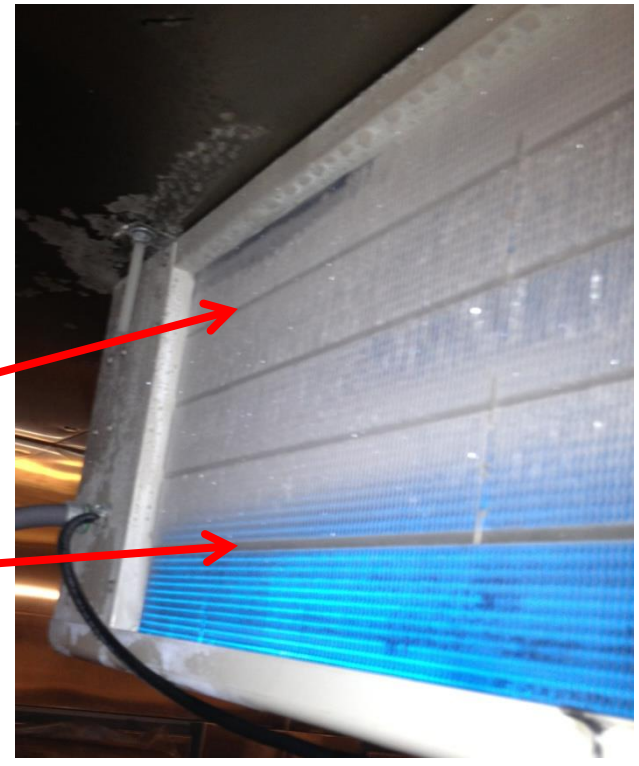


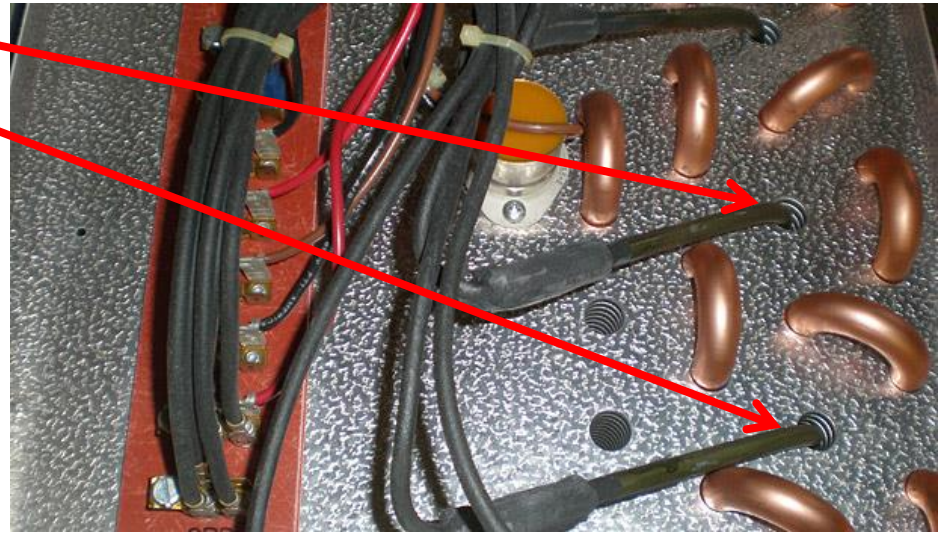

- **Reverse Cycle**
  - Single Compressor System
  - Reversing Valve Shifts Flow of Refrigerant Condenser↔Evaporator



# Electric Defrost

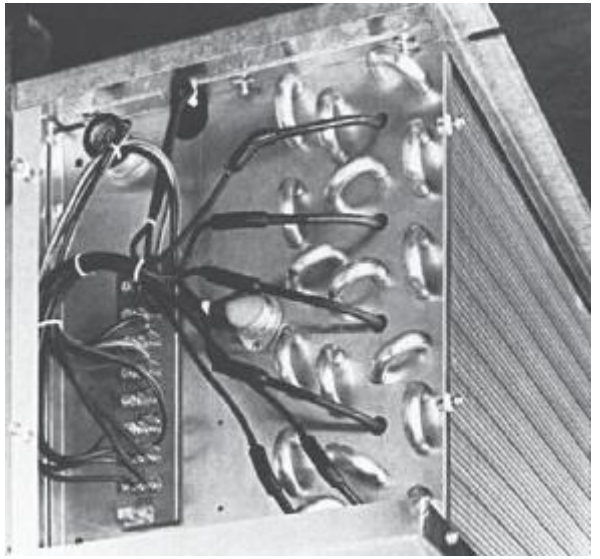
- **Simple to Operate & Maintain**
- **Typically longer to Defrost than Hot Gas since heat has to travel from heaters to frost**
  - Surface Mounted Heaters
  - Heater Elements Inserted into Coil
- **Uses External Heat Source for Defrost Heat**
- **Up to 80% of Heat Load can be transferred to Refrigerated Space**



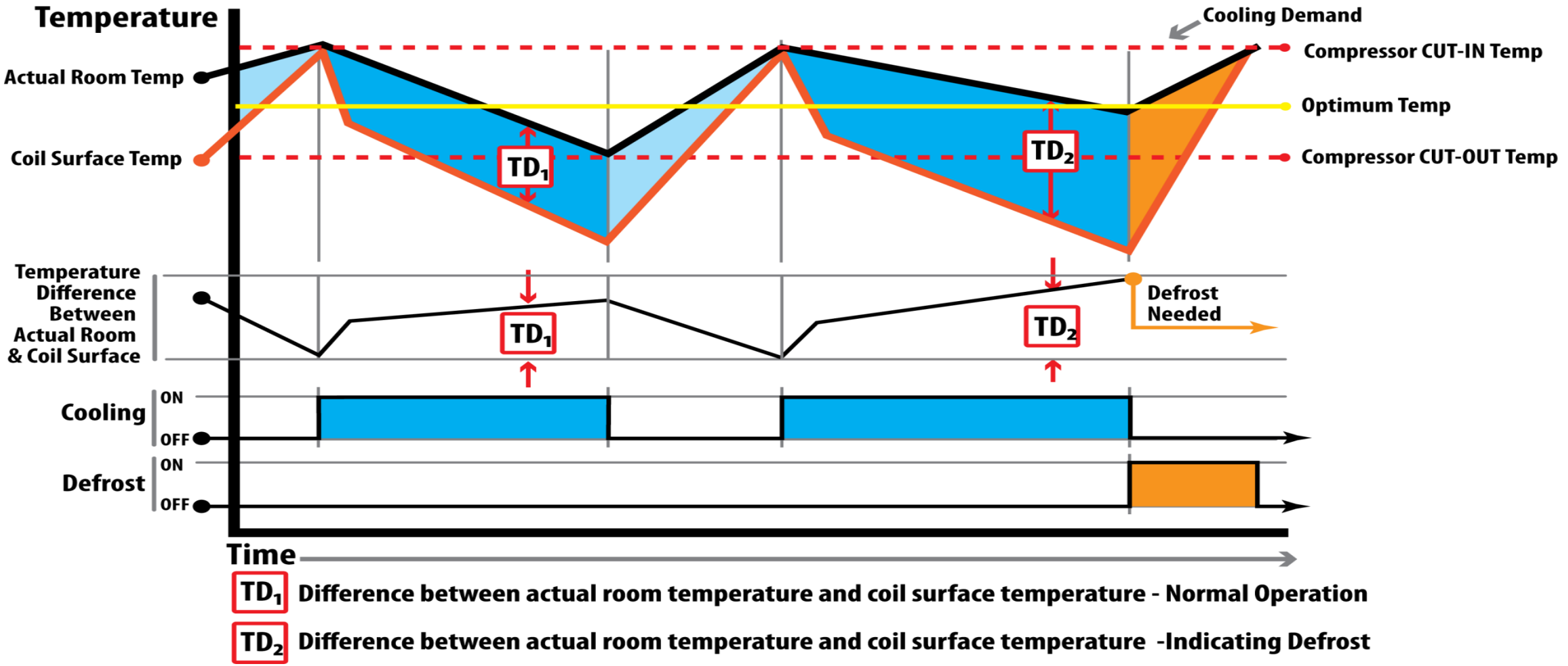


# Electric Defrost Techniques

- **Time Intitiated**
  - Typically set for “worst case” and seldom adjusted
  - Can be Time or Temperature Terminated
- **Runtime Defrost Schemes**
- **Adaptive Defrost Schemes**
  - Reactive
  - Proactive

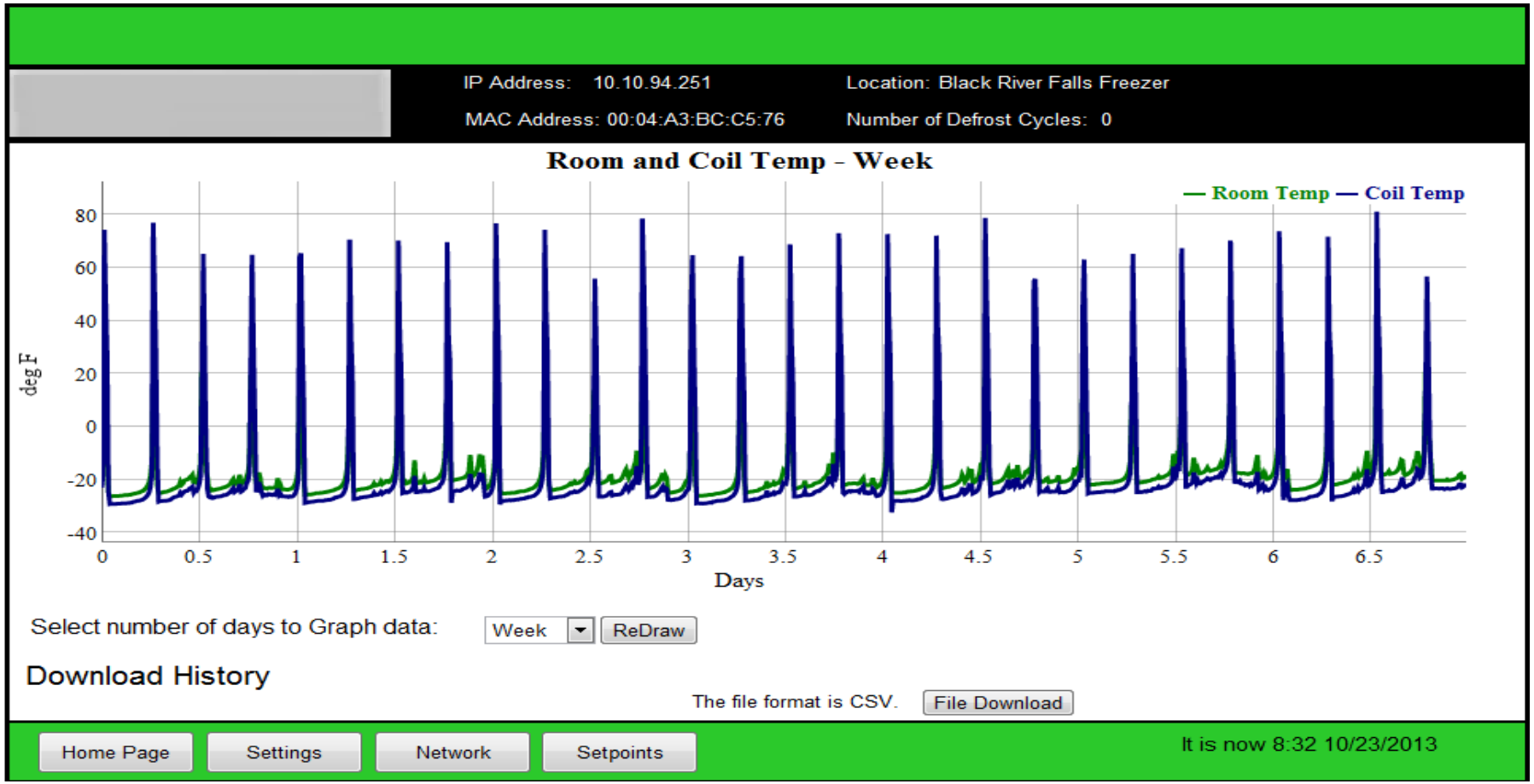




# Proactive Defrost Constantly Monitors System Performance



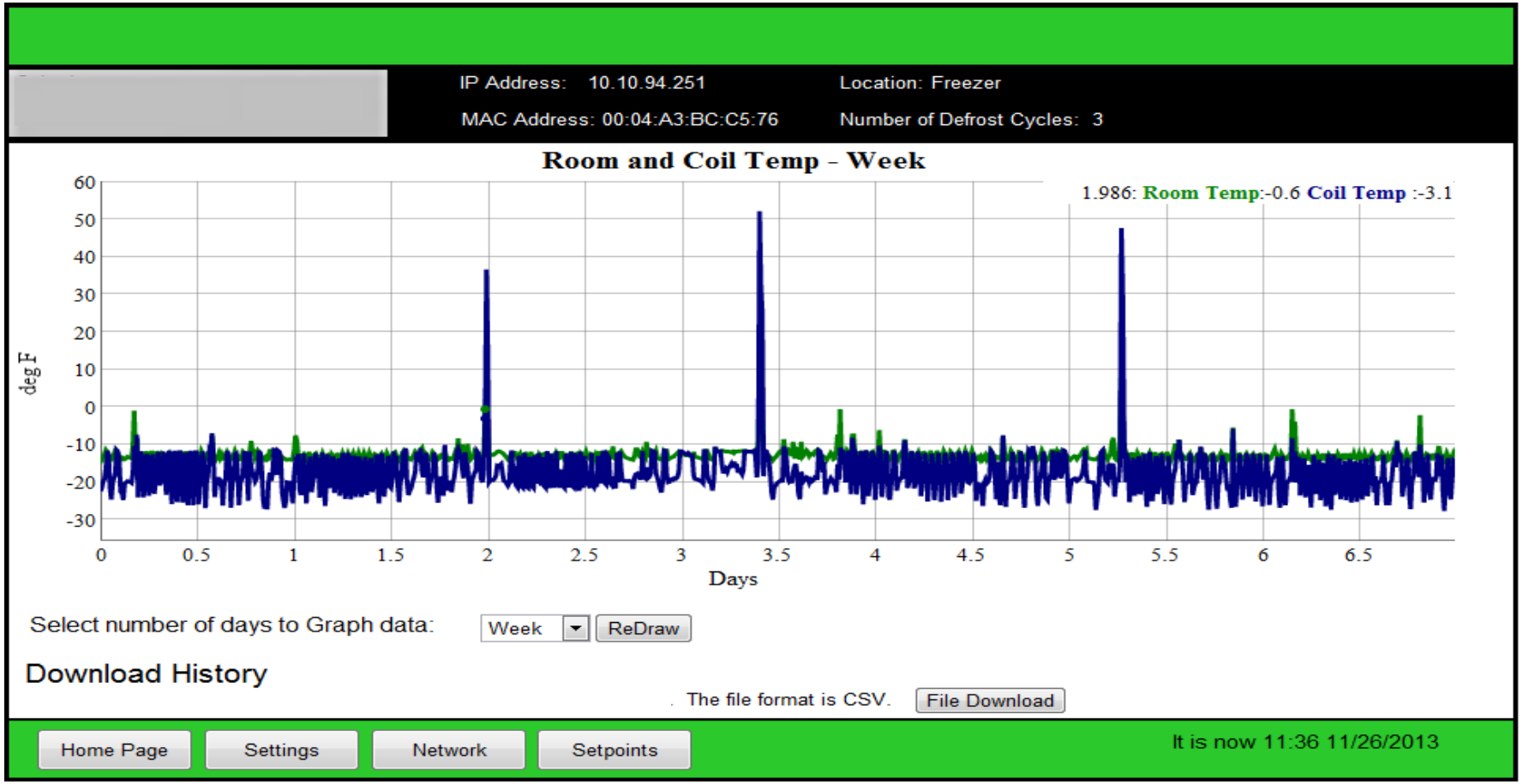
# Walk-In Freezer (Before)

7 day graph with defrost timeclock set to (4) 30 minute defrosts/day



# Walk-In Freezer (After)

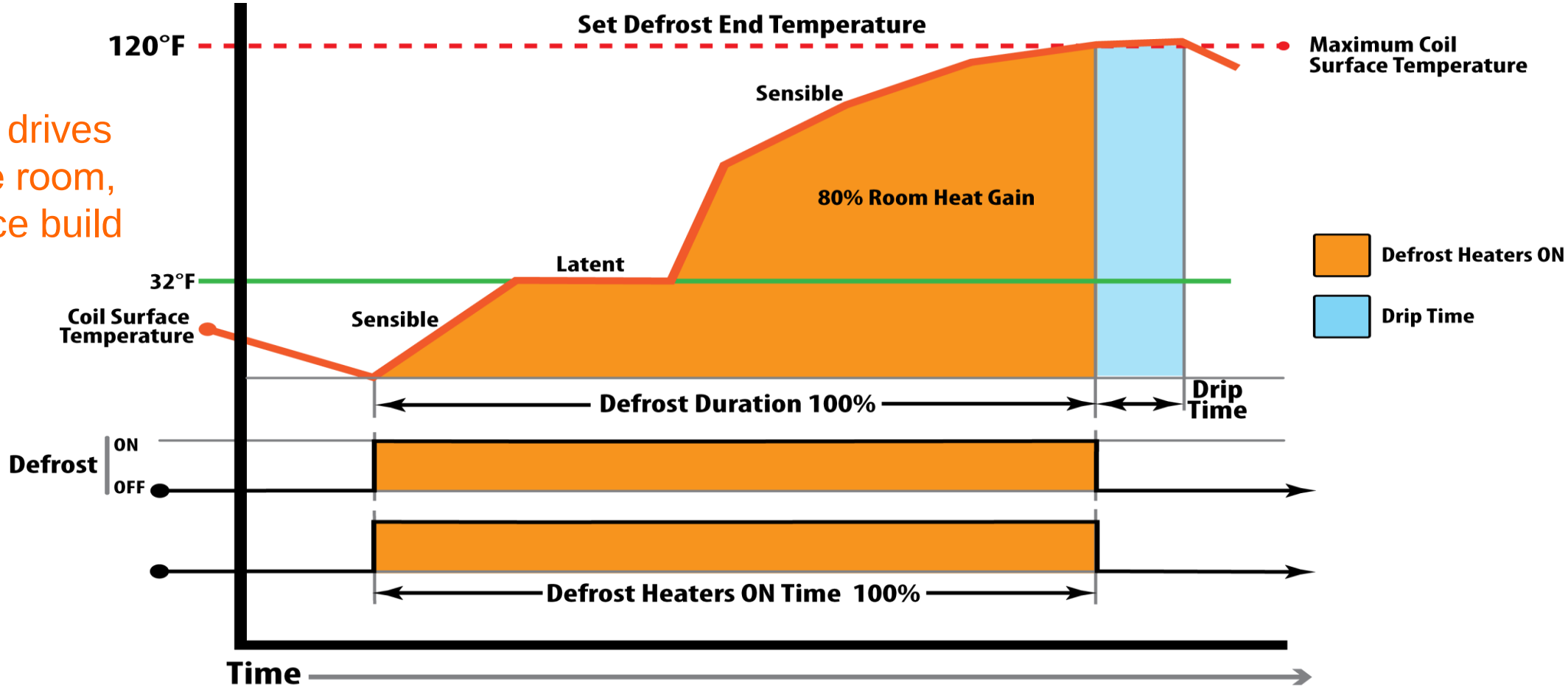
As Few As 3 Defrosts in 1 Week



# Electric Defrost Heater Control

80% additional room heat gain (radiation + convection) due to high heater temperature

High coil temperature drives “fog” into the room, can create ice build up problems

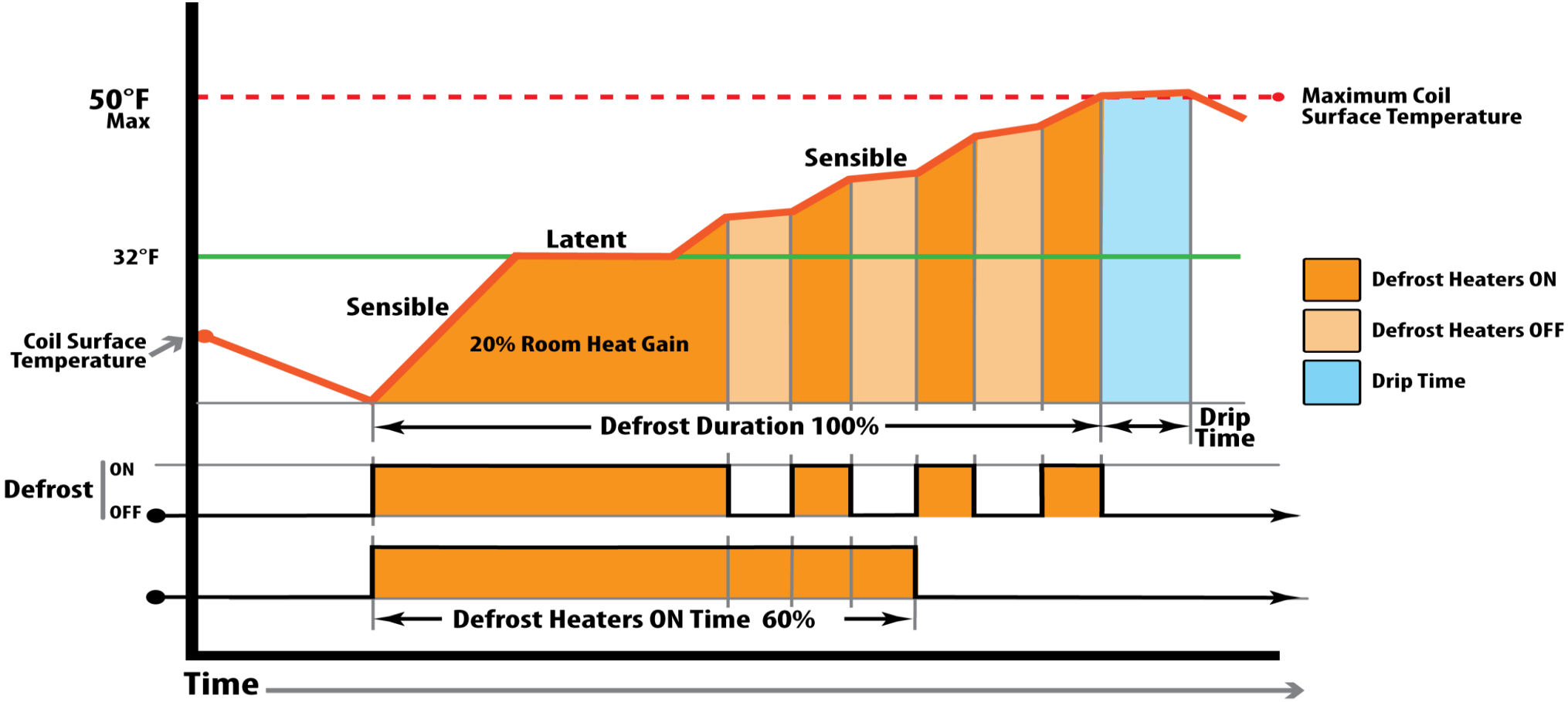


# Consequences of Fogging

# Advanced Defrost Heater Control

Only 20% additional heat gain (radiation + convection) due to heater temperature

Ensures lower coil temperature, less energy usage, decreased product heating



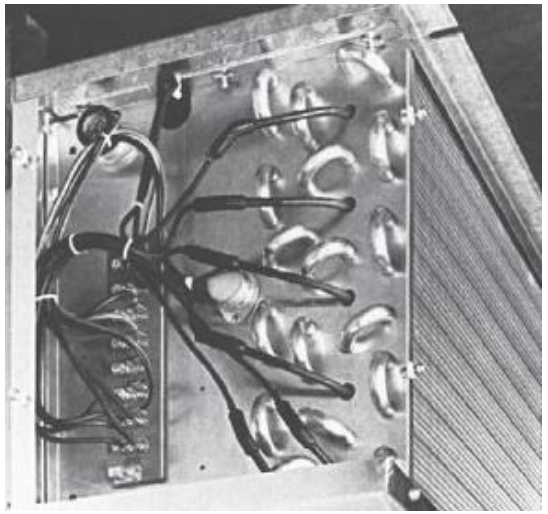
# Results of Improved Defrost Control

**Before** - June 15, 2012

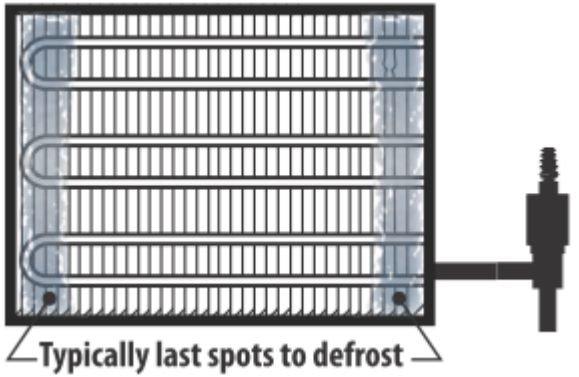
**After** - July 22, 2012

# Defrost Termination

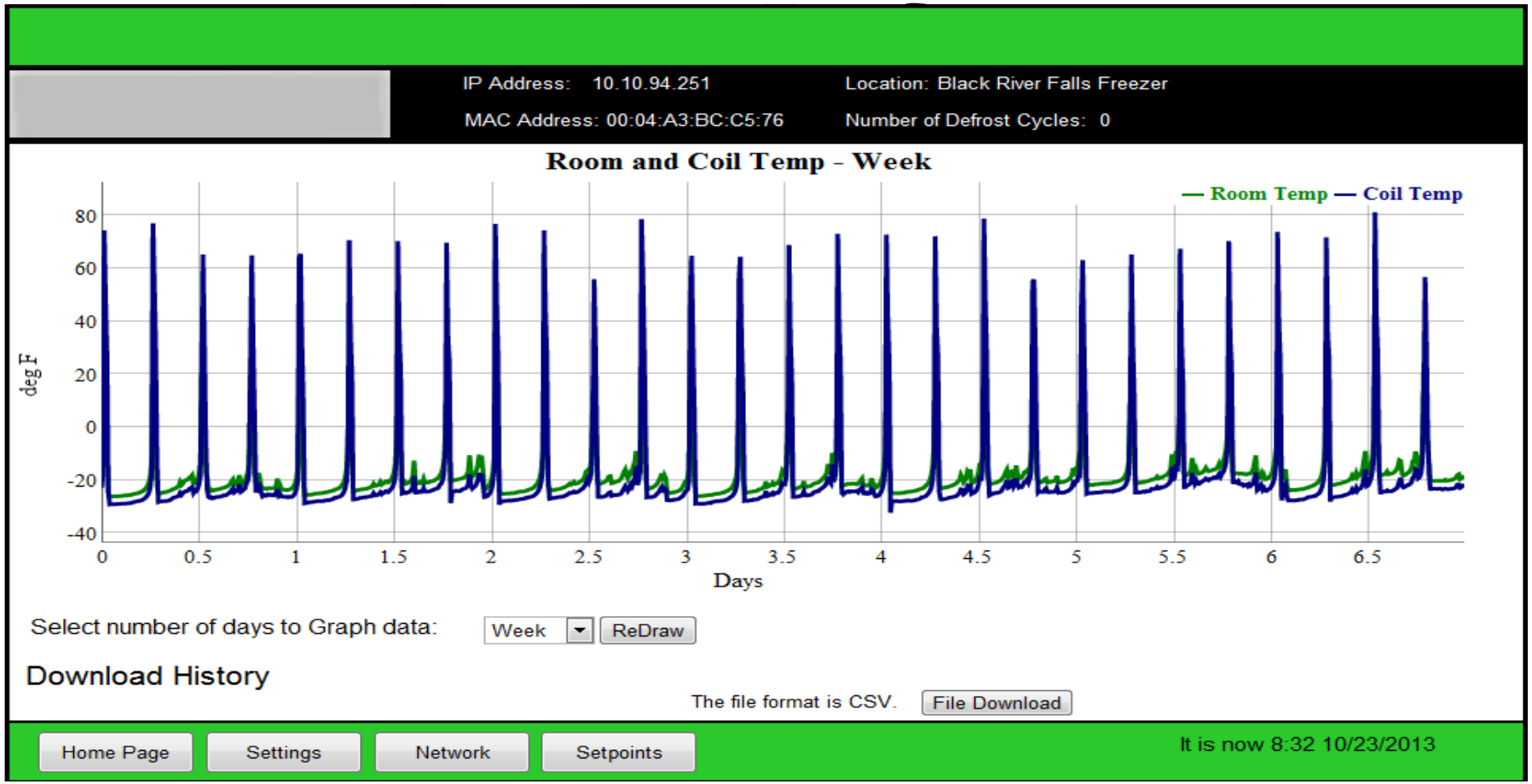
- **Defrost Termination On Time**
  - No gaurantee coil is defrosted
  - Doesn't prevent addition of unnecessary heat into refrigerated space

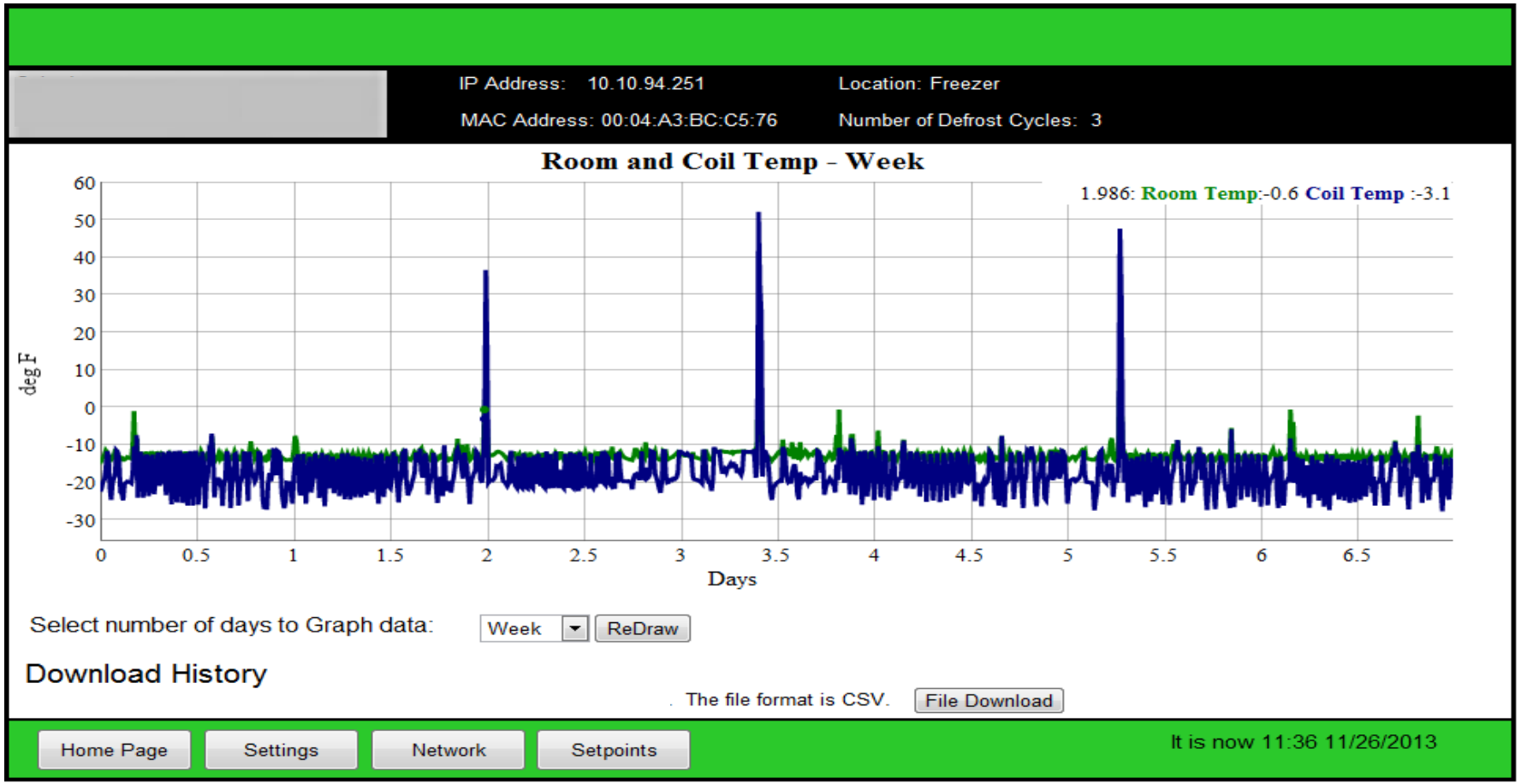
- **Defrost Termination on Temperature**
  - Fixed Temperature Setting vs. Adjustable
  - Adjustable Defrost Termination Location vs. Fixed
  - More than 1 Defrost Termination Location?



# Coil Temperature Reaching 80°F



# Improved Defrost Termination




# THANK YOU!