



# Remote Refrigeration Diagnostics and Controls

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# Common Issues with Refrigeration Systems

- Significant energy use and peak demand
- Equipment is sized for peak
- Inadequate controls
  - 24/7 operation
  - Typical thermostat control with no user interface
  - EE aspects are often disabled
- Lack of maintenance
  - Redundant systems
  - Service when it breaks
  - Third party maintenance companies
- Difficult for EE Programs to deal with
  - Systems are complex
  - Wide variation in size/configuration require customized approaches

# Objectives

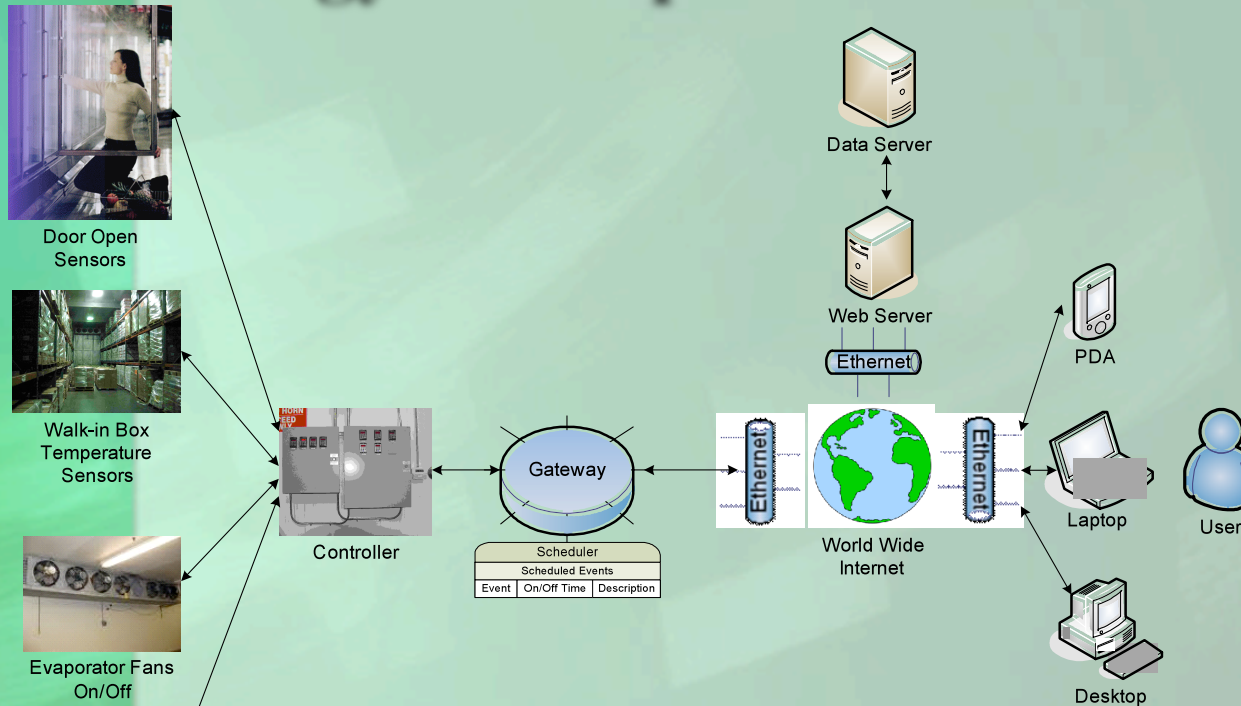
- Quantify energy performance impacts of implementing a continuous commissioning control technology in 2 applications
  - Retail walk-in cooler/freezer
  - Refrigerated warehouse
- Gather intelligence on typical operating conditions of refrigeration equipment
- Observe behavioral changes due to increased visibility of data

# What is “Continuous Commissioning”?

- “an ongoing process to resolve operating problems, improve comfort, optimize energy use and identify retrofits for existing commercial and institutional buildings and central plant facilities.” (FEMP)



# Technology Description



## Internet-Based Refrigerant Monitoring and Control System

- Collects data from various sensors
- Records changes in value
- Controls compressors, evaporator fans, defrost periods, temperature setpoints, and other parameters
- Data and control are visible via secure web access
- DR potential

## Technology Description (cont)

- Straight-forward user interface
- Allows instantaneous visibility and control from anywhere with internet access
- Historical data available for comparison
- Enables continuous commissioning of equipment
- Automated text or pager alerts can be incorporated

# User Interface

**Marquez TODO 4 LESS, INC.**

330 Parriott Place, City Of Industry Ca 91746

Tel: (626) 330-3310

**Ontario Intl Apt, CA**

Last Updated on Nov 29 2009, 10:53 am PST - A Few Clouds  
Temperature 67°F, Humidity 22%, Dewpoint 27°F

Log Out: emrejs5

[Help](#)

**Energy Trend**

NRM Mini CoolTrol			Temperature °F				Status					Starts 24 Hr.			% Run 24 Hr.			% Run 7 Days			
Description	Content	Status	Space	Evap	SP	24hr	Mode	Dfirst	Sol	Fan	Door	Amps	Sol	Comp	Fan	Sol	Comp	Fan	Sol	Comp	Fan
<a href="#">Big Cooler</a>	-		35	32	<u>36</u>	37.9	<a href="#">Run</a>	<a href="#">Off</a>	Off	On	Closed	0.6	63	68	161	10.9	12.4	35.5	13.3	14.9	39.6
<a href="#">Freezer</a>	-		6	0	<u>0</u>	2.8	<a href="#">Run</a>	<a href="#">Off</a>	On	On	Closed	21.9	139	139	139	23.1	24.8	36.8	25.2	27.7	38.3
<a href="#">Small Cooler Freezer Entry</a>	-		40	34	<u>38</u>	39.9	<a href="#">Run</a>	<a href="#">Off</a>	Off	Off	Closed	0.4	45	74	159	5.2	7.3	27.5	8	10.5	33.2

**Door Heater Controller**

**Doors**

**Alarms**

Start Time	End Time	Ack Time	Text
2009-11-28 02:27:29	2009-11-28 03:01:48		MQZ0005 Freezer Defrost Failure

Using Smart Defrost, an alarm was set to notify user if there was no defrost for after 2 days.

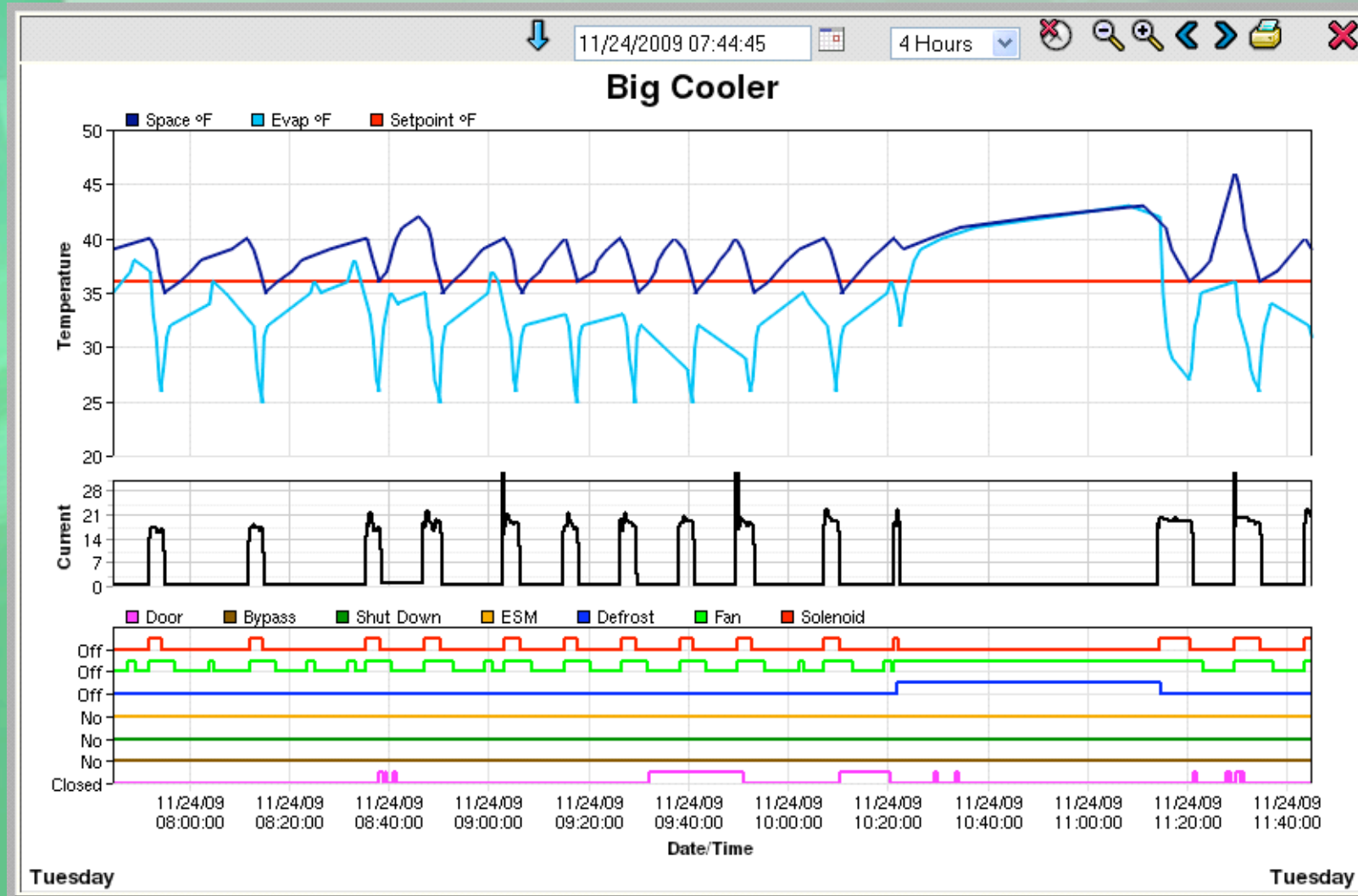
**Comments**

Timestamp	User	Comment
2009-10-06 07:11:46	emrejs5	I set the freezer defrost to smart defrost and I am watching it to see effect it has on run time and performance.

Select Action

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# Historical Data Plots





# Project Stages

## **Existing Equipment**

- Monitor performance “as-is”
- Identify necessary maintenance work

## **Optimized Current Operation**

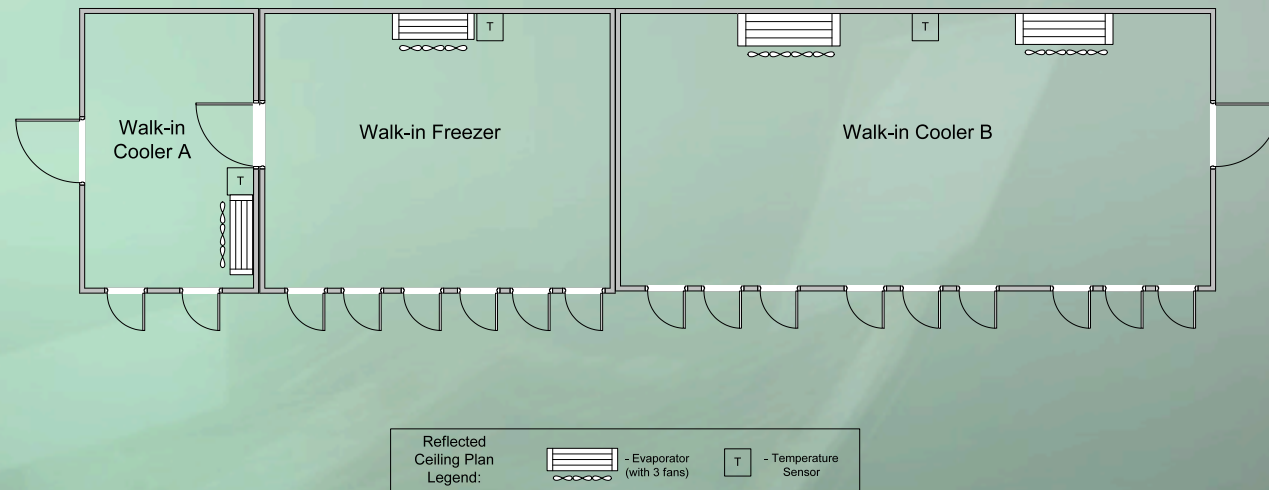
- Perform maintenance
- Allow system to run with current control strategy

## **Implement Control Strategy and Optimize Performance**

- Activate control functions
- Monitor performance and optimize controls
- Gauge how behavior is affected

# Site Description

- Cheese manufacturer and distributor
- City of Industry, CA
- Dry goods warehouse
  - 210,000 sq ft
- Retail store
  - 200 sq ft walk-in freezer
  - 100 & 300 sq ft walk-in coolers



# Site Description (cont)

- Refrigerated warehouse
  - 5,800 ft<sup>2</sup> cooler
  - 17 evaporators
  - 9 compressors
  - All Med Temp
  - Forklift doors



# Equipment Retrofits

## Retail store walk-in cooler/freezer

- Replaced with ECM fans
- Added anti-sweat heater control

## Refrigerated warehouse

- Added 18 destratification fans
  - 30-35 W, operate continuously
- ECMs not available for the evap fans at the time





# Instrumentation

## Standard Installation

- Evaporator temp
- Space temp (inlet to coil)
- Compressor current
- Evap fan power
- Anti-sweat heater power (store only)
- Humidity (store only)
- Door open sensors (store only, main door)

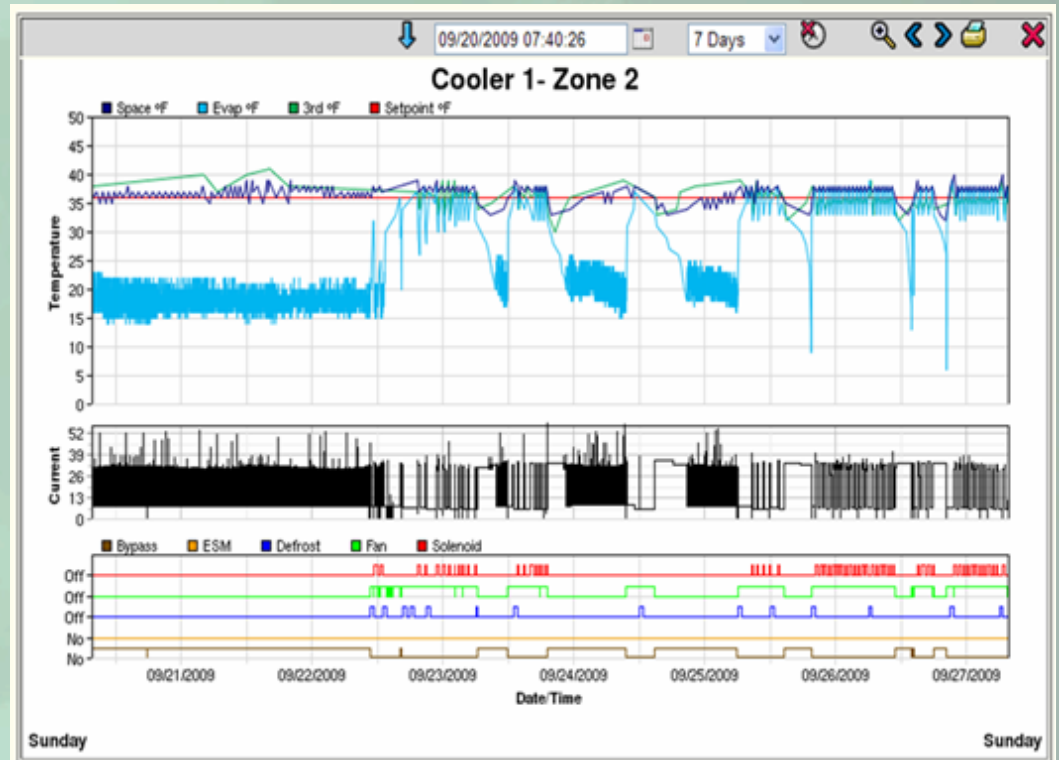
Polled every 7-20 seconds

## Additional Sensors

- SCE meter
- Discharge & suction pressure\*
- Compressor power\*
- Outdoor ambient temp
- Product temp
- Chart recorder (HACCP)



# Maintenance



- Dirty line filters
- Dirty evap and condenser coils
- Evap coils completely covered in ice
- Low thermostat set point
- Excessive defrosts
- Compressor short cycling caused by low refrigerant charge
- Compressors not responding to call for cooling due to low refrigerant charge and improper pressure control settings
- Systems ran without providing any cooling, but not visible because of redundant systems
- No balance in run-time between multiple zones

# Controls Implemented

## **Large refrigerated warehouse**

- Optimize evap fan run times
- All setpoints to 36°F
- Alarms for out-of-range temps
- Alternating run time between various units
- Reduced compressor run time

## **Store walk-in cooler/freezer**

- Temp & humidity based anti-sweat heater controls
- Freezer defrosts reduced from 4 per day to 1 every other day

# Results

## **Retail store**

- Evap fan run times reduced from 100% to 38-54%
- ASH run time reduced from 100% to 48% (freezer) and 12% (cooler)

## **Refrigerated warehouse**

- Evap fan run times reduced from 100% to 35-50%
- Compressor run time reduced by 3-60%
  - (1 increased, not operating during baseline)

## **Energy consumption**

- Reduced by ~680 kWh/day (@SCE meter)

## **Operational**

- Personnel now have insight into operation

Full report at [www.etcc-ca.com](http://www.etcc-ca.com)



# Questions?

