IBM, Vermont – Facilities

Free Cooling Overview

PMI-CV Dinner Meeting
1-16-2013

M.R. Pelletier P.E. C.E.M.

Today's Agenda - WELCOME!

- **Intro**
- **Free Cooling Project (s)**
- **Walk to 971 Tour of Chiller Room**
- **Walk to 963 Tour of Central Utility Plant**

IBM Vermont: “A SMART Enterprise”

Water Use

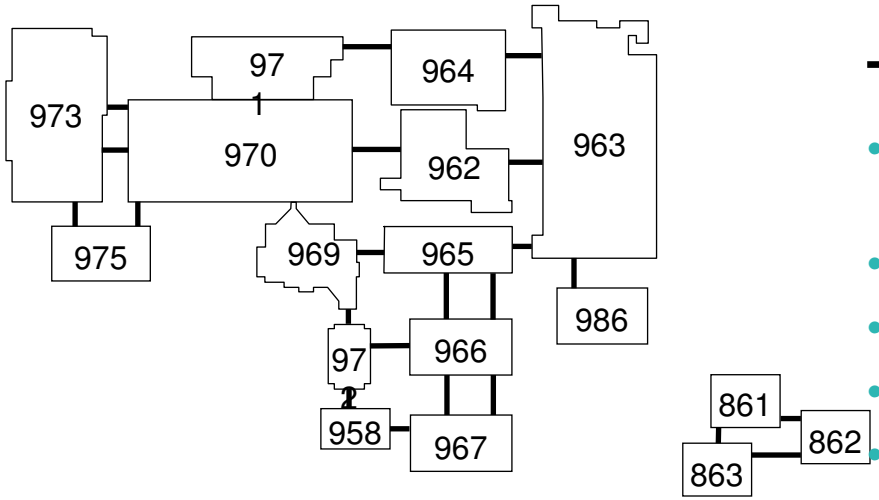
- **3.2 MGD**
- **2 MGD Ultra Pure Water**
- **Waste water treatment - 3 MGD**

Cooling Plant

- **~ 35,000 HP of motors**
- **4160 and 480 Volts**
- **Operates 24 / 7**

SMART Attributes

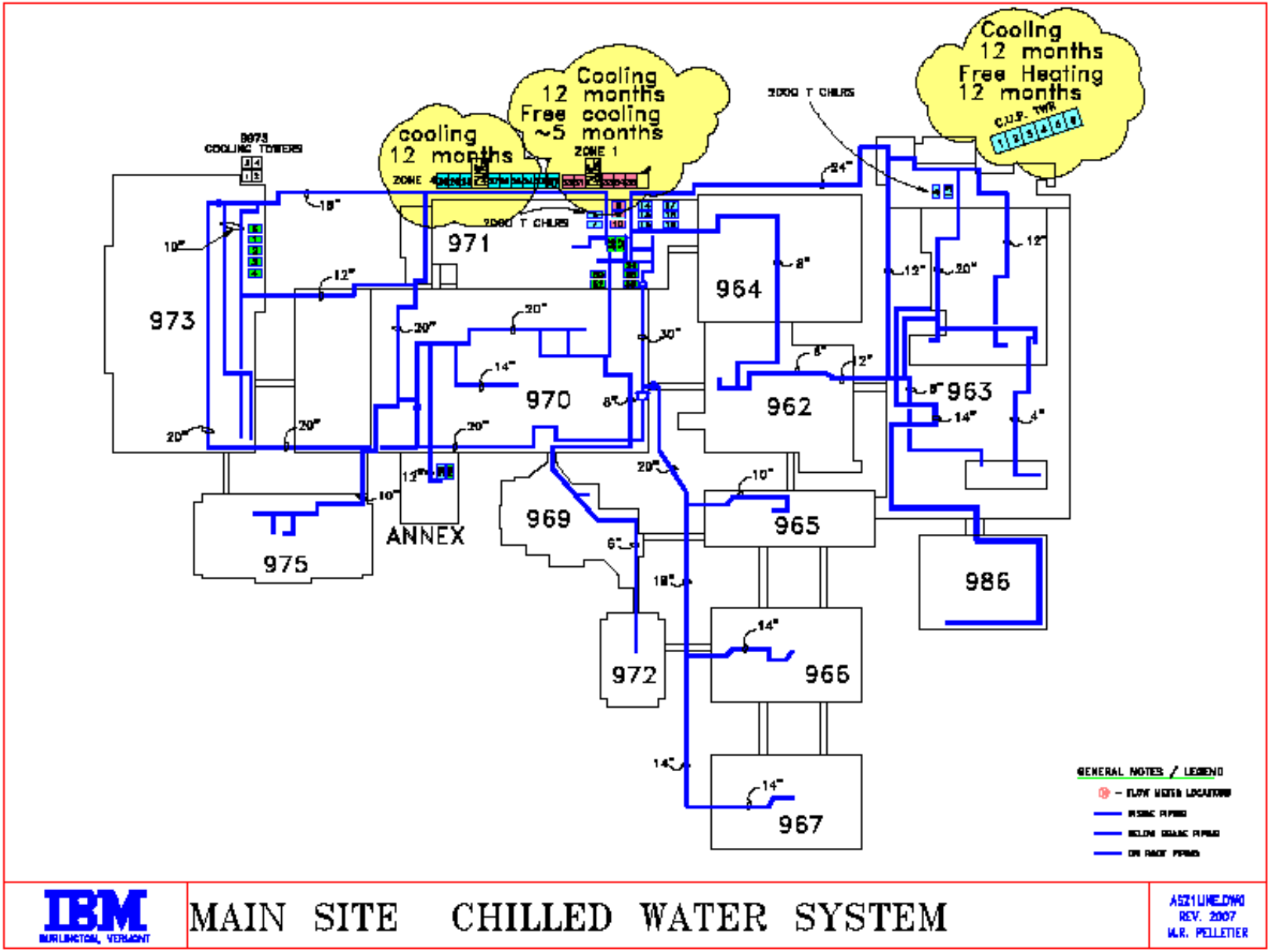
- **Data tracking on 30,000 points**



- Smart Infrastructure for Site Operations
  - 60,000 Field-Points
  - 700 Programmable Logic Controllers
  - 75 In-Field Workstations

TYPES OF SPACE (3.5 Million SF)

- Manufacturing Environments (Clean Rooms)
- Industrial Waste Treatment Facility
- Data Centers
- Material Distribution Centers
- Administrative Space
- Cafeterias
- Classrooms
- Laboratories (Chemical, Analytical)
- Leased space
- Chemical Distribution and Disposal Center
- Test Facilities
- Centralized Utility Plant



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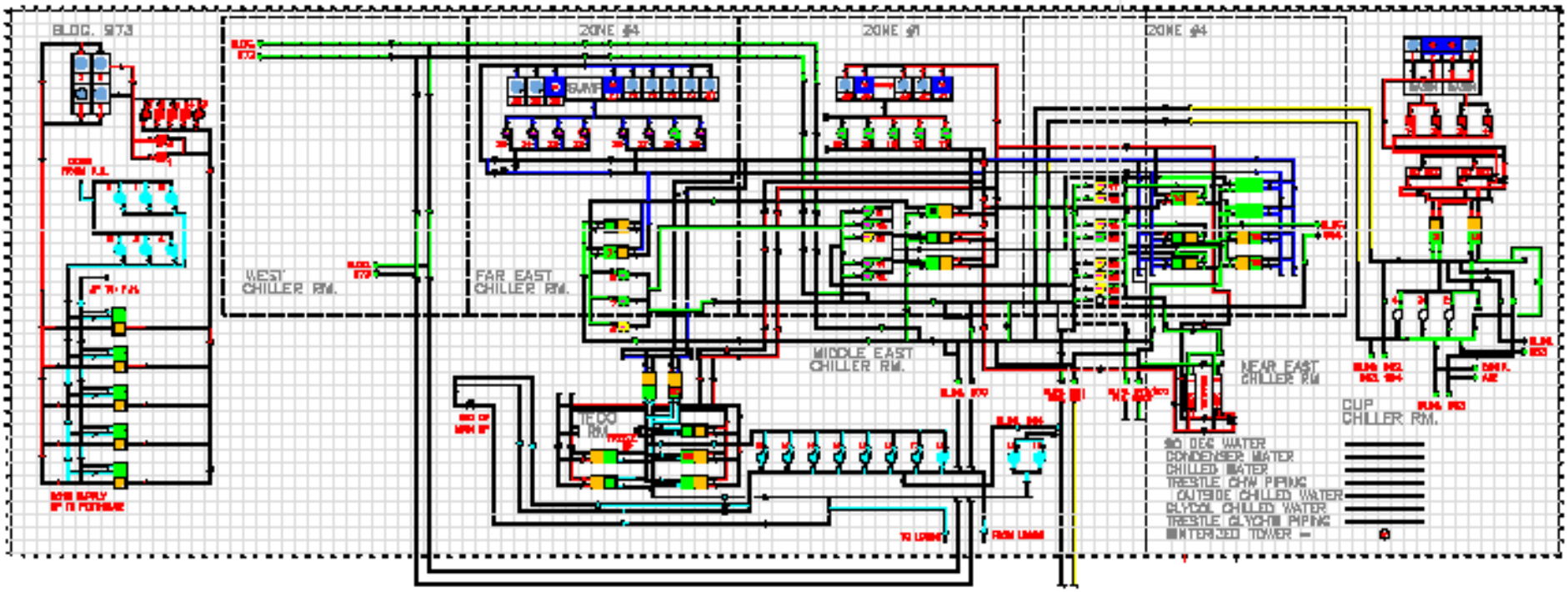
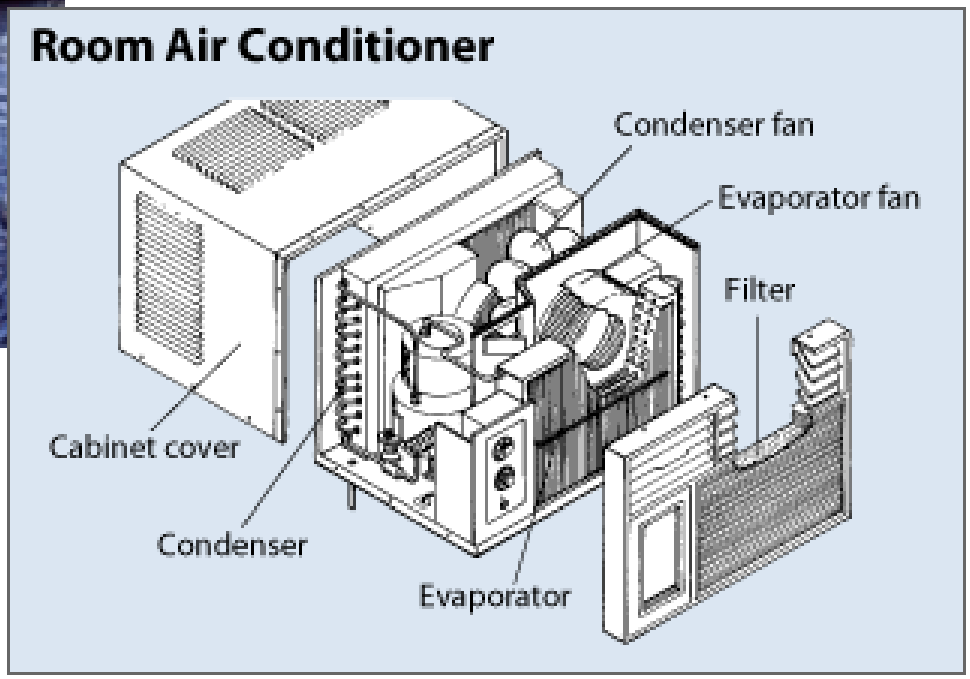


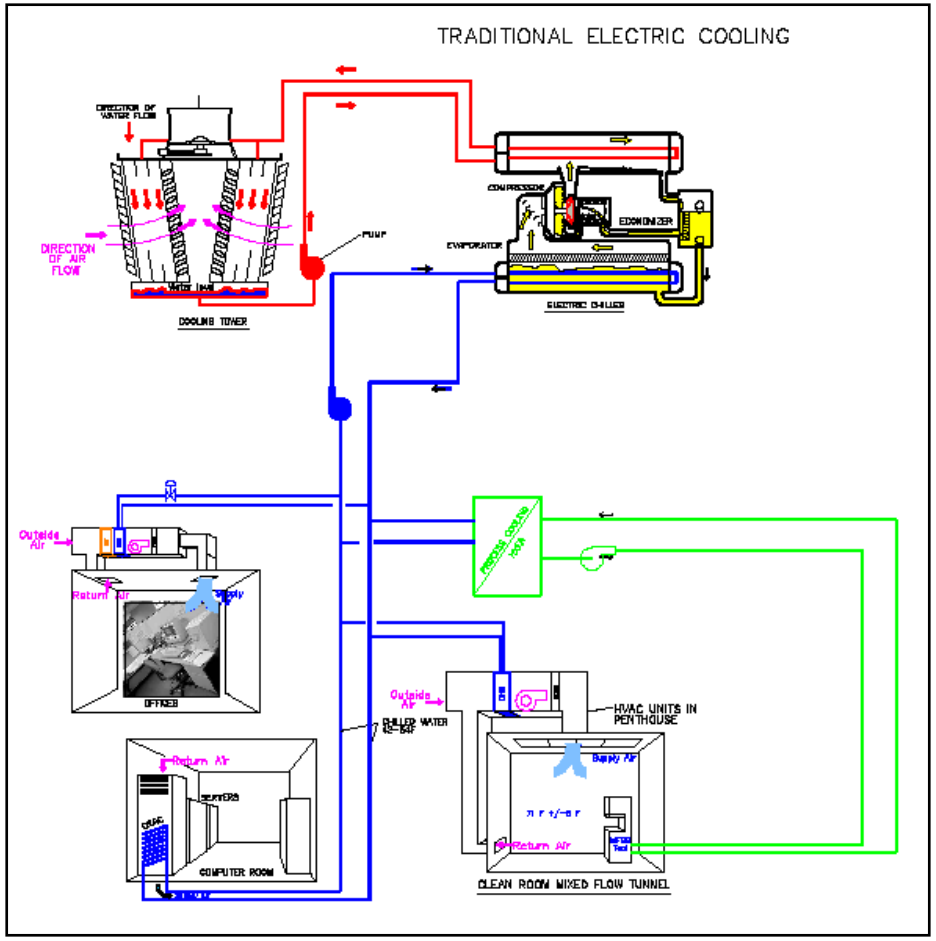
Chillers 101 – Trane Chiller training for IBM

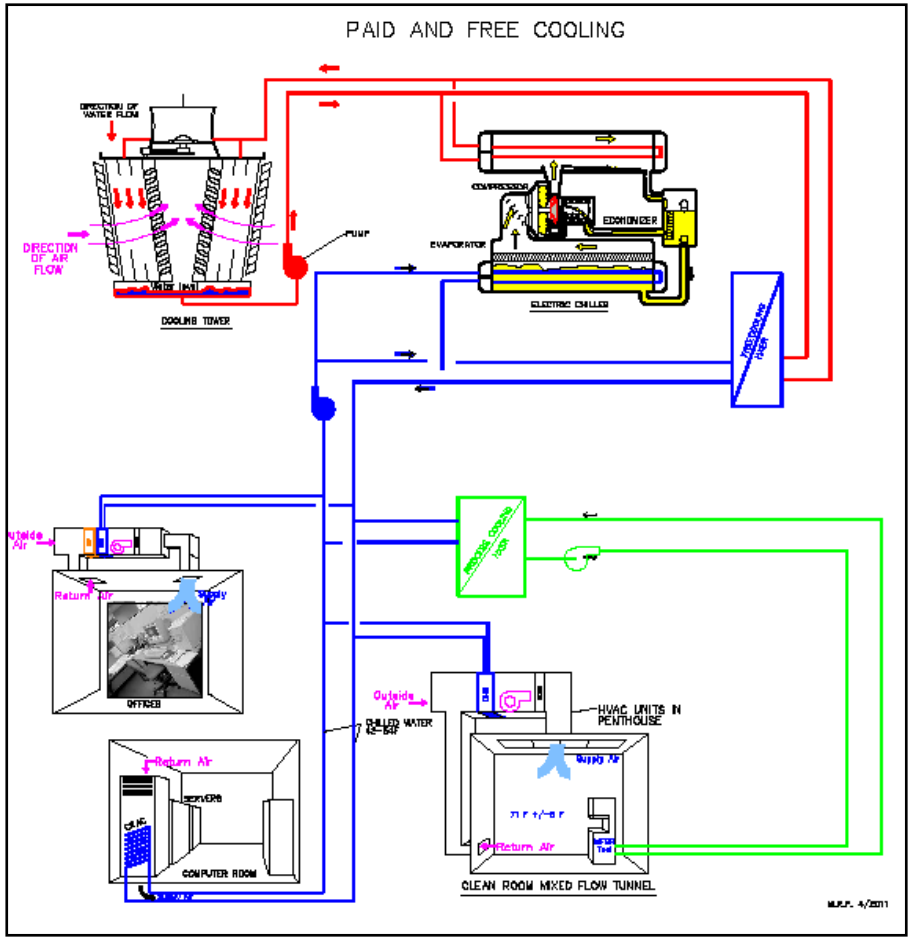
TRANE®

An American-Standard Company

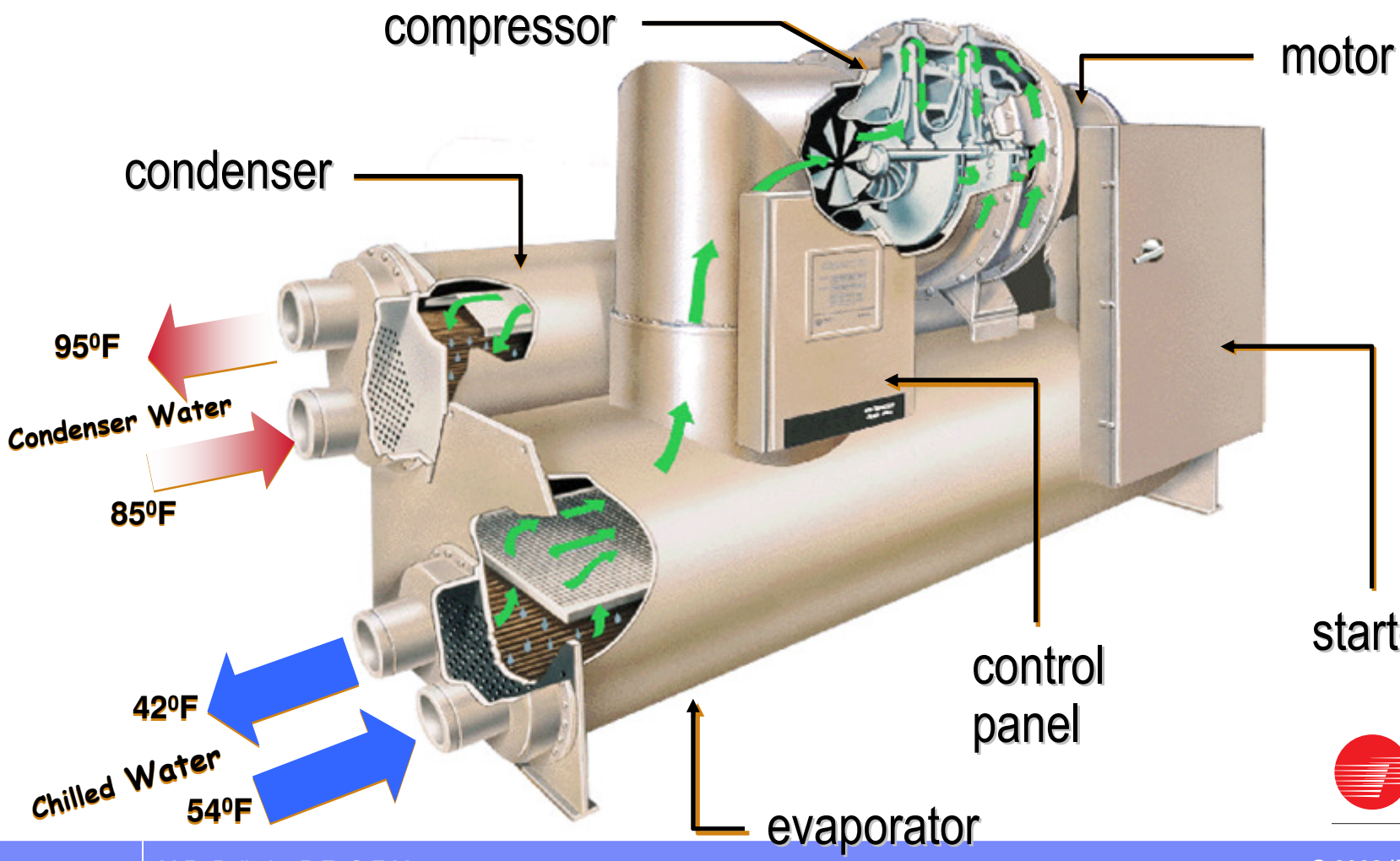
Window air conditioner







components of a
Centrifugal Water Chiller



TRANE
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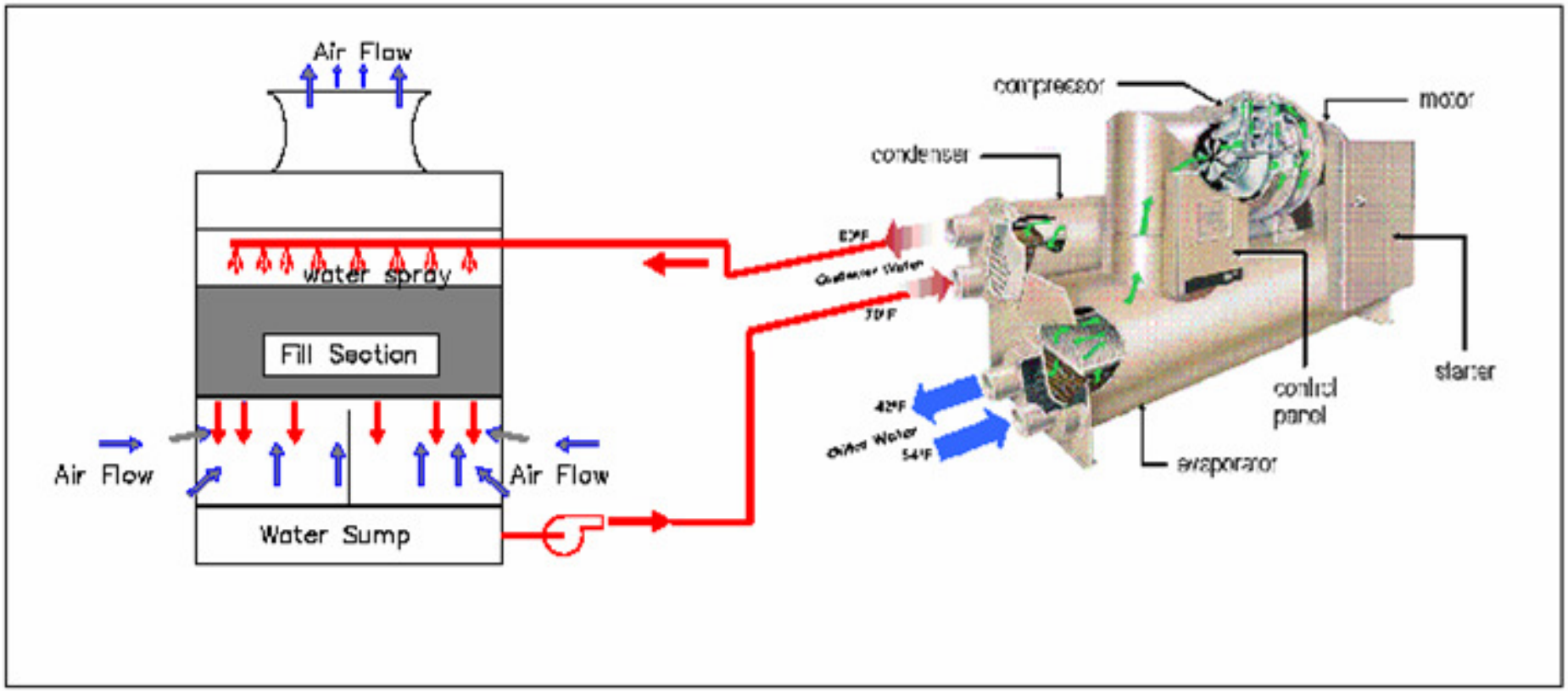
components of a
Centrifugal Water Chiller - Condenser System



Zone #4 Cooling Tower

Save Energy – shut off Chiller(s) in winter

- Chiller motor = 1,750 HP
- Equivalent to 2,000 window air conditioners
- 12,000 light bulbs

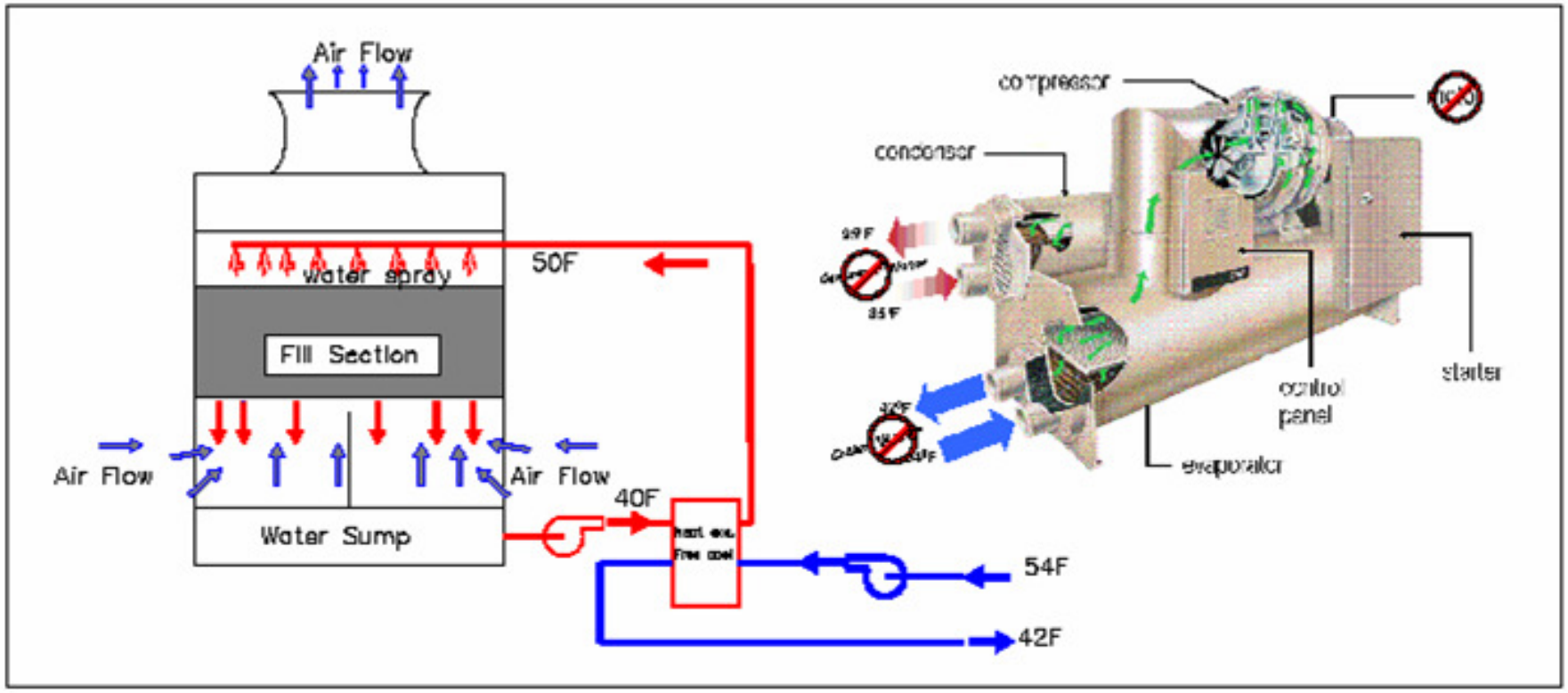
~~Winter rates~~
~~$55 / hour~~
~~$1300/day~~

Cooling Summary

- **The Burlington site uses very high amounts of cooling; so much that supplemental cooling equipment must run 24/7 even in the winter.**
- **There is over 35,000 horsepower of installed cooling equipment. Each chiller costs over $1350 per day to operate**
- **This chilled water cooling is accomplished with:**
  - Electric chillers which use water and pumps to remove heat from the building loop and send it into the secondary loop (condenser water)
  - Cooling towers that dissipate the heat through the secondary water loop (cooling towers are “water fall-like” structures on the North Road).

- **Wet “Free Cooling” concept:**
  - Shut down some of the chillers when it is very cold and dry and will use the ambient conditions for cooling.
  - This cooling is accomplished through a heat exchanger and pumps using the same cooling towers (with de-icing installed).
  - System can operate for ~ 4 full months and 2 partial months

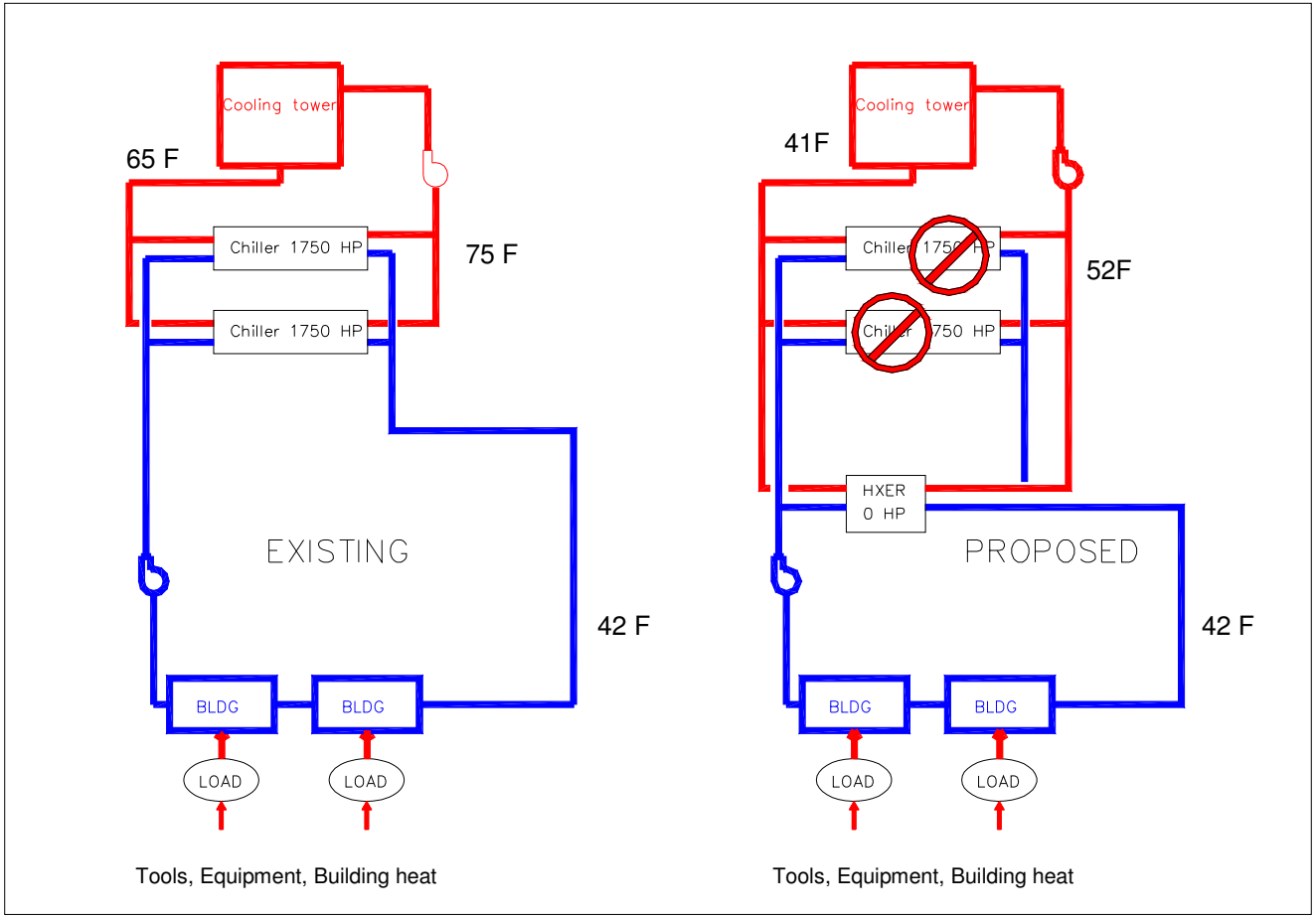
components of a
Centrifugal Water Chiller Condenser System w/ Free cooling



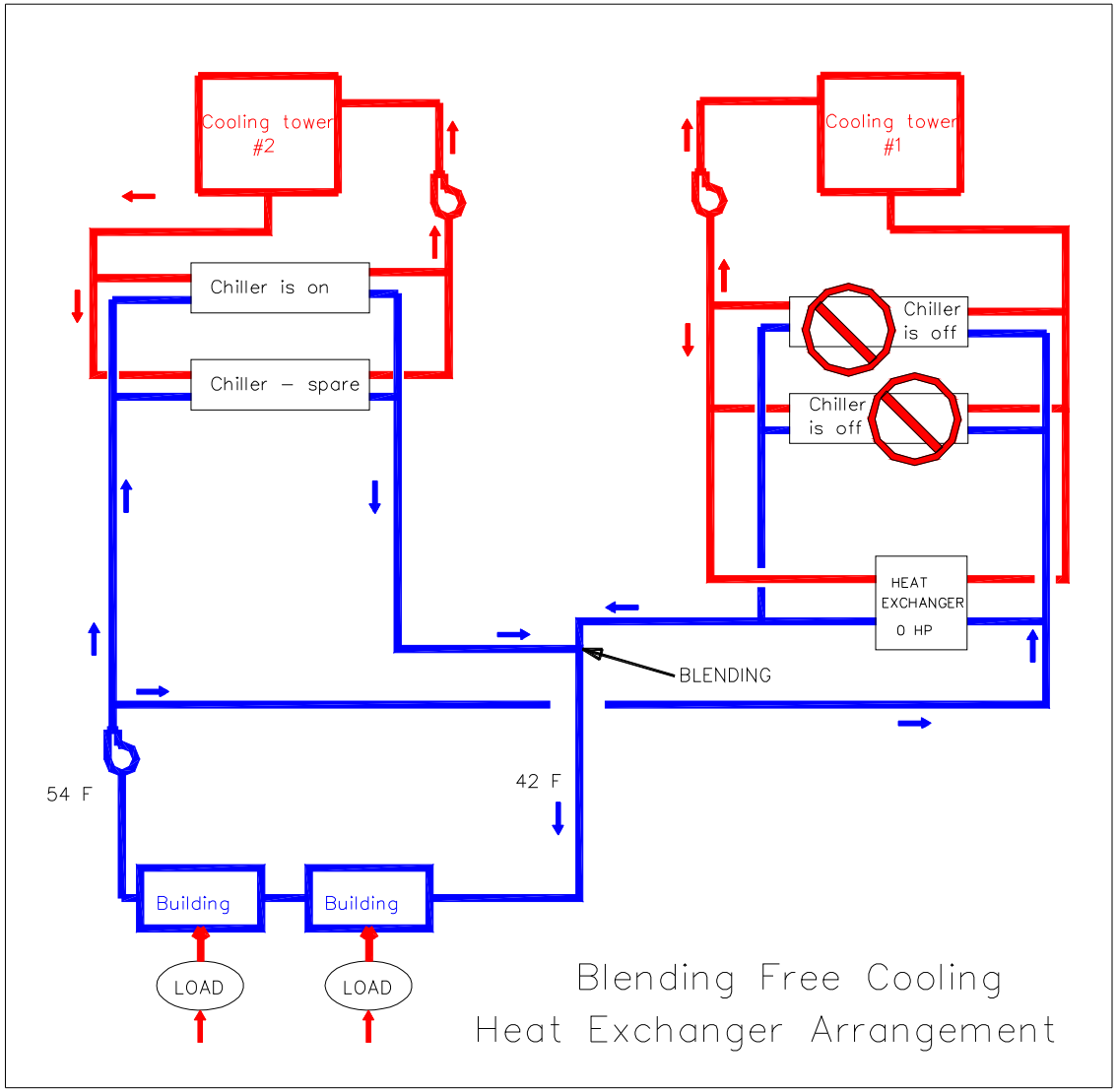
Zone #1 Cooling Tower = Free Cooling Tower

Chiller “Free Cooling” Concept for Winter

- Use Cold Winter air to lower the water temperature of secondary loop.
- Dissipate heat from the chilled water system via cold return water and heat exchangers
- Eliminate the need to operate two 1750 Hp chillers
- No changes to chilled water temperature or pressure delivered to Fab and site building (using same system pumps)



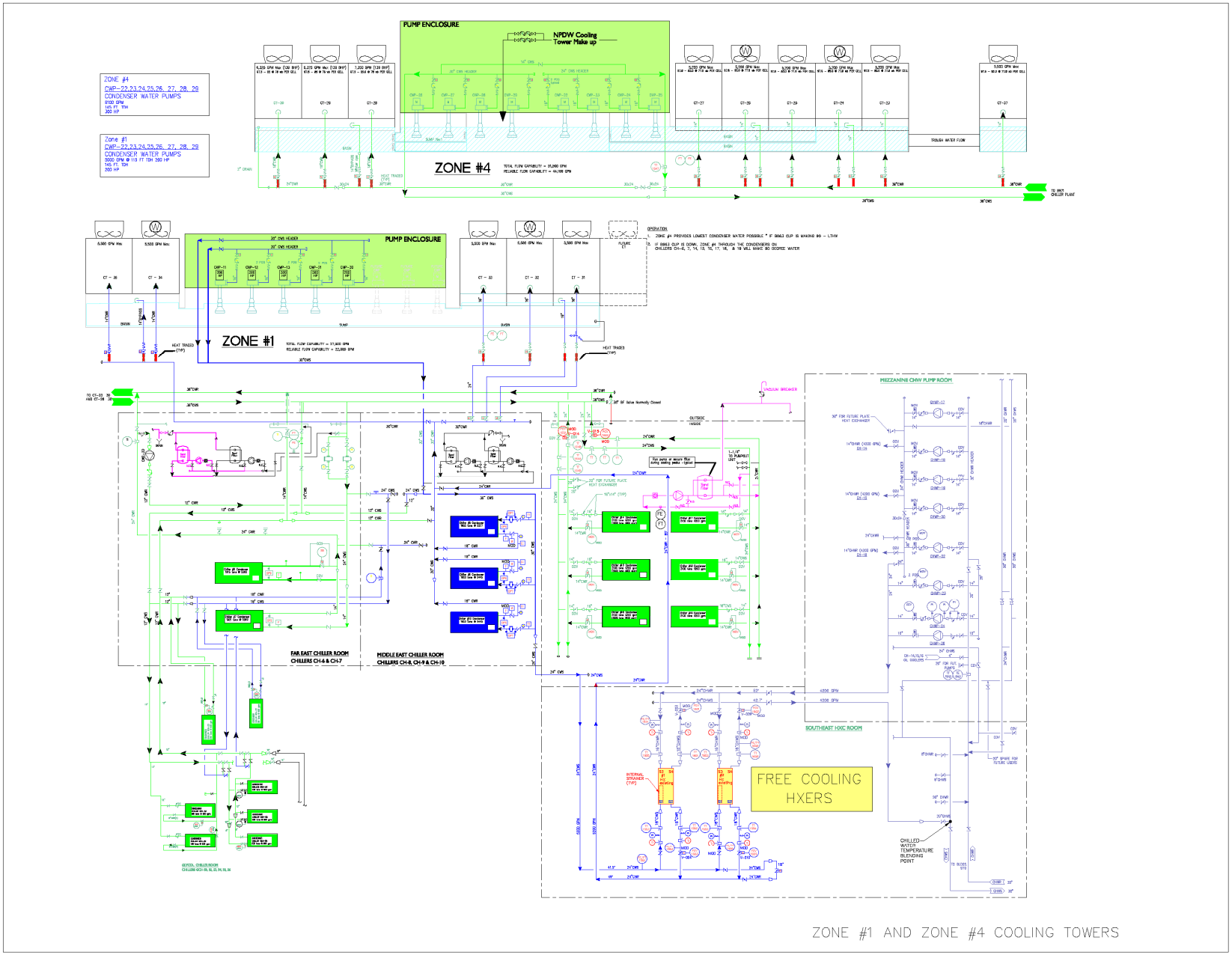
Chiller "Blended Free Cooling" Concept for Winter



Project Summary - Original Scope

Pump building, new 24 inch pipe, recomissioned heat exchangers, full tear down, new controls, etc.

1. Completed feasibility study and preliminary costing
2. Engaged CUP technicians and Operators to define “least risky and most flexible concept”
3. Revised Scope and re-estimated – no site shutdowns allowed
4. The scope and savings was considered “Good Enough” and was not developed completely
5. Phase 2 funding was identified for unknown scope items
6. Project Created – Design funds only were released
7. Funding released after bidding and imminently before construction window (all the equipment is needed in summer)
   - Started work as early as possible in fall to complete ASAP to recover savings
   - Original planned start up – end of February
8. Aggressive – work scope bid for best completion date w/o overtime
9. Engaged all players – contractor summary presentation was held during lunch to explain the urgency and scope
10. Qualified new suppliers and materials to maintain the schedule
11. Completed panelized 2 story height building for pumps
12. Completed adequate sections of the work and started the system on 12-31-2008 New Years Eve
13. Continued and finished construction on schedule



ZONE #1 AND ZONE #4 COOLING TOWERS

CHW piping

CHW piping

CW piping

CW pump basin - Before

During Construction

Pumps after overhaul

Walls and steel to be erected early November

During Construction

Where are we now- During Construction

Thanks to Larry Riegert for this Video

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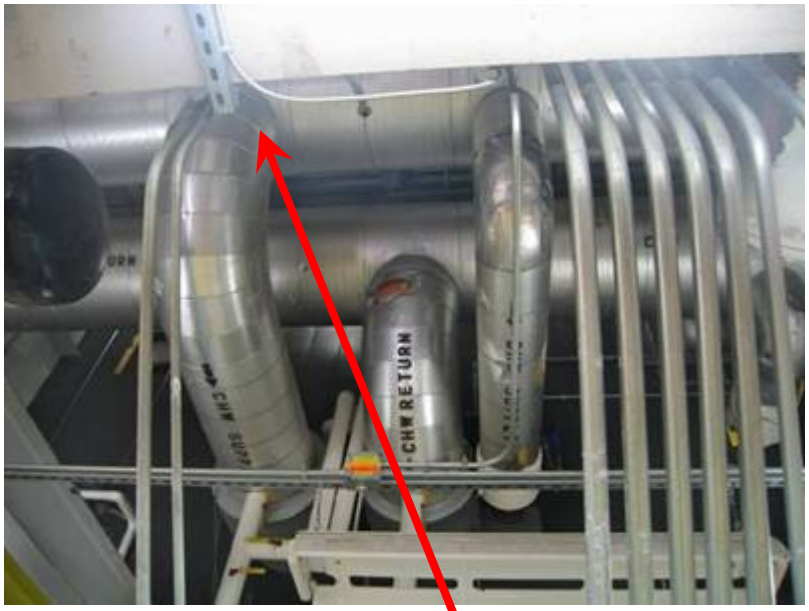
Free Cooling Heat Exchangers

Free Cooling Heat Exchangers

Disassembled and cleaned prior to start-up.

Blending point – Free cooling and zone 4 chillers



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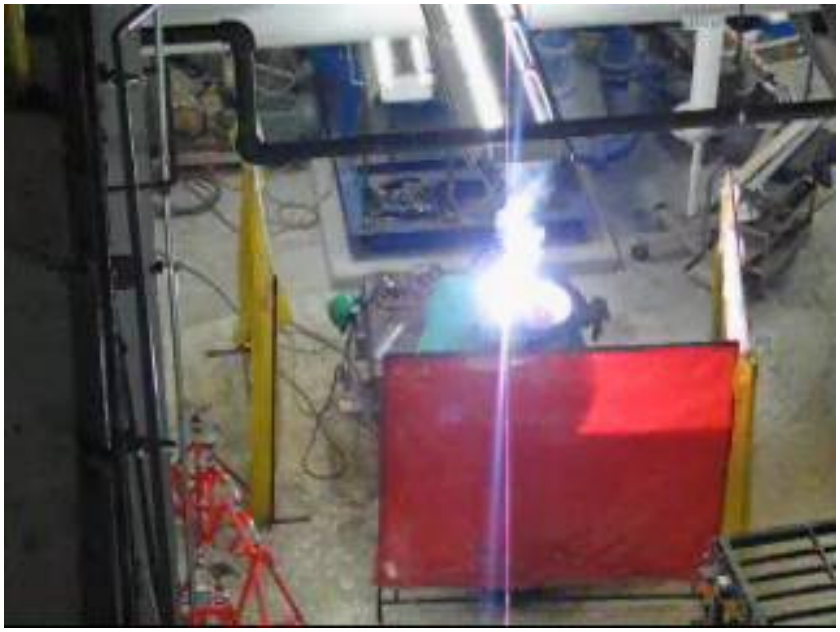

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What are the tools – icing control

1. Cameras for observations
2. Vibration Monitoring
3. Fan speed control – VFD and reversal
4. Heated Louvers
5. Dump valve
6. Combinations of 3-4-5 & water temp.
7. Trial and error - practice

Camera on North Road

Picture of ice on louver on a “warm day” – very little ice present

Ice forms on all leaks and louvers and grows down the columns. Technicians must break the ice from below with a steel pipe – Safety issue. The alternative methods are to turn on a chiller and melt the ice or prevent it from forming.

Vibration monitoring – 4-20 mA

What are the tools – icing control – Fan Reversal

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Fans – 125 HP, 16 -18 foot diameter – 500,000 CFM ea.

VFDS - will not over cool the water and can reverse with electronic controls

Louvers and Tower

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Reduce ice build up on louvers

Cooling towers freeze in the winter and many steps are used to reduce ice formation and keep free cooling running:

1. Fans are shut off to allow warmer water to melt the ice on the louvers, columns, and walls
2. Fans are reversed to blow slightly warmer air out the front melting the ice on the louvers/walls
3. Chillers are operated to heat up the water and melt the ice

Double wall heat exchangers are installed instead of louvers to redirect the water into the tower and keep the surface temperature above 32F. The louvers are heated with waste heat to prevent/reduce ice formation and extend the free cooling hours

Louvers with Cooling Tower Water

What are the tools – icing control Basin Dump valve

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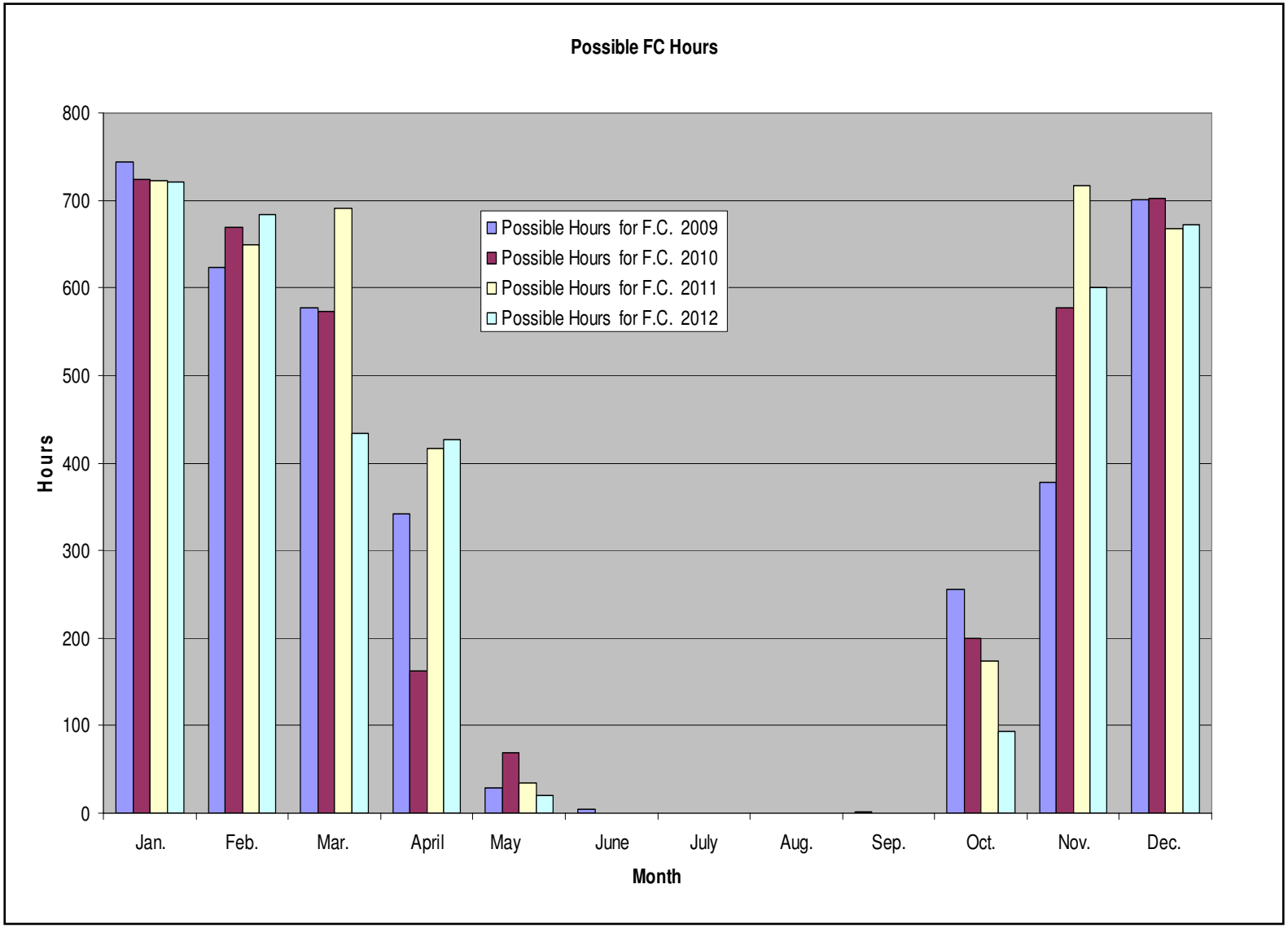
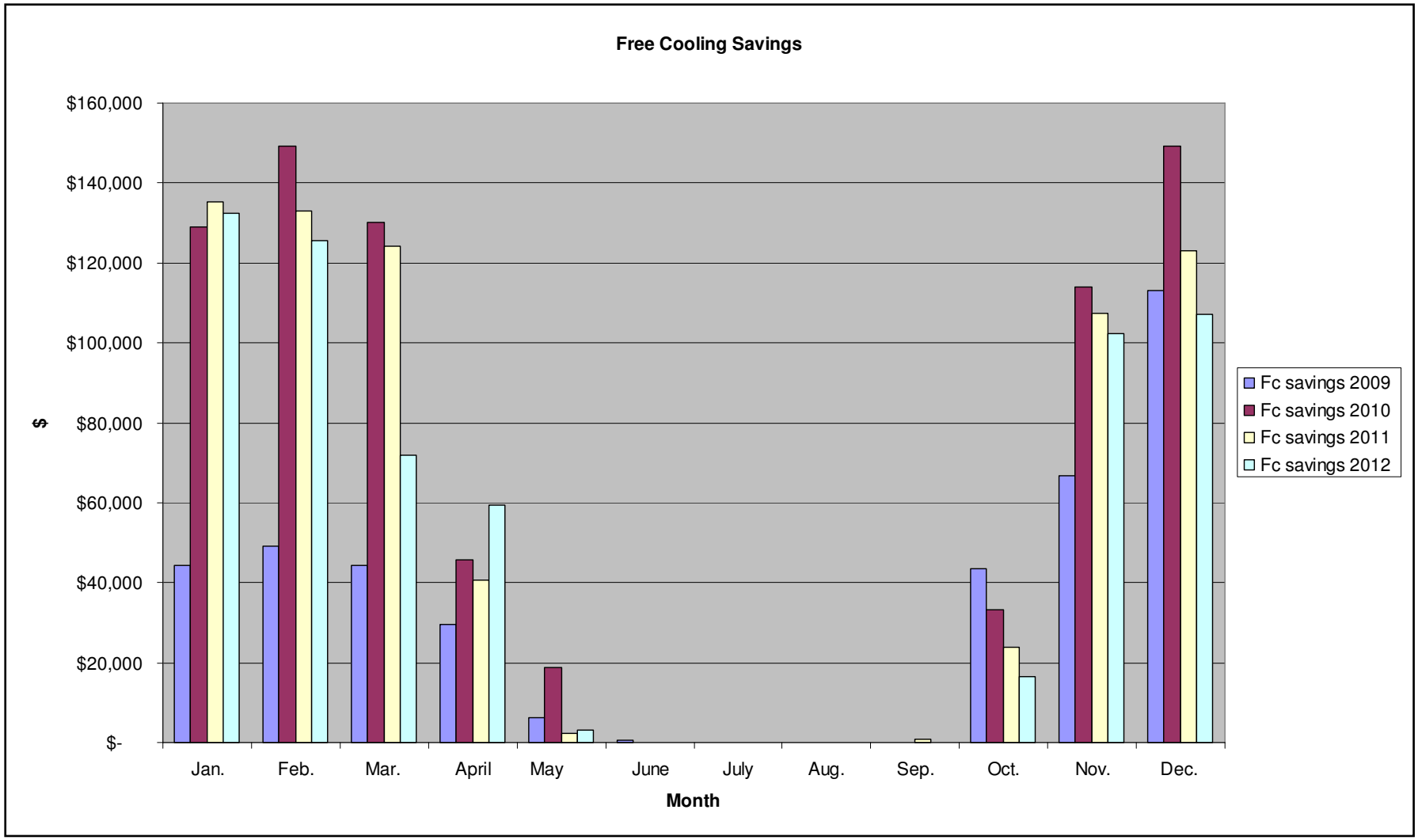
Dump valve opening / riser valve closing 1 pump = 5000 gpm





2010

Free Cooling Savings	Jan.	Feb.	Mar.	April	May	Oct.	Nov.	Dec.	Total
2009	$ 44,269	$ 49,189	$ 44,292	$ 29,464	$ 6,361	$ 43,501	$ 66,680	$ 113,205	$ 397,669
2010	$ 129,076	$ 149,223	$ 130,207	$ 45,792	$ 18,617	$ 33,145	$ 113,853	$ 149,294	$ 769,208
2011	$ 135,290	$ 133,101	$ 124,295	$ 40,758	$ 2,211	$ 23,976	$ 107,378	$ 123,182	$ 691,139
2012	$ 132,533	$ 125,737	$ 71,869	$ 59,379	$ 3,209	$ 16,550	$ 102,380	$ 107,108	$ 618,763
	$ 441,169	**$ 457,250**	**$ 370,663**	**$ 175,392**	**$ 30,398**	**$ 117,173**	**$ 390,291**	**$ 492,789**	**$ 2,476,780**

Follow On Projects – AEE Award

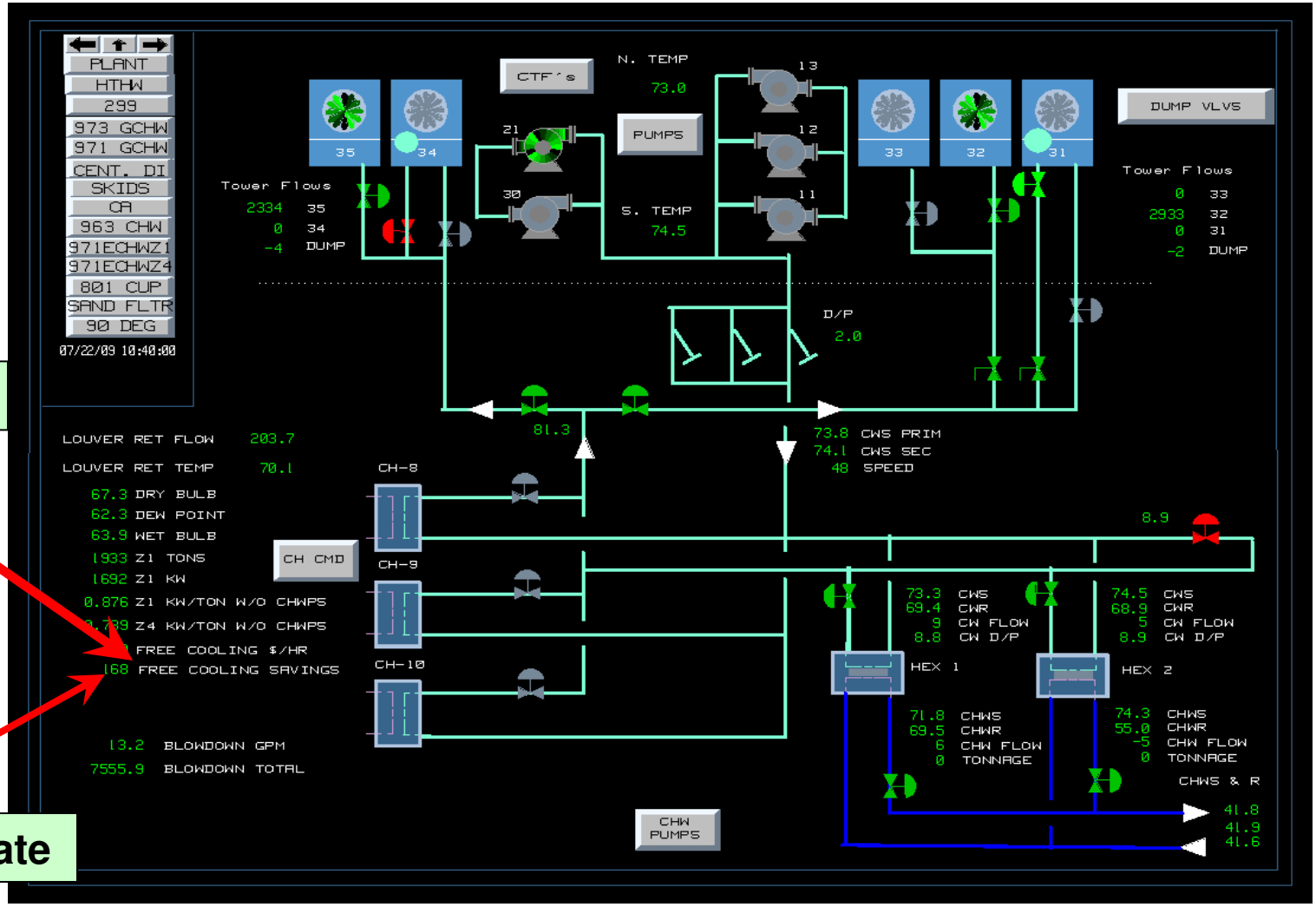
1. Replace all the Flow Switches
2. Revise Operations – continuously – example - higher Water flow at <0F temps
3. Revise Operations – alarm if not in use (it can not be disabled anonymously)
4. Relocate a smaller Chiller to provide minimal load and no cost heating for the idling cooling tower
5. Convert the small chiller to 2 pass in lieu of 3 pass – eliminates the need for an extra pump
6. Revise the heat source for the louver heaters to boiler source *(140 F versus ~ 55 F tower water – no ice bridging across the louvers
7. Install a VFD for the condenser pump when running the smaller chiller 2400 GPM is the minimum flow – the pump generates 7,000 GPM
8. Add plates to the HXERS
9. Install Tarps and spray water to prevent icing on columns
10. Operational changes

Current work

- Installing a bypass on the CUP Chillers
- Install 4 - 300 HP VFD'S

Revise Operations - Live feed back of savings for operators

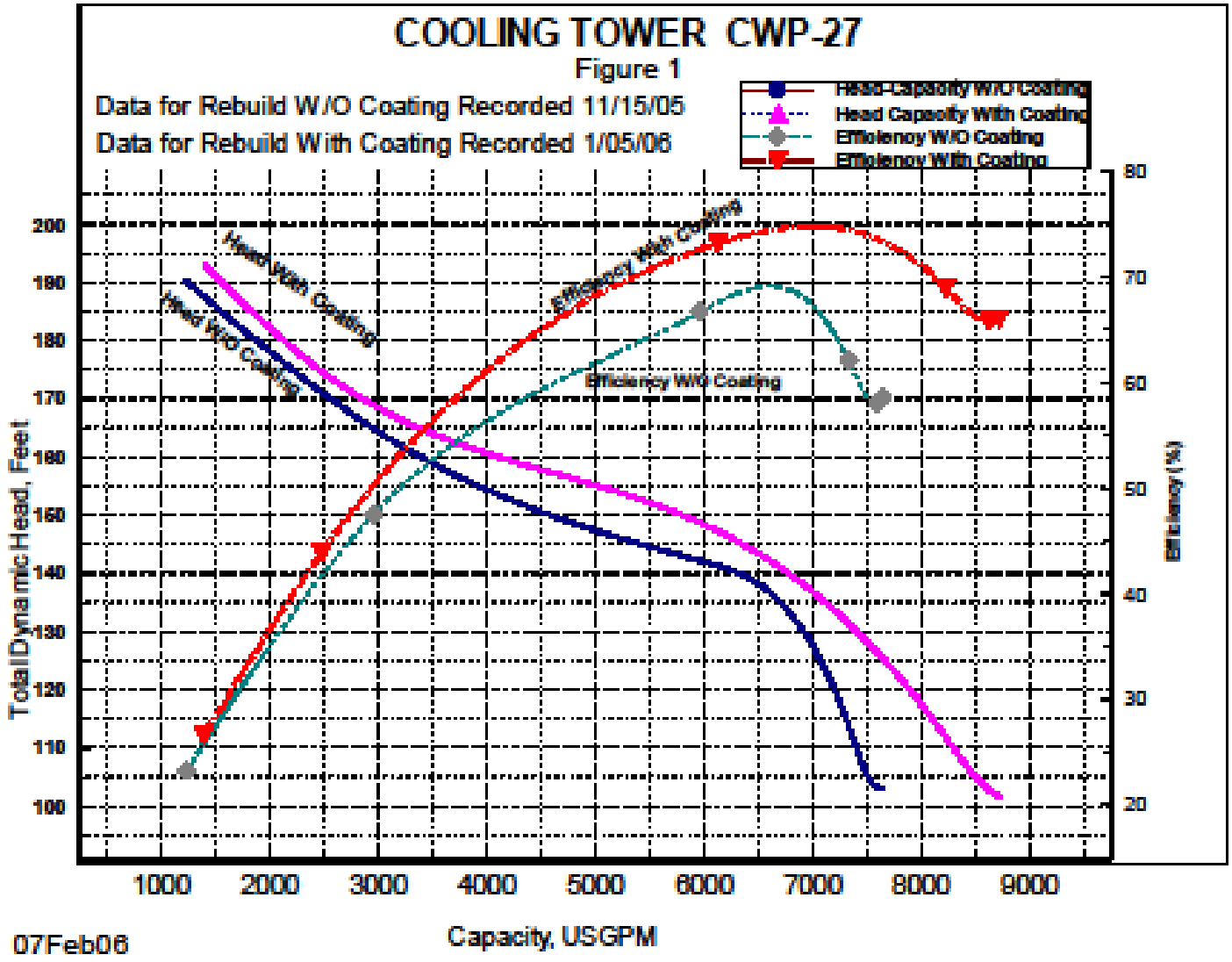
Operators watch the screens and can see the impacts of their actions – live $ savings



$avings/HR

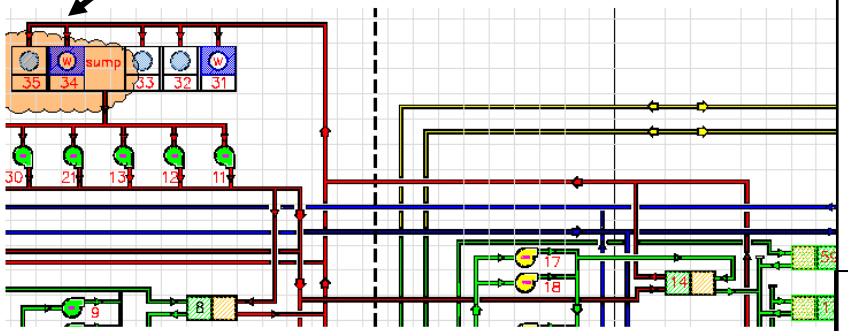
$avings to date

Typical performance from pump overhaul

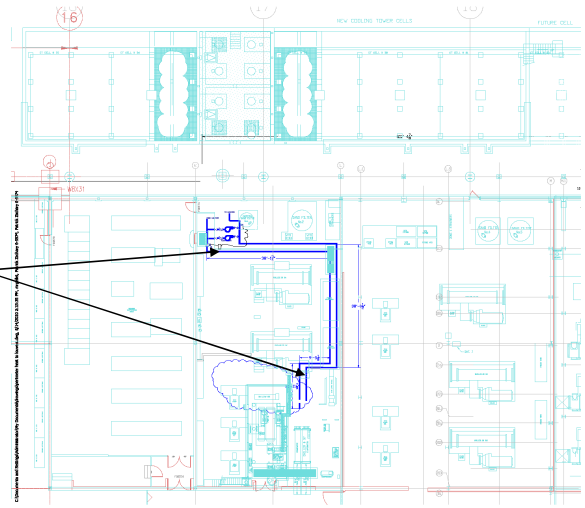


Follow On Projects

Add Louver Heaters - 2 cells



Install pumps, piping and controls into existing louver heater piping



Follow On Projects

Building 971

500 TON CHILLER

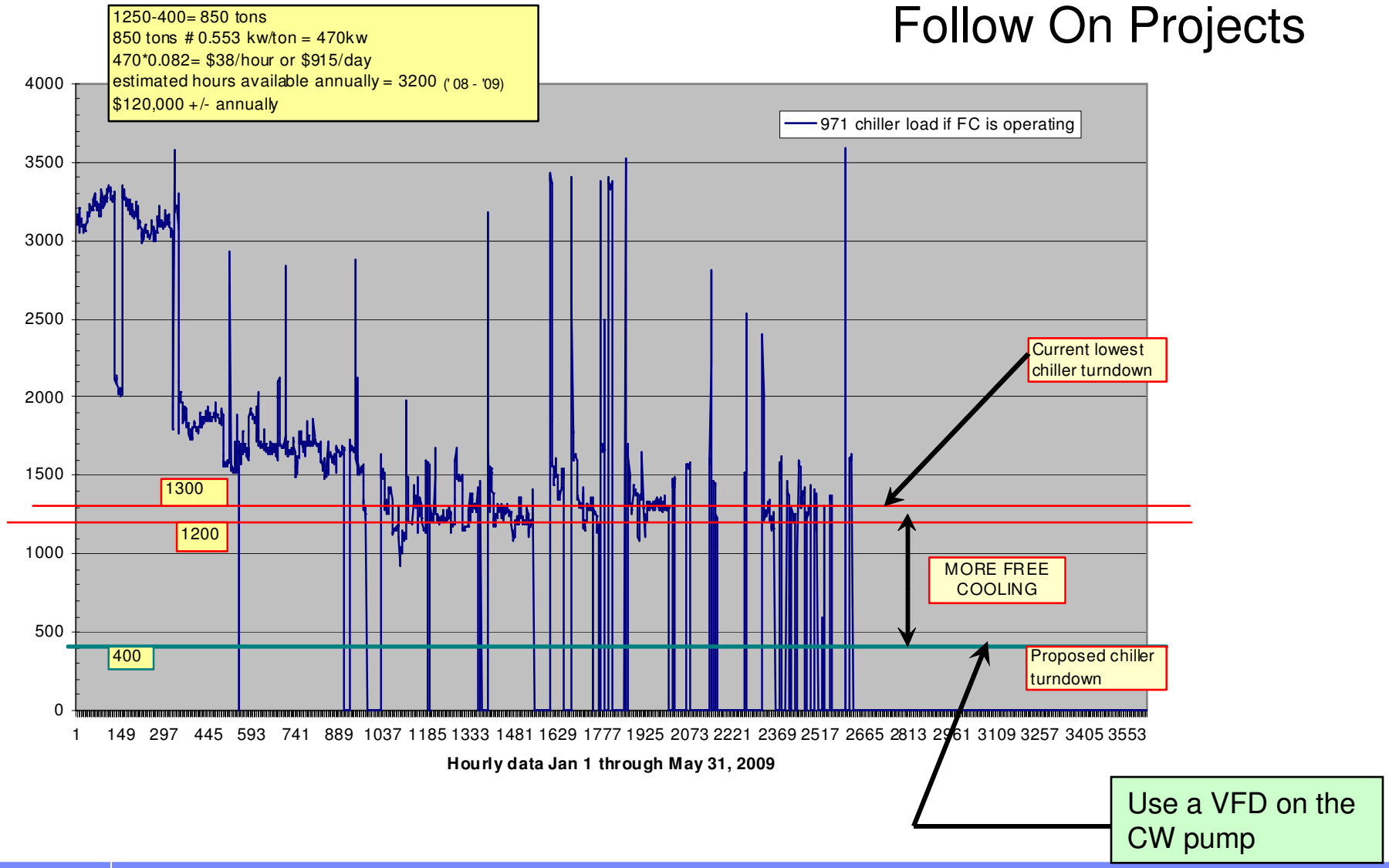
Building 971

2000 TON CHILLER

Relocated chiller is 500 tons – allowing for the smallest chiller to remain operating to maximize the free cooling.
3 pass configuration shown – opposite end connections

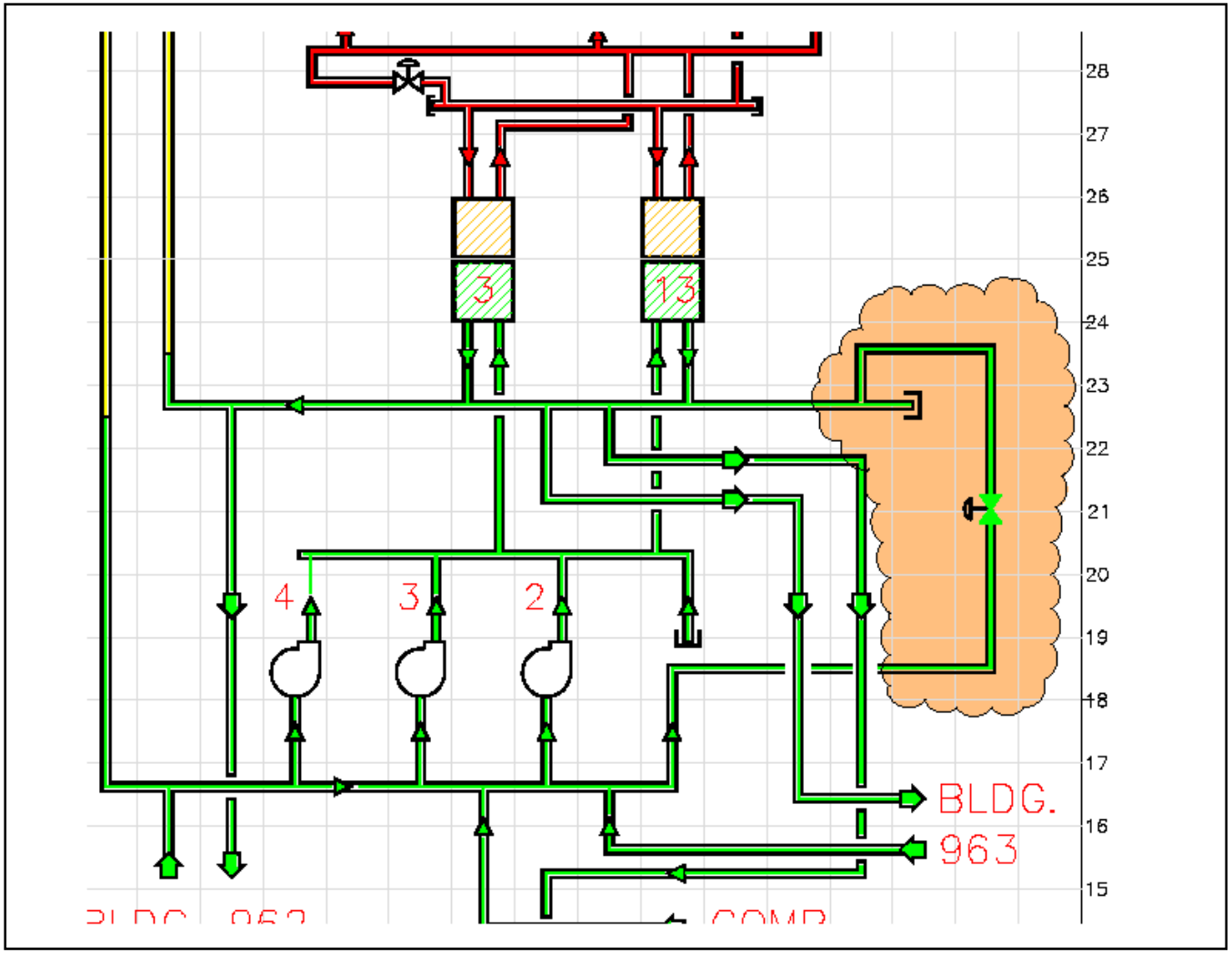
Flow Switch Replacement & VFD on CW pump for Relocated Chiller

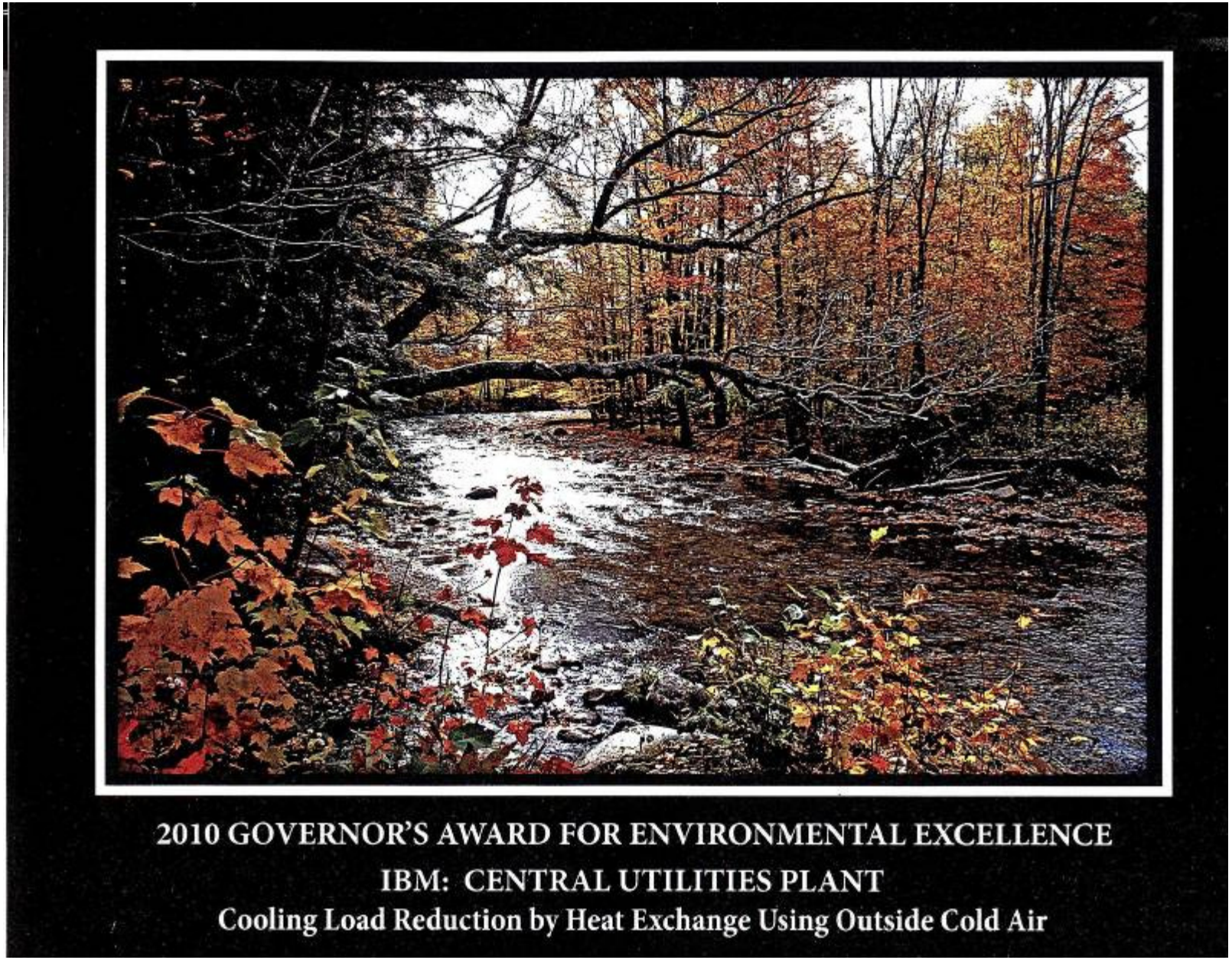
Follow On Projects

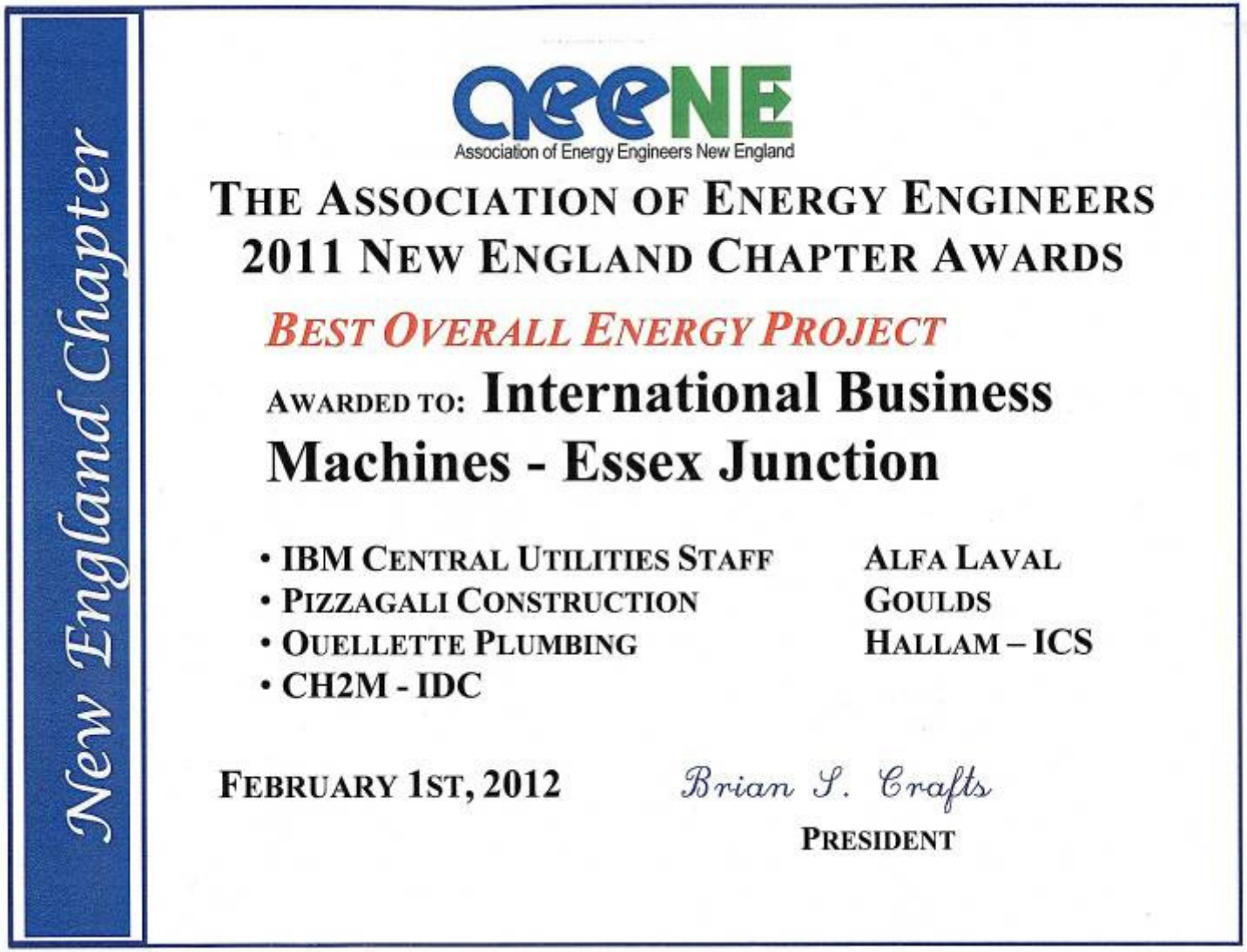


Follow On Projects – CUP Chiller Bypass

allows more free cooling by making less free heating – only as much as needed







New England Chapter

Association of Energy Engineers New England

THE ASSOCIATION OF ENERGY ENGINEERS
2011 NEW ENGLAND CHAPTER AWARDS

BEST OVERALL ENERGY PROJECT

AWARDED TO: **International Business Machines - Essex Junction**

- IBM CENTRAL UTILITIES STAFF
- PIZZAGALI CONSTRUCTION
- OUELLETTE PLUMBING
- CH2M - IDC

ALFA LAVAL
GOULDS
HALLAM – ICS

FEBRUARY 1ST, 2012

Brian S. Crafts

PRESIDENT

This presentation will explain:

- what a chiller is
- how it operates
- the concept of a free cooling operation
- the selection of the system configuration.

The project discussion will highlight the challenges, innovative approaches, funding, and aggressive schedules that were dealt with along the way.

The scope of the core project and all the follow on, or enhancement projects, will be summarized.

Questions

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