

Retro-Commissioning in Hospitals



Agenda



- American Society of Healthcare Engineering (ASHE) Introduction
- Significant Elements of the ASHE Health Facility Retro-Cx Process
- Retro-Cx Case Studies
 - Baptist Hospital
 - Sacred Heart Hospital
 - Ft. Scott
 - Oklahoma Heart Hospital
 - Family Medical
- Summary

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American Society for Healthcare Engineering
of the American Hospital Association



- Guidelines
- Handbook
- Specific to Health Facilities
- Case Studies
- E2C Program
- Energy Star Benchmarks

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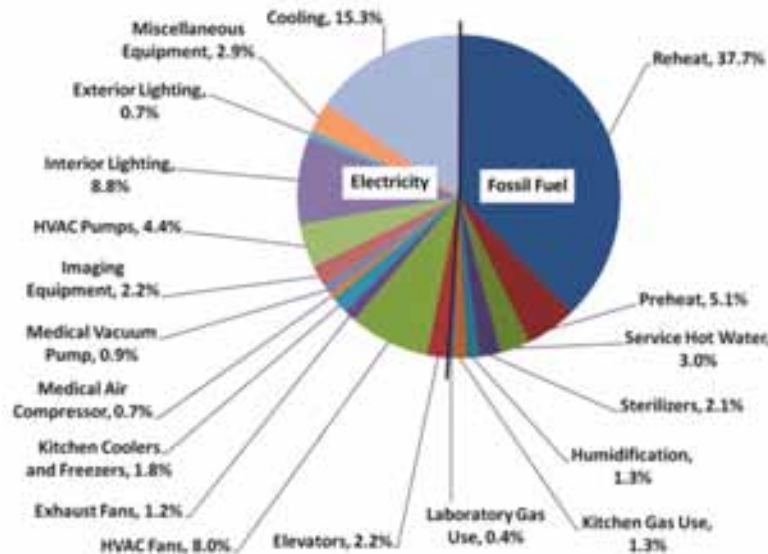
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Summary

Significant Elements of the ASHE HFRCx Process



- Majority of Work by Hospital O&M Staff
- 3rd Party Retrocommissioning Team Leader
- Energy Efficiency is Benchmarked using EPA Energy Star
- Supply-Side Energy Audit
- Strategic Energy Plan
- Set Goals

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Summary

Significant Elements of the ASHE HFRCx Process

- Equipment Testing
- Repair or Replace Failed Components
- Room Ventilation Schedule per ASHRAE Standard 170
- Weekly Schedules - Setbacks
- BAS Continuous Data Archival and Trends



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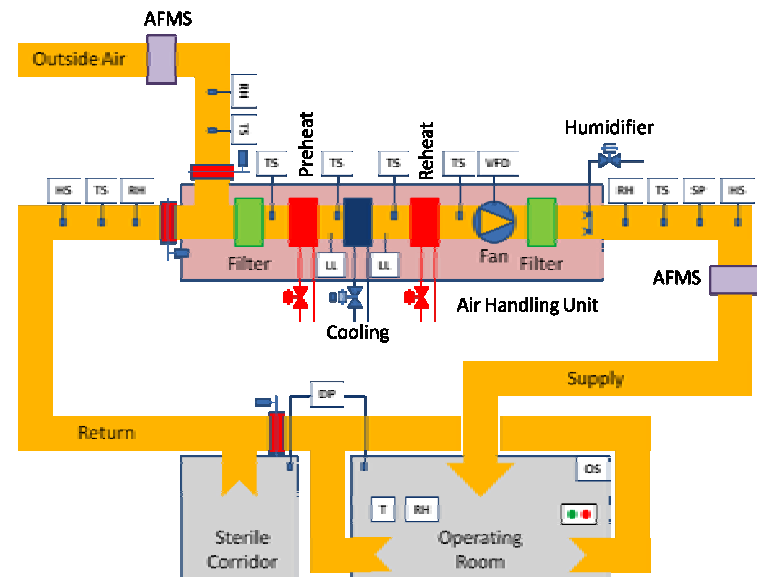
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Summary

Significant Elements of the ASHE HFRCx Process

- Revise Air Handling Unit Programming
- Rebalance Outside Air and Exhaust Systems
- Revise CHW and HW System Programming
- Revise Air Terminal Programming
- Measure and Verify Results



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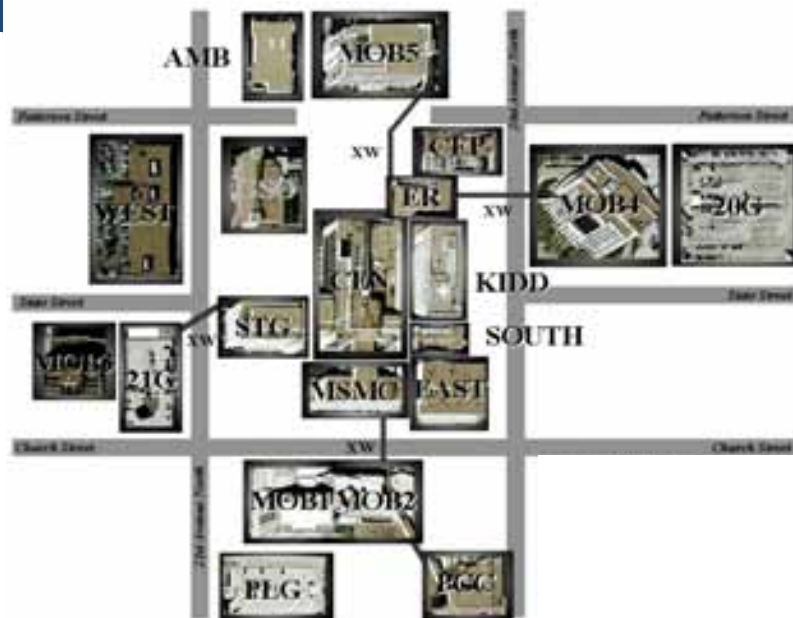
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Summary

Baptist Hospital, Nashville, Tennessee



- 1,565,184 SF
- 661 Inpatient Beds
- 30 Operating Rooms
- 1950 - Original Construction
- Numerous Expansions and Renovation
- 13 Baseline Energy Star Rating

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Baptist Hospital Retro-Commissioning Process



- Majority of Work Accomplished by Hospital O&M Staff
- Majority of Work Accomplished without Capital
- Essential Capital Provided by Ascension Health FIP Program
- Accumulated Energy Cost Savings are Reinvested in New Projects
- Energy Conservation Program Started in 2008
- Energy Efficient Control Strategies Provided by 3rd Party Retrocommissioning Team Leader

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Energy Awareness Newsletter

LIFE ONLINE

Baptist Hospital
Jan 03, 2013

Baptist Hospital & me: Average Electric Bill

me (MyEnergy) is the campus wide Energy Conservation Program at Baptist Hospital.

Did you know: The average monthly electric bill for the main hospital building is \$215,855.00 and we use 2,743,578 kilowatts. Compare that to your electric bill at home.

My Energy at work: WOW! Think of the above statement. What do you use in your area that uses electricity? What you turn on does matter. What you turn off also matters.

My Energy at home: It's winter! Do you use all electric heating at home or natural gas? Do you have a predictable schedule that would benefit from having a programmable thermostat when no one is home? If you manually set the thermostat back before you leave home, consider how many times you have forgotten. Programmable thermostats don't get busy and forget. If you don't have one, go to Home Depot, Lowes or any other hardware stores and purchase one that matches your system requirements. If you aren't sure what to purchase, the sales associates can help you. After one is installed and set for your daily schedule, you can relax knowing you are saving energy automatically.

Associates and My Energy

If you would like to participate with suggestions or examples of what your department has done to reduce energy, email greg.foreman@baptisthospital.com

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Summary

Chilled Water System Retrofit



- **Existing System**

- Primary/Secondary/Tertiary
- 34 Constant Speed Pumps
- 750 Total Pump HP
- 3 Decouplers
- Independent Low Temperature System
- 3-way and 2-way Valves

- **Modified System**

- Variable Primary
- 6 Variable Speed Pumps
- Low Temperature System Connected to Main System
- 2-way Valves

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Chilled Water Systems Optimization

- Maximum Capacity Chilled Water Sequencing
- Automatic CHW Differential Pressure Setpoint Reset
- Chilled Water Supply Temperature Setpoint Reset
- Condenser Water Supply Temperature Setpoint Reset
- Chiller Flow Target Control of CHW Differential Pressure



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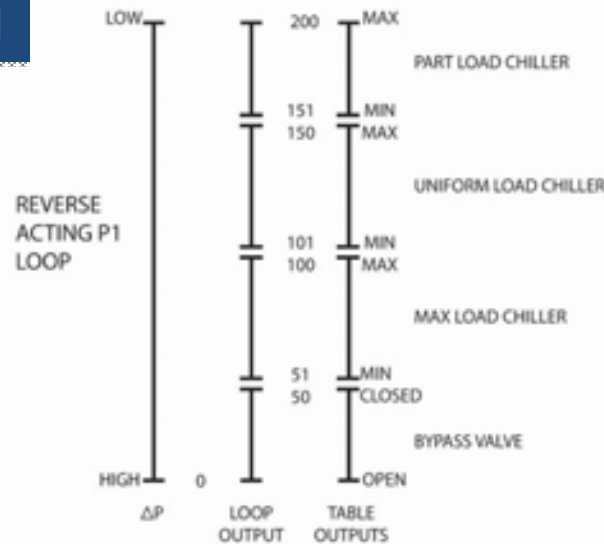
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Controlling CHW Differential Pressure



- **Conventional Method**

- Pump Speeds Modulated to Maintain Differential Pressure at Setpoint
- Bypass Valve Modulates to Maintain Minimum Chiller Flow

- **Recommended Method**

- Pump Speeds Modulated to Maintain Chiller Flow at Setpoint
- Chiller Flow Setpoints Reset to Maintain Differential Pressure Setpoint
- Bypass Valve Modulates to Maintain Differential Pressure

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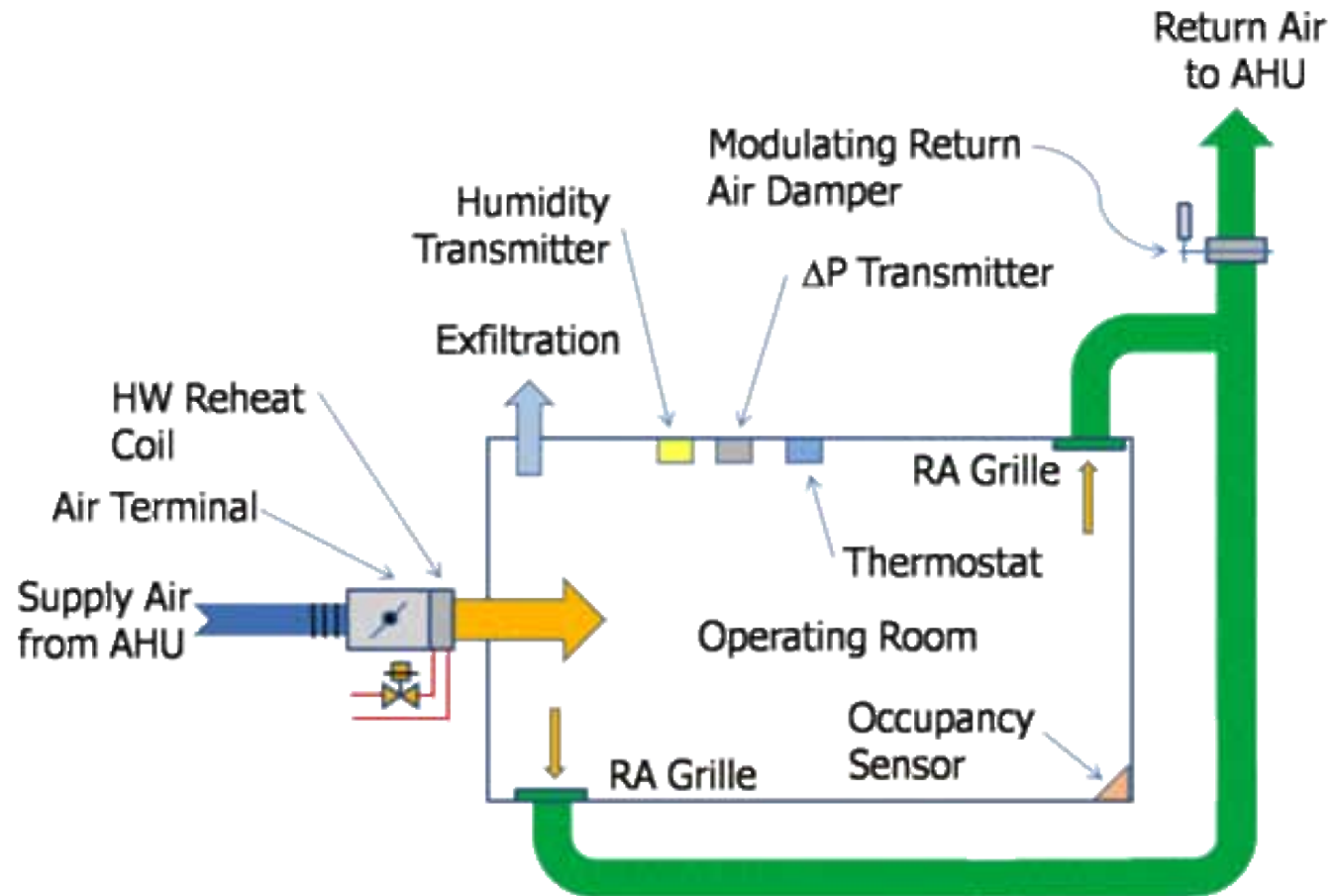
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Unoccupied/Occupied Controls in Operating Rooms



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Revised Air Handling Unit Programming



- Disable Economizer Cycles as the First Stage of Humidification
- Single Loop Control of Heating Water and Chilled Water Control Valves
- Supply Air Temperature Setpoint Reset
- Supply Air Static Pressure Setpoint Reset
- Proper Sequencing of Outside Air and Return Air Dampers
- Replaced Inlet Vanes with Variable Frequency Drives

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Daily Log of System Changes

Date	Description of Change	Utility Affected			Hospital Only	Hospital & Other Bldg's
		Electric	Nat. Gas	HVAC		
10/15/08	Implemented daily chiller logging.			X	X	
2/14/09	Conducted thorough PM's on chillers to improve efficiencies.	X		X	X	
7/8/09	Replaced the main steam line to the MSMC bldg. Reduced losses of steam and condensate.		X	X	X	
11/1/09	Removed operator overrides on non critical air handlers supply air setpoints.			X	X	
11/1/09	Added supply air resets to non critical air handlers.			X	X	
11/1/09	Tuned the economizer operation for non critical air handlers to prevent the chilled water valve opening during econ. mode.	X		X	X	
11/1/09	Added hot water resets for all steam converters and removed operator overrides.		X		X	
11/1/09	Modified return fan tracking for air handlers with VFD's. In all cases the fans backed off.	X		X	X	
11/1/09	Lowered the supply static set points for air handlers maxed at 100%.	X		X	X	
11/1/09	Repaired and released programming for air handlers with return fan inlet vanes.	X		X	X	
11/1/09	Modified programming to all air handlers to use one loop in place of two loops for the chilled water valve and heating water valve. Added deadbands to prevent simultaneous heating and cooling.			X	X	
11/1/09	Added room reset control programming for air handlers with zone control.			X	X	
11/1/09	Disabled programming on air handlers with faulty humidifiers or humidity sensors.		X	X	X	
11/1/09	Added local / global points to all programming to prevent data loss.				X	
11/1/09	Lowered humidity set points on several air handlers.		X	X	X	
11/1/09	Modified air handler hot water pump programming to turn the hot water pump on when the hot water valve opens, in place of turning on the hot water pump below 55 degrees outside air temperature.				X	
11/1/09	Modified cold water deck and the hot water deck reset schedules.	X	X	X	X	
11/1/09	Tuned static pressure control loops to prevent swings.			X	X	
11/1/09	Modified programming for all Chapel VAV's to use 100% of the hot water reheat before adding more air flow.		X		X	
11/1/09	Added minimum and maximum temperatures to the Chapel VAV's	X	X	X	X	
11/1/09	Added scheduling to the Kitchen MUA to shut down at night.	X	X	X	X	
11/1/09	Modified programming for the kitchen MUA to sequence the two preheat valves in place of both opening at the same time.		X		X	
11/1/09	Tuned and modified mixed air set point tracking for some air handlers.			X	X	
11/1/09	Added lead / lag alarming programs to pump stations.			X	X	
11/1/09	Tuned operating room loops.			X	X	
12/29/09	Implemented chiller schedules based on weather forecast.	X		X	X	
4/1/11	Replaced 3-60hp constant speed vacuum pumps with 4-15hp variable speed lead/lag claw pumps.	X			X	

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Daily M&V Report

From: Cortney [<mailto:cortney@hayesenergy.com>]
Sent: Wednesday, October 26, 2011 10:38 AM
To: Ingram, Bill; Skelton, Damian; Foreman, Gregory; King, Jason M.; john@hayesenergy.com; johnny@hayesenergy.com; wes@hayesenergy.com
Cc: cortney@hayesenergy.com
Subject: energy report (Baptist Nashville)

Please see attached report.

John our readings this morning (2/16/12) were as follows:

Electric = 14663

Gas #1 = 830532, Gas #2 = 744703

Thanks for the e-mail Chris.

Based on yesterday's temperature (15 HDD) your savings were:

	Electric	Gas
Predicted	88,837 kWh	600 Dth
Actual	<u>77,780 kWh</u>	<u>510 Dth</u>
Units Saved	11,057 kWh	90 Dth
Dollars Saved	\$967	\$504

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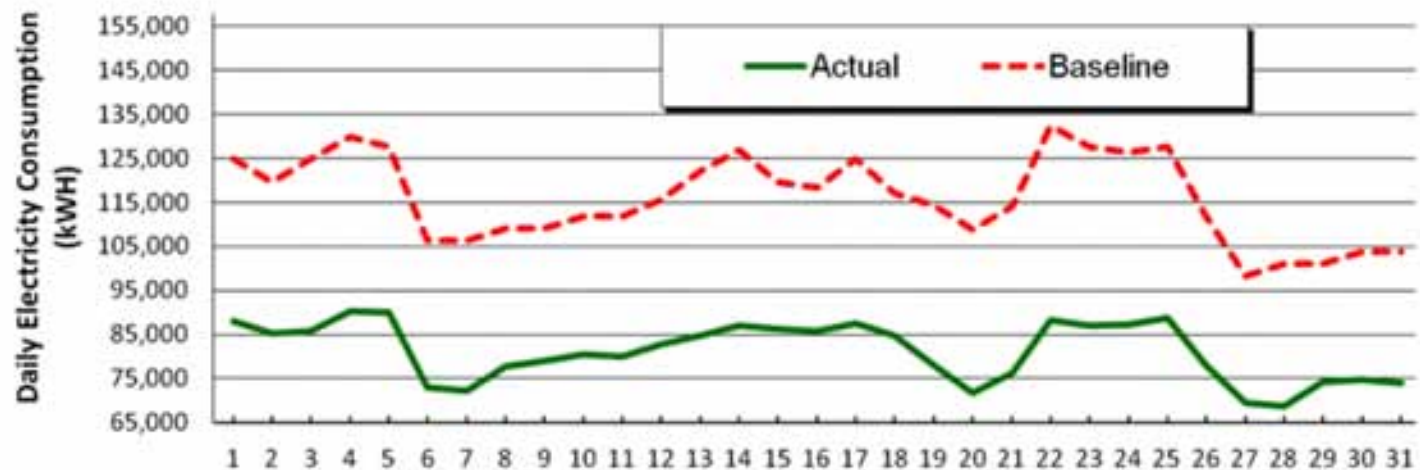
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Monthly Electricity Report



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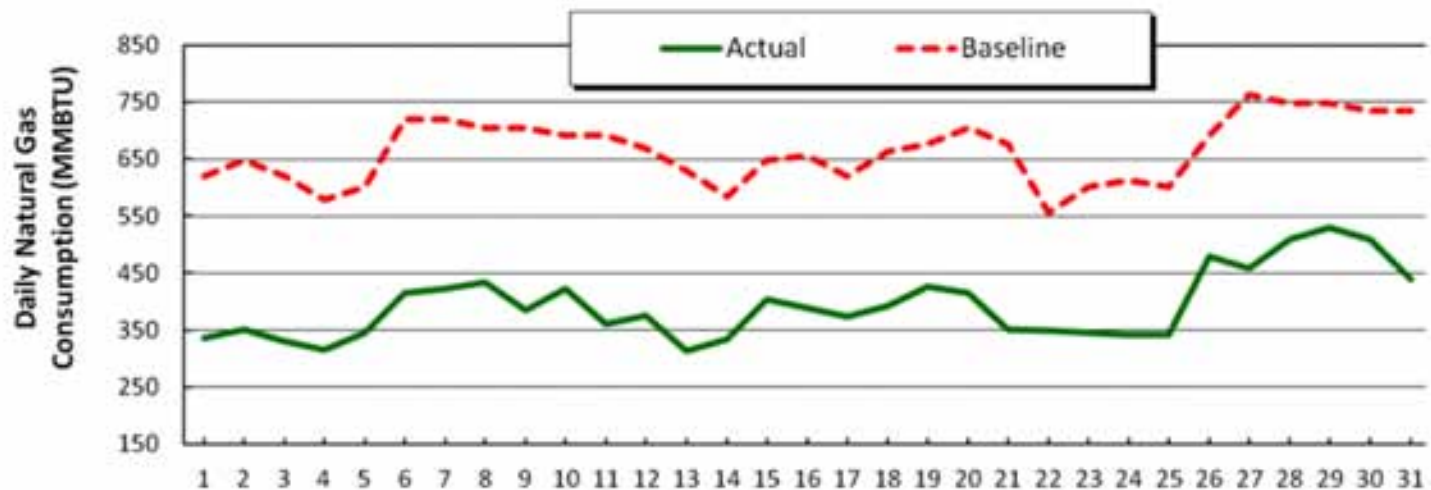
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Monthly Natural Gas Report



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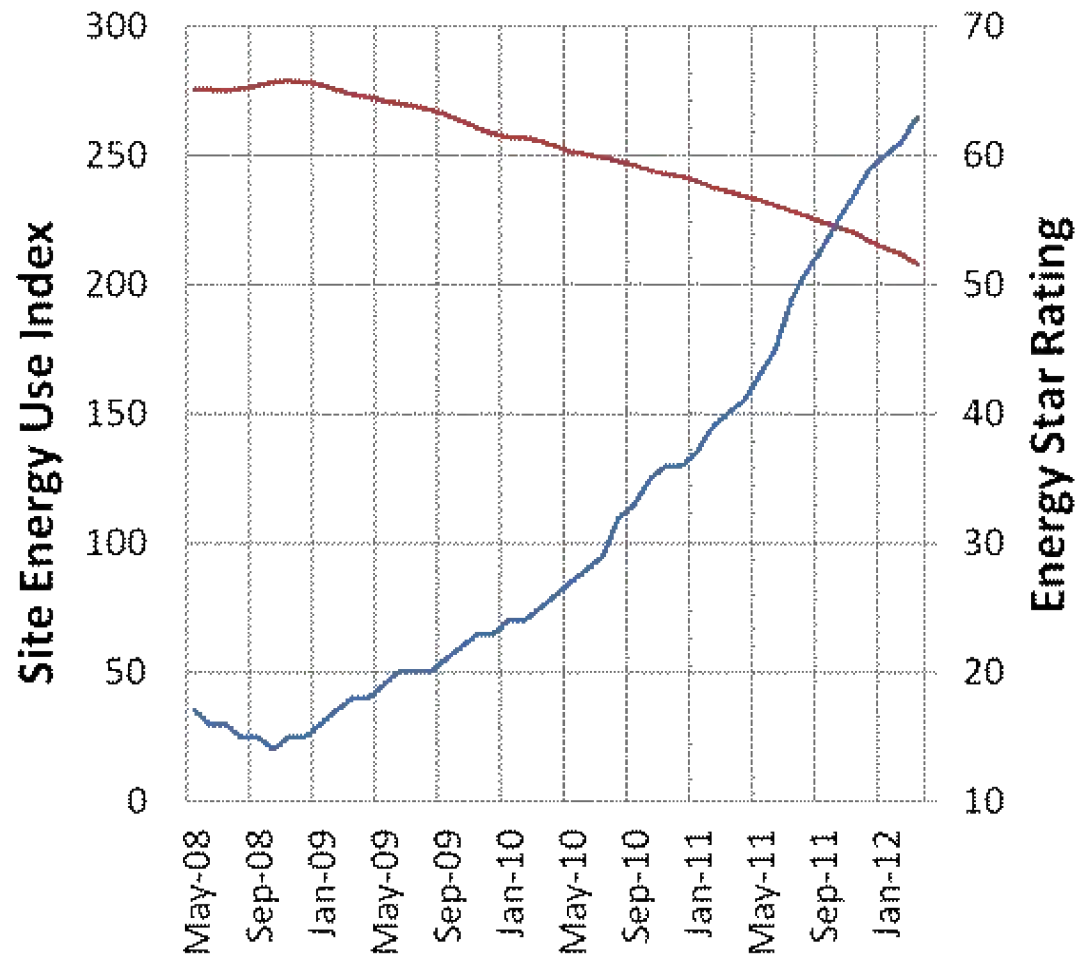
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Baptist Hospital Energy Star Rating



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Actual Baptist Hospital Results

- Energy Star Rating Increased from **13** to **75**
- Proven Annual Energy Cost Savings Exceed **\$1.8** Million
- Cumulative Program Savings Exceed **\$7** Million
- Trained O&M Staff
- Daily Scorecard Ensures Sustainable Results

Energy Performance Comparison

Performance Metrics	Evaluation Periods		Comparisons		
	Current (Ending Date 12/31/2012)	Baseline (Ending Date 05/31/2008)	Rating of 75	Target	National Median
Energy Performance Rating	72	13	75	N/A	50
Energy Intensity					
Site (kBtu/ft ²)	190	276	186	N/A	214
Source (kBtu/ft ²)	420	582	412	N/A	473
Energy Cost					
\$/year	\$ 4,356,801.68	\$ 5,741,491.25	\$ 4,277,845.84	N/A	\$ 4,902,377.36
\$/ft ² /year	\$ 2.78	\$ 3.74	\$ 2.73	N/A	\$ 3.13

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Sacred Heart Hospital, Port St. Joe, Florida



Facility

Sacred Heart Hospital on the Gulf
3801 E Hwy98
Port St. Joe, FL 32456

Year Built: 2010

Gross Floor Area (ft²): 64,323

Energy Performance Rating² (1-100) 1

- Floor Area – **64,323 SF**
- Energy Star Rating – **1**
- Site Energy Use Index – **401 kBTU/SF**
- Source Energy Use Index – **843 kBTU/SF**
- Energy Cost Index - **\$6.99/SF**
- Annual Energy Cost - **\$449,654**
- Opened on March 15, 2010
- Water-Cooled Chillers
- Robust Building Automation System

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Preliminary Sacred Heart Review

- No Weekly Schedules
- No Energy Efficient Control Strategies
- Constant Air Volume
- Numerous Temperature and Humidity Control Problems
- BAS Graphic Snapshots Indicated Significant Problems



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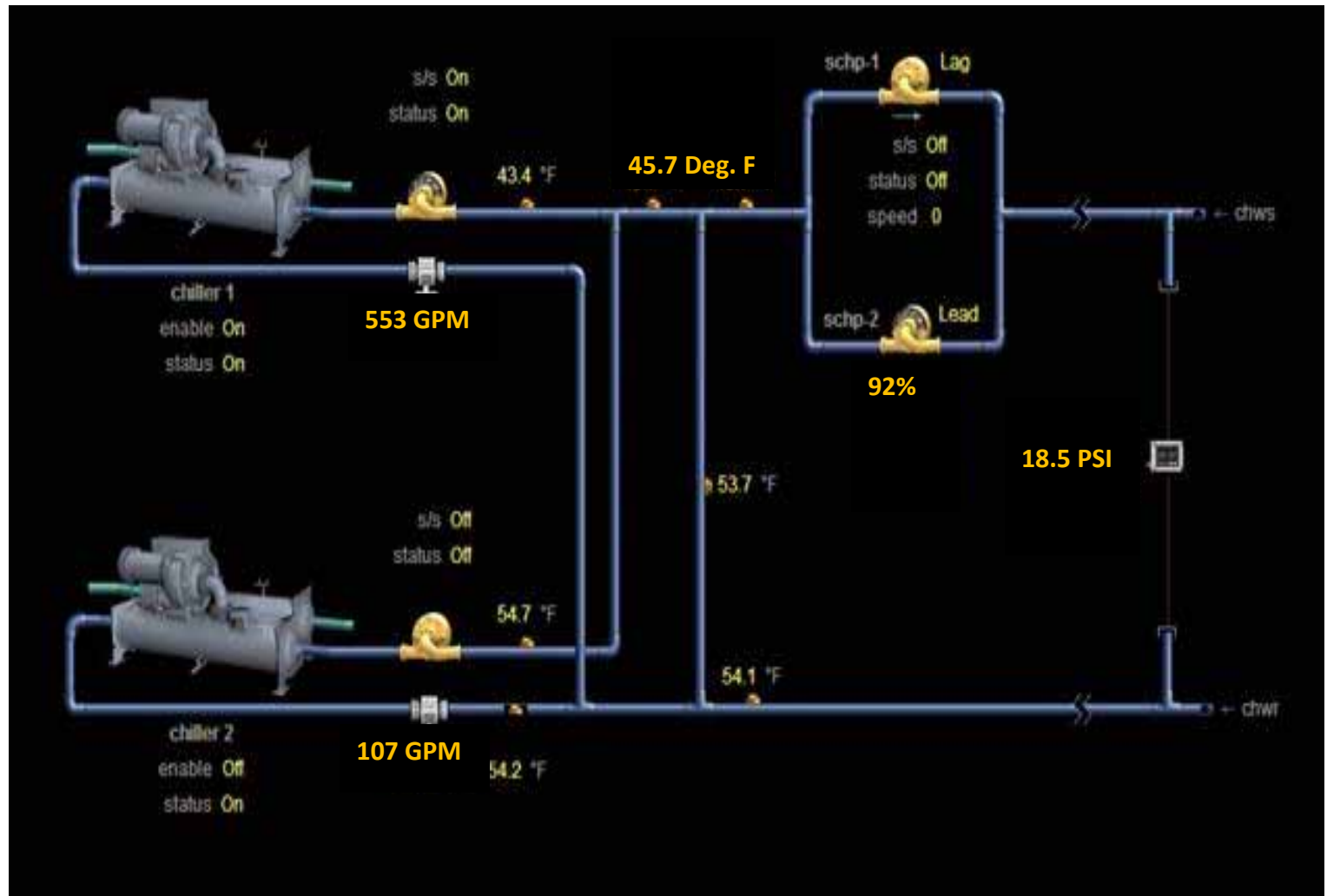
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Summary

What's Wrong With This Picture?



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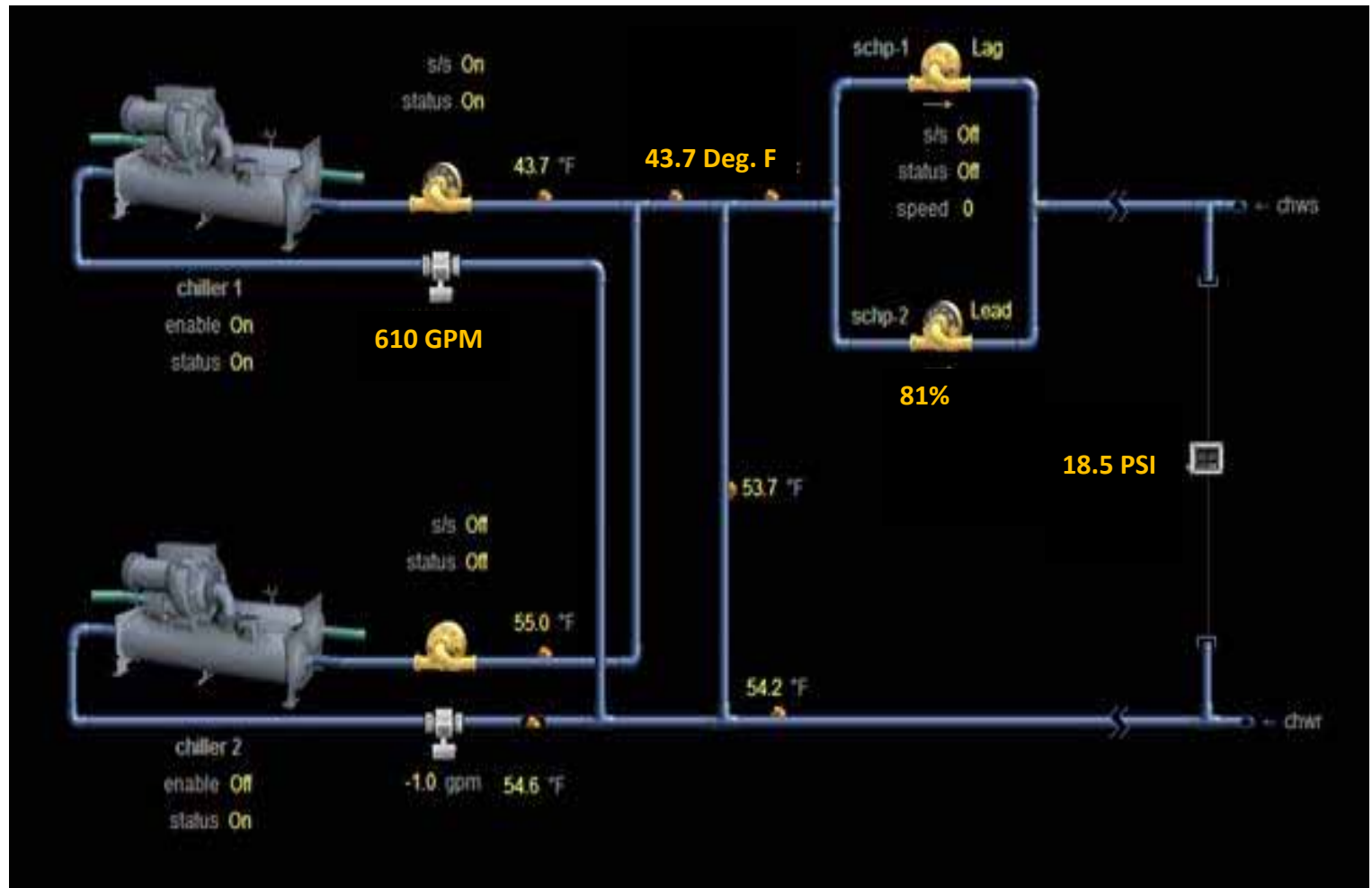
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With Isolation Valve Closed



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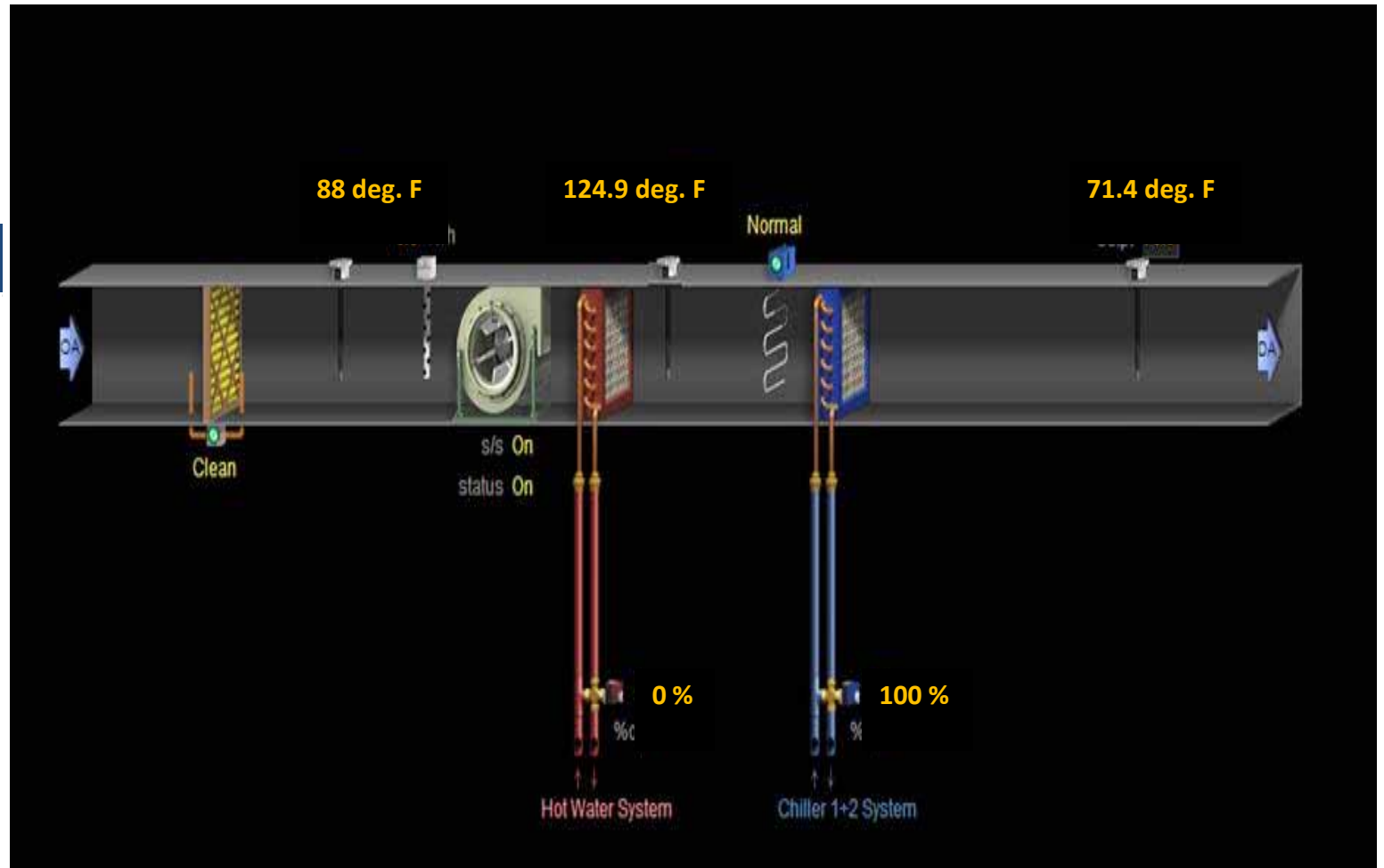
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Summary

Make-Up Air Unit Heating Water Valve



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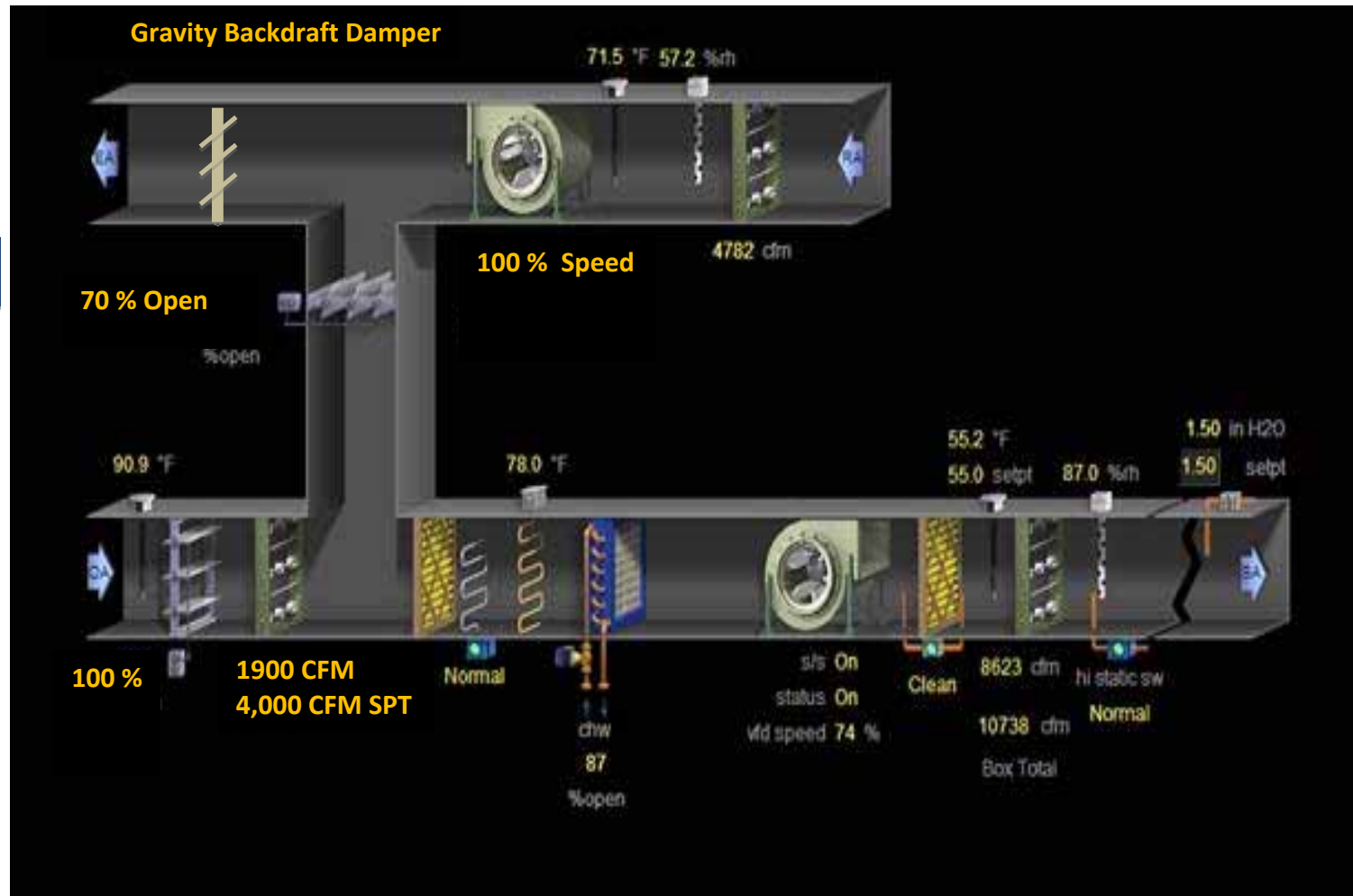
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Summary

Air Flow Tracking Fighting Mixed Air Damper Sequencing



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Summary

Sacred Heart Retrocommissioning Process

	A	B	C
1		ROOM VENTILATION SCHEDULE	
2		PROJECT: Sacred Heart Hospital Port St. Joe, Florida	
3		JOB #: 01-12-0154	
4		DATE: 10-17-12	
5			
6			
7	ROOM	ROOM	AIR HANDLING
8	NUMBER	NAME	UNIT
9			#
10			
11	100	Vestibule	AHU-1
12	C-101	Corridor	AHU-1
13	101	Lobby	AHU-1
14	102	Security/Control	AHU-1
15	102A	Men's	AHU-1
16	102B	Women's	AHU-1
17	128	Consult/BVT	AHU-1
18	113	Janitor	AHU-1
19	C-100	Corridor	AHU-1
20	P-101	Passage	AHU-1
21	114	Treatment	AHU-1
22	116	Isolation	AHU-1
23	117	Treatment	AHU-1
24	118	Treatment	AHU-1
25	115	Decon	AHU-1
26	119	Elec.	AHU-1
27	119A	IDF	AHU-1
28	120	Equipment	AHU-1
29	127	Triage	AHU-1
30	129	Pat. Toilet	AHU-1
31	130	Nour./Phys.	AHU-1
32	131	Medis	AHU-1
33	132	Nurse's Station	AHU-1
34	133	Staff Toilet	AHU-1

- Room Ventilation Schedule
- Unoccupied/Occupied Air Flow Rates for Operating Rooms
- Air Terminal Programming Revisions
- Surgery AHU Programming Revisions
- Supply Air Setpoint Reset
- Supply Air Static Pressure Setpoint Reset
- AHU Ventilation Air Flow Programming Reset
- Kitchen Hood Exhaust Fan Make-Up Air Unit Programming Revisions
- Miscellaneous Repairs

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- Weekly Schedule
- Changed Air Flow Setpoints to Match RVS
- Adjusted Occupied Minimum and Maximum Thermostat Setpoints
- Adjusted Heating and Cooling Deadbands
- Adjusted Unoccupied Heating and Cooling Setpoints
- Adjusted Cooling Request and Pressure Request Parameters

Air Terminal Programming Revisions

Design Parameters	
Cooling Max Airflow:	<input type="text" value="340"/> cfm
Heating Max Airflow:	<input type="text" value="120"/> cfm
Occupied Min Airflow:	<input type="text" value="80"/> cfm
Unoccupied Min Airflow:	<input type="text" value="0"/> cfm
Auxiliary Heat Min Airflow:	<input type="text" value="120"/> cfm
Manufacturer's specified air flow at 1" water column:	<input type="text" value="435"/> cfm
<input checked="" type="checkbox"/> Use supply air for heating when Heat Mode is ON	

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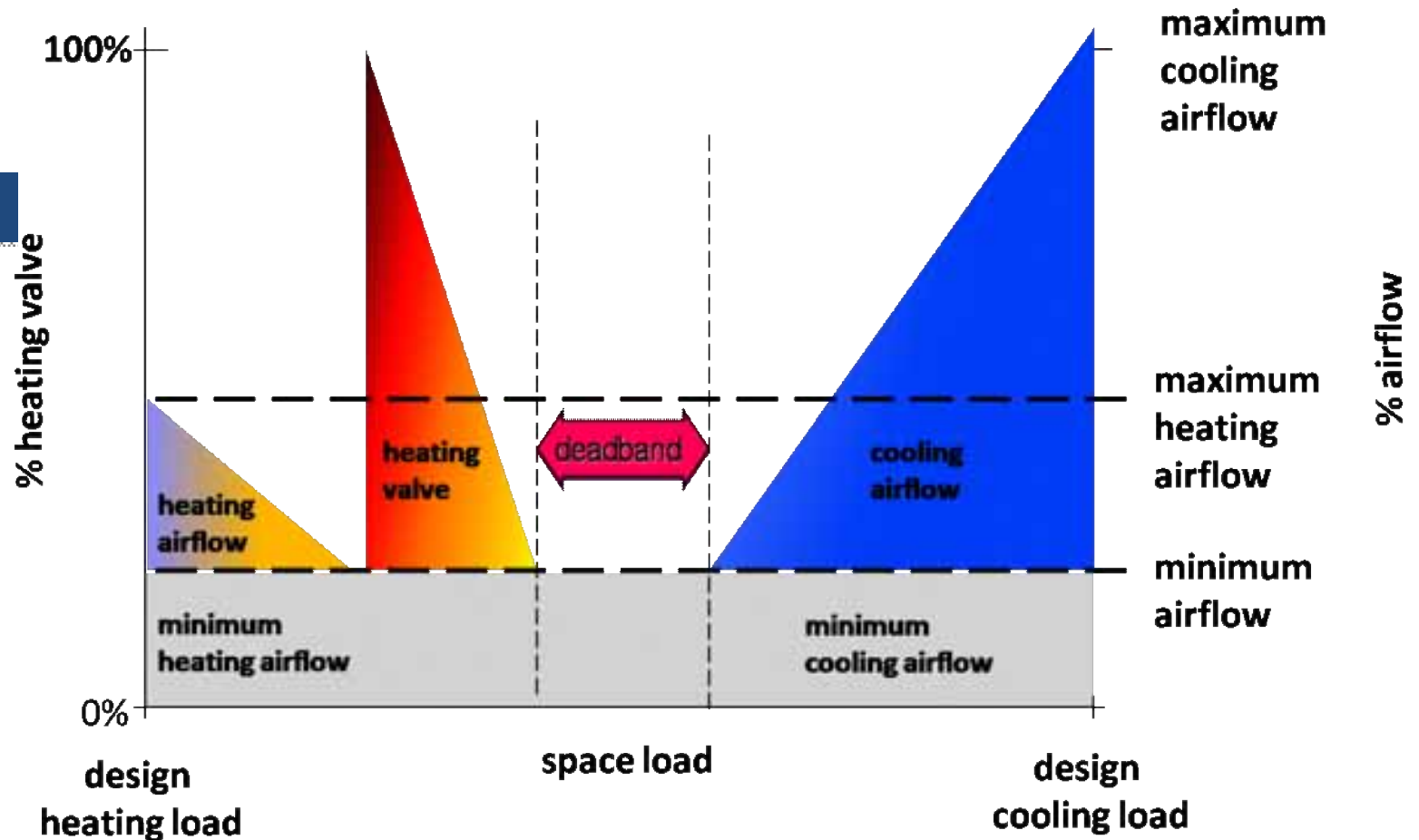
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Summary

Revise Air Terminal Programming



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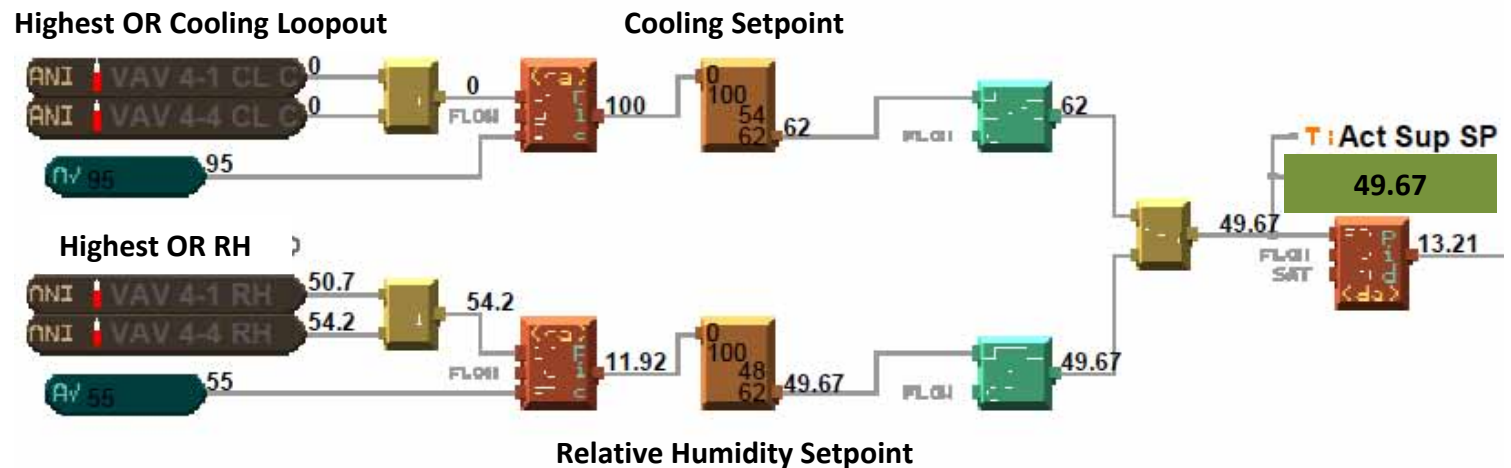
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Supply Air Temperature Setpoint Reset

- Minimum and Maximum Supply Air Temperature Setpoints
- Based on Highest OR Air Terminal Cooling Loopout
- Overridden as Required to Limit Highest OR Relative Humidity to 55%



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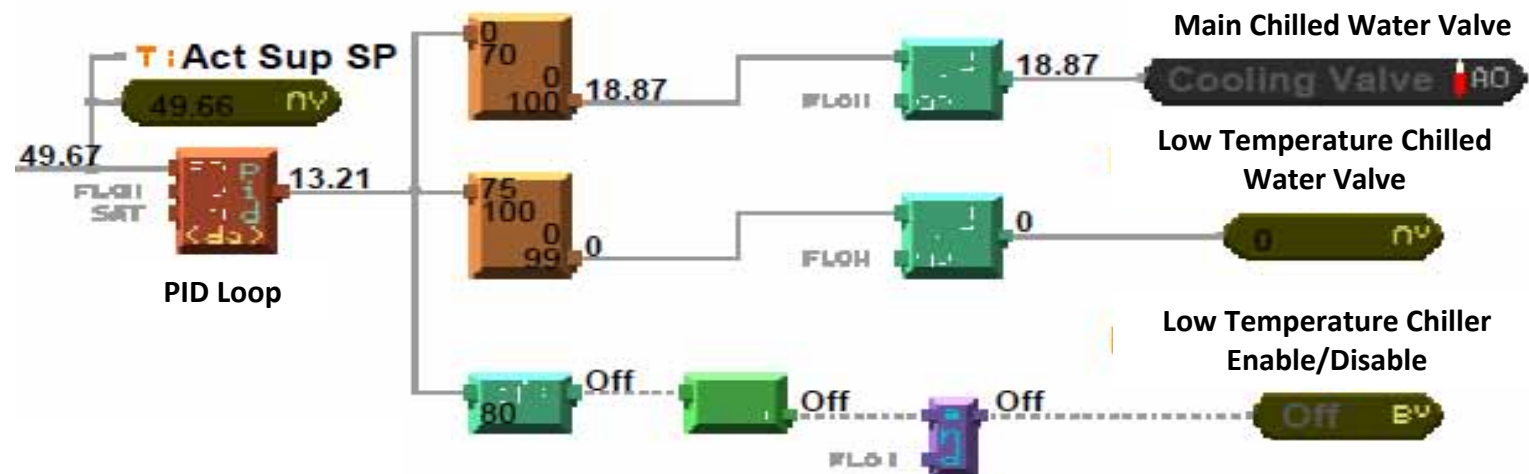
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Summary

Single Loop Supply Air Temperature Control

- Stage 1: Close Heating Water Valve
- Stage 2: Open Chilled Water Valve
- Stage 3: Enable Low Temperature Chiller
- Stage 4: Open Low Temperature Chilled Water Valve



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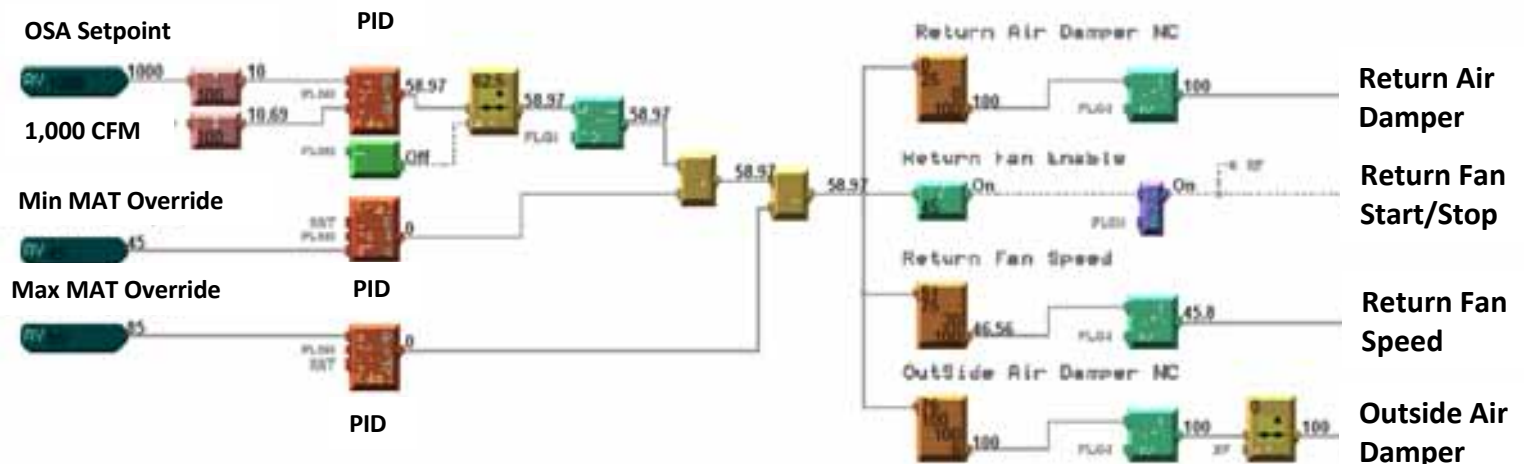
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AHU Ventilation Air Flow Programming

- Stage 1 – Open Return Air Damper
- Stage 2 – Start Return Air Fan
- Stage 3 – Increase Return Air Fan Speed from Minimum Setpoint to Maximum Setpoint
- Stage 4 – Close Outside Air Damper



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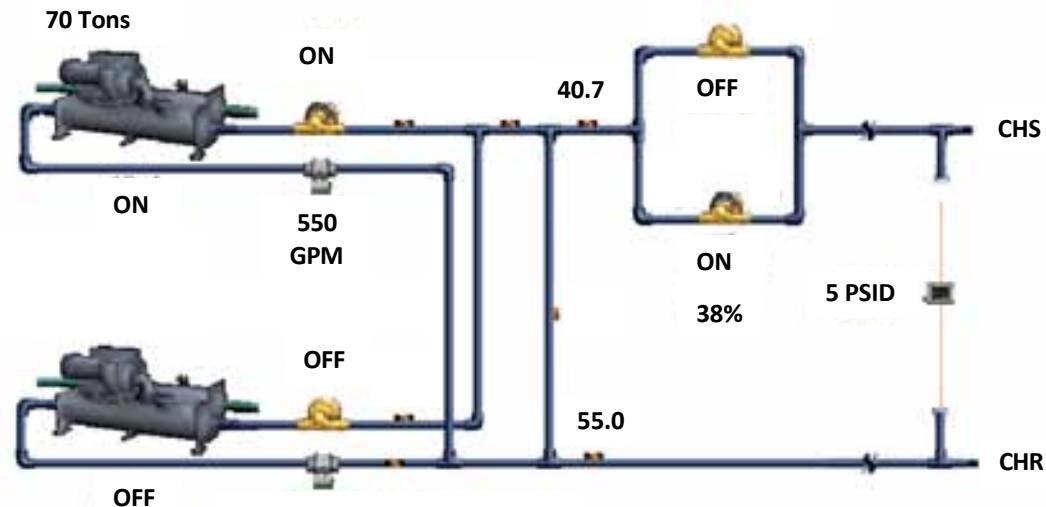
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Summary

Central Plant Programming Revisions

- Chilled Water Supply Temperature Setpoint Reset Based on OSA Temperature
- Condenser Water Supply Temperature Setpoint Reset Based on OSA Wet Bulb Temperature
- Maximum Capacity Chiller Sequencing



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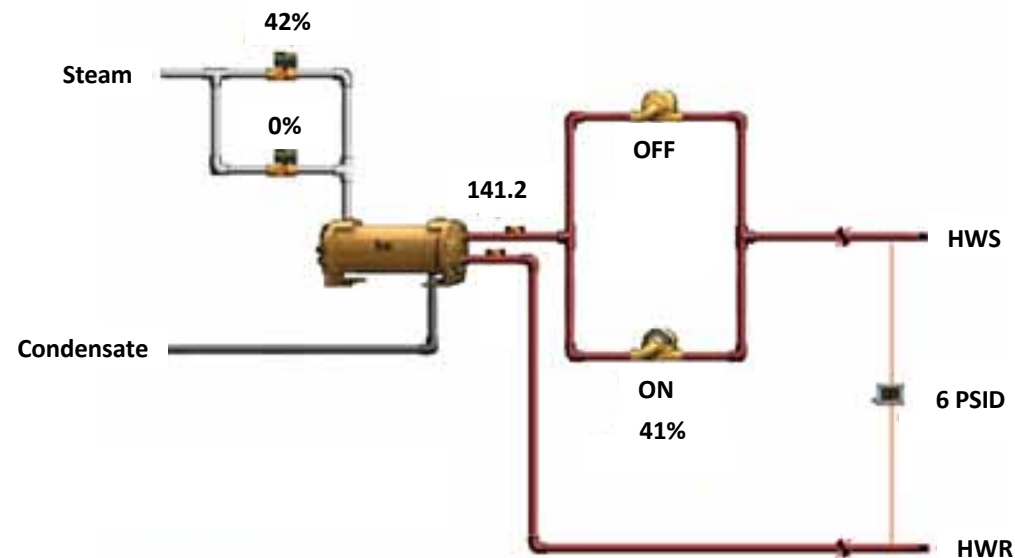
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Central Plant Programming Revisions

- Chilled Water Differential Pressure Setpoint Reset Based on Most Open CHW Valve
- Heating Water Supply Temperature Setpoint Reset Based on OSA Temperature
- Heating Water Differential Pressure Setpoint Reset Based on Most Open HW Valve



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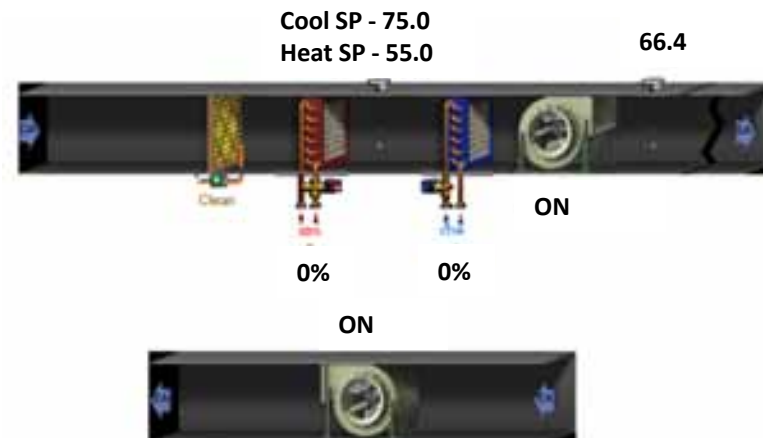
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Summary

Kitchen Hood Exhaust Fan and Make-Up Air Unit Programming

- Heating Water Valve Modulated to Maintain Minimum Make-Up Air Temperature of 55 deg. F
- Chilled Water Valve Modulated to Maintain Maximum Make-Up Air Temperature of 75 deg. F
- Kitchen Hood Exhaust Fan and Make-Up Air Unit are Operated Between 5A and 9P
- Minimum Heating Water Valve and Chilled Water Valve Positions of 15% of MUA of OFF and OSA Temperature is Less than 40 deg. F



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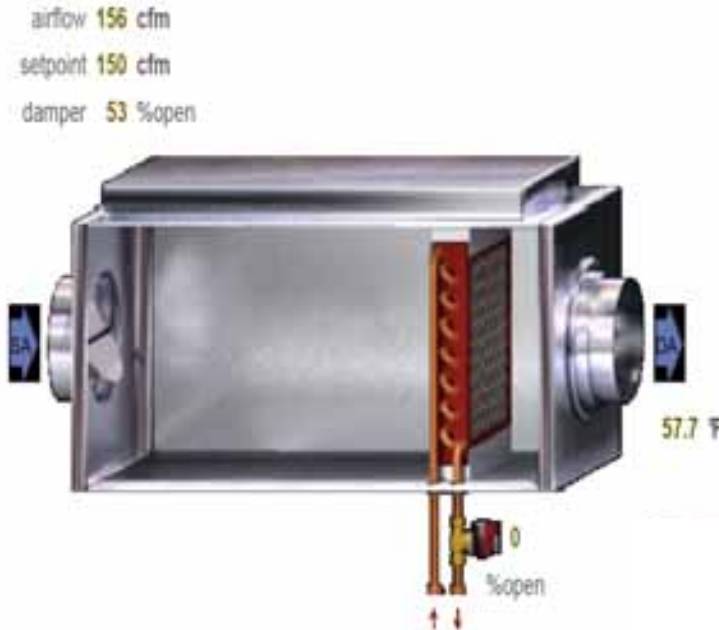
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Miscellaneous Repairs



- Replaced Outside Air Temperature Sensor
- Replaced Kitchen Hood Make-Up Air Unit Heating Water Valve
- Repaired AHU Variable Frequency Drives
- Repaired Air Terminal Air Flow Measuring Stations
- Calibrated Air Flow Measuring Stations
- Calibrated Relative Humidity Transmitters
- Added Temperature Sensors for Diagnostic Purposes

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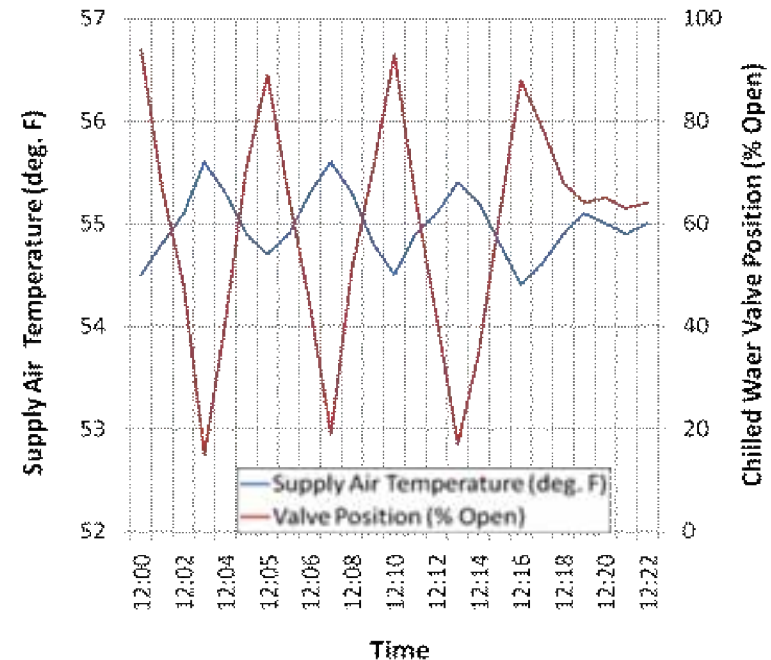
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Summary

BAS Remote Monitoring

- Security Clearance Requirements
- Tuned PI Loops
- Optimized Programming and Setpoints
- Troubleshoot Problems
- Identify Additional Cost Reduction Opportunities



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Summary

December 2012 Electric Bill

Account Name: SACRED HEART HOSPITAL
Account Number: 2880523402 (Account active since 10/28/2008)
Account Address: 3801 E US HIGHWAY 98, PERM, PORT ST JOE, FL 32456

		Current Month	Prior Year
	Date Mailed	1/10/2013	1/11/2012
	Days In Period	34	34
	Total Current Bill	\$9,939.08	\$26,855.18
	Kilowatt Hour Usage	129,600	292,400
	Average Daily kWh	3,812	8,600
	Average Daily High Temperature	66	68
	Average Daily Low Temperature	46	45

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January 2013 Electric Bill

Account Name: SACRED HEART HOSPITAL
Account Number: 2880523402 (Account active since 10/28/2008)
Account Address: 3801 E US HIGHWAY 98, PERM, PORT ST JOE, FL 32456

		Current Month	Prior Year
	Date Mailed	2/8/2013	2/09/13
	Total Current Bill	\$13,667.88	\$23,287.90
	Kilowatt Hour Usage	168,200	244,000
	Average Daily High Temperature	71	70

Agenda

ASHE

Significant
HFRCx Elements

Baptist

Sacred Heart

Ft. Scott

OK Heart

Family Medical

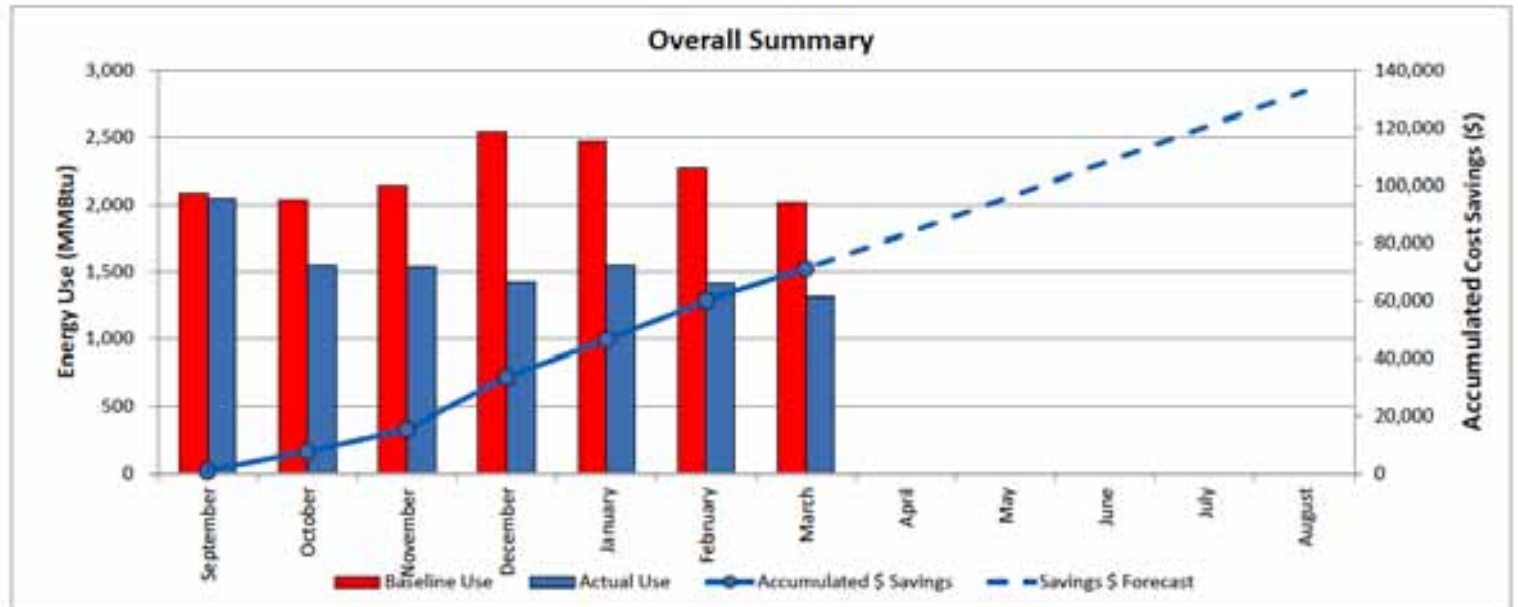
Clay County

Summary

Monthly M&V Report

Overall Summary

Month	Year	Baseline		Actual		Utility Invoicing		Weather Adjusted Savings		Savings Percent	
		MMBtu	\$	MMBtu	\$	MMBtu	\$	MMBtu	\$	% MMBtu	% \$
September	2012	2,067	38,231	2,049	37,445	2,049	37,445	38	786	1.8%	2.1%
October	2012	2,039	35,094	1,544	28,375	1,544	28,375	495	6,719	24.3%	19.1%
November	2012	2,141	36,661	1,537	28,781	1,537	28,781	603	7,880	28.2%	21.5%
December	2012	2,541	36,998	1,423	18,985	1,423	18,985	1,117	18,013	44.0%	48.7%
January	2013	2,470	35,637	1,542	22,623	1,542	22,623	928	13,014	37.6%	36.5%
February	2013	2,268	36,063	1,416	22,537	1,416	22,537	852	13,525	37.6%	37.5%
March	2013	2,019	32,847	1,312	21,701	1,312	21,701	707	11,147	35.0%	33.9%
April	2013	0	0	0	0	0	0	0	0	N/A	N/A
May	2013	0	0	0	0	0	0	0	0	N/A	N/A
June	2013	0	0	0	0	0	0	0	0	N/A	N/A
July	2013	0	0	0	0	0	0	0	0	N/A	N/A
August	2013	0	0	0	0	0	0	0	0	N/A	N/A
Annual Totals		15,563	251,532	10,823	180,448	10,823	180,448	4,740	71,084	30.5%	28.3%



Agenda

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Family Medical

Clay County

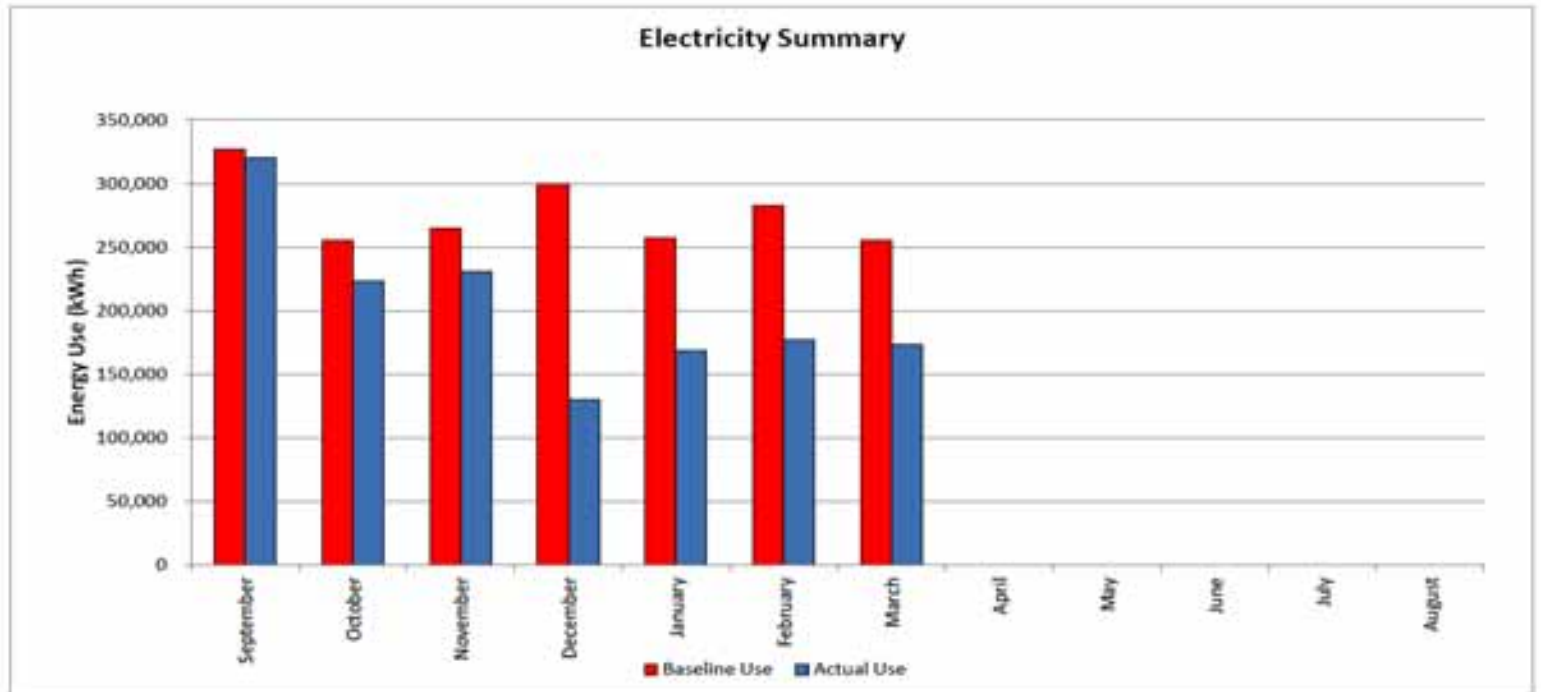
Summary

Monthly Electricity Report

Electricity Summary

Month	Year	Billing Period		Baseline		Actual		Utility Invoicing		Savings	
		Start	End	kWh	\$	kWh	\$	kWh	\$	kWh	\$
September	2012	09/08/12	10/09/12	327,328	29,385	319,800	28,709	319,800	28,709	7,528	676
October	2012	10/10/12	11/07/12	255,643	23,900	223,200	20,867	223,200	20,867	32,443	3,033
November	2012	11/08/12	12/07/12	264,461	24,638	230,800	21,502	230,800	21,502	33,661	3,136
December	2012	12/08/12	01/10/13	300,069	23,012	129,600	9,939	129,600	9,939	170,469	13,073
January	2013	01/11/13	02/08/13	257,362	20,913	168,200	13,668	168,200	13,668	89,162	7,245
February	2013	02/09/13	03/11/13	282,901	23,492	177,000	14,698	177,000	14,698	105,901	8,794
March	2013	03/12/13	04/10/13	255,212	21,410	173,000	14,513	173,000	14,513	82,212	6,897
April	2013			0	0	0	0			0	0
May	2013			0	0	0	0			0	0
June	2013			0	0	0	0			0	0
July	2013			0	0	0	0			0	0
August	2013			0	0	0	0			0	0
Annual Totals				1,942,976	166,750	1,421,600	123,896	1,421,600	123,896	521,376	42,854

Electricity Summary



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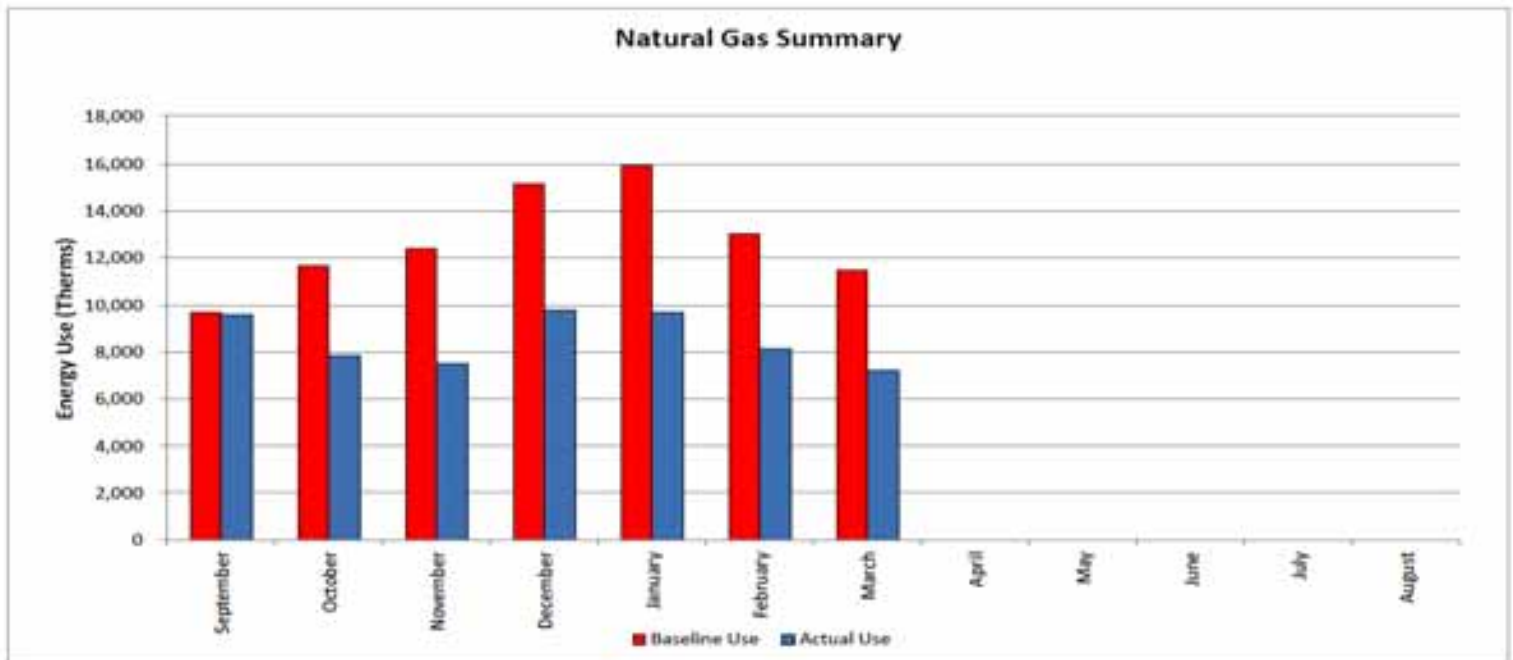
Clay County

Summary

Monthly Natural Gas Report

Natural Gas Summary

Month	Year	Billing Period		Baseline		Actual		UTILITY Invoicing		Savings			
		Start	End	Therms	\$	Therms	\$	Therms	\$	Therms	\$		
September	2012	09/18/12	10/15/12	9,695	8,847	9,574	8,736	9,574	8,736	121	110		
October	2012	10/16/12	11/12/12	11,660	11,194	7,821	7,508	7,821	7,508	3,839	3,686		
November	2012	11/13/12	12/10/12	12,380	12,024	7,495	7,280	7,495	7,280	4,884	4,744		
December	2012	12/11/12	01/14/13	15,164	13,986	9,808	9,046	9,808	9,046	5,356	4,940		
January	2013	01/15/13	02/18/13	15,918	14,724	9,682	8,955	9,682	8,955	6,236	5,768		
February	2013	02/19/13	03/19/13	13,026	12,571	8,124	7,840	8,124	7,840	4,903	4,731		
March	2013	03/20/13	04/16/13	11,476	11,437	7,212	7,187	7,212	7,187	4,264	4,250		
April	2013			0	0	0	0			0	0		
May	2013			0	0	0	0			0	0		
June	2013			0	0	0	0			0	0		
July	2013			0	0	0	0			0	0		
August	2013			0	0	0	0			0	0		
Annual Totals						89,319	84,782	59,715	56,552	59,715	56,552	29,604	28,230



Agenda

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Summary

Actual Sacred Heart Results

- Total RetroCx Cost - **\$61,000**
- Projected Annual Savings - **\$150,000**
- Actual Energy Cost Savings to Date- **\$71,804**
- Actual Energy Savings to Date— **30.5%**
- Projected Energy Star Rating – **59**



Agenda

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Clay County

Summary

Fort Scott Hospital

- High Average Electricity Demand
 - Questionable Lighting Technology
 - Questionable Cooling Efficiency
 - **Simultaneous Heating and Cooling**
 - Excessive Ventilation and/or Exhaust Air Flow
- High Electricity Consumption
 - No Weekly Schedules
 - No Occupancy Sensors
 - Constant Air Volume
 - **Simultaneous Heating and Cooling**



Agenda

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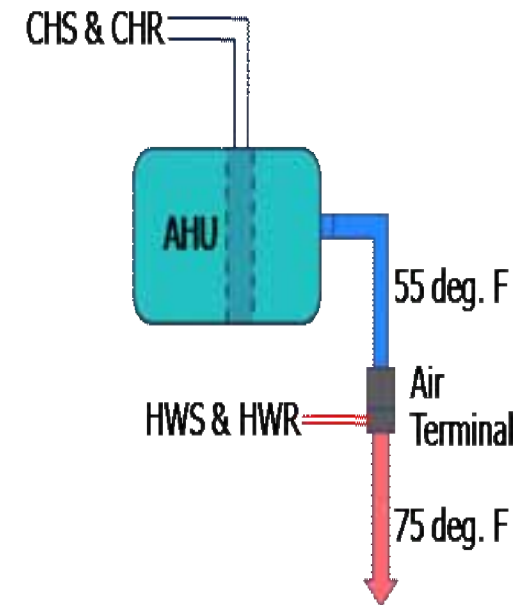
Family Medical

Clay County

Summary

Fort Scott Hospital

- High Cooling Load
 - Questionable Building Envelope
 - **Simultaneous Heating and Cooling**
 - Excessive Ventilation and/or Exhaust Air Flow
- High Heating Fuel Consumption
 - Questionable Building Envelope
 - **Simultaneous Heating and Cooling**
 - Questionable Heating Efficiency
 - Excessive Humidification



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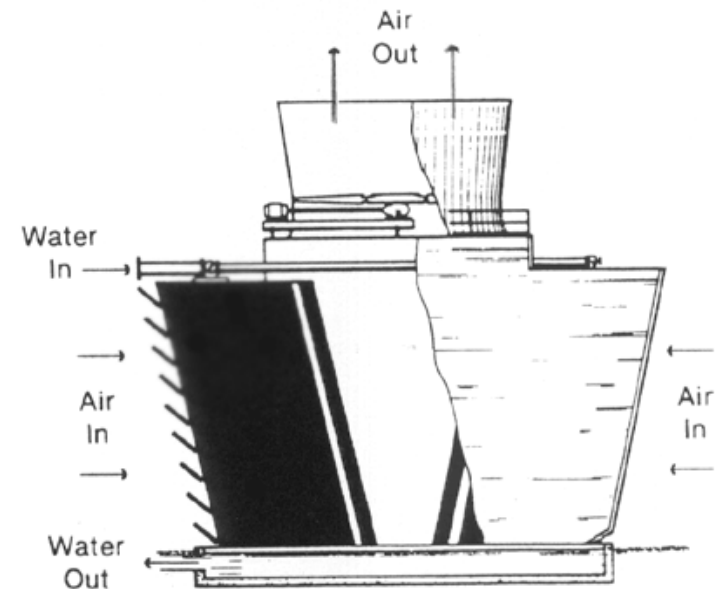
Family Medical

Clay County

Summary

Fort Scott Issues

- Air Terminal Settings
- Return Fan Speed Control
- Cooling Tower Capacity
- Constant Volume HW System
- Excessive Building Exhaust
- Nearly Closed Balancing Valves



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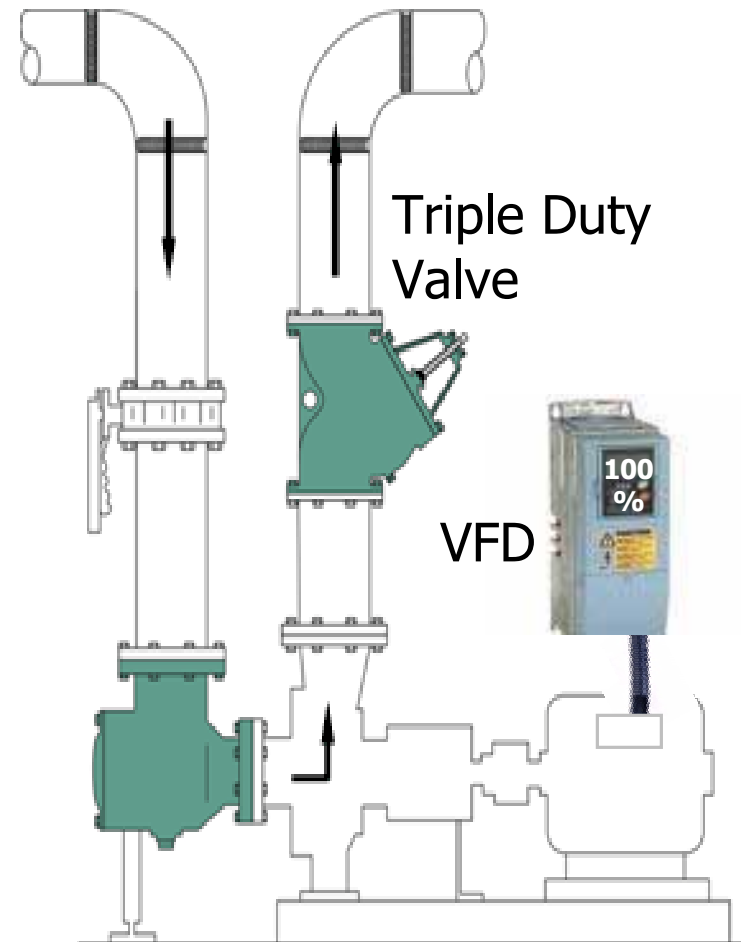
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Clay County

Summary

Pump Flow Balancing

- Triple Duty Valves at Pump Discharge Nearly Closed
- VFD's Operating at Full Speed
- Bulk of Motor Energy Wasted at Balancing Valve



Agenda

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Clay County

Summary

Fort Scott Retro-Cx Costs

Preliminary Energy Audit	\$8,350
Phase 1A and 1B	\$199,439
Total Cost (\$)	\$207,789

Agenda

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HFRCx Elements

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Clay County

Summary

Fort Scott Savings

Item	Before	After	Savings (%)	Remarks
Electricity Consumption (kWh)	7,808,800	5,249,800	32.8	
Average Peak Demand (kW)	1,230	929	24.5	
Electricity Consumption (kWh/SF/year)	44.0	29.6	32.8	Mercy average is 32 kWh/SF/year
Average Peak Demand (watts/SF)	6.93	5.23	24.5	
Natural Gas Consumption (MMBtu)	43,114	23,523	45.4	
Natural Gas Consumption (Therms/SF/year)	2.43	1.33	45.4	Mercy average is 1.23 therms/SF/year
Total Energy Consumption (MMBTU)	70,137	41,457	40.9	
Energy Utilization Index (kBtu per SF)	393	233	40.6	Mercy average is 232 kBtu/SF/year
Total Energy Cost (\$/year)	916,182	540,058	41.1	
Energy Cost Index (\$/SF/year)	5.16	3.04	41.1	Mercy average is \$2.85/SF

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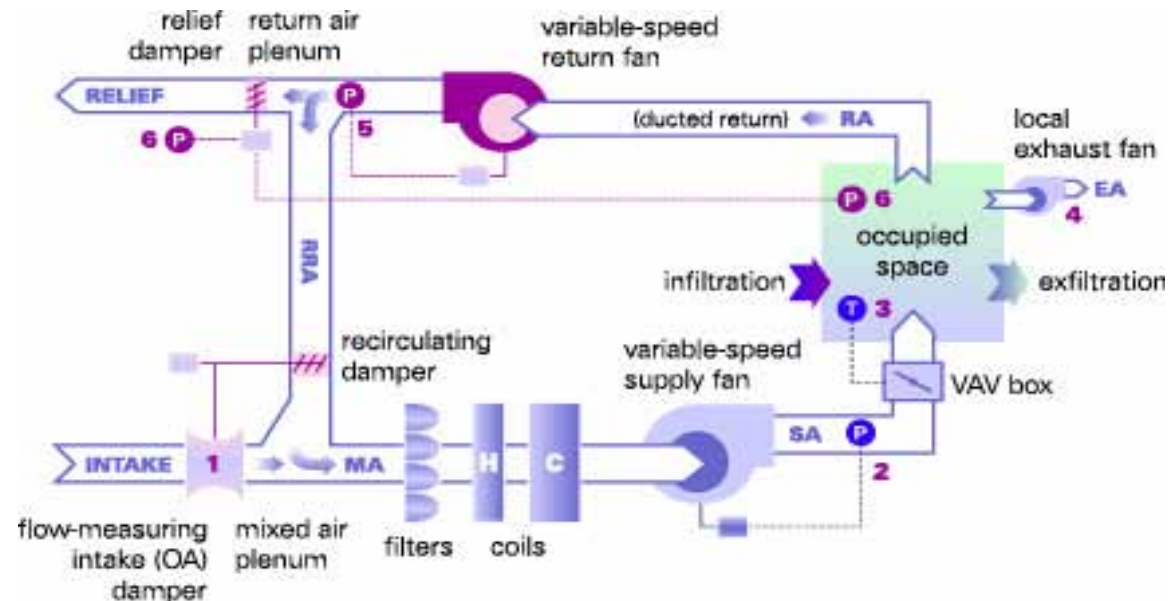
OK Heart

Family Medical

Clay County

Summary

OK Heart Issues



- Ventilation Air Flow Control
- Return Fan Speed Control
- Air Terminal Settings
- Operator Overrides
- CHW And HW DP Setpoints
- Excessive Exhaust
- Exhaust Fan Controls
- Chiller And Tower Sequencing
- OR Controls Disabled

Agenda

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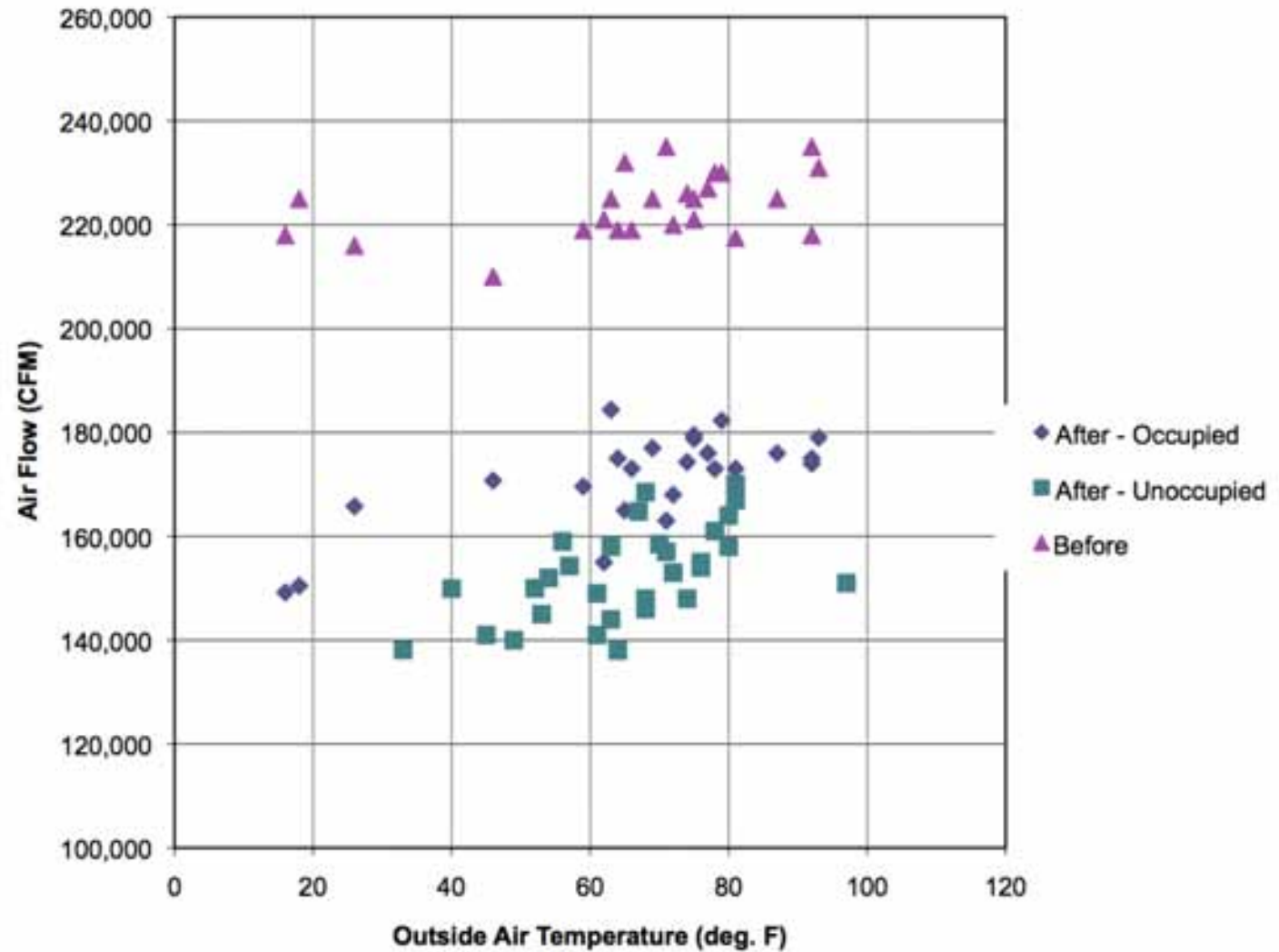
OK Heart

Family Medical

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Summary

OK Heart Supply Air Flows



Agenda

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Summary

OK Heart Retro-Cx Costs

Retro-Commissioning Cost	\$55,000
ATC Retrofits	\$353,500
Infrastructure Upgrade	<u>\$238,000</u>
Total Cost (\$)	\$646,000
Less Electrical Service	(\$210,000)
Less Water Chiller And Tower	(\$250,000)
Less Cath Lab AHU	(\$90,000)
Less CEP Expansion	<u>(\$218,000)</u>
Net Cost (\$)	(\$122,000)



Agenda

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HFRCx Elements

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OK Heart

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Clay County

Summary

OK Heart Savings

Item	Before	After	Savings (%)	Remarks
Electricity Consumption (kWh)	10,175,200	8,884,600	12.7	
Average Peak Demand (kW)	1,499	1,403	6.4	
Electricity Consumption (kWh/SF/year)	49.9	43.6	12.7	Mercy average is 32 kWh/SF/year
Electricity Load Factor (%)	77	72	6.7	
Average Peak Demand (watts/SF)	7.3	6.9	6.4	
Natural Gas Consumption (MMBtu)	35,507	28,283	20.3	
Natural Gas Consumption (Therms/SF/year)	1.7	1.4	20.3	Mercy average is 1.23 therms/SF/year
Total Energy Consumption (MMBTU)	70,235	58,606	16.6	
Energy Utilization Index (kBtu per SF)	396	330	16.6	Mercy average is 232 kBtu/SF/year
Total Energy Cost (\$/year)	1,121,614	801,141	28.6	
Energy Cost Index (\$/SF/year)	5.50	3.93	28.6	Mercy average is \$2.85/SF

Agenda

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Significant
HFRCx Elements

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Sacred Heart

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OK Heart

Family Medical Office Building

Clay County

Summary

Family Medical Office Building



University of Arkansas for
Medical Sciences

Little Rock, Arkansas

- 2 Story Building
- 2 Air Handling Units and 32 Fan-Powered VAV Terminals
- Air-Cooled Chiller and Gas-Fired Heating Water Boiler
- 27,617 SF
- New HVAC System and DDC Controls Installed in 2003
- Frequent Hot and Cold Calls
- Baseline Conditions
 - **Energy Star Rating: 1**
 - Annual Energy Costs: \$87,769
 - ECI : \$3.18 per SF
 - Source EUI: 434 kBtu per SF

Agenda

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Family Medical

Clay County

Summary

Retro-Commissioning Team



- **Consulting Engineer**
 - Lighting Audit
 - Room Ventilation Schedule
 - Equipment Sequences of Operation
 - Measurement and Verification of Savings
- **Maintenance Staff**
 - Repairs
 - Equipment Installation
 - Lighting Retrofit
- **Control Contractor**
 - Control System Components
 - Programming
 - Dashboards

Agenda

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Summary

Retro-Commissioning Plan

- Room Ventilation Schedule (air flow settings)
- Variable Air Volume
- Critical Zone Reset of Static Pressure and Differential Pressure Setpoints
- Variable Volume Heating Water and Chilled Water
- Air-Side Economizer Cycles
- Supply Air Temperature Setpoint Reset with Humidity Override
- Occupancy Sensors to Control Lights and HVAC Equipment
- Unoccupied Heating and Cooling Temperature Setpoints
- Testing, Adjusting, and Balancing
- Lighting Retrofit
- Repair HVAC and Control Equipment

Agenda

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Summary

Estimated Retro-Commissioning Cost

Category	Item	Units	Estimated Cost
Retrocommissioning Team Leader	Retrocommissioning Labor	hours	53
	Lighting Audit Labor	hours	48
	Cost	\$	12,595
Automatic Temperature Controls	Labor	hours	178
	Labor Cost	\$	13,891
	Material Cost	\$	30,379
	Total Cost	\$	44,269
UAMS Personnel	Controls Labor	hours	356
	Lighting Retrofit Labor	hours	316
	Labor Cost	\$	10,578
	Lighting Material Cost	\$	18,937
	Total Cost	\$	29,516
Total	Total Cost	\$	86,380
	Total Cost	\$/SF	3.13

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Summary

Estimated Annual Energy Cost Savings

Category	Item	Units	Baseline Value	Target Value
General	Building Floor Area	SF	27,617	27,617
	Energy Star Rating	%	1	82
Electricity	Annual Consumption	kWh	765,590	326,599
	Estimated Average Billed Demand	kW	165	62
	Estimated Average Billed Demand	watts/SF	5.97	2.25
	Average Billed Demand Load Factor	%	53	60
	Annual Cost	\$	63,115	26,240
	Average Unit Cost	cents/kWh	8.24	8.03
Natural Gas	Annual Consumption	CCF	30,068	0
	Annual Cost	\$	24,654	600
	Average Unit Cost	\$/CCF	0.82	N/A
Heating Water	Annual Consumption	MMBtu	0	487
	Energy Unit Cost	\$/MMBtu	N/A	7.50
	Annual Cost	\$	0	3,654
Chilled Water	Annual Consumption	ton-hours	0	165,702
	Energy Unit Cost	cents/ton-hour	N/A	5.60
	Annual Cost	\$	0	9,279
Totals	Annual Source Energy Consumption	MMBtu	11,978	4,850
	Source EUI	kBtu/SF	434	176
	Annual Cost	\$	87,769	39,773
	Annual Cost	\$/SF	3.18	1.44

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Summary

Economic Analysis

Item	Units	Value
Project Cost	\$	86,380
Annual Savings	\$/year	47,996
Simple Payback	years	1.80
Internal Rate of Return	%	58%
30 Year Life Cycle Cost Savings	\$	\$693,492

Agenda

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Clay County

Summary

Executing the Retro-Commissioning Plan



- Majority of Work by UAMS Maintenance Staff
- Temporarily Used Control Contractor Staff to Perform Maintenance (hot and cold calls)
- Bi-Weekly Conference Calls
- Daily Measurement and Verification of Savings
- Hands - On Training
- Trends
- Dashboards
- Corrections and Repairs

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Summary

Documenting the Results

- Work Completed in March 2012 (8 weeks duration)
- Total Retrocommissioning Cost - **\$61,855** (as compared to \$86,380 estimate)
- Energy Savings Measured and Verified by Comparison of Actual Consumption and Costs to Weather Adjusted Baseline Consumption and Costs
- **35%** Reduction in Electricity Consumption
- **86%** Reduction in Natural Gas Consumption (the utility company came out to check the meter just to be sure it was working!)
- Energy Star Rating has Increased from 1 to **38** (in just a few months!)
- Actual Energy Cost Savings to Date – **\$13,206** (in just a few months!)

Agenda

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Clay County

Summary

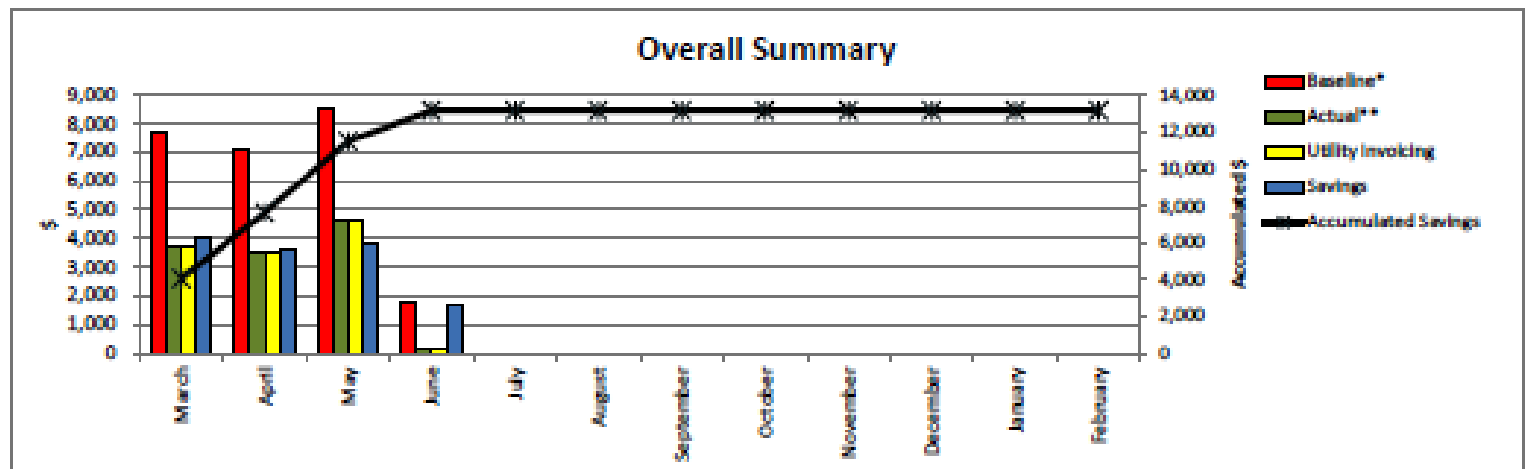
Family Medical Energy

Measurement & Verification Monthly Summary

University of Arkansas for Medical Sciences
Family Medical Center
Little Rock, Arkansas

Overall Summary

Month	Year	Baseline*		Actual**		Utility Invoicing		Savings		Savings																																																													
		kBtu	\$	kBtu	\$	kBtu	\$	kBtu	\$	% kBtu	% \$																																																												
March	2012	519,729	7,733	202,272	3,693	202,272	3,693	317,457	4,039	61.1%	52.2%																																																												
April	2012	512,930	7,134	205,273	3,541	205,273	3,541	307,657	3,593	60.0%	50.4%																																																												
May	2012	529,195	8,320	209,620	4,639	209,620	4,639	319,575	3,861	60.4%	45.3%																																																												
June	2012	237,938	1,779	17,400	130	17,400	130	220,538	1,649	92.7%	92.7%																																																												
July	2012	0	0	0	0	0	0	0	0	N/A	N/A																																																												
August	2012	0	0	0	0	0	0	0	0	N/A	N/A																																																												
September	2012	0	0	0	0	0	0	0	0	N/A	N/A																																																												
October	2012	0	0	0	0	0	0	0	0	N/A	N/A </tr <tr> <td>November</td> <td>2012</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>N/A</td> <td>N/A</td> </tr> <tr> <td>December</td> <td>2012</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>N/A</td> <td>N/A</td> </tr> <tr> <td>January</td> <td>2013</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>N/A</td> <td>N/A</td> </tr> <tr> <td>February</td> <td>2013</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>N/A</td> <td>N/A</td> </tr> <tr> <td colspan="2">Annual Totals</td> <td>1,799,792</td> <td>25,166</td> <td>634,565</td> <td>12,023</td> <td>634,565</td> <td>12,023</td> <td>1,165,227</td> <td>13,142</td> <td>64.7%</td> <td>52.2%</td> </tr>	November	2012	0	0	0	0	0	0	0	0	N/A	N/A	December	2012	0	0	0	0	0	0	0	0	N/A	N/A	January	2013	0	0	0	0	0	0	0	0	N/A	N/A	February	2013	0	0	0	0	0	0	0	0	N/A	N/A	Annual Totals		1,799,792	25,166	634,565	12,023	634,565	12,023	1,165,227	13,142	64.7%	52.2%
November	2012	0	0	0	0	0	0	0	0	N/A	N/A																																																												
December	2012	0	0	0	0	0	0	0	0	N/A	N/A																																																												
January	2013	0	0	0	0	0	0	0	0	N/A	N/A																																																												
February	2013	0	0	0	0	0	0	0	0	N/A	N/A																																																												
Annual Totals		1,799,792	25,166	634,565	12,023	634,565	12,023	1,165,227	13,142	64.7%	52.2%																																																												



* Baseline is based on reported utility quantities and actual rates

Agenda

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Significant
HFRCx Elements

Baptist

Sacred Heart

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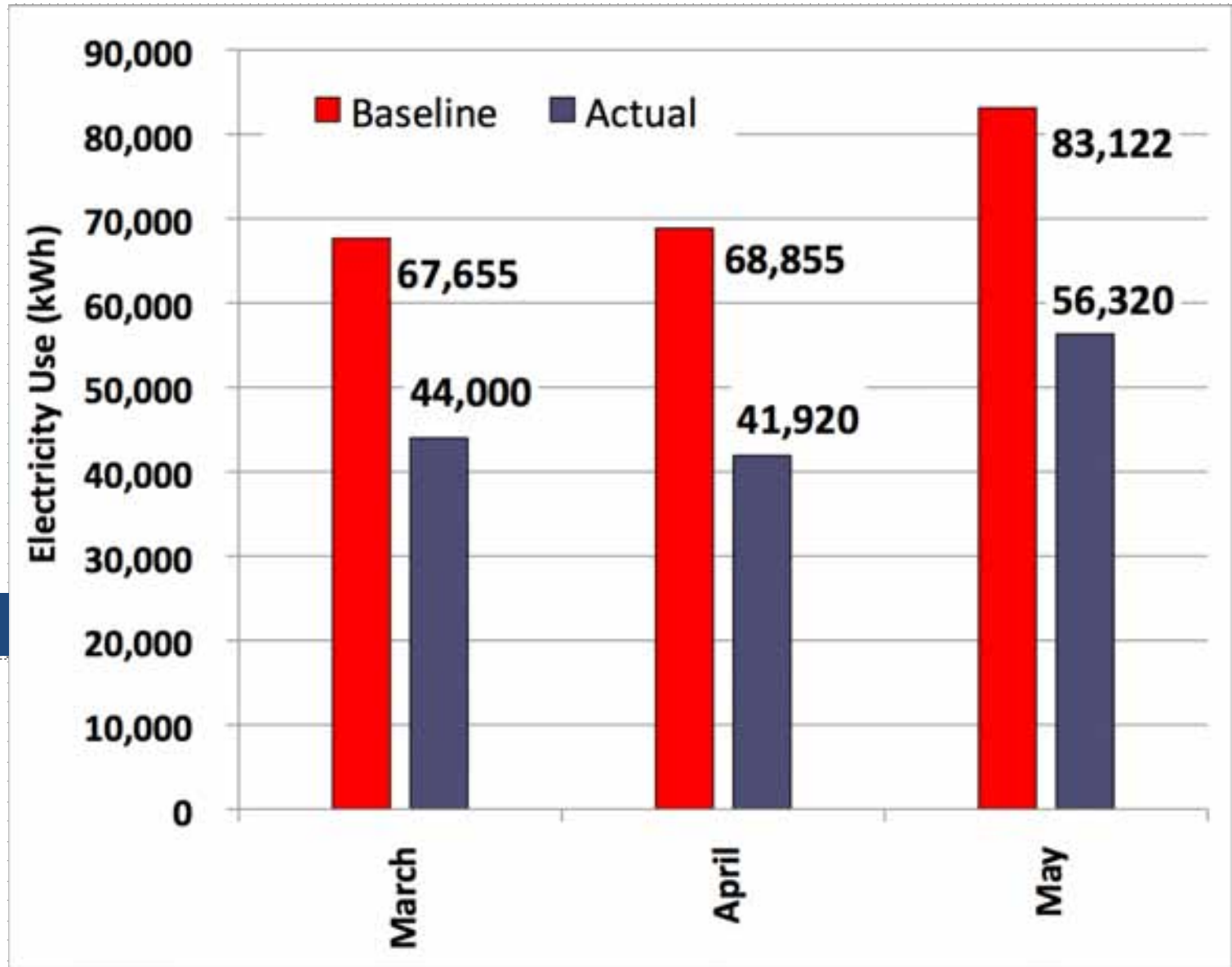
OK Heart

Family Medical

Clay County

Summary

Electricity Consumption



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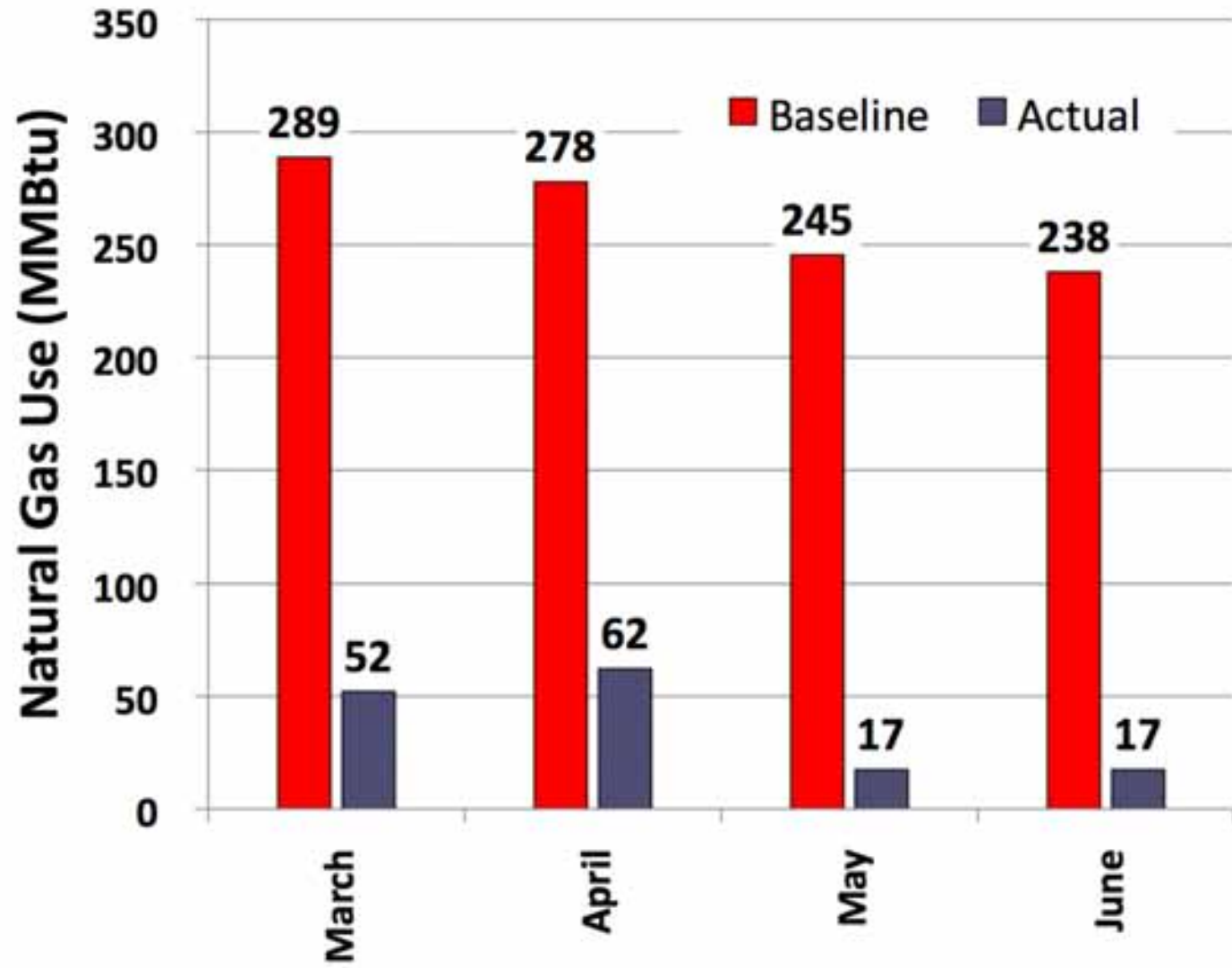
OK Heart

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Summary

Natural Gas Consumption



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Family Medical

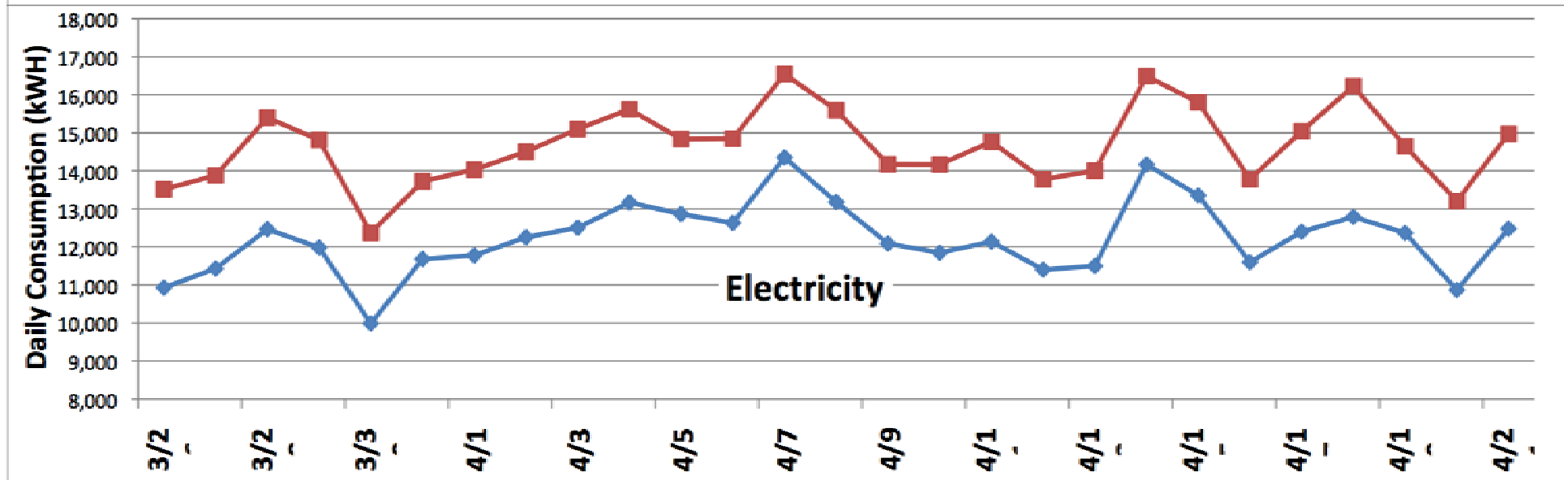
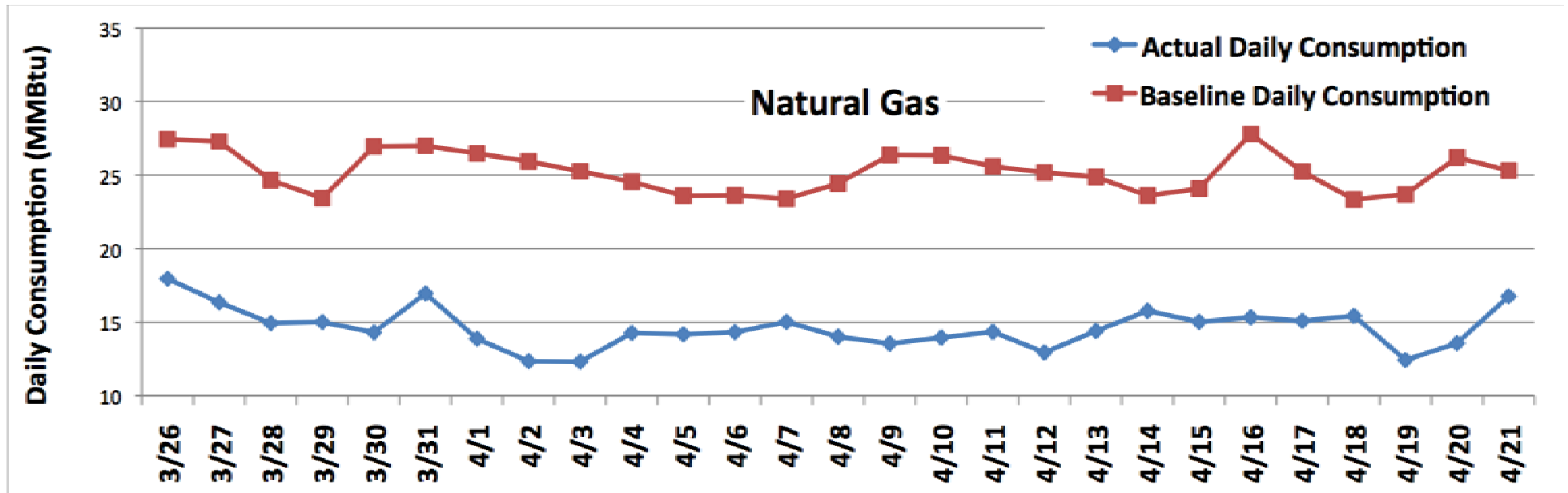
Clay County

Summary

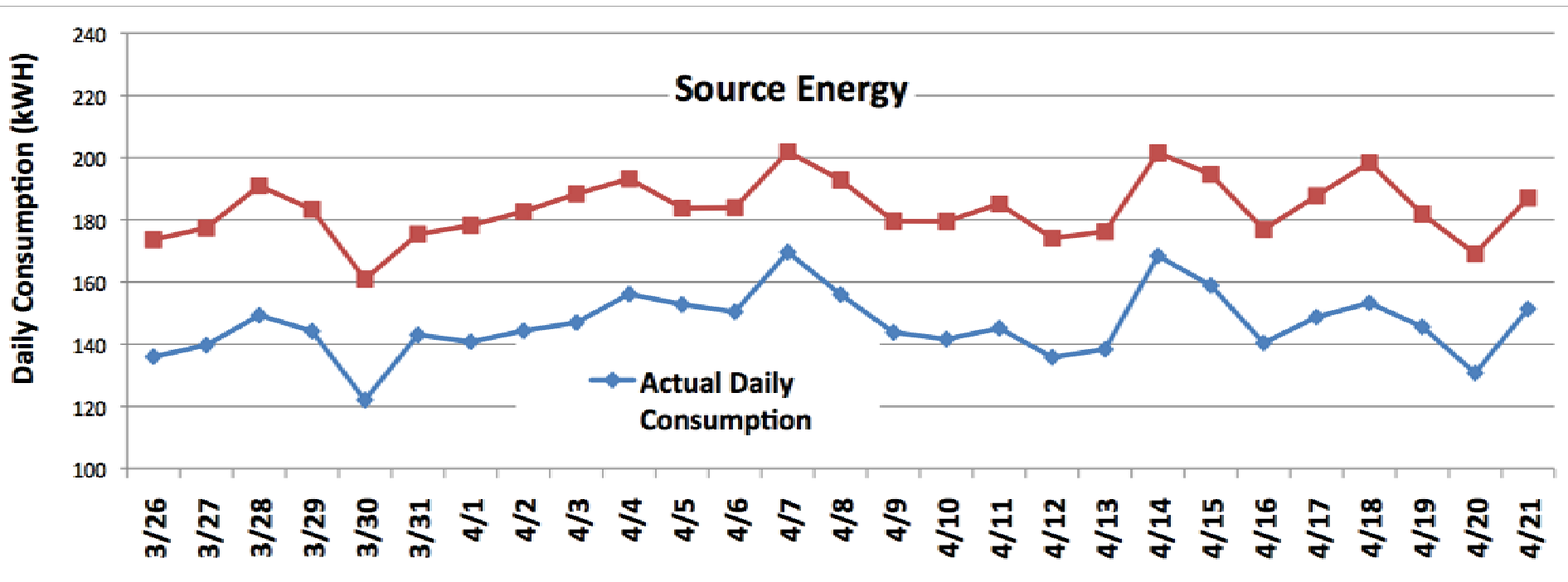
Clay County Setpoint Reset Strategies

Unit	Area Served	Cool Dmnd	Damper	Humidity	HW Valve	
TU1_03_01	OR2	0 <input checked="" type="checkbox"/>	35 <input checked="" type="checkbox"/>	51.6 <input checked="" type="checkbox"/>	11 <input checked="" type="checkbox"/>	Trend
TU1_03_02	14762	100 <input type="checkbox"/>	30 <input checked="" type="checkbox"/>	--	0 <input checked="" type="checkbox"/>	Trend
TU1_03_03	OR1	100 <input checked="" type="checkbox"/>	54 <input checked="" type="checkbox"/>	48.7 <input checked="" type="checkbox"/>	0 <input checked="" type="checkbox"/>	Trend
TU1_03_04	OR3	0 <input checked="" type="checkbox"/>	95 <input checked="" type="checkbox"/>	50.4 <input checked="" type="checkbox"/>	15 <input checked="" type="checkbox"/>	Trend
TU1_03_05	OR5	0 <input checked="" type="checkbox"/>	37 <input checked="" type="checkbox"/>	54.3 <input checked="" type="checkbox"/>	17 <input checked="" type="checkbox"/>	Trend
TU1_03_06	14748	27 <input type="checkbox"/>	50 <input checked="" type="checkbox"/>	--	0 <input checked="" type="checkbox"/>	Trend
TU1_03_07	OR6	0 <input checked="" type="checkbox"/>	41 <input checked="" type="checkbox"/>	52.2 <input checked="" type="checkbox"/>	13 <input checked="" type="checkbox"/>	Trend
TU1_03_08	OR4	0 <input checked="" type="checkbox"/>	37 <input checked="" type="checkbox"/>	49.8 <input checked="" type="checkbox"/>	18 <input checked="" type="checkbox"/>	Trend
TU1_03_09	14720	40 <input checked="" type="checkbox"/>	43 <input checked="" type="checkbox"/>	--	0 <input checked="" type="checkbox"/>	Trend
RTU_03	Operating Rooms	--	--	--	0 <input checked="" type="checkbox"/>	Trend

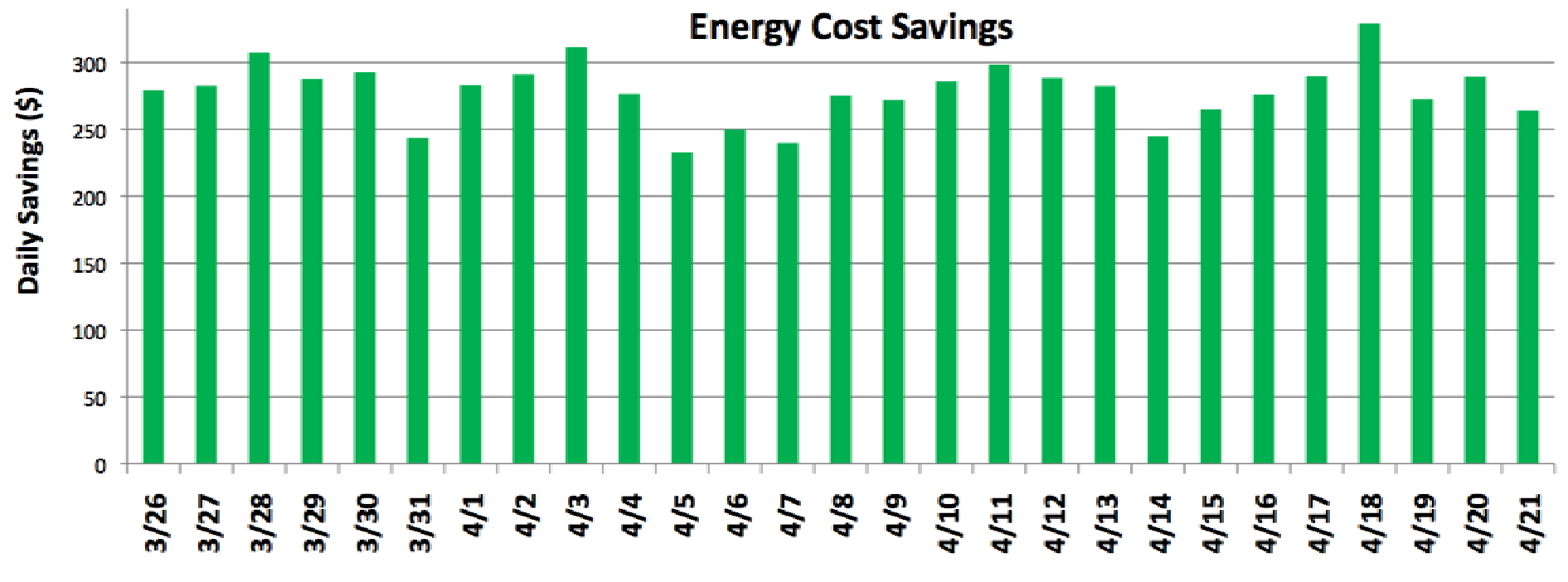
Clay County Daily Energy Scorecard



Source Energy



Energy Cost Savings



Agenda

ASHE

Significant
HFRCx Elements

Baptist

Sacred Heart

Ft. Scott

OK Heart

Family Medical

Clay County

Summary

Health Facility Retro-Cx Outcomes

- Heightened Energy Awareness (Engineer, Control Contractor, Maintenance Staff, and Occupants)
- Increased Competence of Maintenance Staff (treat the cause not the effect)
- Vesting and Empowerment of Maintenance Staff
- Increased Credibility with C-Suite
- Significant Reduction in Patient, Staff, and Visitor Hot and Cold Calls (almost nonexistent)
- Reduction in Hospital Cost Structure (more dollars to spend on research and patient care)

Agenda

ASHE

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Summary

Summary

- Involve the Hospital O&M Staff
- Rotate Maintenance Staff between Maintenance and Retro-Cx Teams
- Sustain the Results using Dashboards, M&V of Savings, Staff Training, and Automatic Fault Detection
- Use the Savings to Fund Higher Cost and Longer Payback Energy Cost Reduction Measures (also known as the “Long Push”)
- Daily Measurement and Verification of Savings is Critical