Continuous Commissioning[®] Process Case Study of Tripler Army Medical Center Honolulu, HI



Proceedings of the Eleventh International Conference Enhanced Building Operations, New York City, October 18-20, 2011



Commissioning Consulting Firm specializing in

Continuous Commissioning[®]

New Building Functional Commissioning

Energy Analysis

Project Management



Presentation Outline

- Facility Management's Objectives
- Project Description
- ➤ CC[®] Process applied
- ≻ Tripler CC[®] Measures
- Energy Savings
- ➤ Training

Facility Management Objectives

Identify and solve existing operational problems
 Improve building thermal comfort
 Verify indoor air quality

- Minimize building energy consumption
- Minimize total operating cost
- Document Energy and Cost Savings

CC[®] **Process**

Preliminary CC[®] Assessment

- Field Investigations
- Drawing Reviews
- Utility Bill Analysis
- Develop Comfort Baseline
 - Temperature, RH, CO₂

CC[®] **Process**

Develop CC[®] Implementation Plan

- Validate sensors and equipment functionality
- Review EMCS programming
- Investigate reported problem areas

Implement the Plan

• Fine Tune with Adjustments over time

Present Results

- Final Report and Savings Report
- Training Workshop

CC[®] **Process**

Continue to Monitor the Facility

- Continuous" part of the CC[®] Process
- To insure a continuity of savings, continue to monitor and fine tune the systems
- Institute a program to ensure retrofits and additions are accomplished in concert with the established CC[®] program

Tripler Site Description

Full Service Hospital ► 1.2 Million Sq Ft Over 75 Major AHUs Mostly SDVAV & SDCAV AHUs with RA fans ➢ JCI Metasys EMCS Two Main chilled water loops Non-Critical Loop (two 900 ton Chillers) Critical Loop (two 600 ton Chillers) Central Plant is remote to the main building Steam Plant Two 150 Hp fire tube boilers

CC[®] Measures Employed

- Equipment Maintenance & Sensor Calibrations
 - •Over 300 items repaired or replaced
 - Verified and adjusted valve and damper operation
 - Tuned PID loops
 - Verified air flows and static pressure readings with EMS
 - •Verified static pressure drops across coils
 - Set up trend logs on key components in EMS
 - Supply Air Temp, SP, Fan Speed, CHW Valve position, etc.

CC[®] Measures Employed

AHUs (mostly non-critical)

Static pressure reset schedules

- Occupancy schedules
- •OA modulated based on CO₂ on certain AHUs

•OA adjusted on other AHUs

- Adjusted flow differential on return air fans
- Terminal Box (over 300 boxes programmed)
 - •Verified damper, flow and reheat operation vs. set points
 - Occupancy scheduling
 - Temperature set points with dead bands for both occupied and unoccupied time periods
 - •Air flow minimums and maximums

CC[®] Measures Employed

Chiller Plant

• Simplified critical and non-critical loop DP sensor control logic.

- Implemented a linear re-set schedule based on OAT
- Optimized chilled water differential pressure (DP)
- Repaired make up water pressure regulators and adjusted expansion tank pressures
- Extended the existing combined loop operation time by 3 hours daily.
- Optimized the condenser water heat reclaim operation
- Optimized chilled water supply temperature

Boiler Plant

- Trended steam pressure and flow
- Optimized steam pressure reductions



Typical Single Duct Constant Volume or Variable Volume AHU (SDCAV or SDVAV)



Typical Static Pressure Linear Reset Schedule



Cumulative Cost Savings based on Audit Rates (February 2007 - June 2010)

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CC[®] Energy Savings Results

Total Cumulative Energy Savings (2/28/2007 – 6/30/2010) \$827,978

Energy Savings February 28, 2007 to June 30, 2010

Electricity5,046,918 kWhEmissionsReductions CO_2 8,736,266 lbs SO_2 21,032 lbs No_x 19,583 lbs

Projected Fuel Oil savings based on steam pressure reductions this past year (10/2010 - 9/2011): 13,000 gal ~ \$65,000.00



Electricity Consumption Patterns versus Outside Temperature

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Tripler Army Medical Center									
Honolulu, HI							PRICE \$/kWh		
					Measured	Baseline	÷	Savings	\$0.1641
Month	Day	Year	Days/Mo	Tdb	Total Cons	Total Cons			
No.				°F	[kWh]	kWh	kWh	%	USD
2	28	2007	28	73.1	2,428,000	2,489,405	61,405	2.47%	\$10,074
3	31	2007	31	73.9	2,848,000	2,783,918	(64,082)	-2.30%	(\$10,513)
4	30	2007	30	75.6	2,708,000	2,756,750	48,750	1.77%	\$7,998
5	31	2007	31	77.6	2,860,000	2,921,410	61,410	2.10%	\$10,075
6	30	2007	30	79.7	2,876,000	2,900,423	24,423	0.84%	\$4,007
7	31	2007	31	80.1	2,820,000	3,013,193	193,193	6.41%	\$31,695
8	31	2007	31	80.9	2,676,000	3,042,081	366,081	12.03%	\$60,058
9	30	2007	30	80.6	3,136,000	2,932,272	(203,728)	-6.95%	(\$33,423)
10	31	2007	31	79.3	3,008,000	2,981,746	(26,254)	-0.88%	(\$4,307)
11	30	2007	30	76.3	2,680,000	2,781,168	101,168	3.64%	\$16,597
12	31	2007	31	75.0	2,672,000	2,824,142	152,142	5.39%	\$24,960
1	31	2008	31	72.9	2,600,000	2,748,083	148,083	5.39%	\$24,294
2	29	2008	29	74.3	2,460,000	2,620,046	160,046	6.11%	\$26,257
3	31	2008	31	76.6	2,768,000	2,882,649	114,649	3.98%	\$18,809
4	30	2008	30	76.5	2,548,000	2,786,830	238,830	8.57%	\$39,181
5	31	2008	31	78.5	2,744,000	2,952,127	208,127	7.05%	\$34,144
6	30	2008	30	79.7	2,732,000	2,900,423	168,423	5.81%	\$27,631
7	31	2008	31	81.1	2,976,000	3,049,760	73,760	2.42%	\$12,101
8	31	2008	31	80.6	2,880,000	3,031,477	151,477	5.00%	\$24,851
9	30	2008	30	79.7	2,672,000	2,901,485	229,485	7.91%	\$37,648
10	31	2008	31	79.0	3,000,000	2,971,507	(28,493)	-0.96%	(\$4,674)
11	30	2008	30	76.7	2,748,000	2,796,384	48,384	1.73%	\$7,938
12	31	2008	31	74.7	2,712,000	2,813,172	101,172	3.60%	\$16,598
1	31	2009	31	72.1	2,636,000	2,721,023	85,023	3.12%	\$13,949
2	28	2009	28	72.8	2,332,000	2,481,148	149,148	6.01%	\$24,469
3	31	2009	31	72.8	2,468,000	2,744,060	276,060	10.06%	\$45,289
4	30	2009	30	73.9	2,748,000	2,697,299	(50,701)	-1.88%	(\$8,318)
5	31	2009	31	77.8	2,704,000	2,926,530	222,530	7.60%	\$36,507
6	30	2009	30	82.9	2,768,000	3,014,017	246,017	8.16%	\$40,361
7	31	2009	31	81.9	2,992,000	3,079,745	87,745	2.85%	\$14,395
8	31	2009	31	81.9	2,924,000	3,079,745	155,745	5.06%	\$25,551
9	30	2009	30	82.8	2,872,000	3,010,832	138,832	4.61%	\$22,776
10	31	2009	31	81.6	2,888,000	3,065,484	177,484	5.79%	\$29,117
11	30	2009	30	79.4	2,792,000	2,889,453	97,453	3.37%	\$15,988
12	31	2009	31	74.3	2,652,000	2,798,911	146,911	5.25%	\$24,102
1	31	2010	31	74.9	2,724,000	2,822,314	98,314	3.48%	\$16,129
2	28	2010	28	73.4	2,384,000	2,499,644	115,644	4.63%	\$18,972
3	31	2010	31	75.1	2,512,000	2,829,627	317,627	11.23%	\$52,109
4	30	2010	30	76.2	2,616,000	2,777,275	161,275	5.81%	\$26,458
5	31	2010	31	78.6	2,764,000	2,957,612	193,612	6.55%	\$31,763
6	30	2010	30	80.0	2,812,000	2,911,747	99,747	3.43%	\$16,364
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					112,140,000	117,186,918	5,046,918	4.31%	\$827,978

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TRAINING

Troubleshooting

- Start remotely with the location of the issue
- Continue to move towards the primary cooling/heating source
 - Zone
 - » Box
 - AHU
 - Hot/Chilled water system

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AHU Trend Troubleshooting

- Notice start time of DAT rise and DP drop compared to scheduled fan set back
- Notice the effect on the DAT immediately after the fan slows down
- Based on the triplex pumps running at full speed, what is your conclusion?



DP Troubleshooting

- Why is the level 4 set point 0?
- What is the driving DP set point on the comfort loop?
- What do you think happens to the DP for the critical chillers in combined loop mode?

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途					Loop Diff. Pressures		<u>6080</u>
All Items Tripler	Summary						
Tripler	Status	Item		Value	Description		
Central Plant	Jointe	DPX1 S	YSTEM CMND	Start	Duplex VED1 System Cmnd		
		DPX2 S	YSTEM CMND	Stop	Duplex VFD2 System Cmnd		
DPX1 SYSTEM CMND		H DUPLE	X VFD SPD CMND	93.5 %	Duplex Calc Max Diff VFD Spd Cmnd		
DPX2 SYSTEM CMND	Remote	DP-1 SI	TPT-C (DUPLEX)-PLANT				
DUPLEX VED SPD CMND		DP-2 SI	ETPT-C (DUPLEX)-BLDGH-8F	6.1 psi	DP-2 BldgH-8F SP (Duplex-Crit) (6.0PSI)		
DP-1 SETPT-C (DUPLEX)-PLANT		DP-3 SI	TPT-C (DUPLEX)-BLDGD-4F	0.0 psi	DP-3 BldgD-4F SP (Duplex-Crit) (5.0PSI)		
DP-2 SETPT-C (DUPLEX)-BLDGH-8F		DP-1 C	RIT LOOP (DUPLEX)-PLANT	21.9 psi	DP-1 Plant (Duplex-Crit)		
DP-3 SETPT-C (DUPLEX)-BLDGD-4F		DP-3 C	RIT LOOP (DUPLEX)-BLDG-D 4F	28.5 psi	DP-3 Bldg D 4th (Duplex-Crit Loop)		
DP-1 CRIT LOOP (DUPLEX)-PLANT		DP-2 C	RIT LOOP (DUPLEX)-BLDG-H 8F	6.1 psi	DP-2 Bldg H 8th (Duplex-Crit Loop)		
DP-3 CRIT LOOP (DUPLEX)-BLDG-D 4F		TPX1 S	YSTEM CMND	Start	Triplex VFD1 System Cmnd		
DP-2 CRIT LOOP (DUPLEX)-BLDG-H 8F		TPX2 S	YSTEM CMND	Start	Triplex VFD2 System Cmnd		
TPX1 SYSTEM CMND		TPX3 S	YSTEM CMND	Stop	Triplex VED3 SystemCmnd		
TPX2 SYSTEM CMND		H TRIPLE	X VED SPD CMND	93.1 %	Triplex Calc Max Diff VFD Spd Cmnd		
TPX3 SYSTEM CMND	Remote	DP-1 SI	TPT-NC (TRIPLEX)-PLANT				
TRIPLEX VED SPD CMND		DP-2 SI	TPT-NC (TRIPLEX)-BLDGH-8F	10.4 psi	DP2 BldgH 8F SP(TPX-Non-Crift) (12.5 PSI)		
B DP-1 SETPT-NC (TRIPLEX)-PLANT		DP-3 SI	TPT-NC (TRIPLEX)-BLDGA-13E	2 0 nsi	DP3 BldgA 13E SP(TPX-Non-Crift) (4 0 PSI)		
DP-2 SETPT-NC (TRIPLEX)-BLOGH-8E		(2) DP-1 N	ON-CRIT LOOP (TRIPLEX)-PLANT	44 4 nsi	DP-1 Plant (Tripley-Non-Crit)		
DP-2 SETPT-NC (TRIPLES) BLDGA 125	•	DP-2 N	ON-CRITI OOP (TRIPLEX)-BLDG-H S	RF 125 nsi	DP-2 Bldg H 8th (Tripley-Non-Crit)		
DP-1 NON-CRIT LOOP (TRIPLEYO-PLANT		B DP-3 N	ON-CRIT LOOP (TRIPLEX) BLDG-41	3F 2 3 nsi	DP-3 Bldg A 13th (Triplex-Non-Crit)		
DP-2 NON-CRIT LOOP (TRIPLEY)-PLDG-H 95		Dunley	Critical Loon	51 2.5 051	of a bidg it fair (inplex from only		
B DP-3 NON-CRIT LOOP (TRIPLEYO-BLDG-A 13E		Duplex	Childen 200p				
Durs Note Chill Coon Dursey- Critical Loon							
Wing A							
AHU 12A 04 : Elevator Labor 4th to 11th Elevator							
E C ALLI 10A 024 : Conforance Pm							
R AHU 12A 01 : Medical Library							
AHO-12A-01 : Medical Library							
FCU-3A-01 : Hot Lab & Patient Rm							
FCU-3A-2A : Fone Cameras							
FCU-3A-03 : Skylight Camera							
FCU-3A-04 PETCT Control Rm							
FCU-3A-01-MRI File Office							
FCO-3A-02-MRT. File Storage							
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Critical Loop Differential Pressure



HVAC CC® Energy Efficiency with New Construction or Remodels

CC[®] Energy Efficiency with New Construction or Remodels

<u>Items to Consider</u>
Lighting
Air Handling Units
Terminal Boxes
TAB and Commissioning

Lighting

T-8 system or better
 Electronic Ballasts
 Motion Sensors

 Conference Rooms
 Break-rooms
 Break rooms
 Storage rooms
 Offices

Air Handling Units

✓ DDC Controls (tied into the front end!!!)

- ✓ High Efficiency VFD Compatible Motors
- ✓ Variable Frequency Drives
- ✓ Proper Sensors
- ✓ Coils 8 row max, with 12 fins/inch

If more capacity needed, split into two series coils with space to clean

✓ UV lights (optional)

Terminal Boxes

- ✓ DDC Controls (mapped back to the front end!!)✓ Program Them
 - Occupied / Unoccupied schedule
 - Max / Min Flows
 - Temperature Set Points
- \checkmark Hot water re-heat preferable to electric in this case
- ✓ Ensure Box is accessible for maintenance
- Leave manual balance dampers as set by the TAB contractor

Specifications

✓ Independent TAB ✓ Commissioning Review drawings prior to construction Inspections during construction Validation after construction Ensure EMS programming is working ✓ Re-inspect system in opposite season prior to end of warranty period

Any Questions ?