THE BUSINESS AND TECHNICAL CASE FOR CONTINUOUS COMMISSIONING® FOR ENHANCED BUILDING OPERATIONS A CASE STUDY: ALAMO COMMUNITY COLLEGE DISTRICT, SAN ANTONIO, TEXAS, USA

BY

Malcolm Verdict, Guanghua Wei, Joseph T. Martinez, David E. Claridge, Juan-Carlos Baltazar-Cervantes and W. Dan Turner

Energy Systems Laboratory, Texas A&M University System, College Station, Texas, United States of America

Summary

This paper provides a business and technical case study for the Continuous Commissioning®(CC®) [1] process developed by the Energy Systems Laboratory (ESL) at Texas A&M University System for building optimization.

The business and technical advantages for CC include: 1) project risk mitigation, 2) enhanced occupant comfort and productivity, 3) retrofit identification and 4) a high return on investments [average ROI of 0.5].

ESL applied CC from 2002 to 2004 at Alamo Community College District (ACCD) with conditioned space of 2.35 million square feet, as part of a broader energy efficiency project. The project has produced savings of $510,400 [US]in 23 months with $315,000 from CC alone in first 18 months. The total project cost was $3.5 million [US] and included the cost of CC, deferred maintenance and other Energy Cost Reduction Measures (ECRMs) with a payback of 6.7 years.

Keywords: continuous commissioning, business case, building optimization, metering, verification.

Introduction

Increased use of technologies such as variable frequency drives, building automation and digital control systems, and metering and monitoring devices have become the norm for significantly reducing building energy use. At the same time, the need for increased occupant productivity and comfort and leaner profit margins as a result of increased global competitiveness is driving the quest by facility managers to "do better with less." Hence, the use of continuous commissioning to minimize controlable expenses has gained popularity from a business standpoint but still faces many market and technology development barriers.

Continuous commissioning is defined as an ongoing process to resolve operational problems, improve comfort, optimize energy use and identifying retrofits in existing commericial and institutional buildings and central plant facilities. It differs significantly from retro and new building commissioning since it focuses on optimizing the building for <u>existing</u> conditions and operations, not to original design conditions, and should be done on a <u>continuing</u> basis.[1]

The CC engineering process was developed by the Energy Systems Laboratory at the Texas A&M University System beginning in 1993. Continuous comissioning evolved naturally from an extensive metering, monitoring and savings verification program conducted by ESL for the State of Texas as part of a very successful $96 million LoanSTAR energy retrofit loan program for tax-supported institutions.

Business Case for CC

Today's facility/energy managers are bombarded by new technologies promising to reduce energy use which are often sold on the basis that the building's baseline consumption cannot be decreased without the use of expensive energy improvements that "pay for themselves" over time. At the same time, facility managers utilize a building automated controls industry who frequently take a very conservative approach [one size fits all] to optimizing HVAC systems and central plants. Corporate and institutional facility energy managers increasingly out source their

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[1] The term Continuous Commissioning® and CC® are registered trade marks of the Energy Systems Laboratory, Texas Engineering Experiment Station, Texas A&M University System. To enhance readability, these marks will not be used for the remainder of the paper.

controls system maintenance and their operations and maintenance activities as their equipment and BAS become much more complicated. Also, they often leave energy retrofits to energy service companies without benefit of an accurate baselining of facility energy use, due to the lack of metering and/or skilled analysis.

With this mixing of responsibilities and services, it is virtually impossible for the facility operator/manager to optimize his interactive building systems without the services of a highly skilled field engineer. He must fully understand building HVAC systems, unitary and automated controls and the optimization of energy use and comfort and not be driven by the profit motive to "sell capital equipment."

Fortunately, the judicious use of CC, independently of or in conjunction with a comprehensive energy retrofit project, provides the financially and technically astute facilty manager with a low-cost alternative to enhance building operations. Some of the unique business and technical advantages of the CC process include:

1) Risk mitigation through accurate baselining of energy use prior to retrofit selection,
2) Enhanced building performance/operations that increase comfort, indoor air quality and productivity,
3) Enhanced retrofit identification which can negate the need for expensive capital retrofits, and
4) Comparatively high return on investments [paybacks often less than 24 months and annual savings of 10-25% of whole building energy consumption].

These advantages greatly influenced senior management at ACCD to invest in CC as the cornerstone of their mulit-million dollar energy-efficiency project and will be further discussed in the case study analysis.

Market Barriers to CC in the United States

Market barriers for the CC engineering process are similar to those facing other, more mature, energy efficiency technologies. Even though the use of CC by the ESL has proven dramatically cost-effective [$70 million (US) in over 200 buildings since 1993], it is still not a widespread practice in the U.S.

Some of the common market barriers include:

- Lack of awareness: It is not easy for decision makers to find reliable, objective information on the application and effectiveness of CC although the ESL and others have published numerous papers and case studies and developed a "Guidebook to Continuous Commissioning®" in 2002 for the U.S. Department of Energy's Federal Energy Management Program. (This program provides technical assistance to approximately ½ million federal buildings with $3+ billion annual energy use.)
- Perceived Risk: Percieved risk in the technical performance of CC is high due to the lack of understanding of the process and the low compatibility between parts, systems and controls. Also, each building system and the degree of controls and level of maintenance cause the potential for CC to be unique to that facility. This complexity contributes to the actual project risk . Inadequate operations and maintenance, sub-optiminal building controls and facility staff expertise create opportunities for building optimization while adding to the complexity and risk [rate of return potential] to be assessed by the facility manager.
- Immaturity of Market Infrastructure: Wide spread use of emerging sound engineering practices such as CC face "chicken and egg" problems caused by lack of suitable infrastructure such as widepspread availibility of skilled CC engineers and the lack of standardized approaches and automated commissioning tools and software. It will take considerable investment in development of "smart software" tools to move the application of CC from an apprentice model to one of semi-skilled technicians aided by intelligent soft ware-based tools to accelerate the application of CC.

The good news is that the application of CC is increasing in some quarters such as federal and state government buildings in the U.S. The U.S. Air Force recently conducted a $1.5 million pilot study of CC in 3 major military installations. The State of Texas has recently negotiated a contract for services for comprehensive energy management services in over 170 million square feet with CC as the corner stone for baselining energy use, identifying opportunities and the rapid reduction of energy use. The State of California is conducting several million dollars in research and implementation activities closely related to CC using public funds from electricity restructuring.

The reaction from facility managers utilizing CC is very positive when savings are often found in buildings thought to be well run and maintained. CC can also fix comfort problems that typical HVAC contractors are unable to resolve. For example, a federal building manager of a Navy avaition training facility in San Diego, California recently stated that "after 7 or 8 years of requesting maintenance to fix hot and cold problems in several zones, he had given up before ESL CC engineers fixed the majority of his problems in one week on-site."

Many of these market barriers concerning perceived risk were overcome with on-site testing and careful analysis prior to commencement of the ACCD continuous commissioning project which began in early 2002. Based on the dramatic results at ACCD, the head of facilities and contruction at ACCD was commended in early 2004 by their Board of Directors for his foresight in utilizing CC and his contribution to lowering energy expense and the use of natural resources which contribute to the air pollution problems in San Antonio for NOx.

Case Study for ACCD Continuous Commissioning Project

Program Overview
In 2002, the Alamo Community College District (ACCD) in San Antonio, Texas, USA initiated a $3.5 million project aimed at improving energy efficiency at its four major campuses and two administrative office buildings. The four campuses are San Antonio College (SAC), St. Philips College (SPC), Palo Alto College (PAC), and SPC Southwest Campus. The two administrative office buildings are located in downtown San Antonio. The total conditioned space included in this program is 2,350,000 square feet. Major ECRMs include conversion of lighting to T-8 lamps and electronic ballasts, CC of all major building systems, cooling tower replacement at the SPC campus, building automation system (BAS) upgrades, roof-top package unit replacements, variable air flow and variable chilled water pumping, and other HVAC system replacements and retrofits.

CC Payback Ranking
Continuous Commissioning had the shortest payback period of any of the ECRMs implemented in the $3.5 million ACCD project. The CC paybacks at various campuses ranged from a low of 2.3 years to 3.7 years with an average 3.0 year simple payback which also included $140,000 for deferred maintenace or almost 20 percent of the CC budget. The retrofit paybacks for cooling tower, HVAC replacements, lighting replacement, and upgraded building automated controls ranged from 4.0 years to 20 years. The total project payback was 6.7 years including the cost for deferred maintenance and financing. Including CC in the approved list of improvements helped significantly to lower the total project payback [7]. See Appendix A.

Program Savings for CC and ECRMs
The estimated total annual retrofit and CC savings are $450,000 or roughly 21% of the base year energy costs. Figure A shows the breakout of estimated annual cost savings by category. The majority of the expected savings (62%) come from CC, followed by the lighting retrofits (22%) and the remaining upgrades and retrofits (16%). Because of CC's dominance in total savings and its relatively short payback (3 years in this case), some capital intensive upgrades with relatively long paybacks were possible, while still keeping the overall project payback at 6.7 years including financing charges and deferred maintenance [1]. The project was financed with a bank loan of 4 percent and construction management was conducted by an outside energy engineering company, Texas Energy Engineering Services, Inc.

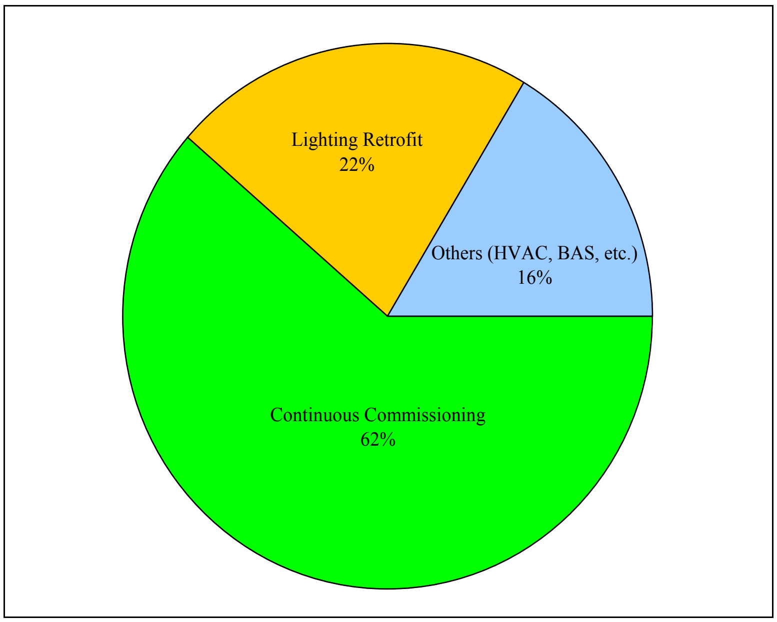

Figure A: Total Estimated Annual Energy Cost Savings (%) at ACCD by ECRM.

CC As An Energy Conservation Retrofit Measure (ECRM)

Major CC opportunities at each site were identified during the initial assessment process. These measures were prioritized during the detailed CC plan development phase. The CC engineers began implementation of the CC measures at the three main campuses (SAC, SPC, and PAC) during the summer of 2002. This was a logical choice because these three campuses represent 75% of total floor area and have a modern BAS at each site, allowing many control strategies to be implemented quickly to reduce peak electric demand, as well as electricity and gas usage.

Major CC activities are outlined below with a brief description of each measure:

- Optimize Chiller Control
- Chilled/Hot Water Loop Delta Pressure Resets
- Air Handler Static Pressure Resets
- Calibration and Repair of Sensors
- Improved Start/Stop Schedules
- Optimize Boiler Control
- Air Handler Unit Temperture Resets
- Economizer Operation Optimization
- Repair of Deferred Maintence Items
- VAV Box Calibration

Optimize Chiller Control

Criteria and set points for chiller start/stops were fine-tuned to improve the staging sequences. Reset schedules for the chilled water supply temperature set points were introduced to improve part-load chiller efficiency.

Optimize Boiler Control

Boiler start/stop sequence and existing hot water supply temperature set point reset schedules were refined to minimize simultaneous heating and cooling.

Chilled/Hot Water Loop Delta Pressure (DP) Resets

All three campuses have primary-secondary configurations at the chiller plants, with constant-speed chilled water pumps on the primary loop and variable frequency drives on the secondary pump motors. DP set points used to be constant and were relatively high for normal operation. In one of the campuses, the DP set point was so high (30psi) that it drove five secondary pumps (75 horsepower each) to full speed in the middle of the winter (one chiller has to be operated year round due to the lack of economizer capabilities in some buildings). Reducing and resetting the DP set point saved a significant amount of pumping power. This measure also helped reduce the simultaneous heating and cooling due to over pressurization of the chilled water loop.

Most of the building chilled water pumps are also equipped with VFDs. Their DP set points were also reset based on load conditions. Similarly, DP reset schedules were implemented on the campus hot water loops and building hot water loops for all three campuses.

Air Handling Unit (AHU) Temperature Resets

Supply air temperature and cold/hot deck temperature set points were reset to reduce simultaneous heating and cooling energy consumption. This measure was implemented in both variable and constant air volume AHUs.

AHU Duct Static Pressure Resets

By resetting the AHU duct static pressure set points, significant fan power reductions were achieved. The Library Building at SAC is a good example. The duct static pressure set point used to be so high (3.5 inches of water column) that it drove all three supply air fans to full speed in the middle of the winter. One of the main supply air ducts literally came apart, apparently due to over-pressurization. By reducing and resetting the duct static pressure set point, it was estimated that approximately 150 kW of peak fan power demand was saved in that building alone [3]. Like the water loop DP reset, this measure also helped reduce simultaneous heating and cooling by reducing unnecessary air mixing and reheat at the terminal boxes.

Improved Economizer Operation

The range and set points of economizer operations for the single-duct AHUs were optimized to take advantage of free cooling. Since the supply air temperature set points were reset based on outside air temperature, the economizer set points were chosen to follow the same reset schedule.

Calibration and Repair of Sensors

Key sensors, such as the outside air temperature sensor, AHU cold and hot deck temperature sensors, duct static pressure sensors, and water DP sensors, were checked and calibrated when necessary. In some cases, the sensors were relocated to obtain better readings.

Repair of Malfunctioning Devices

The CC engineer generated a list of deferred maintenance items, and prioritized the items based on their impacts on building comfort and system efficiency. Typical items include broken VFDs, leaky valves, broken dampers, dirty coils, etc. Most of these items fall into the deferred maintenance category, and they were dealt with separately, as discussed in the section - Deferred Maintenance.

Improved Start/Stop Schedules

Room-by-room surveys were performed to determine the occupancy schedules, especially during the evenings and weekends. AHU start/stop schedules were optimized accordingly to minimize the runtime.

VAV Box Calibration

Minimum and maximum VAV box airflow settings were evaluated and properly adjusted based on current space function and occupancy schedules. Along the way, broken pneumatic and DDC box controllers were replaced and/or repaired and recalibrated.

Deferred Maintenance

One of the many challenges facing CC and recommissioning engineers during building optimization is the handling of deferred maintenance issues. To some extent, the success of the program depends on resolving the deferred maintenance issues and restoring the funtionality of the control devices. Therefore, it is critical to obtain cooperation from the site operation and maintenance (O&M) staff to resolve these issues in a timely fashion. Any delay in resolving these issues will not only continue to cost the owner in wasting extra dollars, but also result in unrealized/lost savings opportunities since many of those issues directly impact system performance. Sometimes these issues can also lead to comfort problems. Our experience suggests that many operators are capable of performing most of those deferred maintenance items, provided they are given enough time and a reasonable amount of resources to accomplish the task. Unfortunately, the resources are not always provided.

Based on the initial CC survey findings, ESL estimated the resources needed to fix the deferred maintenance items. ESL then approached and convinced the owner to allocate $140,000 to the CC cost to deal with these items, which raised the payback of CC from 2.5 years to 3.0 years. However, fixing these “broken” devices allowed the CC work to progress faster.

After consulting with the owner and O&M personnel, suitable mechanical, electrical and controls sub-contractors were selected to work on those deferred maintenance issues. The CC engineer assumed the responsibility of creating the work order for each item, touring the job site with the sub-contractors, and obtaining quotes from the sub-contractors. After the work orders were issued, the CC engineer oversaw the repair work and field verified the work performed before approving the invoices from the sub-contractors.

The process worked quite well, with major repair work completed at three campuses as of this writing.

Initial Results

By the summer of 2003, most of the CC measures had been implemented at SAC, SPC, and PAC campuses, while the rest of the ECRMs were just getting started after the completion of the design and competitive bid processes. Therefore, it is possible to separately evaluate the savings that are largely attributed to the CC efforts.

Using monthly utility bills, a baseline was established for each campus based on the 2001-2002 year. Energy models were developed for each energy cost, i.e., electric energy, demand, and natural gas. Based on the pre-CC energy consumption models, actual CC savings of $315,566 were achieved from June 2002 through September 2003. This represents 105% of the original estimated commissioning savings for these three campuses for the same time period, even though the CC activities were on going throughout much of this period.

By April 2004, the cumulative electricity, electric demand, and gas savings at these three campuses totaled approximately $510,400 (See Figure B). This includes the savings from Continuous Commissioning and a few months of lighting retrofit savings. The lighting project was implemented on a campus-by-campus basis. SPC started in July 2003 and was completed in August. SAC started in August and was completed in September, followed by PAC, which started in September and was completed in October. Therefore, the savings seen in this twenty-three-month period are largely due to the CC efforts.

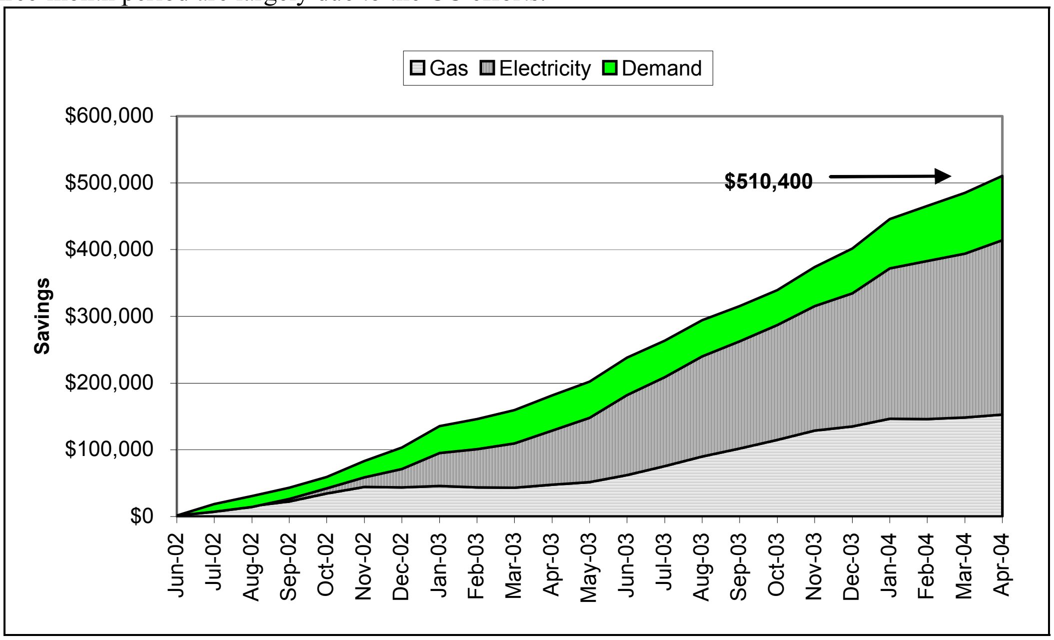

Figure B. Cumulative Energy Cost Savings at PAC, SPC, and SAC

Table 1 provides a summary of savings by campus during the reporting period. Each campus is divided into three categories, electricity savings, electric demand savings, and gas savings. The utility rates used for the savings are $0.029/kWh for electricity, $8.07/kW for electric demand, and $3.95/MCF for natural gas.

Table 1: Summary of Energy Cost Savings for Three ACCD Facilities as of April 2004 (23 months)*

Items	Palo Alto College	St. Philip's College	San Antonio College	Total
Electricity Savings	$33,413	$101,019	$126,640	$261,072
Demand Savings	$2,761	$27,106	$66,419	$96,286
Gas Savings	$72,856	$38,489	$41,697	$153,043
Cumulative Savings	$109,030	$166,614	$234,756	$510,400

* Reporting periods of electricity use and demand: PAC, Mar 03 – Apr 04; SPC, Jul 02 – Apr 04; SAC, Jul 02 – Apr 04. Reporting periods of gas usage: PAC, Jun 02 to Apr 04; SPC, Jul 02 – Apr 04; SAC, Jul 02 – Apr 04.

Summary

Continuous Commissioning has been successfully applied as one of the ECRMs for a $3.5 million energy efficiency program at ACCD covering 2.35 million sq. ft. of conditioned space. Major CC measures and part of the remaining ECRMs have been implemented in the three main campuses. Preliminary analysis showed over $510,400 of cumulative cost savings in the first twenty-three months after the program started. Major commissioning activities for the central plant and building HVAC systems yielded significant savings proving the business and technical case for CC. One unique aspect of this program is a special fund set up to address the issue of deferred maintenance, with the CC engineers designated to adminster the repair work that falls into the deferred maintenance category. The retrofits will be completed in late 2004. The CC engineer will continue to closely monitor the savings and work with the ACCD staff to constantly fine-tune the operations of the buildings, i.e., the "continuous" portion of Continuous Commissioning, as well as conduct CC of the new energy retrofits installed in 2004.

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About the Authors

Malcolm Verdict, C.E.M. is an Associate Director of the Energy Systems Laboratory and project manager of the Alamo Community College District energy management initiative. He was the developer of the Texas LoanSTAR energy retrofit loan program which had the first mandatory monitoring and verification feature in the United States.

Guanghua Wei, P.E. is an Assistant Research Engineer and Assistant Director of the Energy Systems Laboratory. He has extensive hands-on experience in building commissioning. His expertise is implementing optimized operational and control schemes for thermal plants and building HVAC systems.

Joe Martinez is a Project Engineer of the Energy Systems Laboratory. He is the Project Engineer for the case study presented in this paper. He has considerable expertise commissioning large building HVAC systems and central plant controls optimization. Mr. Martinez is proficient in several building automation control sytems.

David Claridge, P.E., PhD. is a Professor of Mechanical Engineering and Associate Director of the Energy Systems Laboratory. He is a licensed Professional Engineer in Texas and has been with the Mechanical Engineering Department and ESL for 18 years. Prior to coming to Texas A&M, he taught at the University of Colorado and prior to that, he worked for NREL and OTA. Dr. Claridge is one of the originators of the Continuous Commissioning® process.

Dan Turner. P.E., PhD. is a Professor of Mechanical Engineering and Director of the Energy Systems Laboratory. He is a licensed Professional Engineer in Texas and Arkansas and has 35 years of university experience in teaching, research, and administration. He is one of the original developers of the CC® process.

REFERENCES

1. Turner, W. D., Claridge, D. E., Deng, S., and Wei, G. "The Use of Continuous Commissioning^{SM} as an Energy Conservation Measure (ECM) for Energy Efficiency Retrofits". *Proceedings of the 11th National Conference on Building Commissioning*. Palm Springs, California, May 20- 22 2003.
2. Liu, M., Claridge, D. E., and Turner, W. D., "Continuous Commissioning^{SM} of Building Energy Systems," Journal of Solar Energy Engineering, Aug. 2003, Vol. 125, Issue 3, pp. 275-281.
3. Wei, G. "Key Procedures for Continuous Commissioning® of a Large Campus with Multiple Buildings", *Proceedings of Building Integration Solutions, Architectural Engineering 2003 Conference*, Austin, Texas, 17-20 September 2003.
4. Claridge D. E., Turner W. D., Liu M., Deng S., Wei G., Culp C., Chen H. and Cho S. Y., "Is Commissioning Once Enough?" *Solutions for Energy Security & Facility Management Challenges: Proc. of the 25 Th WEEC*, Atlanta, GA, Oct. 9-11, 2002, pp. 29-36.
5. Claridge D. E., Culp C. H., Liu M., Deng S., Turner W. D., and Haberl J. S., 2000. "Campus-Wide Continuous Commissioning^{SM} of University Buildings," *Proc. of ACEEE 2000 Summer Study on Energy Efficiency in Building*s, Pacific Grove, CA, Aug. 20-25, Vol. 3, pp. 101-112.
6. Liu M., Claridge D. E., and Turner W. D., 1999, "Improving Building Energy System Performance by Continuous Commissioning^{SM}," *Energy Engineerin*g, Vol. 96, No. 5, pp. 46-57.
7. Energy Assessment Report for Alamo Community College District, April 2002.
8. LoanSTAR Energy Assessment Report for Prairie View A&M University, August 20, 2003

APPENDIX A [7]

SUMMARY OF ENERGY COST REDUCTION MEASURES (ECRM)

ECM #	ECRM Title	Annual Savings Electric (KWH/yr)	Demand (KW/yr)	Gas (MCF/yr)	Cost ($/yr)	O&M ($/yr)	Impl Cost ($)	Simple PB (yrs)	Est'd Proj Life (yrs)
1.1	Interior Lighting Retrofit, SAC	395,776	1,276.8	(23.5)	21,688	10,100	138,028	4.3	15
1.2	Continuous Commissioning, SAC	2,600,000	1,800.0	10,100.0	130,000	--	383,400	3.0	--
2.1	Interior Lighting Retrofit, SPC	735,513	2,386.8	(43.8)	34,461	19,220	264,927	4.9	15
2.2	Replace Cooling Tower, SPC	241,148	1,433.8	0.0	18,564	2,100	412,544	20.0	25
2.3	Modify AHUs, SPC/SLC	645,059	0.0	0.0	3,073	0	11,250	3.7	20
2.4	Continuous Commissioning, SPC	1,400,000	900.0	5,100.0	68,000	--	248,480	3.7	--
3.1	Interior Lighting Retrofit, SWC	388,749	1,111.2	(23.0)	20,949	7,740	145,607	5.1	15
3.2	Replace HVAC Units, SWC	124,226	769	0.0	9,662	2,000	104,902	9.0	20
3.3	Install EMS/DDC, SWC	226,182	0.0	0.0	7,690	3,600	119,660	10.6	20
3.4	Continuous Commissioning, SWC	223,000	0.0	0.0	7,600	--	17,820	2.3	--
4.1	Interior Lighting Retrofit, PAC	294,549	1,082.4	(18.2)	17,205	8,592	122,922	4.8	15
4.2	Install AHU VFD, PAC	192,303	0.0	0.0	5,577	0	36,886	6.6	20
4.3	Modify CHW Loop, PAC	258,072	0	0.0	7,484	0	41,843	5.6	20
4.4	Continuous Commissioning, PAC	1,200,000	900.0	5,300.0	63,000	--	161,160	2.6	--
5.1	Interior Lighting Retrofit, Houston	100,031	278.4	0.0	5,369	2,586	31,835	4.0	15
5.2	Replace HVAC Units, Houston	91,343	792.0	0.0	8,705	1,000	100,418	10.3	20
5.3	Install EMS/DDC, Houston	105,441	0.0	0.0	3,585	1,500	55,222	10.9	20
5.4	Continuous Commissioning, Houston	88,000	0.0	0.0	3,000	--	10,970	3.7	--
6.1	Interior Lighting Retrofit, Sheridan	7,325	20.4	(0.4)	391	160	1,945	3.5	15
6.2	Replace HVAC Units, Sheridan	69,754	604.8	0.0	6,648	1,800	92,248	10.9	20
6.3	Install EMS/DDC, Sheridan	91,629	0.0	0.0	3,115	1,200	48,547	11.3	20
6.4	Continuous Commission'g, Sheridan	118,000	0.0	0.0	4,000	--	12,340	3.1	--
7.1	Motion Sensors	700,833	0.0	(41.8)	20,159	0	152,048	7.5	15
	ECRM Subtotal	--	--	--	--	--	1,880,832	--	--
	CC Subtotal (*)	--	--	--	--	--	834,170	--	--
Energy Assessment & Design							201,205		
Measurement, Verification & Reporting							300,000		
	Subtotal						3,216,207		
Interest on $3,216,207 @ 3.5% Interest & 6 Year Term							354,183		
	TOTALS:	**10,296,933**	**13,355.8**	**20,349.3**	**469,925**	**61,598**	**3,570,390**	**6.7**	

(*) Continuous Commissioning costs include $140,000 in deferred maintenance cost items.