Retrocommissioning Report
Facility A
Clearlake, California

Prepared with funding from

Pacific Gas & Electric

In partnership with

Institute for Market Transformation

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EXECUTIVE SUMMARY

OVERVIEW OF RESULTS

Portland Energy Conservation Incorporated (PECI) in conjunction with the Institute for Market Transformation (IMT) and Pacific Gas and Electric (PG&E) performed a retrocommissioning evaluation on the 30,244 SF Facility A long-term care facility in Clearlake, California. The retrocommissioning process has involved a coordinated effort between PECI and the building operating staff. Documents were provided for review, interviews and field investigations were conducted, and building systems were monitored and analyzed. This report presents the results of these efforts.

Retrocommissioning, or existing building commissioning, is an event in the life of a building that applies a systematic investigation process for improving and optimizing a building's operation and maintenance. It is typically an independent process that focuses on the building's energy using equipment such as the HVAC and other mechanical equipment, lighting equipment, and related controls. It may or may not emphasize bringing the building back to its original intended design specifications. In fact, via the process, the retrocommissioning team may find that the original specifications no longer apply. The process may result in recommendations for capital improvements, but its primary focus is to optimize the building systems via tune-up activities, improved operation and maintenance (O&M), and diagnostic testing. Details of the process used in this project are provided later in the report.

The retrocommissioning process involved obtaining documentation about the facility equipment and its operation and making a site visit for further review of operating parameters and conditions with facility staff. Selected systems were monitored with data loggers during the site visit to trend system operation. Eighteen findings overall were identified at the facility and eight recommendations were implemented. Energy savings estimates were made for the significant findings where sufficient data was available and project scope allowed. PECI then met with the Facility A management staff to discuss and review the findings. The management decided which measures to implement. PECI offered limited assistance during implementation. Facility A took full responsibility for contracting out the implementation or performing the work themselves. Facility A was also responsible for obtaining all necessary permits and approvals from the Office of State-wide Health Planning and Development (OSHPD) for implementing any findings or energy conservation measures recommended by PECI. All measures and findings are summarized below.

> <u>Operation and Maintenance Measures.</u> Nine operation and maintenance measures were identified. These measures were relatively simple and low in cost. In-house staff could implement many of them. Energy savings and implementation cost calculations were performed for all measures, but only seven of the nine measures were recommended by PECI for implementation because two of the measures were mutually exclusive with other measures. The owner chose to implement six of the seven recommended measures.

Five are completed and the sixth is currently in progress. The total estimated annual savings for these measures are 91,972 kWh, 433 gallons of propane, and $8,752 in annual utility costs. Estimates of energy savings were reduced by 15% to account for interactive effects between measures that reduce the savings from one measure when another is implemented. The total cost to implement these measures is estimated to be $12,985, which assumes that in-house staff purchase most materials and perform most labor. This results in a simple payback of 1.5 years.

Capital Improvement Measures. Three capital improvement measures were identified. These measures require significant capital outlay and outsourced contract work. Energy savings and implementation cost calculations were performed for all three measures but none were recommended by PECI for implementation and none were implemented.

Total Project Summary. The implemented measures result in total savings of 91,972 kWh, 433 gallons of propane, and a utility cost savings of $8,752. The calculated savings have been reduced by 15% to account for interactive effects between measures that reduce the savings from one measure when another is implemented. The total cost to implement all of the recommended measures is $12,985, resulting in an overall simple payback of 1.5 years. Refer to the following “Savings Summary Projection” table and “Energy Usage and Cost Index Comparison Projection” graph for details of the total project savings and costs.

Energy Management Improvement Opportunities. Two energy management improvement opportunities were identified. These measures enhance how the facility manages and tracks energy usage. The facility manager chose not to adopt either strategy at present, but may reconsider the measures in the future. Having a better understanding of energy use in the facility can help facility personnel identify savings opportunities. However, it is difficult to quantify potential savings that result from this increased understanding. The savings and implementation costs for these two measures presented in the “Savings Summary Projection” table are intended to illustrate potential “soft” savings but are not included in the total project summary.

Additional Findings. There were four additional findings that pertained to safety, comfort, indoor air quality, or other non-energy related issues. The owner implemented two of these. Some of the findings may have potential energy savings but were not calculated as they were beyond the scope of this study. All findings and the implementation plan for the facility are listed in the following “Finding and Implementation Plan Summary” table.

RECOMMENDATIONS, COST AND SAVINGS SUMMARY TABLES

SAVINGS SUMMARY PROJECTION

Facility A

EXISTING ENERGY USE

Building Area (Sq. Ft.)	Baseline Building	Existing Electric Energy (kWh/Yr)	Average Electric Demand (kW/Mo)	Existing Propane (Gallons Per Year)	Existing Annual Energy Cost	Existing EUI (BTU/Sq.Ft. per Year)	Existing ECI ($/Sq.Ft. per Year)
30,244	1999-2000 Total Energy Use	639,388	133	45,424	$103,072	200,580	$3.41

Note: Energy Use Index (EUI) and Energy Cost Index (ECI) are based on gross building square footage

OPERATION AND MAINTENANCE MEASURES

Recommendation Selection Owner	Recommendation Selection PECI	Finding Number	Energy Conservation Project Title	Electric Energy Saved (kWh/Yr)	Propane Saved (Gallons Per Year)	Annual Cost Savings	Implementation Cost	Simple Payback (Years)	% Reduction of Cost Savings
No	No	17	Install Programmable Thermostats*	1,136	215	$307	$0	0.0	0.3%
Yes	Yes	18	Adjust Vending Machine Operation	1,256	0	$110	$0	0.0	0.1%
No	No	14	Replace Twist Timers Controlling Heat Lamps*	2,303	(21)	$169	$134	0.7	0.2%
Yes	Yes	01	Enable Economizer Controls*	51,154	215	$4,679	$3,434	0.7	4.5%
Yes	Yes	03	Clean Return Air and Outside Air Filters	8,623	0	$828	$716	0.9	0.8%
No	Yes	12	Improve Walk-in Compressor Configuration	2,716	0	$260	$260	1.0	0.3%
Yes	Yes	04	Install Occupancy Sensors*	14,406	(128)	1,145	$1,684	1.5	1.1%
Yes	Yes	15	Tune-up Packaged HVAC Units	26,254	0	$2,521	$3,900	1.5	2.4%
Yes	Yes	10	Modify HVAC Supply and Exhaust to Minimize Building Negative Pressurization	6,510	423	$1,013	$3,250	3.2	1.0%
Total Recommendation Package as Selected by PECI				110,918	510	$10,556	$13,245	1.3	10.2%
	15%		Measure interaction of total package	94,281	433	$8,973	$13,245	1.5	8.7%
Total Recommendation Package as Selected by Owner				108,203	510	$10,296	$12,985	1.3	10.0%
	15%		Measure interaction of total package	91,972	433	$8,752	$12,985	1.5	8.5%

Note: Measures with an (*) in the title are mutually exclusive with other measures

CAPITAL IMPROVEMENT MEASURES

Recommendation Selection Owner	Recommendation Selection PECI	Finding Number	Energy Conservation Project Title	Electric Energy Saved (kWh/Yr)	Propane Saved (Gallons Per Year)	Annual Cost Savings	Implementation Cost	Simple Payback (Years)	% Reduction of Cost Savings
No	No	05	Install Automatic Flue Dampers	0	324	$298	$1,162	3.9	0.3%
No	No	09	Install Indirect Evaporative Cooling Module on Laundry HVAC Unit	4,775	0	$355	$3,444	9.7	0.3%
No	No	09	Install Indirect Evaporative Cooling Module on Kitchen HVAC Unit	7,317	0	$575	$6,027	10.5	0.6%
Total Recommendation Package as Selected by PECI				0	0	$0	$0	N/A	0.0%
	15%		Measure interaction of total package	0	0	$0	$0	N/A	0.0%
Total Recommendation Package as Selected by Owner				0	0	$0	$0	N/A	0.0%
	15%		Measure interaction of total package	0	0	$0	$0	N/A	0.0%

Note: Measures with an (*) in the title are mutually exclusive with other measures

TOTAL PROJECT SUMMARY (O&M and Capital Improvement Measures)

	Electric Energy Saved (kWh/Yr)	Propane Saved (Gallons Per Year)	Annual Cost Savings	Implementation Cost	Simple Payback (Years)	% Reduction of Cost Savings
Total Recommendation Package as Selected by PECI	110,918	510	$10,556	$13,245	1.3	10.2%
15% Weighted average measure interaction of total package	94,281	433	$8,973	$13,245	1.5	8.7%
Total Recommendation Package as Selected by Owner	108,203	510	$10,296	$12,985	1.3	10.0%
15% Weighted average measure interaction of total package	91,972	433	$8,752	$12,985	1.5	8.5%

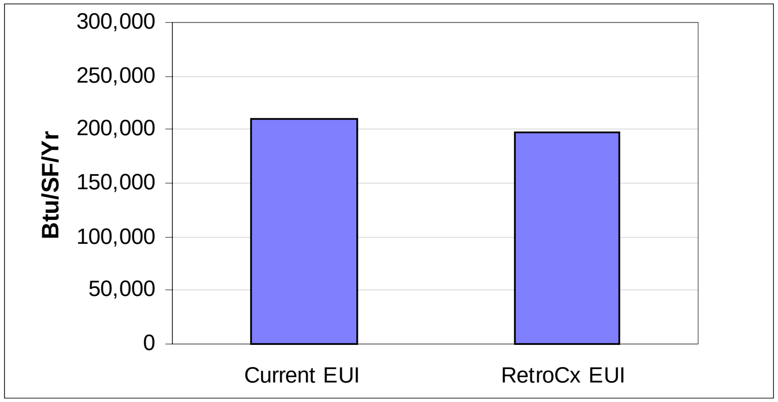
ENERGY MANAGEMENT IMPROVEMENT OPPORTUNITIES

Recommendation Selection Owner	Recommendation Selection PECI	Finding Number	Energy Conservation Project Title	Electric Energy Saved (kWh/Yr)	Propane Saved (Gallons Per Year)	Annual Cost Savings	Implementation Cost	Simple Payback (Years)	% Reduction of Cost Savings
No	Yes	16	Implement an Energy Awareness Program	12,788	910	$2,062	$650	0.3	2.0%
No	Yes	07	Implement a Utility Tracking Program	12,788	910	$2,062	$689	0.3	2.0%
Total Recommendation Package as Selected by PECI				25,576	1,819	$4,124	$1,339	0.3	4.0%
	15%		Measure interaction of total package	21,739	1,546	$3,505	$1,339	0.4	3.4%
Total Recommendation Package as Selected by Owner				0	0	$0	$0	N/A	0.0%
	15%		Measure interaction of total package	0	0	$0	$0	N/A	0.0%

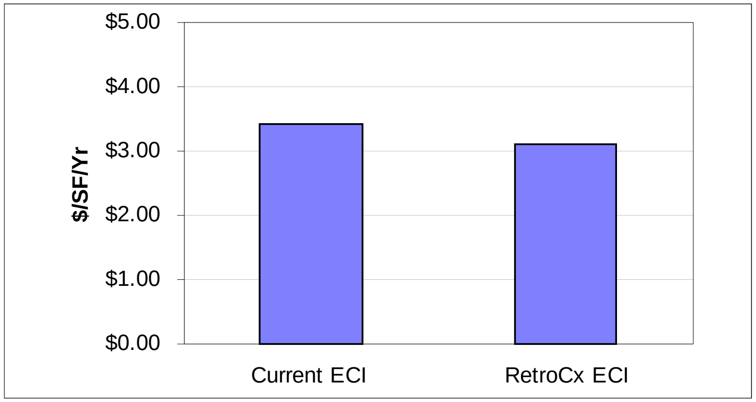
ENERGY USAGE AND COST INDEX COMPARISON PROJECTION
Total Recommended Package as Selected by Owner
Facility A

Current EUI	209,580	Btu/SF/Yr	Current ECI	$3.41	$/SF/Yr
RetroCx EUI	197,630	Btu/SF/Yr	RetroCx ECI	$3.11	$/SF/Yr
Percent Reduction	5.7%		Percent Reduction	8.7%	

Energy Usage Index Chart



Energy Cost Index Chart



Note: RetroCx ECI may include some non-energy savings.

FINDINGS AND IMPLEMENTATION PLAN SUMMARY TABLE

FINDING AND IMPLEMENTATION PLAN SUMMARY

Date:

ID	Finding	Recommendation Name[1]	Package[2]	Priority[3]	Status (C=Complete) (P=In Process) (F=$ Needed) (E= Need Eval.) (N=Not Doing)	4 Date Complete
01	Economizer controls could be optimized	Enable Economizer Controls*	1	1	P	July
02	Laundry area exhaust fan needs more frequent cleaning	Clean Exhaust Fan From Laundry Area	4	1	C	May
03	Return and outside air filters need more frequent changing	Clean Return Air and Outside Air Filters	1	1	C	May
04	Lights are on when spaces are unoccupied	Install Occupancy Sensors*	1	1	C	June
05	Automatic flue dampers are not used on hot water boilers	Install Automatic Flue Damper Controls on Hot Water Boiler Stacks	2	2	N	-
06	Hot water flowing from the cold water tap	Investigate Laundry Area Piping	4	1	C	May
07	Energy usage at the facility should be tracked	Implement a Utility Tracking Program	3	1	N	-
08	Kitchen MUA unit cools 100% outside air	Install Indirect Evaporative Cooling Module on Kitchen MUA Unit	2	3	N	-
09	Laundry MUA unit cools 100% outside air	Install Indirect Evaporative Cooling Module on Laundry MUA Unit	2	3	N	-
10	Building is negatively pressurized	Modify HVAC Supply and Exhaust to Minimize Building Negative Pressurizatior	1	1	C	June
11	Hot flue gases are exhausted from each hot water boiler	Install Boiler Stack Heat Recovery Units	4	3	N	-
12	Walk-in compressors have problems operating during summer months	Improve Walk-in Compressor Configuration	1	1	N	-
13	Residents complain of "drafty" conditions in the building	Reduce Drafty Conditions	4	1	N	-
14	Timer switches in two shower rooms do not work	Replace Timer Switches in the Shower Rooms.*	1	2	N	-
15	Packaged HVAC units should be tuned-up regularly	Tune-up Packaged HVAC Units	1	1	C	June
16	Formal energy awareness program should be put in place	Implement Energy Awareness Program	3	1	N	-
17	Packaged HVAC systems operate 24 hours per day	Install Programmable Thermostats*	1	2	N	-
18	Vending machines operate 24 hours per day	Adjust Vending Machine Operation	1	2	C	March

Notes:

1. Recommendations with an (*) in the title are mutually exclusive with other measures
2. Package identification: 1 - low cost measure, 2 - capital improvement measure, 3 - energy management improvement opportunity, 4 - non-energy saving measure
3. Priority ratings: 1 - high priority, 2 - Medium priority, 3 - low priority

INTRODUCTION

This report presents the results of the retrocommissioning study performed on the Facility A, a long-term care facility located in Clearlake, California. This retrocommissioning study was completed as part of an energy-efficiency market-transformation program funded by Pacific Gas & Electric and managed by the Institute for Market Transformation. Portland Energy Conservation Inc. (PECI) completed the retrocommissioning study.

Retrocommissioning is an excellent way to obtain energy savings through low cost improvements that optimize building systems so that they operate efficiently and effectively. On average around the country, commissioning existing buildings reduces a building's energy costs by 5% to 20%. The payback for investment in low cost opportunities typically ranges from a few months to two years. In addition, retrocommissioning can improve occupant comfort, reduce indoor air quality problems and reduce operations and maintenance costs.

The retrocommissioning process also identifies potential capital intensive improvements that can be made at the facility to further reduce energy usage and utility costs. Often, the savings associated with the low cost improvements can be used to "buy down" the implementation costs associated with the capital-intensive measures and make the overall package more economically viable.

METHODOLOGY

Commissioning of existing buildings, or "retrocommissioning" is a systematic process applied to existing buildings to identify and implement operational and maintenance (O&M) improvements and to ensure building system functionality. The primary goal of retrocommissioning is to optimize equipment and system operation so that they function together efficiently and effectively, although retrocommissioning may also result in recommended capital improvements. The basic process includes four fundamental procedures:

- Investigation and data collection
- Analysis of data
- Implementation of recommendations
- Verification of energy savings

Each of these procedures is discussed in detail below.

INVESTIGATION & DATA COLLECTION

The retrocommissioning process begins by collecting and evaluating data pertaining to facility equipment and current operation. The primary tasks for this project are outlined below.

Documentation Review

The investigative process consists of first obtaining as much building documentation as possible to allow PECI staff to become familiar with the building and its systems. Equipment lists, control program code, system schematic drawings and 12 months of utility billing data are generally requested. For the current project, only the billing history was available for review prior to the site visit.

Initial Site Assessment

The next step was to conduct an initial site assessment. The initial site assessment consisted of spending two days in the building during December interviewing staff, reviewing control code, inspecting equipment, performing a night walk-through, and performing an analysis of the site-gathered data. The assessment identified several significant findings, as well as areas where additional analysis is needed, including monitoring and testing.

Monitoring/Data Logging

For the current project, data loggers were used to monitor equipment usage since the facility does not have a central building automation system. Four-channel data loggers were used to monitor seven HVAC system temperatures and operation, light loggers were used to measure interior light levels in the employee lounge, shower rooms, day room, dining room, and kitchen areas, and occupancy loggers were used to monitor space occupancy in the employee lounge and dining room areas. This data was used to develop an operating profile for the facility.

Manual Testing

PECI developed test procedures for a few issues where monitoring could not provide adequate data to make a diagnosis – for example correct economizer operation. Economizer operation, or lack there of, was determined by reviewing control wiring diagrams, physical examination of the HVAC control wiring, manipulating space temperature setpoint, and visual observation of system operation. Both PECI and facility staff participated in conducting the tests.

ANALYSIS OF DATA

PECI analyzed the site interview data, written documentation, trend and monitored data and manual test data. From this work the findings were formalized, estimates for their associated energy savings and costs to implement were developed, and this report generated.

Baseline Calibration

The software analysis tool EZSim was used to develop a calibrated baseline of energy consumption for the facility. The EZSim tool is spreadsheet-based and ties together whole-building level billing data and a simplified engineering simulation model. The program accepts detailed input about the facility such as lighting and equipment loads, building construction, HVAC operation and control setpoints, general occupancy, equipment operating schedules, and local weather data. The tool is designed to quickly "tune" or calibrate the engineering model against the existing monthly energy usage. The program compares the calculated usage profile to the existing usage profile using least-squared curve fit analysis and the user adjusts building input data until the calculated profile matches the existing profile as closely as possible.

PECI attempts to achieve a least-squared value between 90% and 100%. This process helps to identify problems within the building – for example, if the energy efficiency ratio (EER) for an HVAC system has to be lowered significantly from nameplate in order to make the curves match, this would indicate that the equipment is currently operating less efficiently than originally designed.

To provide an additional level of confidence in the baseline provided by EZSim, PECI calculated all baseline loads by hand in an Excel spreadsheet, to within 5% of existing energy usage, and compared them to the values provided by EZSim. Then, we adjusted the inputs to the EZSim model until both methods were reasonably close. Once we were confident the building model had been calibrated as accurately as possible, an equipment end-use profile and overall building energy use index (EUI) was developed. The end-use data was then used to determine how effectively the building is using energy and the energy usage predicted by the calibrated building model was used as the baseline for the energy savings calculations.

Energy Use Analysis

As described above, the building calibration can be used to determine the breakdown of existing energy usage for various pieces of equipment in the facility (end-use profile) and the overall energy usage per square foot (energy use index). The end-use profile allows the user to see where all of the energy is being used in the facility and where the greatest opportunities for energy conservation exist. The energy use index can be used to compare energy usage in the existing facility against similar building types under similar weather conditions. For example, multiple health-care facilities in similar climates can be compared to each other and the ones with the highest energy use per square foot may have the greatest opportunities for energy conservation. Refer to the *Baseline Facility Description* section for detailed discussion of existing energy usage at the facility.

Trend Analysis

The monitored data gathered during the site visit was plotted and the graphs analyzed for any anomalies. Trend analysis can be used to identify and validate existing energy usage and potential conservation opportunities. For example the graphs entitled “Employee Lounge Lighting and Occupancy Profile” and “Shower Room Lighting Profile”, located in *Appendix C – Data Logging Trend Analysis*, verify that the lights are on in both the employee lounge and shower rooms throughout the night when the spaces are unoccupied. These areas would benefit greatly by installing occupancy sensors to control the lights. Most of the graphs indicate that the HVAC systems are operating adequately. Refer to *Appendix C – Data Logging Trend Analysis Figures* for all trend graphs of data collected during the site visit.

Retrocommissioning Database

All findings for the facility are recorded in a database. Information contained in the database includes a detailed description of each finding, a recommendation of how to fix the problem, a detailed implementation plan, estimate of utility savings and payback associated with the finding, and whether further investigation is necessary by either PECI or the owner.

Energy Savings Calculations

Energy savings can be calculated in a variety of ways. For simple measures, customized spreadsheets based on standard engineering practices and rules of thumb can be used to estimate savings. For the evaluation of more complex systems and to account for equipment interactions, a simulation program calculating energy usage on an hourly basis may be used. For this project, all calculations were performed using spreadsheets to minimize the time and cost of the retrocommissioning project. The calibrated building model was used to establish baseline energy consumption and information gathered during the site visit was used to validate the energy savings calculations.

Cost savings are generally calculated using the average unit cost per utility. For example, the average cost of electricity is calculated by dividing the total monthly cost, which includes demand costs and taxes, by the monthly consumption. However, some measures may not achieve any demand savings and therefore cannot use the average electricity cost described above. These measures must use the actual electrical energy cost based on the utility rate schedule, including all taxes. For this project the average electricity cost is calculated at $0.09604/kWh, the electrical energy cost from the utility rate schedule is $0.08761/kWh, and the average cost of propane is calculated at $0.917/gallon. All energy savings cost calculations use either the average cost of electricity, the electrical energy cost, and/or average cost of propane.

Project Costs

Implementation costs are estimated for each measure based on a variety of methods – i.e. contractor budgetary cost estimates, R.S. Means cost estimation guidebooks, manufacturer price lists, etc. The cost projections assume that facility staff will complete the installation or be available to assist a contractor with the implementation. Costs include contractor's industry-standard overhead and profit mark-up, engineering design and construction-phase service fees, contingencies, project management fees, and taxes. However, measurement and verification (M&V) costs, performance bond costs, and audit report costs have not been included, nor have costs associated with development of design documents and specifications that may be required to successfully engineer and implement some capital-intensive projects.

Measure Selection

Energy and cost savings and implementation costs were first determined for each measure on an individual basis. All measures were then entered into a summary spreadsheet and prioritized based on payback. PECI then recommended measures for installation at the facility. The spreadsheet totals the energy savings, cost savings, and implementation cost only for the recommended measures. There are various reasons for not recommending a measure. For example, in some cases, measures are mutually exclusive with others and a selection must be made. Energy and cost savings for all the recommended measures are de-rated by a factor of 15% to account for the interaction of measures with each other.

Once the owner has reviewed the project, the owner then selects which measures they want to implement and the summary spreadsheet automatically totals the energy savings, cost savings, and implementation cost only for these selected measures. Energy and cost savings for all the selected measures are also de-rated by a factor of 15% to account for the interaction of measures with each other.

Spreadsheets for all measures with energy saving calculations can be found in *Appendix D – Savings and Cost Estimates.*

IMPLEMENTATION OF RECOMMENDATIONS

Once the owner has selected the desired measures, the next step is to implement these measures. In the state of California, all projects must receive permits and approval from the Office of Statewide Health Planning and Development (OSHPD) agency before installation. The owner is responsible for contacting their OSHPD Area Compliance Officer, providing them with the necessary documentation, and awaiting approval before hiring any contractors to do the work. PECI could offer limited assistance to the owners in satisfying the criteria required by OSHPD. After approval has been granted, the owner should have facility personnel implement all the measures within their capability and hire outside contractors to install the rest.

VERIFICATION OF ENERGY SAVINGS

The measurement and verification techniques used will follow the IPMVP (International Performance Measurement and Verification Protocol) Option C – Whole Meter Approach. Total energy savings for the facility can be verified by comparing the post-retrocommissioning utility bills with bills for the same months before the study. The monthly usage figure will be normalized to account for variations in the length of billing cycles. Changes in weather or facility use will be taken into consideration in analyzing the graphs.

BASELINE FACILITY DESCRIPTION

GENERAL INFORMATION

Facility A is a long-term care facility located in Clearlake, California. The building was constructed in 1991 and includes approximately 30,244 square feet of resident rooms, common areas, kitchen area, laundry area, and office spaces. Basic construction for the facility is wood frame with stucco exterior and asphalt shingle roofing. The attic space is insulated with R-19 fiberglass batt insulation and it is assumed that the walls are insulated with R-11 fiberglass batt insulation. All windows are double pane.

General occupancy for the facility is 24 hours per day, 365 days per year. There are 99 residents and approximately 40 daytime facility staff members. The kitchen area operates between 5 a.m. and 8 p.m., 365 days per year and the laundry area is occupied between 5 a.m. and midnight, 365 days per year.

HVAC SYSTEMS

The facility is served by 15 packaged HVAC (heating, ventilating, and air conditioning) units, each with a supply fan, a direct expansion cooling coil, and a propane-fired hot air furnace. Details regarding the individual HVAC system components are outlined below.

Cooling

The cooling capacity for each of the 15 HVAC units range from 3 tons to 5 tons, for a total connected load of approximately 57 tons. The cooling efficiency (EER) for each unit has been estimated at 8.5 Btu/watt.

Heating

The heating capacity for each of the 15 HVAC furnace sections range from 74 kBtuh to 115 kBtuh, for a total connected load of approximately 1,520 kBtuh. The combustion efficiency for each unit has been estimated at 75%.

Fans

The supply fan horsepower for each of the 15 HVAC units range from 0.5 HP to 2.0 HP, for a total connected load of approximately 12.25 HP. The total amount of air delivered to the building is estimated at 22,700 CFM, based on the test and balance report performed in 1992. Two of the HVAC units, one serving the kitchen and the other serving the laundry area, are 100% outside air units. The remaining 13 HVAC units bring in approximately 5,140 CFM, or 27%, of outside air for ventilation.

There are seven general exhaust fans ranging from 1/6 HP to 3/4 HP, for a total connected load of approximately 2.83 HP. The kitchen grill exhaust fan is rated at 1.5 HP and the laundry area exhaust fan is rated at 1/2 HP. All of the exhaust fans operate 24 hours per day, except the kitchen grill exhaust which operates 15 hours per day and the laundry area exhaust which operates 18 hours per day, 365 days per year.

HVAC Controls

All 15 HVAC units are controlled by thermostats located throughout the facility. Heating and cooling setpoints for the 13 HVAC units serving the resident and common areas are 73°F and 75°F, respectively and operate 24 hours per day, 365 days per year. A couple of the thermostats serving these areas have the capability of programming a night set-back or set-up sequence, but this feature is currently not used since most areas are continually occupied. It was discovered during the site visit that these 13 HVAC units have economizer control capability, however the current thermostats do not allow this control strategy to be used.

The kitchen HVAC unit heating and cooling setpoints are approximately 68°F and 70°F, respectively and operate 15 hours per day, 365 days per year. The laundry area HVAC unit heating and cooling setpoints are approximately 68°F and 70°F, respectively and operate 18 hours per day, 365 days per year.

ELECTRICAL SYSTEMS

Interior Lighting

The interior lighting for the facility includes fluorescent, incandescent, and compact fluorescent fixtures. A majority of the fixtures have T8 lamps with electronic ballasts. Based on a lighting count from the electrical plans and building square footage, the facility has an average lighting load of 0.9 watts per square foot.

Exterior Lighting

The exterior lighting for the facility includes high intensity discharge area light fixtures and compact fluorescent perimeter light fixtures. There are 14 fixtures around the facility estimated to contain 150-watt high-pressure sodium lamps and 10 perimeter fixtures, estimated to contain 26-watt compact fluorescent lamps. The total exterior lighting load is estimated at 3.0 kW. All exterior lights are controlled by photocells.

Lighting Controls

All interior lights are controlled by toggle switches and all exterior lights are controlled by photocells.

Miscellaneous Electrical Systems

Miscellaneous electrical equipment at the facility includes dishwasher booster, kitchen cooking equipment, kitchen refrigeration units, laundry washing machines, dryer motors, domestic hot water circulating pumps, HVAC furnace electric load, and general plug loads. The following table lists equipment application and estimated rated power loads.

Miscellaneous Electrical Equipment

Application	Rated Load
Dishwasher booster	8.2 kW
Kitchen cooking equipment	2.3 kW
Refrigeration units	7.8 kW
Laundry washing machines	13.5 kW
Laundry dryer motors	5.4 kW
Domestic hot water circulating pumps	0.2 kW
HVAC furnace electric load	0.6 kW
General plug loads	6.4 kW

FOSSIL FUEL SYSTEMS

Domestic Hot Water

There are two propane-fired hot water boilers that provide 120°F domestic hot water to the facility and kitchen. These boilers are rated at 399 kBtuh input with a 598 gallon per hour recovery at 60°F temperature rise. The domestic hot water system also includes a 534 gallon storage tank and a thermostatically controlled mixing valve to ensure domestic hot water temperature does not exceed 120°F.

There is one propane-fired hot water boiler that provides 160°F hot water to the laundry area. This boiler is rated at 670 kBtuh input with a 603 gallon per hour recovery at 100°F temperature rise. The laundry system also includes a 277 gallon storage tank.

Miscellaneous Fossil Fuel Systems

Miscellaneous fossil fuel equipment at the facility includes kitchen cooking equipment and laundry dryers. The following table lists equipment application and estimated rated loads.

Miscellaneous Fossil Fuel Equipment

Application	Rated Load
Kitchen cooking equipment	82.5 kBtuh
Laundry dryers	165.0 kBtuh

Operations & Maintenance Procedures

Currently, in-house personnel perform most equipment operation and maintenance. This includes adjusting thermostats, replacing light bulbs, replacing filters in packaged HVAC units, and general repairs. Outside contractors are used if facility staff is unable to remedy the situation or to perform more complex maintenance procedures.

Energy Utilization

The Facility A uses electricity and propane to meet its energy needs. The facility used 639,388 kWh of electricity ($61,406) and 45,424 gallons of propane ($41,666) for the 12 month period between December 1999 and November 2000. This corresponds to an energy use index (EUI) of 209,580 BTU/sq. ft./year and an energy cost index of $3.41/sq. ft./year. Energy consumption and utilization for the facility is tabulated below.

Facility Utility History
Facility A

Gross Floor Area: 30,244 SF

Read Date	Electrical				Propane		
	(KWH)	(KW)	($)	(AVG. $/KWH)	(Gallons)	($)	(AVG. $/Gal.)
Dec-99	43,948	134	$3,911	$0.08900	6,025	$4,211	$0.70
Jan-00	42,120	92	$3,293	$0.07817	5,840	$4,732	$0.81
Feb-00	45,240	90	$3,517	$0.07773	5,181	$5,112	$0.99
Mar-00	42,000	86	$3,274	$0.07795	4,978	$4,775	$0.96
Apr-00	47,520	126	$3,742	$0.07874	3,353	$3,128	$0.93
May-00	45,480	125	$4,161	$0.09149	2,808	$2,450	$0.87
Jun-00	63,480	155	$6,773	$0.10669	2,374	$1,957	$0.82
Jul-00	70,680	158	$7,435	$0.10519	2,038	$1,669	$0.82
Aug-00	73,680	158	$7,702	$0.10454	2,018	$1,764	$0.87
Sep-00	62,400	152	$6,656	$0.10667	2,277	$2,374	$1.04
Oct-00	58,080	161	$6,332	$0.10901	3,268	$3,564	$1.09
Nov-00	44,760	161	$4,611	$0.10302	5,264	$5,931	$1.13
Totals	639,388	1,598	$61,406	N/A	45,424	$41,666	N/A
Average	53,282	133	$5,117	$0.09604	3,785	$3,472	$0.917

Facility Energy Use Calculations
Facility A

Read Date	Millions of BTU's Electric	Propane	Combined	ECI ($/Sq. Ft.)	EUI (BTU/Sq.Ft.)
Dec-99	149.99	551.29	701.28	$0.269	23,187
Jan-00	143.76	534.36	678.12	$0.265	22,421
Feb-00	154.40	474.06	628.47	$0.285	20,780
Mar-00	143.35	455.49	598.83	$0.266	19,800
Apr-00	162.19	306.80	468.99	$0.227	15,507
May-00	155.22	256.93	412.16	$0.219	13,628
Jun-00	216.66	217.22	433.88	$0.289	14,346
Jul-00	241.23	186.48	427.71	$0.301	14,142
Aug-00	251.47	184.65	436.12	$0.313	14,420
Sep-00	212.97	208.35	421.32	$0.299	13,931
Oct-00	198.23	299.02	497.25	$0.327	16,441
Nov-00	152.77	481.66	634.42	$0.349	20,977
Totals	2182.23	4156.30	6338.53	$3.408	209,580
Average	181.85	346.36	528.21	$0.284	17,465

The average cost of electricity is calculated to be $0.09604/kWh, which includes demand costs and taxes. Several of the measures, however, do not claim any demand savings and therefore cannot use the average electricity cost described above. The actual electrical energy cost has been calculated to be $0.08761/kWh, which is based on the utility rate schedule and includes all taxes. The average cost of propane is calculated to be $0.917/gallon, which includes all taxes. All energy savings cost calculations use either the average cost of electricity, the electrical energy cost, and/or average cost of propane.

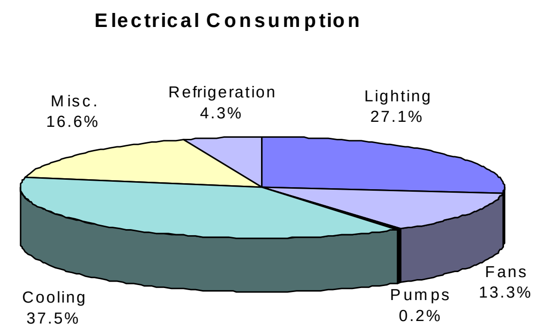
The electrical energy and propane usage profiles for the facility appear to be normal. The electrical energy consumption for the facility follows a typical “bell-shaped” pattern, with a rather constant load and mechanical cooling occurring mostly during the summer months. The electrical demand profile indicates that the base load is about 90 kW, with some cooling occurring during spring and fall months, and then full cooling during the summer months. The propane consumption profile also follows a classic “bell-shaped” curve, with peak consumption during winter months. Refer to the “Monthly Electric Consumption and Demand” and “Facility Energy Use Profile” graphs located in *Appendix B – Utility History Analysis Figures*.

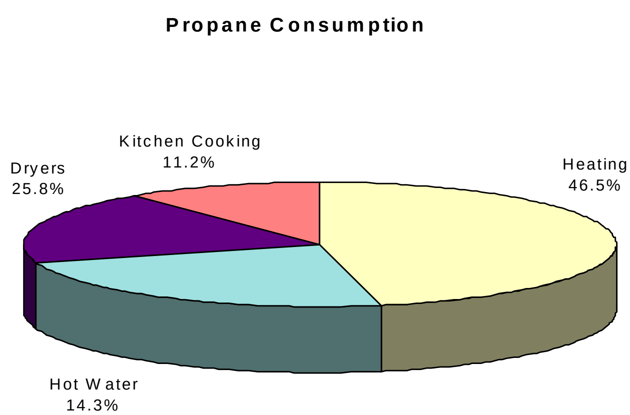
BASELINE ADJUSTMENT

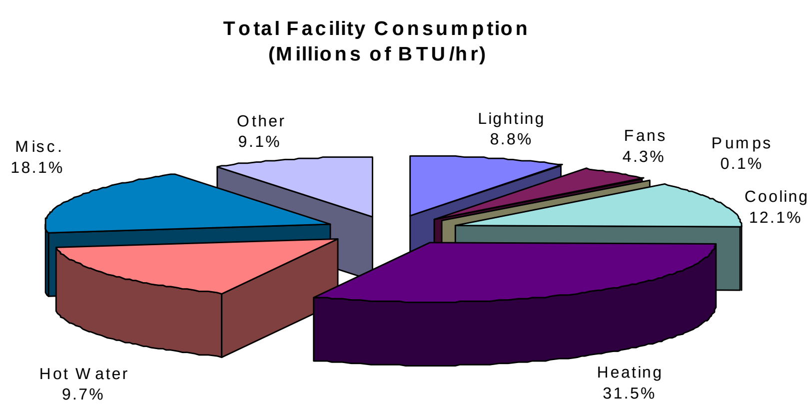
Occasionally retrocommissioning findings and recommendations may require that systems be brought up to present code requirements, which can increase energy consumption in some cases. Existing facilities that met all building codes at the time the facility was constructed are not required to meet current codes. However if major modifications are made or equipment is replaced, compliance with the current codes must be satisfied. For example installing a new HVAC system will require that the new unit meet current minimum outdoor air requirements. Depending on what the codes were when the facility was constructed, the new minimum outside air requirements could be significantly higher and result in increased energy consumption. In this situation, the existing energy consumption baseline may be adjusted to reflect the existing equipment with the increased energy consumption due to increased outside air. This is done to accurately evaluate the savings associated with the increase in energy efficiency of the new unit, while accounting for the energy penalty associated with meeting current outside air requirements.

END-USE BREAKDOWN

The following graphs illustrate the energy consumption by various pieces of equipment at the facility.







FINDINGS, RECOMMENDATIONS & IMPLEMENTATION

DETAILED FINDINGS

01 Economizer controls could be optimized

Finding Description

It was discovered during the site visit that the economizer controls on all of the rooftop packaged HVAC units were never connected and enabled. It was also noticed that the facility does not have the proper kind of thermostat to allow the economizers to operate.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	No	Indoor Air Quality -	Yes
Demand Savings -	No	Comfort -	Yes	Maintenance and reliability -	Yes

Recommendation

It is recommended that 2-stage thermostats be installed throughout the facility and connected so that the economizers will function as the first stage of cooling. Additional savings will occur because the new thermostats will have setback/setup capability for unoccupied periods and the HVAC systems serving the Administration area and Day Room could lower and raise their heating and cooling setpoints, respectively, during unoccupied hours. This measure will be mutually exclusive with the Measure 17 - Install Programmable Thermostats. PG&E will rebate $12 per programmable thermostat installed.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	51,154	kWh/yr	Estimated Annual Cost Savings -	$4,679
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$3,590
Estimated Annual Propane Savings -	215	Gallons/yr	Simple Payback (yrs) -	0.8

Implementation Plan

The new thermostats will be installed and replace the existing thermostats. All wires must be connected to the thermostat according to installation instructions to ensure that the economizer cycle will operate as the 1st stage of cooling and the compressor as the 2nd stage of cooling.

At each HVAC unit, the thermostat signal wires must be connected to the appropriate location on the control circuit board to ensure the economizer acts as the 1st stage of cooling and the compressor will be the 2nd stage of cooling. Each system must be tested to ensure the economizers operate correctly.

All work will be performed by an HVAC contractor.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of the Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Work in Progress
Action Taken –Thermostats will be replaced with 2-stage thermostats and connected to economizer controls.
Date Improvement Completed – July '01

02 Laundry area exhaust fan needs more frequent cleaning

Finding Description

It was observed during the site visit that the screen on the exhaust fan from the laundry area was plugged with lint. This could reduce the amount of air removed from the laundry area, as well as cause the fan to work harder than necessary. The issue affects comfort and indoor air quality, however there may be some negligible energy savings associated as well.

General Finding Impacts

Energy Savings -	No	Propane Savings -	No	Indoor Air Quality -	Yes
Demand Savings -	No	Comfort -	Yes	Maintenance and reliability -	Yes

Recommendation

It is recommended that the screen on the exhaust fan be cleaned on a regular basis.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	N/A
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	N/A
Estimated Annual Propane Savings -	0 Gallons/yr	Simple Payback (yrs) -	N/A

Implementation Plan

Facility personnel should turn off the exhaust fan, remove the shroud, and clean the screen when other rooftop maintenance is occurring. The screen should be checked at least once per month since lint can build up quickly.

In-house staff can perform all work.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	Yes
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	No
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	N/A
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Measure implemented
Action Taken- Screen cleaned during rooftop maintenance.
Date Improvement Completed – May ‘01

03 Return and outside air filters need more frequent changing

Finding Description

It was noticed during the site visit that the return air and outside air filters on all rooftop packaged HVAC units were very dirty. This condition can cause the supply fan to work harder due to the excess pressure drop across the filters, can reduce the amount of air delivered by the system, and cause comfort and indoor air quality problems.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	No	Indoor Air Quality -	Yes
Demand Savings -	No	Comfort -	Yes	Maintenance and reliability -	Yes

Recommendation
It is recommended that the return air and outside air filter be cleaned on a regular basis. For our calculations, we have assumed the dirty filters add 0.2 in. wc. Of static pressure to each supply fan.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	8,623	kWh/yr	Estimated Annual Cost Savings -	$828
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$716
Estimated Annual Propane Savings -	0	Gallons/yr	Simple Payback (yrs) -	0.9

Implementation Plan
Facility personnel should replace the return air filters with new filters when the supply fan filters are changed and clean the outside air filters on a regular basis.

In-house staff can perform all work.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	Yes
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	No
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action
Action Code – Measure implemented
Action Taken – Facility personnel replaced the return air filters with new filters. They also replaced existing washable filters for the supply fan with disposable, lower resistance filters. The reusable filters will be pressure washed and replaced.
Date Improvement Completed – May '01

04 Lights are on when spaces are unoccupied

Finding Description
It was noticed during the site visit that several areas throughout the facility could benefit by using occupancy sensors to automatically control lighting. Occupancy patterns, as well as lighting usage, in various areas were monitored by both physical observation and using data logging equipment.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	No	Indoor Air Quality -	No
Demand Savings -	No	Comfort -	No	Maintenance and reliability -	Yes

Recommendation
The recommendation is to install occupancy sensors in the following areas:
1. All shower rooms
2. Employee lounge
3. Administration office area

This measure is mutually exclusive with Measure 14 - Replace Twist Timers Controlling Heat Lamps. PG&E will rebate $22 per occupancy sensor installed.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	14,406 kWh/yr		Estimated Annual Cost Savings -	$1,145
Estimated Peak Demand Savings -	0 kW		Estimated Implementation Cost -	$1,816
Estimated Annual Propane Savings -	-128 Gallons/yr		Simple Payback (yrs) -	1.6

Implementation Plan

The administration office and employee lounge can be retrofitted with passive infrared wall switches that will replace the existing toggle switches. The shower rooms should use a ceiling-mounted ultrasonic occupancy sensor to ensure the lights stay on when the room is occupied. The ceiling-mounted sensor will need additional wiring and conduit to connect the sensor to the lighting circuit.

An electrical contractor should perform all work.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Night-time site inspection

Owner Action

Action Code – Measure Implemented
Action Taken – Occupancy sensors were installed in the dining rooms and the lounges.
Date Improvement Completed – June ‘01

05 Automatic flue dampers are not used on hot water boilers

Finding Description

It was noticed that the hot water boilers that provided both heating and domestic hot water for the facilities did not have automatic flue dampers. Flue dampers will automatically close when the unit shuts off to reduce heat loss from the boiler up through the stack. The dampers would automatically open back up when the unit turns back on.

General Finding Impacts

Energy Savings -	No	Propane Savings -	Yes	Indoor Air Quality -	No
Demand Savings -	No	Comfort -	No	Maintenance and reliability -	Yes

Recommendation

The recommendation is to install automatic flue dampers on the three hot water boilers at the facility.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr		Estimated Annual Cost Savings -	$297
Estimated Peak Demand Savings -	0 kW		Estimated Implementation Cost -	$1,162
Estimated Annual Propane Savings -	324 Gallons/yr		Simple Payback (yrs) -	3.9

Implementation Plan

Automatic flue dampers should be installed in the exhaust flue from each hot water boiler. Installation will require adapting the flue damper assembly into the stack, wiring power to the damper motor, and connecting the damper controls and interlocks.

A mechanical contractor should perform all work.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Not Implemented
Action Taken – None
Date Improvement Completed – NA

06 Hot water flowing from the cold water tap

Finding Description

It was noticed during the site visit that hot water occasionally flows from the cold water tap at the sink in the laundry area. The water temperature from the tap was measured to be 116°F using temperature probes when the incident occurred. The piping arrangement in the laundry area was traced to try to determine the cause of the anomaly, and preliminary indications are that the piping layout serving this area is incorrect, allowing hot water to be drawn into the pipe that should provide cold water.

The issue concerns safety and comfort more than energy savings. Since very hot water can flow from the cold tap, facility personnel are at risk of burning themselves without warning.

This "cold" water line also serves each clothes washer. Energy savings may occur if the washers have been using warm or hot water, when in fact they were set to operate on a cold water cycle.

General Finding Impacts

Energy Savings -	No	Propane Savings -	No	Indoor Air Quality -	No
Demand Savings -	No	Comfort -	Yes	Maintenance and reliability -	No

Recommendation

The piping arrangement serving the laundry area should be investigated in greater detail, and re-piped as necessary.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	Not calculated
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	Not calculated
Estimated Annual Propane Savings -	0 Gallons/yr	Simple Payback (yrs) -	Not calculated

Implementation Plan

Further investigation is needed to accurately identify exactly what is going on with the water piping system and how the situation can be fixed. It appears that the cold water line leading to the washers and sink should be re-piped to the upstream side of the first check valve on the cold water line supplying the laundry hot water system.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	Yes	Savings Calculation Method -	N/A
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Measure Implemented
Action Taken – Facility Staff re-piped the water supply line. (Facilities manager is a licensed pipe welder.)
Date Improvement Completed - May

07 Energy usage at the facility should be tracked

Finding Description

Currently the facility does not record and track utility bill data.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	Yes	Indoor Air Quality -	No
Demand Savings -	Yes	Comfort -	No	Maintenance and reliability -	Yes

Recommendation

The recommendation is made to implement a utility tracking program. There are several commercially available software programs that can be used to track utility consumption and costs. These programs can assist facility operators in benchmarking energy usage, identifying consumption anomalies, as well as help better manage all utilities at the facility. The California Energy Commission offers a free downloadable handbook entitled *Energy Accounting: A Key Tool in Managing Energy Costs*, that includes tips on choosing software as well as general advice on tracking utility bills. The handbook can be found at the following website – http://www.energy.ca.gov/reports/efficiency_handbooks/index.html. For our calculations, we have estimated that 2% energy savings can be achieved by benchmarking and tracking utility usage at the facility.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	12,788	kWh/yr	Estimated Annual Cost Savings -	$2,062
Estimated Peak Demand Savings -	5	kW	Estimated Implementation Cost -	$689
Estimated Annual Propane Savings -	910	Gallons/yr	Simple Payback (yrs) -	0.3

Implementation Plan

There are several utility tracking programs available on the market, ranging from $250 up to $5,000 or more depending on the types of features offered. We have assumed that a reasonable program can be purchased for $500, before mark-up, contingency, and taxes.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	Yes
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	No
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Interviews with facility staff

Owner Action

Action Code –To be reconsidered later
Action Taken – Facilities manager did not want to devote the time and resources to this project at this time. She observed that they might implement a tracking program after they have taken care of the other issues.
Date Improvement Completed - NA

08 Kitchen MUA unit cools 100% outside air

Finding Description

The kitchen make-up air-handling unit (MUA) currently brings in 100% outside air into the kitchen to compensate for the quantity of air exhausted through the grill and dishwasher exhaust systems. This air is heated, cooled, or brought in "as is" depending on temperature conditions in the kitchen. Due to the climatic conditions where the facility is located, the MUA unit primarily cools the air entering the kitchen.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	No	Indoor Air Quality -	Yes
Demand Savings -	No	Comfort -	Yes	Maintenance and reliability -	Yes

Recommendation

The recommendation is made to install an indirect evaporative cooling module into the MUA unit to pre-cool the outside air before entering the kitchen. Currently, the outside air is mechanically cooled if the outside air temperature is higher than space temperature setpoint. An indirect evaporative cooling module will use water to cool the air down before it enters the MUA unit itself, which will result in less mechanical cooling of the air before it enters the kitchen.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	7,317	kWh/yr	Estimated Annual Cost Savings -	$578
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$6,027
Estimated Annual Propane Savings -	0	Gallons/yr	Simple Payback (yrs) -	10.4

Implementation Plan

An indirect evaporative module can be mounted on the in-take to the Kitchen HVAC unit. Installation would include a roof curb to support the evaporative module, all necessary electrical and water connections, and system controls. Water connection can be made to the city water lines running through the attic space and penetrating a new water line through the roof. New electrical wiring and conduit will be needed from the existing electrical panel to the new unit.

Mechanical and electrical contractors should perform all work.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	Yes	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Not Implemented
Action Taken – None
Date Improvement Completed - NA

09 Laundry MUA unit cools 100% outside air

Finding Description

The laundry make-up air-handling unit (MUA) currently brings in 100% outside air into the laundry area to compensate for the quantity of air exhausted through the dryers and exhaust fan. This air is heated, cooled, or brought in "as is" depending on temperature conditions in the laundry area. Due to the climatic conditions where the facility is located and internal gains in the space, the MUA unit primarily cools the air entering the laundry area.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	No	Indoor Air Quality -	Yes
Demand Savings -	No	Comfort -	Yes	Maintenance and reliability -	Yes

Recommendation

The recommendation is made to install an indirect evaporative cooling module into the MUA unit to pre-cool the outside air before entering the laundry area. Currently, the outside air is mechanically cooled if the outside air temperature is higher than space temperature setpoint. An indirect evaporative cooling module will use water to cool the air down before it enters the MUA unit itself, which will result in less mechanical cooling of the air before it enters the laundry area.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	4,775	kWh/yr	Estimated Annual Cost Savings -	$355
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$3,444
Estimated Annual Propane Savings -	0	Gallons/yr	Simple Payback (yrs) -	9.7

Implementation Plan

An indirect evaporative module can be mounted on the in-take to the Laundry HVAC unit. Installation would include a roof curb to support the evaporative module, all necessary electrical and water connections, and system controls. Water connection can be made to the city water lines running through the attic space and penetrating a new water line through the roof. New electrical wiring and conduit will be needed from the existing electrical panel to the new unit.

Mechanical and electrical contractors should perform all work.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	Yes	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Not Implemented
Action Taken - None
Date Improvement Completed - NA

10 Building is negatively pressurized

Finding Description

It was noticed during the site visit that the building is negatively pressurized. This means that more air is exhausted from the building than is being brought in, and this condition can create comfort and indoor air quality problems. Energy savings may occur but the issue is related more to comfort and indoor air quality.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	Yes	Indoor Air Quality -	Yes
Demand Savings -	Yes	Comfort -	Yes	Maintenance and reliability -	No

Recommendation

The recommendation is made to balance the air system so that the building maintains a slightly positive pressurization. This could be as simple as an air balance by a test and balance contractor or making modifications to both exhaust and supply fan speeds to equalize air flow. For our calculations, we have estimated that 2% energy savings can be achieved on the heating, cooling, and fan usage for all HVAC systems.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	6,510	kWh/yr	Estimated Annual Cost Savings -	$1,013
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$3,250
Estimated Annual Propane Savings -	423	Gallons/yr	Simple Payback (yrs) -	3.2

Implementation Plan

A test and balance was performed on all HVAC systems throughout the facility. The cost associated with a test and balance on the HVAC systems can range between $2,000 to $3,000. We have assumed that a TAB will cost $2,500, before mark-up, contingency, and taxes.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	Yes	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Measure Implemented

Action Taken – A contractor modified the HVAC supply and exhaust fan speeds to balance the building pressure.

Date Improvement Completed – June '01

11 Hot flue gases are exhausted from each hot water boiler

Finding Description

Currently, the flue gases from each hot water boiler are exhausted at about 210 °F.

General Finding Impacts

Energy Savings -	No	Propane Savings -	Yes	Indoor Air Quality -	No
Demand Savings -	No	Comfort -	No	Maintenance and reliability -	Yes

Recommendation

The initial recommendation was to install heat recovery units in each boiler stack in order to recover heat from the flue gases. Maximum energy savings would be achieved if the flue gases are lowered below the condensing temperature but this would require that stainless steel heat exchangers be used to prevent corrosion of the heat exchangers. Due to the very high cost of these exchangers, the energy savings would not justify the cost and have not been calculated.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0	kWh/yr	Estimated Annual Cost Savings -	Not calculated
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	Not calculated
Estimated Annual Propane Savings -	0	Gallons/yr	Simple Payback (yrs) -	Not calculated

Implementation Plan

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	Yes	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Not calculated
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Not Implemented
Action Taken - None
Date Improvement Completed - NA

12 Walk-in compressors have problems operating during summer months

Finding Description

During the site visit, facility staff stated that the walk-in freezer and cooler compressors experience capacity problems during the summer months and occasionally has trouble maintaining walk-in temperature setpoints. Both walk-in freezer and cooler compressors are located in an enclosed space, open only on one end. Due to poor air circulation, it is conceivable that the heat rejected from both compressor units raises the ambient air temperature around the condensers by 10°F or more. This increase in air temperature would cause the compressors to operate at higher condensing pressures. The elevated condensing pressure would waste energy under mild outside air temperatures and could cause the compressors to be unable to generate enough capacity when outside air temperatures got very high during the summer months (as indicated by the facility staff).

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	No	Indoor Air Quality -	No
Demand Savings -	No	Comfort -	No	Maintenance and reliability -	Yes

Recommendation

The recommendation is made to modify the existing configuration of the walk-in freezer and cooler compressor units. Reducing condensing temperature (pressure) can achieve compressor energy savings of 1.0% per 1°F. For our calculations, we will conservatively assume the average condensing temperature could be reduced by 8°F on both (1.0% x 8°F), for a total estimate of 8% energy savings.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	2,716	kWh/yr	Estimated Annual Cost Savings -	$261
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$260
Estimated Annual Propane Savings -	0	Gallons/yr	Simple Payback (yrs) -	1.0

Implementation Plan

Implementation of this measure could take various forms. Simple low cost, no-cost solutions could include ducting air directly to each condenser or improving overall air circulation in the alcove. More costly solutions would entail relocation of both compressors or converting them to water-cooled units. Further investigation is needed to accurately identify how the situation can be fixed. For our calculations, we have estimated that a low cost, no-cost solution could be found for approximately $260.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	Yes
Further Study or Engineering Needed Outside Current Scope -	Yes	Significant Capital Expenditure to Implement -	No
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Interviews with facility staff

Owner Action
Action Code – Not Implemented
Action Taken – Owner continues to use a mister to keep the area cool.
Date Improvement Completed - NA

13 Residents note "drafty" conditions in the building

Finding Description
Facility staff stated that some residents have noted "drafty" conditions. During the site visit, the audit team observed that many of the diffusers used throughout the facility tend to blow a lot of air directly downward. This condition can create a "drafty" condition because the air is blowing directly against the body and the residents feel cold. The issue mainly deals with comfort, but may cause increased energy usage if facility staff turn up the thermostat to compensate for the "cold draft". Other causes could include negative building pressurization (identified in Finding 10) or duct leakage.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	Yes	Indoor Air Quality -	No
Demand Savings -	No	Comfort -	Yes	Maintenance and reliability -	Yes

Recommendation
Further investigation is needed to determine exactly what needs to be done to fix the problem. Various options are outlined below.

1. Install different diffusers and distribute the air more effectively within the space.
2. Check air balance throughout the building and adjust airflow into each space as necessary.
3. Modify existing diffusers to minimize downward airflow pattern.
4. Caulk cracks, install weather stripping, and fix duct leaks

Energy savings may occur if the space temperature setpoint can be lowered, but an estimate of savings has not been made at this time.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	Not calculated
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	Not calculated
Estimated Annual Propane Savings -	0 Gallons/yr	Simple Payback (yrs) -	Not calculated

Implementation Plan
Further investigation is needed to accurately identify exactly how the situation can be fixed.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	Yes	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	N/A
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Interviews with facility staff

Owner Action
Action Code – Not Implemented
Action Taken - None
Date Improvement Completed - NA

14 Timer switches in two shower rooms do not work

Finding Description
It was noticed during the site visit that the timer switches used to control operation of the heat lamps in two of the shower rooms were not operating correctly. The timing mechanism on these switches was not working and the lights never turned off automatically.

General Finding Impacts
Energy Savings -	Yes	Propane Savings -	No	Indoor Air Quality -	No
Demand Savings -	No	Comfort -	No	Maintenance and reliability -	Yes

Recommendation
The recommendation is made to replace all of the timer switches used in each shower room to control operation of the heat lamps. Even though there are four shower rooms and only two had bad switches, we recommend replacing all of the switches because the others are bound to fail sooner or later. This measure is mutually exclusive with Measure 04 - Install Occupancy Sensors.

Estimated Economic Impact Summary
Estimated Annual Energy Savings -	2,383	kWh/yr	Estimated Annual Cost Savings -	$190
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$134
Estimated Annual Propane Savings -	-21	Gallons/yr	Simple Payback (yrs) -	0.7

Implementation Plan
Install new 30 minute twist timers in each shower room to control heat lamps. In-house staff can perform all work.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	Yes
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	No
Further Investigation/Testing Required Of the Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action
Action Code – Not Implemented
Action Taken – None; measure is mutually exclusive with “Install occupancy sensors”
Date Improvement Completed - NA

15 Packaged HVAC units should be tuned-up regularly

Finding Description
A tune-up on each packaged HVAC system should occur on a regular basis. A system tune-up includes checking for correct refrigerant charge, proper adjustment of thermal expansion valve, and maintaining the lowest possible condensing pressure. Recent studies indicate that up to 70% of all packaged HVAC system

are improperly charged or have other system deficiencies, which results in reduced efficiency and system capacity, and energy savings associated with an overall system tune-ups can be 5% or greater. Reducing condensing temperature can achieve compressor energy savings of 1.0% per 1°F. Often the minimum condensing temperature is set very high, which wastes energy when the compressor operates during periods of low outside ambient temperature.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	No	Indoor Air Quality -	No
Demand Savings -	Yes	Comfort -	No	Maintenance and reliability -	Yes

Recommendation

The recommendation is made to have all packaged HVAC units tuned on a regular basis. For our calculations, we will assume that 60% of the packaged HVAC systems at the facility may be improperly charged (60% x 5%) and the average condensing temperature could be reduced by 8°F on all the units (100% x 1.0% x 8°F), for a total estimate of 11% energy savings.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	26,254	kWh/yr	Estimated Annual Cost Savings -	$2,521
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$3,900
Estimated Annual Propane Savings -	0	Gallons/yr	Simple Payback (yrs) -	1.5

Implementation Plan

We recommend that a mechanical contractor perform rigorous tune-ups on all packaged HVAC systems at the facility and reduce minimum condensing temperature setpoints. We have assumed that the cost for a basic system tune-up will be $200 per system.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	No
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	Yes
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Case studies and industry

Owner Action

Action Code – Measure Implemented
Action Taken – All of the packaged HVAC systems received a rigorous tune-up.
Date Improvement Completed – June ‘01

16 Formal energy awareness program should be put in place

Finding Description

The facility does not have a formal energy awareness program in place.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	Yes	Indoor Air Quality -	No
Demand Savings -	Yes	Comfort -	No	Maintenance and reliability -	No

Recommendation

The recommendation is made to implement a formal energy awareness program. A formal program could include such things as education for facility staff on conservation opportunities and behavior modification, as well as possibly providing incentives to facility staff to come up with innovative ways to conserve energy on a daily basis. Education could include workshops or something as simple as stickers on light switches and intermittently used equipment to remind the users to turn lights out when not in use. Another opportunity would be to get everyone to turn their computers and terminals off at night, or set the internal "sleep" command to do it automatically if the computers have this capability. Contests could be held with nominal "prizes" awarded to those who come up with innovative ideas about how to save energy. This gets everyone involved in conservation and makes it fun rather than an inconvenience. For our calculations, we have estimated that 2% energy savings could be achieved by implementing an energy awareness program at the facility.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	12,788	kWh/yr	Estimated Annual Cost Savings -	$2,062
Estimated Peak Demand Savings -	0	kW	Estimated Implementation Cost -	$0
Estimated Annual Propane Savings -	910	Gallons/yr	Simple Payback (yrs) -	0.0

Implementation Plan

We have assumed that training and workshop resources would be available free of charge from the local utility.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	Yes
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	No
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Interviews with facility staff

Owner Action

Action Code – Not Implemented
Action Taken – None
Date Improvement Completed - NA

17 Packaged HVAC systems operate 24 hours per day

Finding Description

It was noted during the site visit that only one or two thermostats throughout the facility were programmable and had the capability to setback/setup temperature setpoints during unoccupied hours, and even these thermostats did not use this feature.

General Finding Impacts

Energy Savings -	Yes	Propane Savings -	Yes	Indoor Air Quality -	No
Demand Savings -	No	Comfort -	No	Maintenance and reliability -	No

Recommendation

The recommendation is made to move the existing programmable thermostats onto the Administration and Day Room HVAC units since these units do not serve resident areas and do not need to maintain normal space temperature 24 hours per day. If the thermostats cannot be relocated, new programmable thermostats should be installed. Energy savings are based on the assumption that the heating and cooling temperature setpoints can be lowered and raised by 5°F, respectively, during unoccupied hours (basically between 10 p.m. and 6 a.m.) This measure is mutually exclusive with Measure 01 - Enable Economizer Control.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	1,136 kWh/yr		Estimated Annual Cost Savings -	$307
Estimated Peak Demand Savings -	0 kW		Estimated Implementation Cost -	$0
Estimated Annual Propane Savings -	215 Gallons/yr		Simple Payback (yrs) -	0.0

Implementation Plan

It is recommended that the existing programmable thermostats be moved and connected to the Administration and Day Room HVAC units. Facility maintenance staff can perform all work.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	Yes
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	No
Further Investigation/Testing Required Of The Owner -	No	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Interviews with facility staff

Owner Action

Action Code – Not Implemented
Action Taken - None
Date Improvement Completed – NA

18 Vending machines operate 24 hours per day

Finding Description

Vending machines can use alot of energy, especially machines with refrigeration equipment like beverage machines. Most machines also have lights that operate continually.

General Finding Impacts

Energy Savings - Yes	Propane Savings - No	Indoor Air Quality - No
Demand Savings - No	Comfort - No	Maintenance and reliability - No

Recommendation

The recommendation is made to discuss energy issues with your current vending provider and negotiate a resolution to make the machines more efficient. For example resetting the temperature of a beverage machine up by 1 or 2 degrees would save compressor energy, or putting a timer on the lights so that they shut off at night. In the following calculations, we demonstrate the energy savings associated with turning off the lights in four vending machines at night. We have assumed each machine has two T12 lamps and energy-saving ballasts (86 watts total input) and the lights could be turned off for 10 hours per day.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	1,256 kWh/yr		Estimated Annual Cost Savings -	$110
Estimated Peak Demand Savings -	0 kW		Estimated Implementation Cost -	$0
Estimated Annual Propane Savings -	0 Gallons/yr		Simple Payback (yrs) -	0.0

Implementation Plan

Since the vending machines are owned (or leased) by a vending provider, both parties need to agree on how to improve the energy usage of the equipment. There should not be any cost associated with this measure.

Further Investigation Required by PECI Under Current Scope -	No	No, or Low Capital Expenditure to Implement -	Yes
Further Study or Engineering Needed Outside Current Scope -	No	Significant Capital Expenditure to Implement -	No
Further Investigation/Testing Required Of The Owner -	Yes	Savings Calculation Method -	Spreadsheet
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Night-time site inspection

Owner Action

Action Code – Measure Implemented
Action Taken – The owner turned out the light in the vending machine (24 hours a day) and turned the thermostat up slightly.
Date Improvement Completed – March '01

IMPLEMENTATION OF RECOMMENDATIONS

IMPLEMENTATION PLAN

Facility staff decided which measures to implement. PECI offered limited assistance during implementation. In the state of California, all projects must receive permits and approval from the Office of Statewide Health Planning and Development (OSHPD) agency before installation. The owner was responsible for contacting their OSHPD Area Compliance Officer, providing them with the necessary documentation, and awaiting approval before hiring any contractors to do the work. Once approval was received from OSHPD, the Facility had full responsibility for contracting out the implementation or performing the work themselves. Some findings required additional analysis or testing to identify the cause of a problem, or to suggest an appropriate solution for implementation.

PRIORITIZATION OF RECOMMENDATIONS

Each measure was prioritized by PECI on a scale of 1 to 3. One represents a high priority finding, two represents a medium priority finding, and three represents a low priority finding. The ranking is subjective, but based on an overall evaluation with consideration given to the criteria of energy savings, project cost, likelihood of being implemented, indoor air quality, safety, and comfort. This assisted the owner in determining the order in which to implement these findings.

IMPLEMENTATION OPTIONS EXPLAINED

There are many ways to implement a recommendation. Low-cost measures are usually well suited for in-house implementation, to save project costs, although they can be contracted out. Capital intensive measures are usually contracted out directly to an installing contractor, or turned over to a performance contractor for financing. The owner had to consider several different equipment options, service contracts, measurement & verification, design, and project management.

MEASUREMENT & VERIFICATION OF SAVINGS

MEASUREMENT & VERIFICATION PLAN

Measurement and verification (M&V) of savings to establish real operating savings merits special attention for retrocommissioning, primarily due to the quantity and nature of the recommendations. Typically, a retrocommissioning study will result in a large quantity of O&M-type improvements that may be difficult or not cost-effective (relative to the project) to measure and verify on an individual basis. The M&V techniques used will follow the International Performance Measurement and Verification Protocol – Whole Meter Approach, normalized to account for variations in the number of days per billing cycle. For example, a utility bill for January 2000 may cover a 34 day billing cycle, while a bill for January 2001 may cover a 30 day billing cycle. In order to compare usage across years, both monthly usage figures must reflect a 31 day period. We did not normalize our results for weather. However, a comparison of site weather data from 2000 and 2001 shows no significant differences.

The overall verification process included the following tasks:

1) Enter the actual energy use for the facility as reported on the utility bills for the period extending from one year before the retrocommissioning study to six months after the study.

2) Normalize the monthly usage figure to account for variations in the length of billing cycles. This is achieved by calculating the average daily usage in a given billing cycle and multiplying by the number of days in that month.

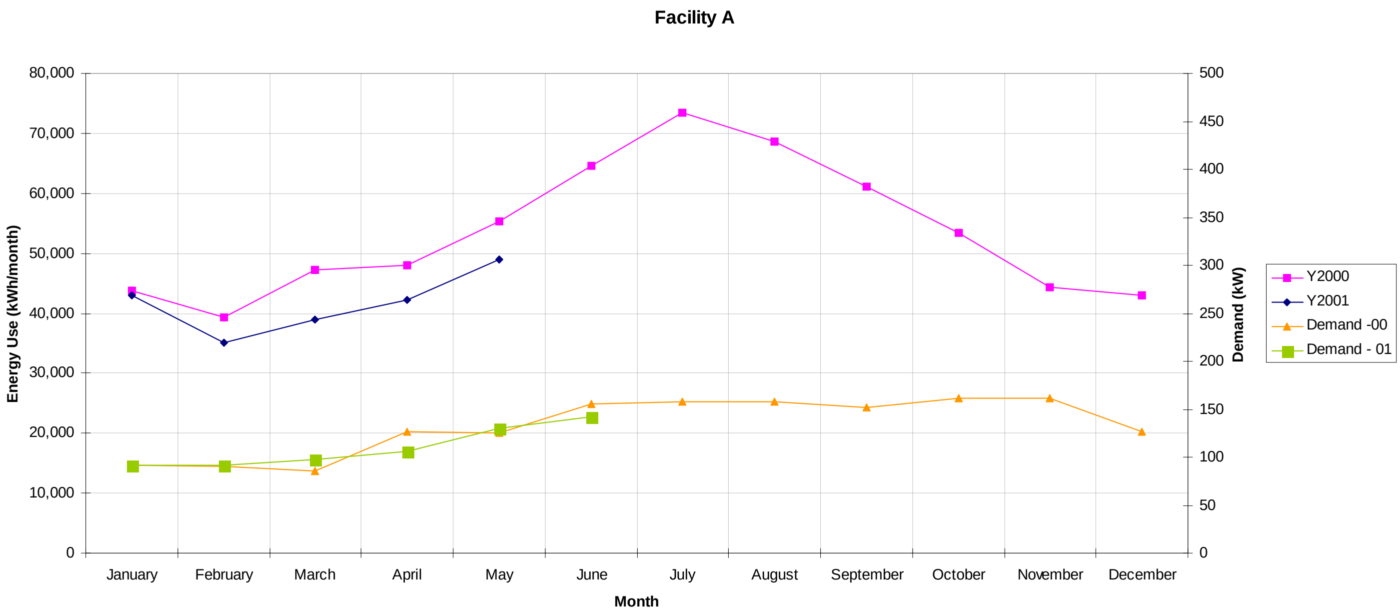
3) Compare usage before the study with post-retrocommissioning usage. Differences in energy use are likely attributable to the study and resulting implemented measures assuming there are no significant weather and facility operation differences.

MEASUREMENT & VERIFICATION RESULTS

As can be seen in the graph below, monthly energy use for 2001 is approximately ten percent below year 2000 use. Interestingly, this reduction precedes the implementation of the recommended measures, which were phased in between May and July of 2001. It appears that the performance of the retrocommissioning study in December, 2000 raised energy awareness among facility operators, motivating them to curtail energy use. For example, facility operators reported being more vigilant about turning out lights at night.

Peak demand appears unaffected by the retrocommissioning study, indicating that preliminary kWh savings were realized at off-peak hours. We expect that upcoming utility bills will also show that the overall package of measures reduce demand only slightly, because the bulk of the measures involve opportunities to curtail use during off-peak hours (reducing lighting in unoccupied areas and “free” economizer cooling).

One measure, enabling the economizer controls, accounts for almost half of the estimated kWh savings. Since implementation of this measure was still in progress in June, upcoming utility bills should reflect additional kWh savings as a result of utilizing free cooling.



MAINTENANCE OF SAVINGS

IMPLEMENTATION PERSISTENCE

Continued maintenance of savings is an essential factor in insuring the success over time of a particular project and of retrocommissioning in general. Retrocommissioning often involves the implementation of measures that can degrade over time if not maintained or managed properly, reducing the net positive cash-flow the owner can realize.

BENCHMARKING & CONTINUOUS MONITORING OF ENERGY USE

In order to insure measure persistence over time and the overall success of the project, the building can be "benchmarked", then have the utility use tracked over time (normalized for weather data or other operating conditions). This continuous monitoring can be configured to notify the owner of any deviation from the savings plan in order to allow for active changes in the building's operation to stay within the savings plan. Options available include third party remote monitoring, building automation system monitoring, dedicated monitoring systems, and low-cost self-monitoring. Additional information on benchmarking can be found at the Environmental Protection Agency web site: www.epa.gov/buildings/label/html/introduction.html, and information on utility tracking can be found at the California Energy Commission web site: www.energy.ca.gov/reports/efficiency_handbooks/index.html.

ENERGY REDUCTION TARGETING

Once the building is benchmarked, a target can be set to encourage further building operations improvements and energy awareness efforts. Many times building owners are unaware of the energy use of their own buildings. Having the tools to track and reduce energy usage is the first step toward being able to optimize a building's operations.

RECOMMISSIONING

Periodically the facility should be recommissioned to verify and ensure that changes made to the building's operations and equipment during the original retrocommissioning process are still applicable and maintained over time. Recommissioning helps to guard against degradation of savings and helps to ensure the net positive cash flow throughout the life of the project that result from the owner's investment. The optimum frequency of recommissioning may vary from every quarter to every five years depending on the size and nature of the project. For this project, annual recommissioning is recommended.

APPENDICES

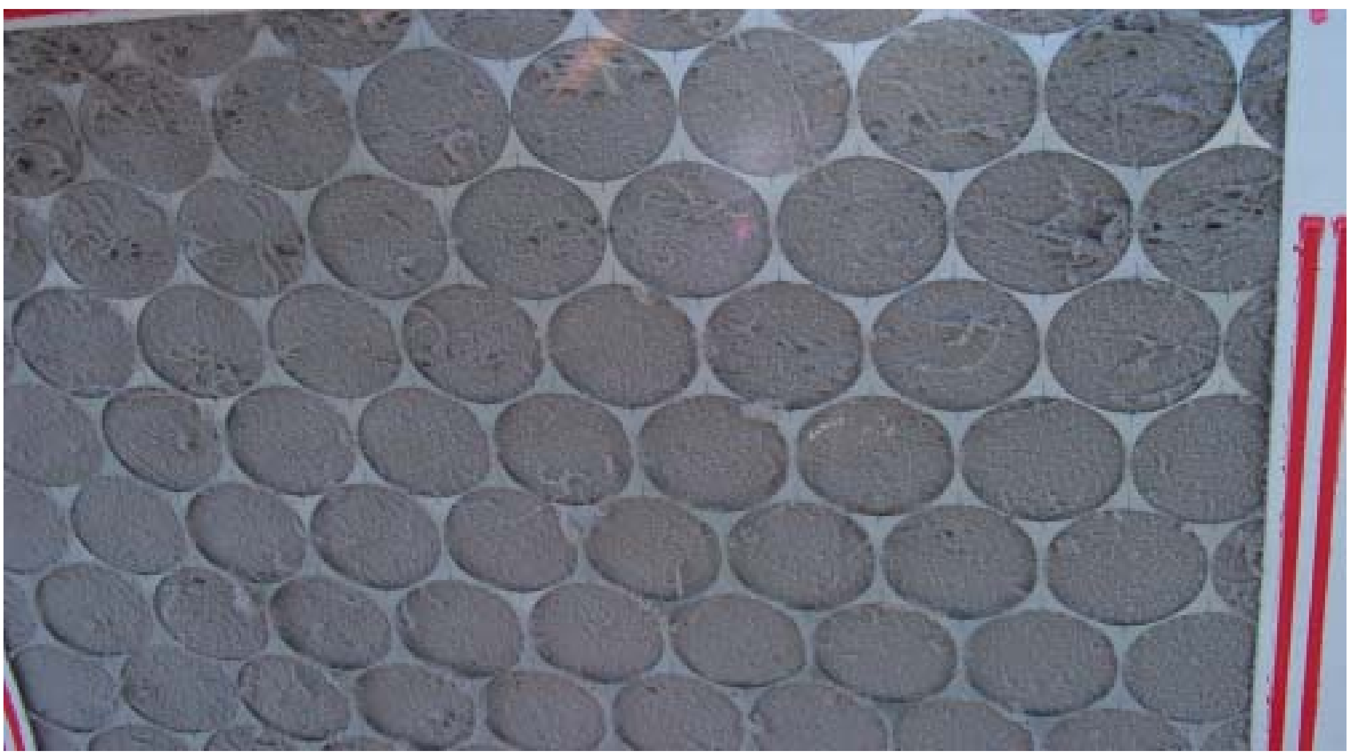
A. Photos

B. Utility History Analysis Figures

C. Data Logging Trend Analysis Figures

APPENDIX A. PHOTOS

Typical return air filters

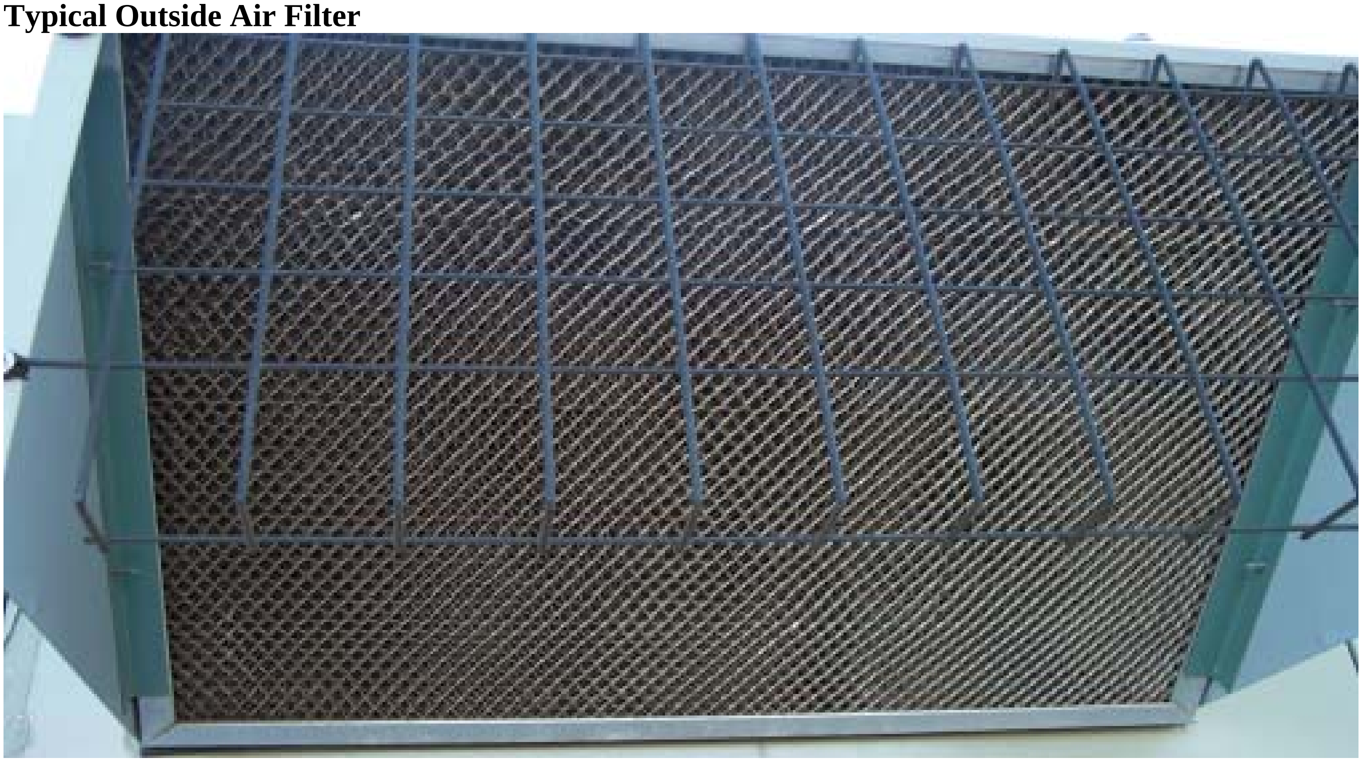


Kitchen HAVC System

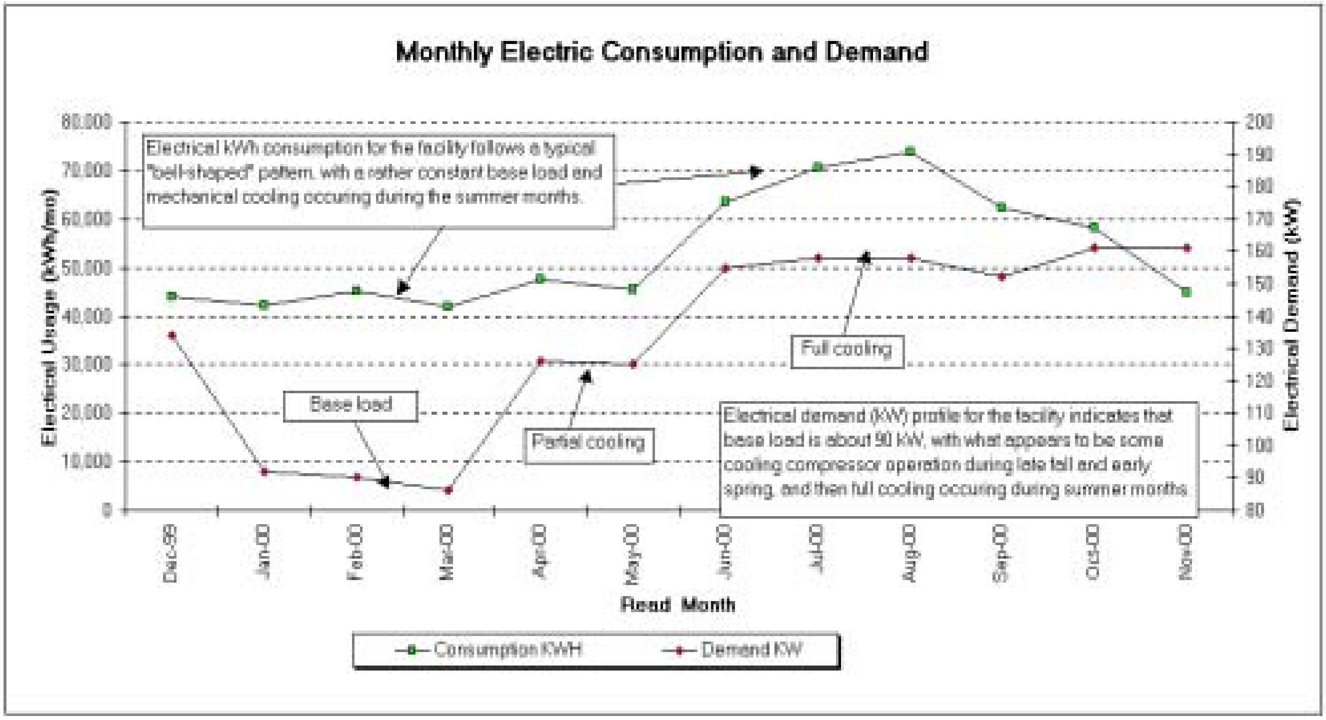
Typical HVAC System

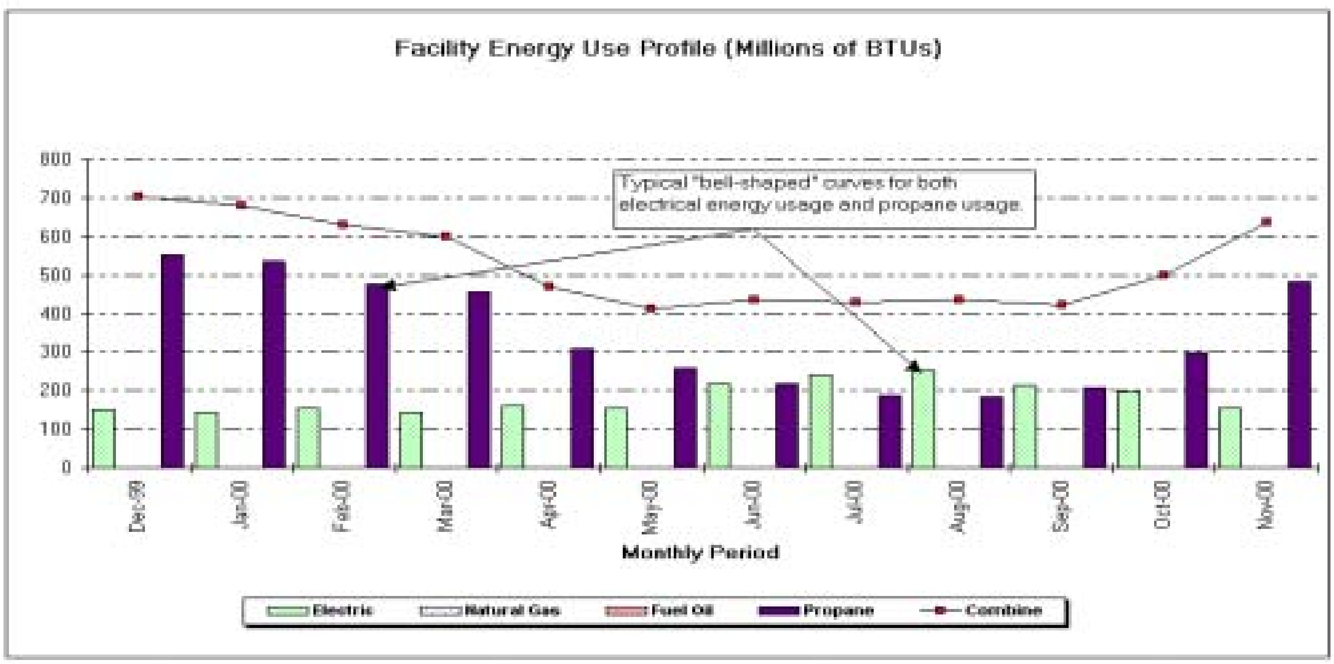
Laundry HVAC System

Typical Outside Air Filter

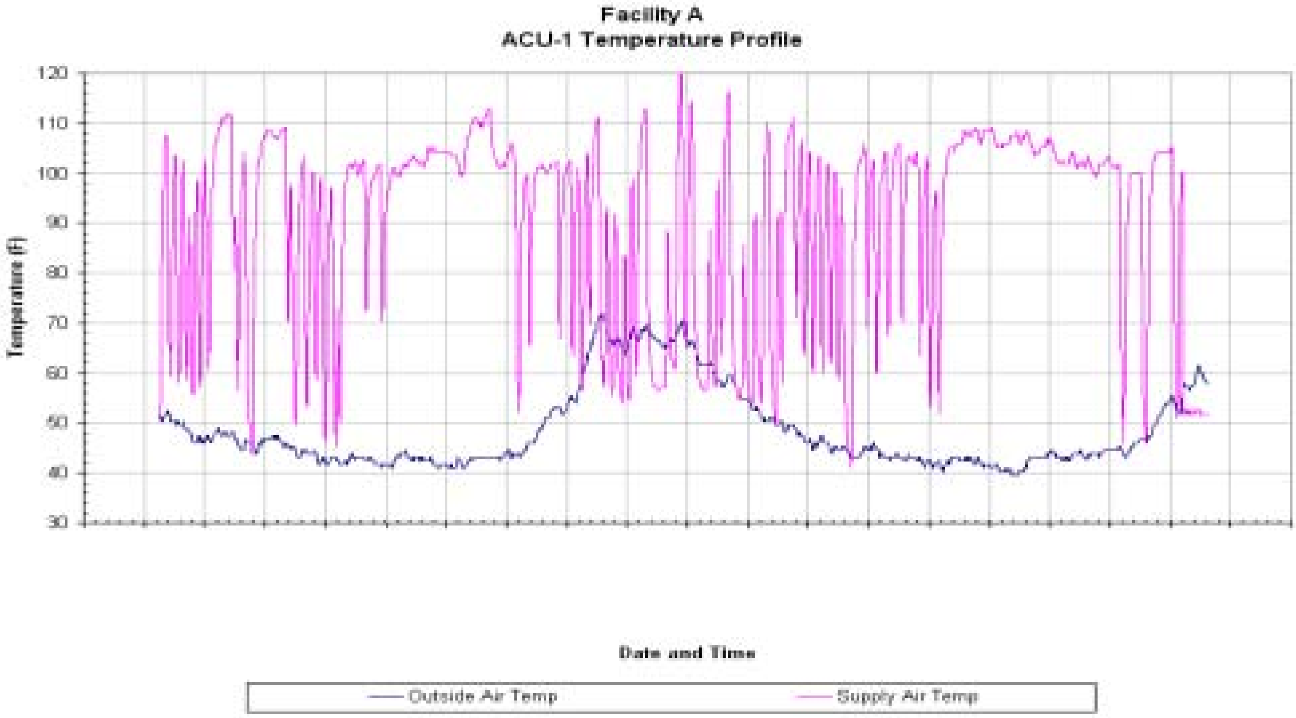


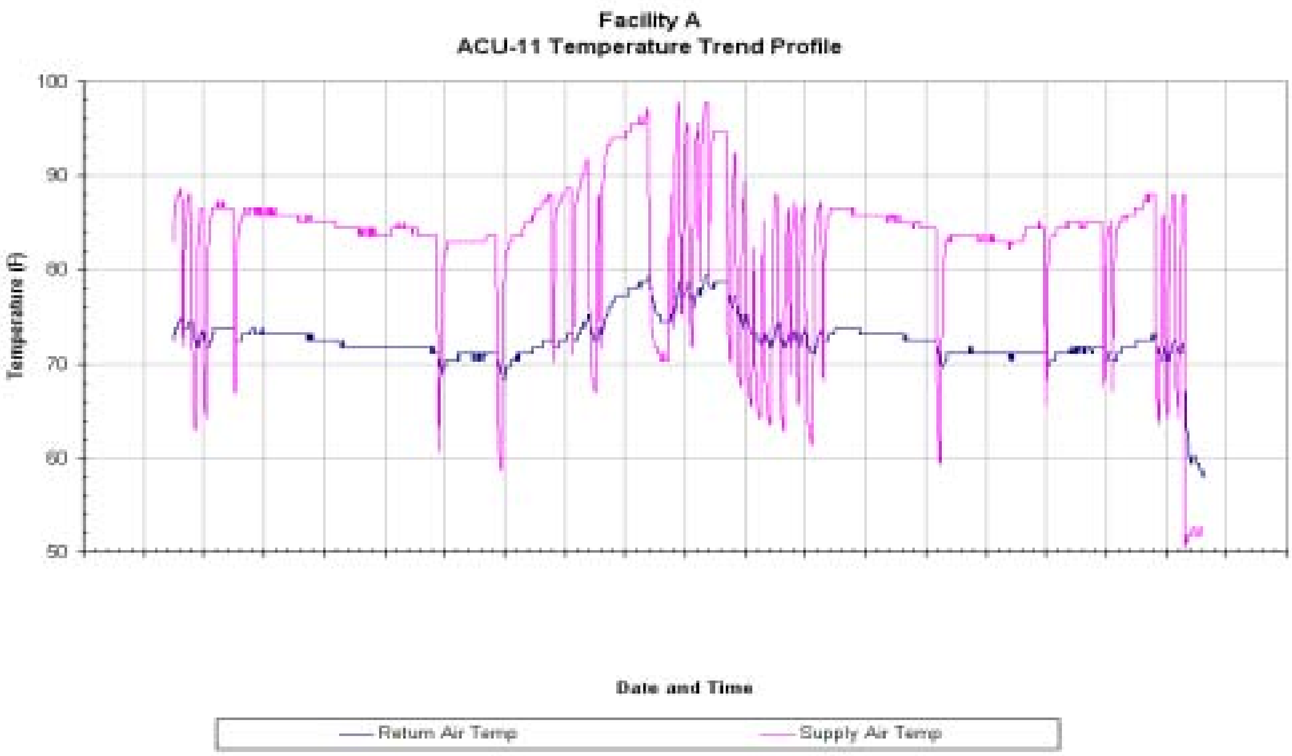
APPENDIX B. UTILITY HISTORY ANALYSIS FIGURES

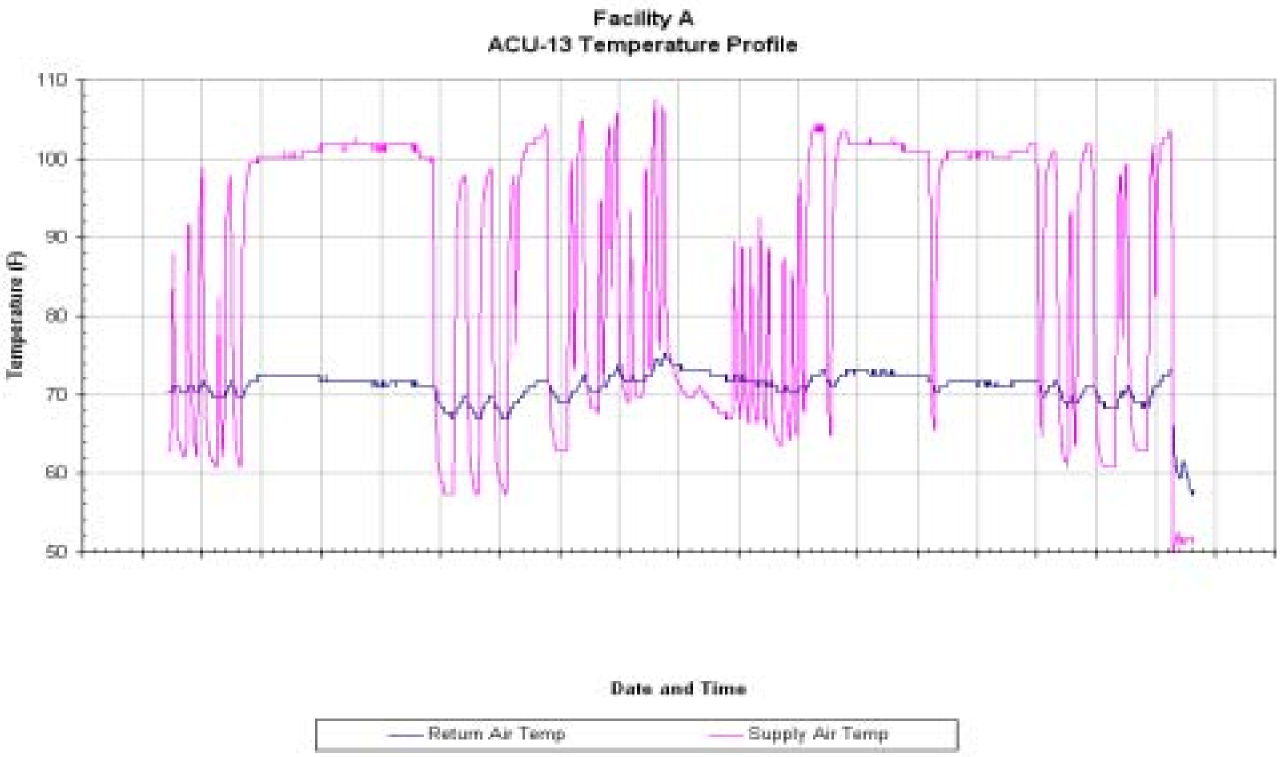


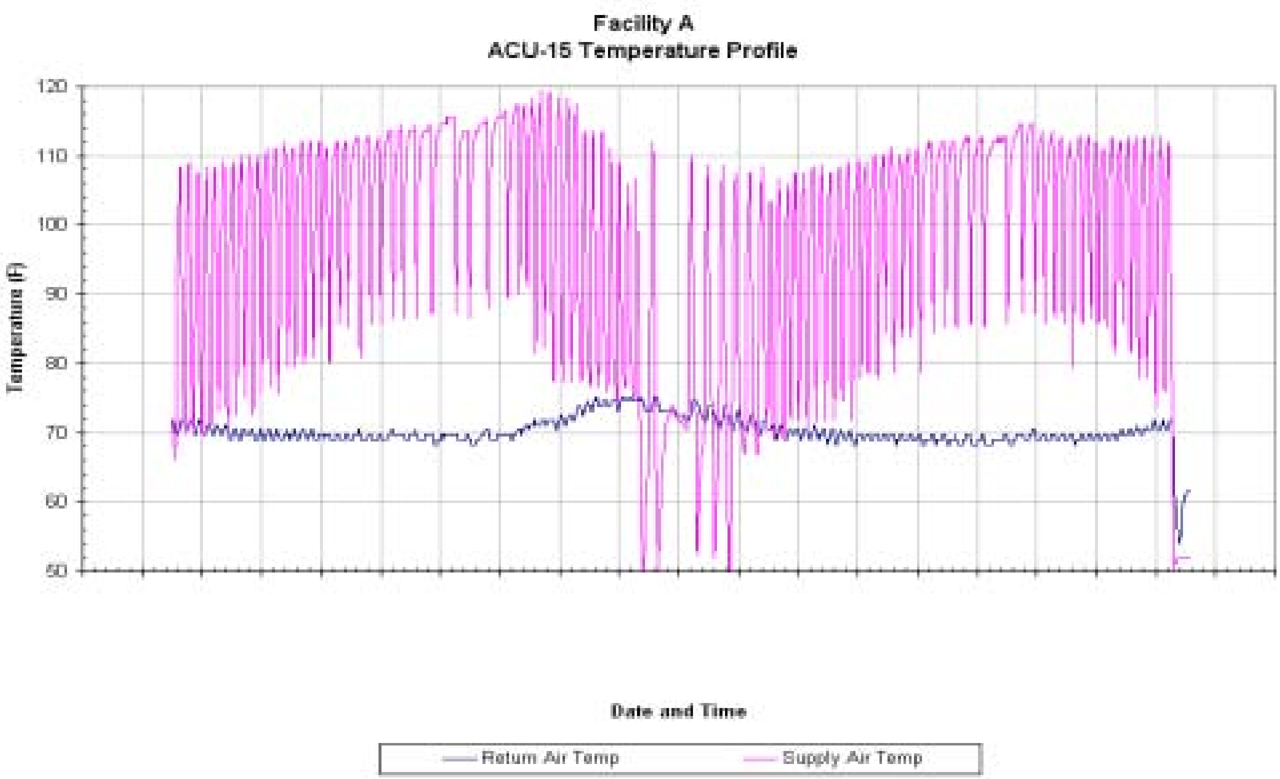


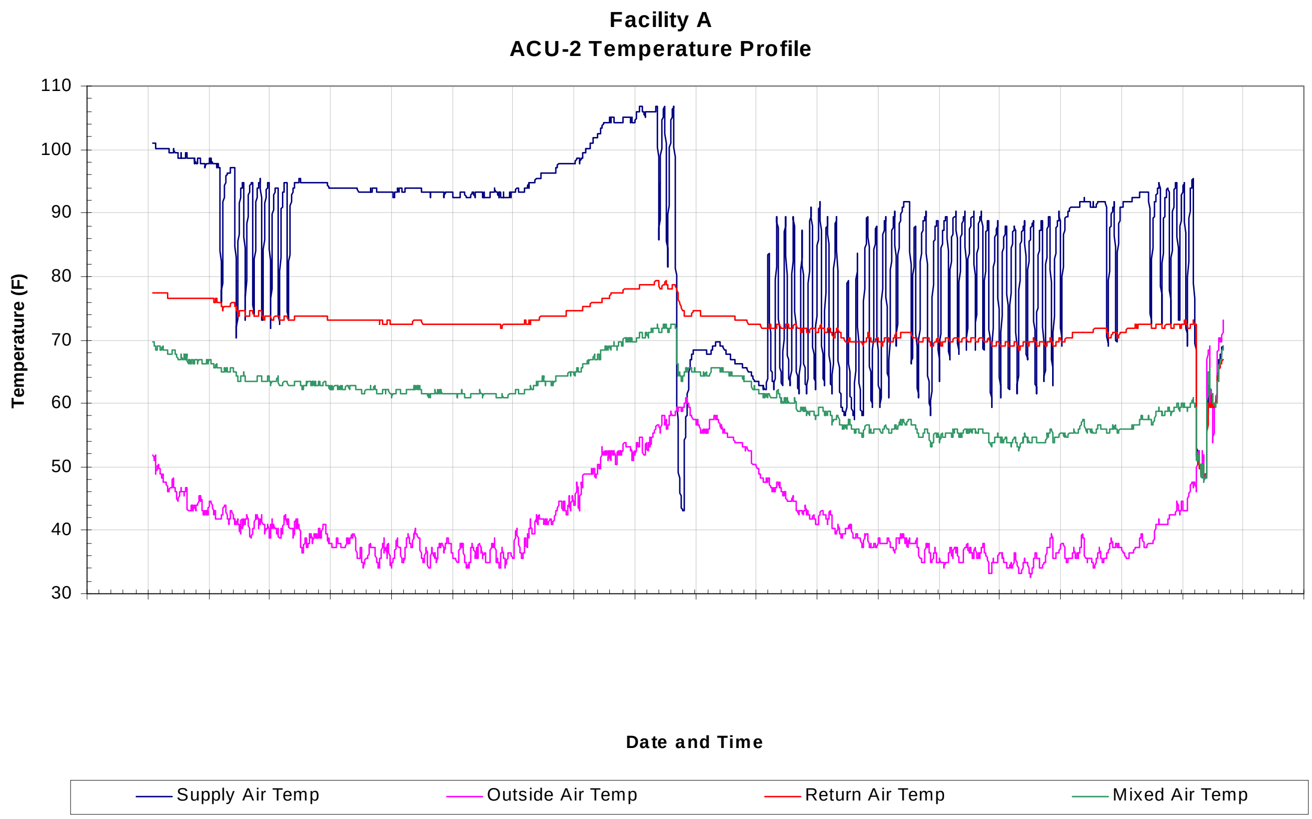
APPENDIX C. DATA LOGGING TREND ANALYSIS FIGURES

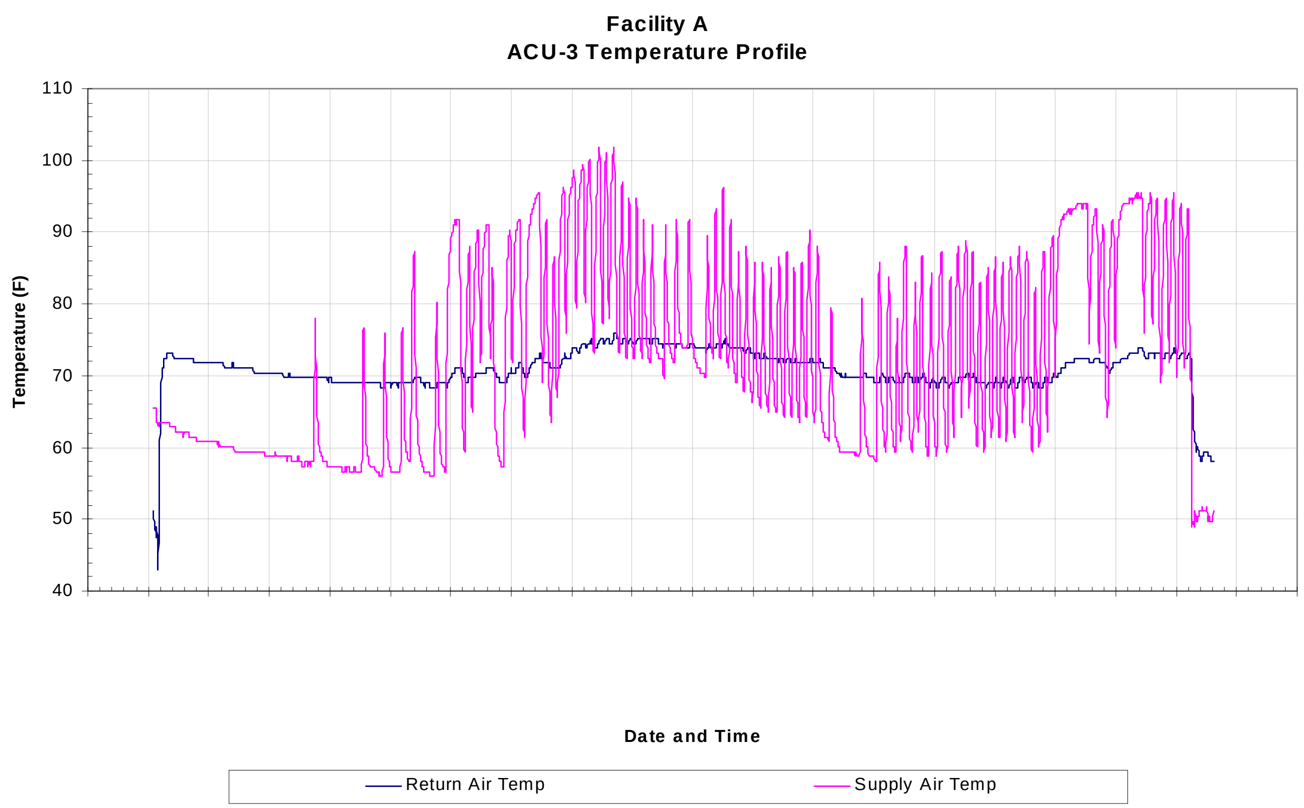


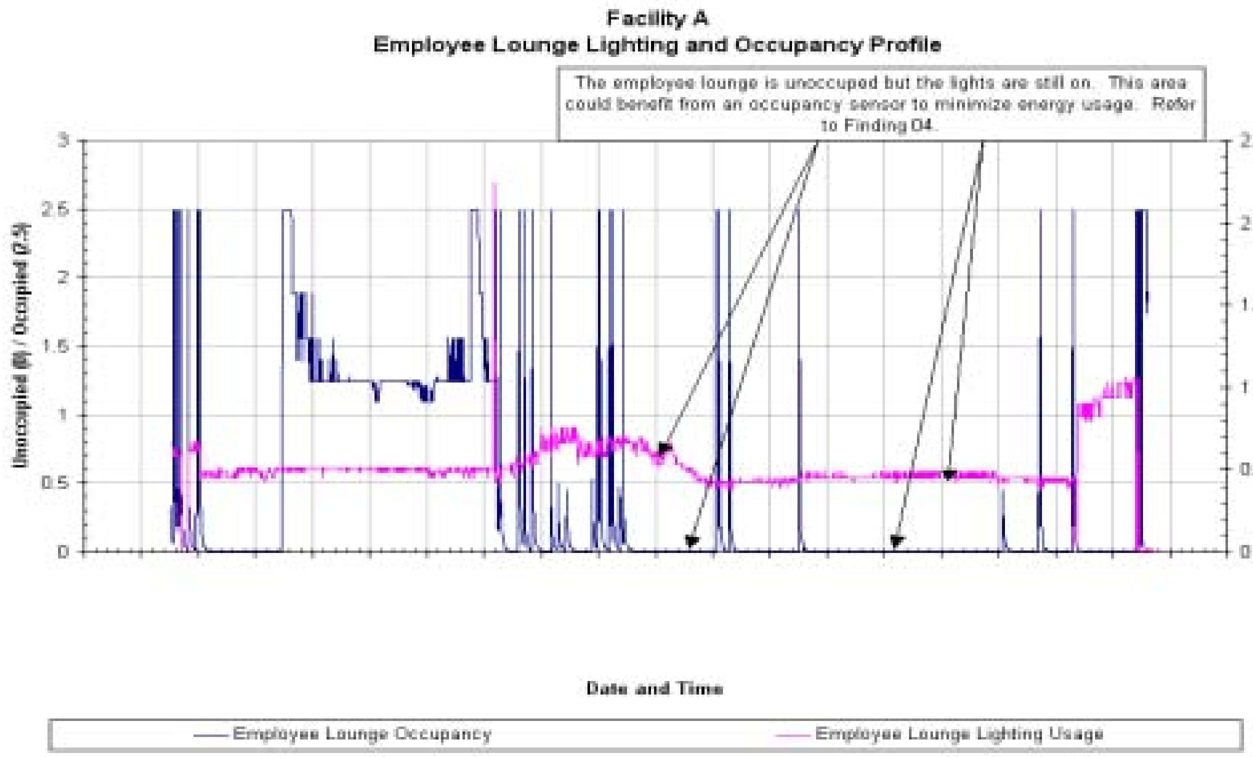


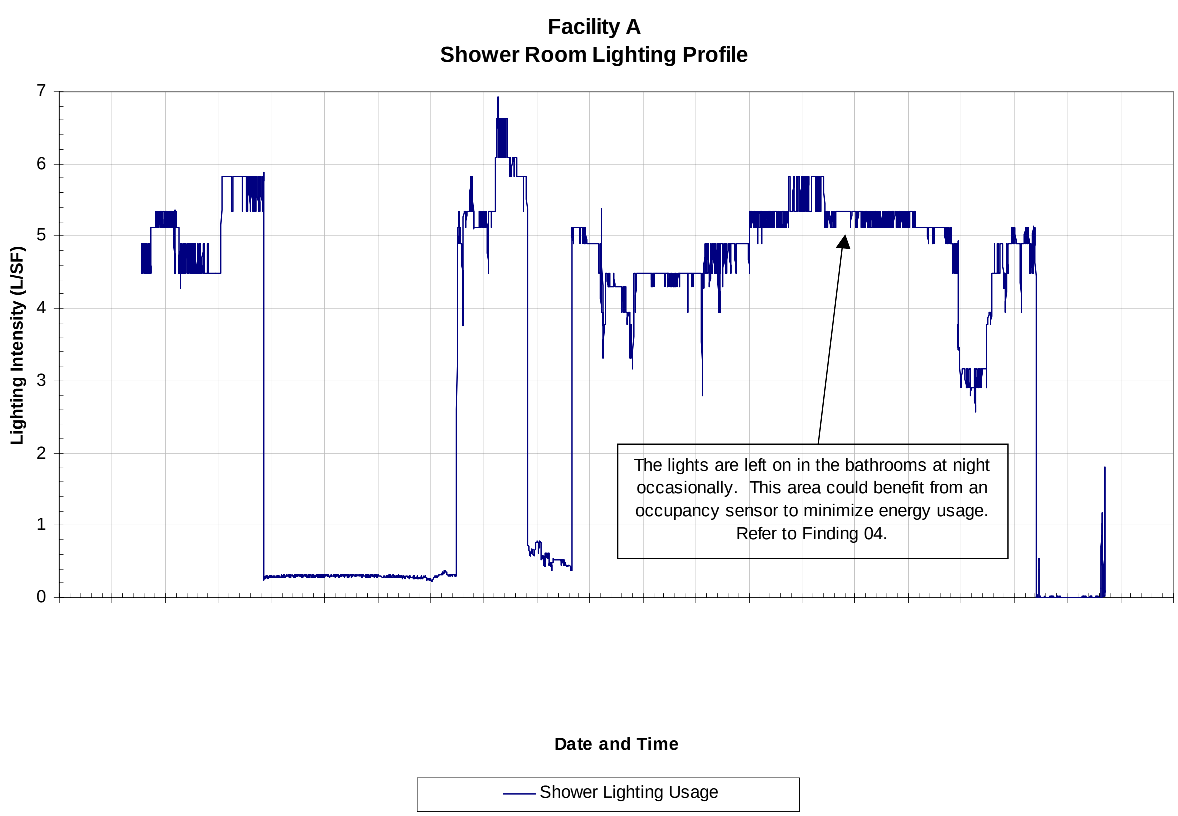

Facility A
ACU-13 Temperature Profile
110
100
90
80
70
60
50
Temperature (F)
Date and Time
Return Air Temp
Supply Air Temp

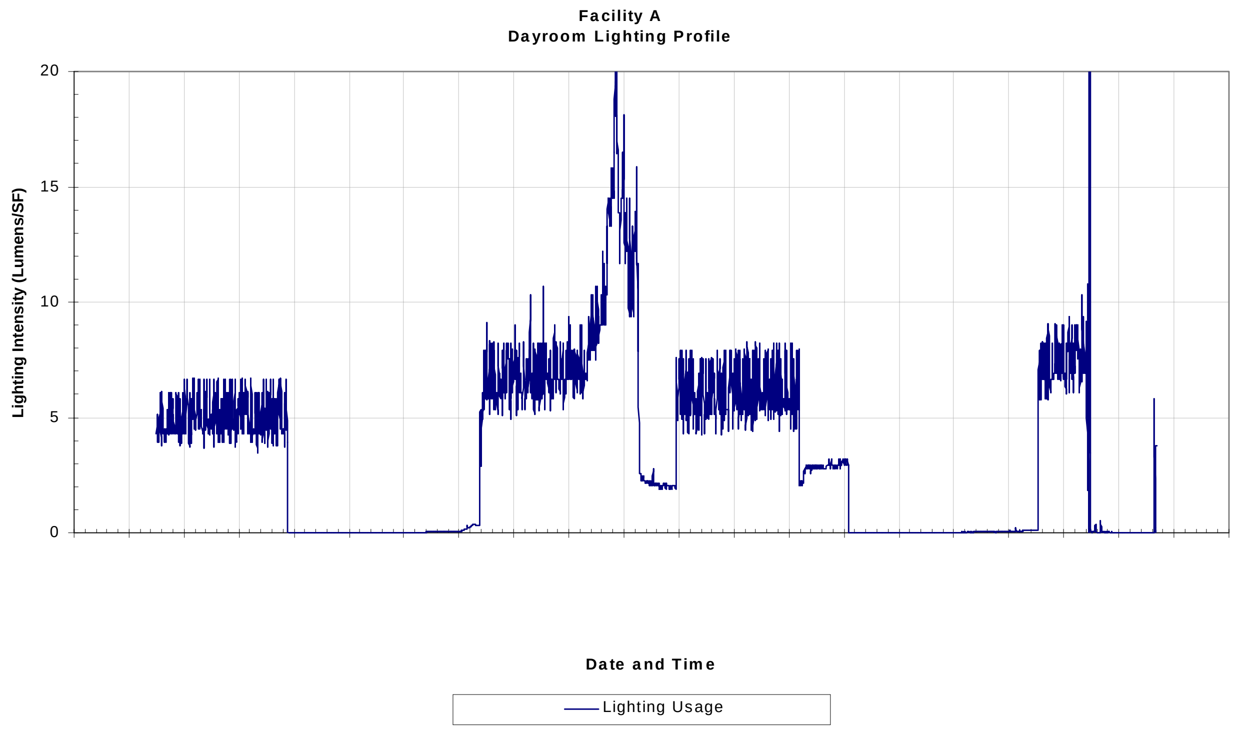

Facility A
ACU-15 Temperature Profile
120
110
100
90
80
70
60
50
Temperature (F)
Date and Time
Return Air Temp
Supply Air Temp

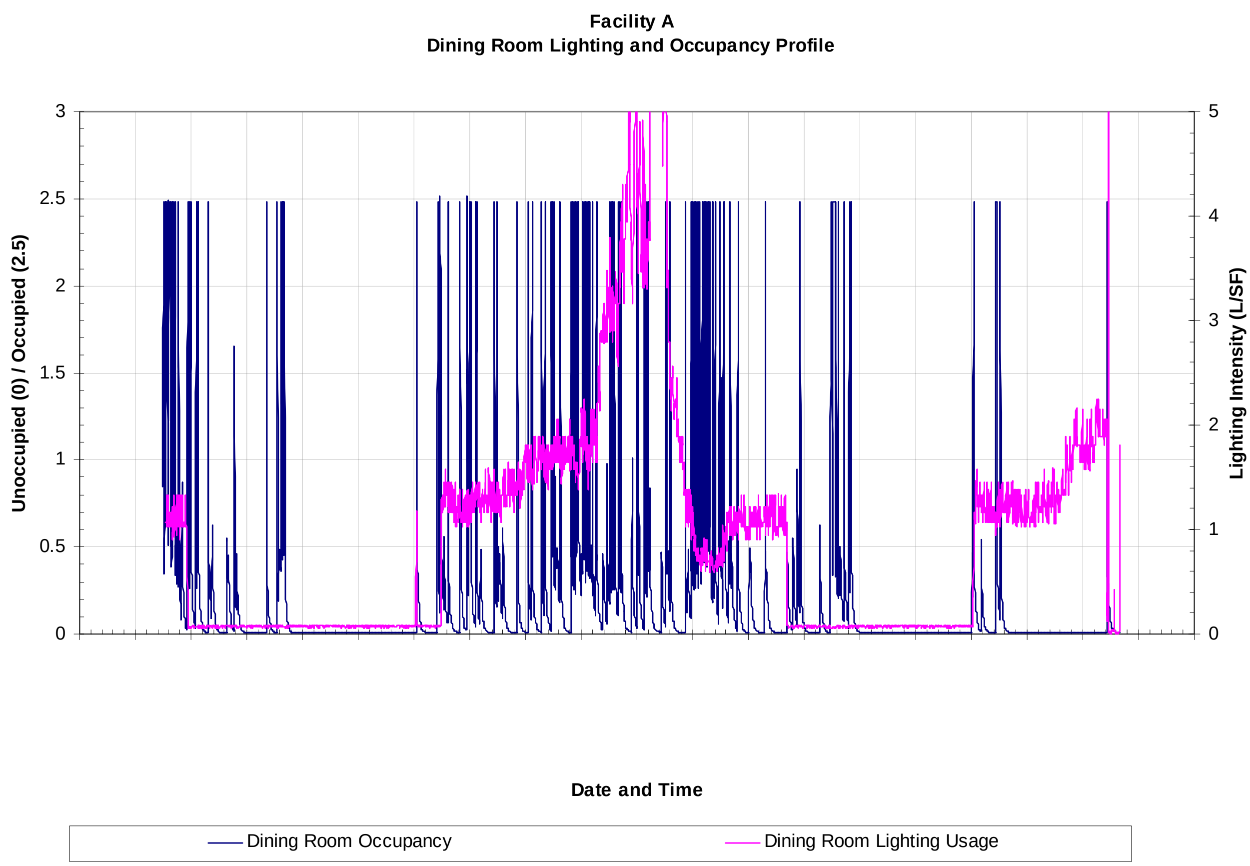

Facility A
ACU-2 Temperature Profile
110
100
90
80
70
60
50
40
30
Temperature (F)
Date and Time
Supply Air Temp
Outside Air Temp
Return Air Temp
Mixed Air Temp

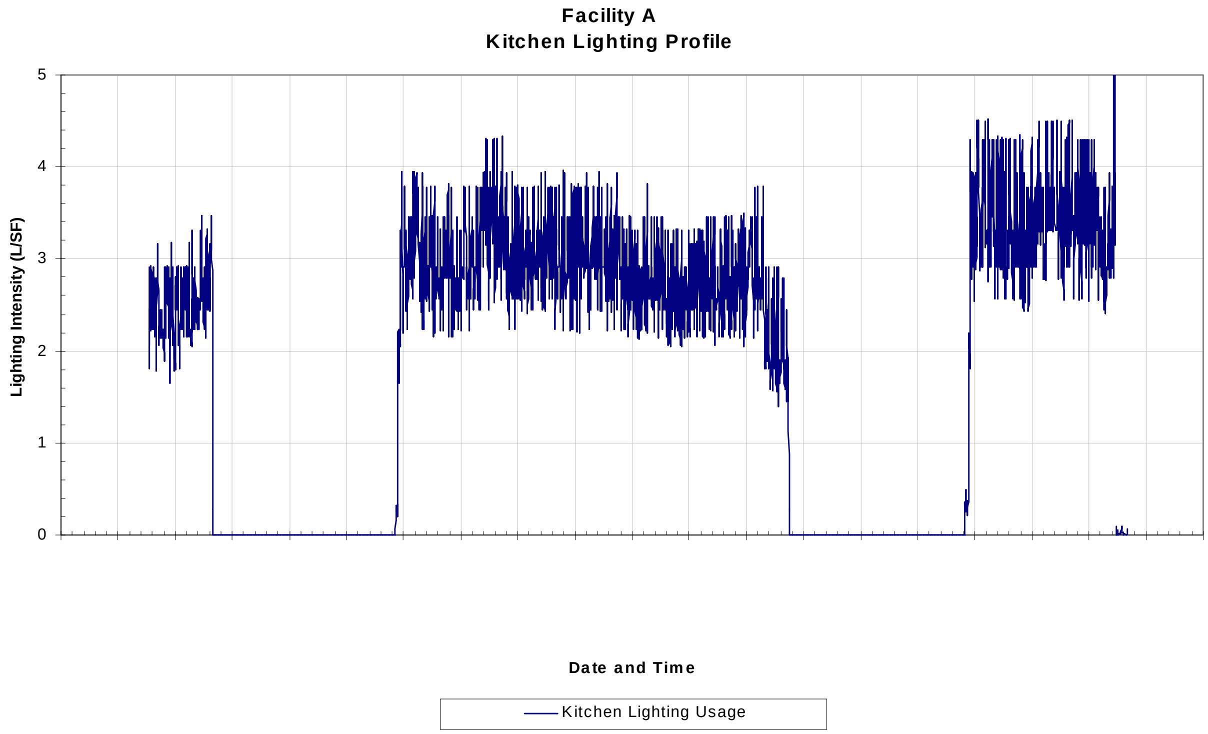

Facility A
ACU-3 Temperature Profile
110
100
90
80
70
60
50
40
Temperature (F)
Date and Time
Return Air Temp
Supply Air Temp

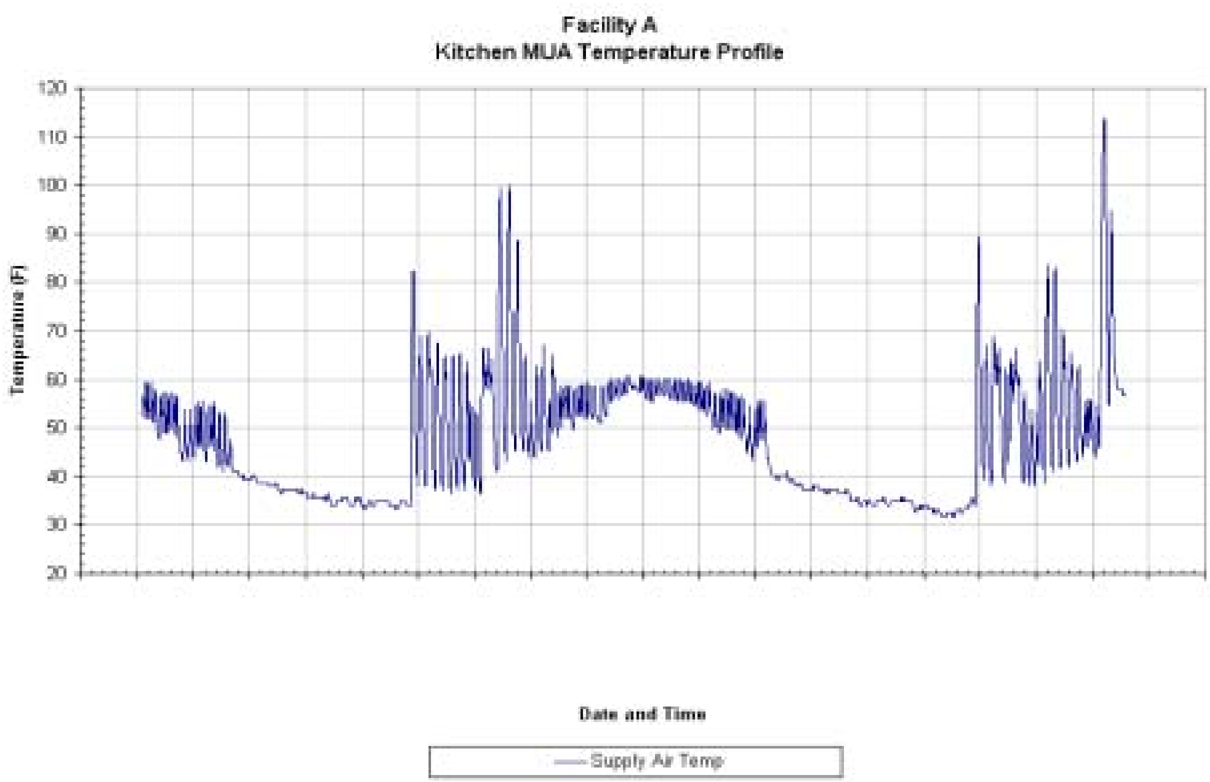

Facility A
Employee Lounge Lighting and Occupancy Profile
The employee lounge is unoccuped but the lights are still on. This area could benefit from an occupancy sensor to minimize energy usage. Refer to Finding 04.
Unoccupied (0) / Occupied (2.5)
Lighting Intensity (L/SF)
Date and Time
Employee Lounge Occupancy
Employee Lounge Lighting Usage


Facility A
Shower Room Lighting Profile
Lighting Intensity (L/SF)
The lights are left on in the bathrooms at night occasionally. This area could benefit from an occupancy sensor to minimize energy usage. Refer to Finding 04.
Date and Time
Shower Lighting Usage


Facility A
Dayroom Lighting Profile
Lighting Intensity (Lumens/SF)
20
15
10
5
0
Date and Time
Lighting Usage


Facility A
Dining Room Lighting and Occupancy Profile
Unoccupied (0) / Occupied (2.5)
3
2.5
2
1.5
1
0.5
0
Lighting Intensity (L/SF)
5
4
3
2
1
0
Date and Time
Dining Room Occupancy
Dining Room Lighting Usage


Facility A
Kitchen Lighting Profile
5
4
3
2
1
0
Lighting Intensity (L/SF)
Date and Time
Kitchen Lighting Usage


Facility A
Kitchen MUA Temperature Profile
120
110
100
90
80
70
60
50
40
30
20
Temperature (F)
Date and Time
Supply Air Temp