Retrocommissioning Report
Facility B
Stockton, California

Prepared with funding from

Pacific Gas & Electric

In partnership with

Institute for Market Transformation

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TABLE OF CONTENTS

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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 45,372 SF Facility B long-term care facility in Stockton, 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. Twenty-four findings overall were identified at the facility and fifteen of these were implemented. Energy savings estimates were made for the significant findings and where sufficient data was available and project scope allowed.

PECI met with the Facility B management staff to discuss and review the findings. The management then decided which measures to implement. PECI provided limited assistance during implementation. Facility B performed some of the work themselves and contracted out some of the work. Facility B was responsible for obtaining all necessary permits and approvals from the Office of State-wide Health Planning and Development (OSHPD) agency for implementing any findings or energy conservation measures recommended by PECI. All measures and findings are summarized below.

> Operation and Maintenance Measures. Eleven operation and maintenance measures were identified and recommended by PECI for implementation. These measures are fairly simple in nature, relatively low in cost and could likely be implemented with the in-house staff. Energy savings and implementation cost calculations were performed for all measures and eight measures were implemented. The total savings for the implemented

measures are 54,023 kWh, 1,371 therms of natural gas, and a total of $6,895 in annual utility cost savings. 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 $12,204 which assumes most materials are purchased, and labor is performed, by in-house staff. This results in a simple payback of 1.8 years.

Capital Improvement Measures. Four 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 four measures but none are recommended by PECI for implementation. One measure was implemented however (installing T8 lamps and electronic ballasts) which is projected to save 17,235 kWh/yr and $1,785 annually. The cost to implement this measure is $5,979 which results in a simple payback of 3.3 years. This measure will result in an increase of 137 therms/yr due to increased heating.

Total Project Summary. The implemented measures combined result in a total annual savings of 68,672 kWh, 1,255 therms of natural gas, and a utility cost savings of $8,412. 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 $18,183, resulting in an overall simple payback of 2.2 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. Three energy management improvement opportunities were identified. These measures enhance how the facility manages and tracks energy usage. Having a better understanding of how energy is used in the facility can help facility personnel identify savings opportunities, however quantifying potential savings is difficult. The energy savings and implementation cost calculations for each measure presented in the "Savings Summary Projection" table are "soft" and intended to illustrate potential savings but are not included in the recommended package. Facility B did not implement any formal energy management systems.

Additional Findings. There were six additional findings that pertained mostly to safety, comfort, indoor air quality, or other non-energy related issues. Facility B implemented all six findings. Some of the findings may have potential energy savings but were not calculated as they were beyond the scope of this study. A list of all findings and the implementation plan for the facility are summarized in the following "Finding and Implementation Plan Summary" table.

RECOMMENDATIONS, COST AND SAVINGS SUMMARY TABLES

SAVINGS SUMMARY PROJECTION
Facility B

EXISTING ENERGY USE

Building Area (Sq. Ft.)	Baseline Building	Existing Electric Energy (kWh/Yr)	Average Electric Demand (kW/Mo)	Existing Nat. Gas (Therms Per Year)	Existing Annual Energy Cost	Existing EUI (BTU/S.F. per Year)	Existing ECI ($/Sq.Ft. per Year)
45,372	1999-2000 Total Energy Use	945,280	170	45,478	$112,866	163,818	$2.49

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)	Nat. Gas Saved (Therms Per Year)	Annual Cost Savings	Implem. Cost	Simple Payback (Years)	% Reduction of Cost Savings
Yes	Yes	07	Reduce Kitchen Domestic Hot Water Temperature	0	1,084	$769	$0	0.0	0.7%
Yes	Yes	23	Adjust Vending Machine Operation	1,256	0	$110	$0	0.0	0.1%
No	Yes	19	Calibrate and Adjust Thermostats	5,515	187	$466	$293	0.6	0.4%
No	Yes	04	Install Programmable Thermostat	2,551	262	$409	$299	0.7	0.4%
Yes	Yes	09	Repair Water Leak in Kitchen and Install Aerators	0	197	$140	$138	1.0	0.1%
Yes	Yes	21	Perform HVAC System Tune-up*	28,122	0	$3,559	$5,855	1.6	3.2%
Yes	Yes	17	Occupancy Sensor Lighting Control	21,892	(174)	$2,093	$3,476	1.7	1.8%
Yes	Yes	22	Time Walk-in Refrigeration Equipment	3,498	0	$334	$586	1.8	0.3%
Yes	Yes	02	Repair Air Leakage at A/C Units*	8,788	466	$1,170	$2,100	1.8	1.0%
Yes	Yes	10	Repair Leaking Pressure Relief Valve*	0	38	$27	$50	1.9	0.0%
No	Yes	01	Balance Air System*	9,932	374	$1,213	$3,892	3.2	1.1%
Total Recommendation Package as Selected by PECI				79,555	2,437	$10,202	$16,678	1.6	9.0%
15%	Measure interaction of total package			67,622	2,071	$8,672	$16,678	1.9	7.7%
Total Recommendation Package as Selected by Owner				63,567	1,613	$8,112	$12,204	1.5	7.2%
15%	Measure interaction of total package			54,023	1,371	$6,895	$12,204	1.8	6.1%

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)	Nat. Gas Saved (Therms Per Year)	Annual Cost Savings	Implem. Cost	Simple Payback (Years)	% Reduction of Cost Savings
Yes	No	18	Install T8 Lamps and Electronic Ballasts	17,235	(137)	$1,785	$5,979	3.3	1.6%
No	No	05	Replace Flue Dampers on Hot Water Heaters*	0	306	$217	$1,070	4.9	0.2%
No	No	15	Replace Rooftop A/C Units*	221,123	1,498	$26,521	$145,912	5.5	23.5%
No	No	16	Replace Domestic Hot Water Heaters*	0	2,552	$2,419	$30,396	12.6	2.1%
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				17,235	(137)	$1,785	$5,979	3.3	1.6%
15%	Measure interaction of total package			14,649	-116	$1,517	$5,979	3.9	1.3%

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)	Nat. Gas Saved (Therms Per Year)	Annual Cost Savings	Implem. Cost	Simple Payback (Years)	% Reduction of Cost Savings
Total Recommendation Package as Selected by PECI		79,555	2,437	$10,202	$16,678	1.6	9.0%
15%	Weighted average measure interaction of total pkg.	67,622	2,071	$8,672	$16,678	1.9	7.7%
Total Recommendation Package as Selected by Owner		60,792	1,476	$9,897	$16,183	1.6	8.8%
15%	Weighted average measure interaction of total pkg.	68,672	1,255	$8,412	$16,183	2.2	7.5%

ENERGY MANAGEMENT IMPROVEMENT OPPORTUNITIES

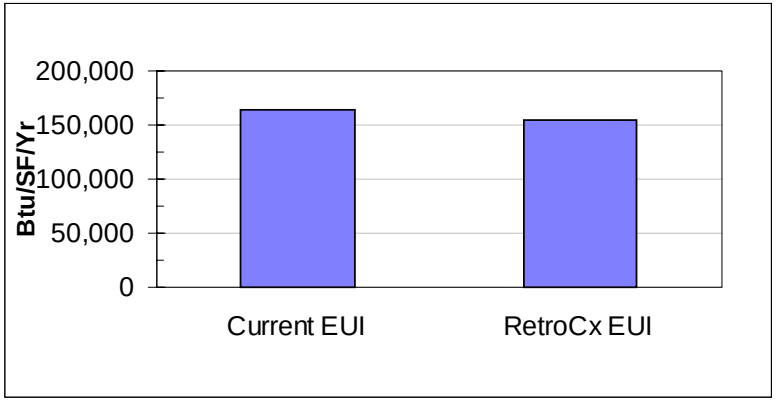
Recommendation Selection Owner	Recommendation Selection PECI	Finding Number	Energy Conservation Project Title	Electric Energy Saved (kWh/Yr)	Nat. Gas Saved (Therms Per Year)	Annual Cost Savings	Implem. Cost	Simple Payback (Years)	% Reduction of Cost Savings
No	Yes	24	Implement an Energy Awareness Program	16,906	910	$2,257	$660	0.3	2.0%
No	Yes	14	Implement a Utility Tracking Program	16,906	910	$2,257	$668	0.3	2.0%
No	Yes	13	Expand O&M Training and Procedures	8,453	455	$1,129	$2,469	2.2	1.0%
Total Recommendation Package as Selected by PECI				42,264	2,274	$5,643	$3,797	0.7	5.0%
15%	Measure interaction of total package			35,924	1,933	$4,797	$3,797	0.8	4.3%
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%

	PECI	OWNER
RETROFIT EUI	154,167	155,888

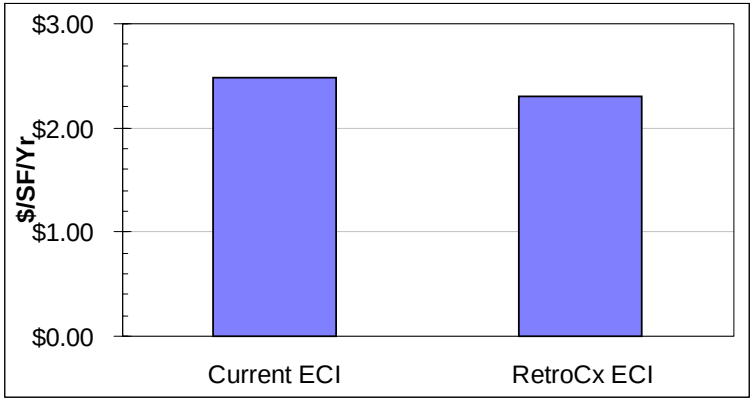
ENERGY USAGE AND COST INDEX COMPARISON PROJECTION
Total Recommended Package as Selected by Owner
Facility B

Current EUI	163,818	Btu/SF/Yr	Current ECI	$2.49	$/SF/Yr
RetroCx EUI	155,886	Btu/SF/Yr	RetroCx ECI	$2.30	$/SF/Yr
Percent Reduction	4.8%		Percent Reduction	7.5%	

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

ID	Finding	Recommendation Name[1]	Package[2]	Priority[3]	Status (C=Complete) (P=In Process) (F=$ Needed) (E= Need Eval.) (N=Not Doing)	Date Complete
01	Building pressure is negative	Balance Air Systems	1	1	N	-
02	Rooftop A/C units have air leaks	Repair Air Leakage at A/C Units*	1	1	C	March
03	Kitchen AC Unit outside air damper may need adjustment	Adjust Outside Air Damper	4	1	C	March
04	Rooftop HVAC unit controls can't setback at night	Install Occupancy-based Programmable Thermostats	1	1	N	-
05	Hot water heater flue dampers are wired open	Replace Flue Dampers on Hot Water Heaters*	2	2	N	-
06	A/C units may have fan operation set on "Auto"	Put Fan Operation in "ON" Position	4	1	C	March
07	Kitchen domestic hot water temperature is too high	Lower Kitchen Hot Water Temperature	1	1	C	March
08	ACU-4 has a noisy contactor	Inspect and Repair ACU-4	4	1	C	March
09	Kitchen sinks have water leaks and need aerators	Repair Water Leaks and Install Aerators	1	1	C	April
10	Pressure relief valve on hot water heater is leaking	Repair Leaking Pressure Relief Valve*	1	1	C	March
11	Rooftop A/C unit outside air is restricted	Clean Outside Air Intakes*	4	1	C	March
12	ACU-8 is missing outside air intake screen	Replace Missing Outside Air Intake Screens	4	1	C	March
13	Expand O&M training and procedures	Expand O&M Training and Procedures	3	1	N	-
14	Energy usage at the facility should be tracked	Implement a Utility Tracking Program	3	1	N	-
15	Rooftop A/C units are near end of expected life	Replace Rooftop A/C Units*	2	2	N	-
16	Hot water heaters are near end of expected life	Replace Domestic Hot Water Heaters*	2	3	N	-
17	Lights are on when spaces are unoccupied	Install Occupancy Sensors	1	1	P	July
18	Facility still has some T12 lamps	Install T8 Lamps and Electronic Ballasts	2	2	C	June
19	Thermostats should be calibrated	Calibrate and Adjust Thermostats	1	1	N	-
20	ACU-14 is short cycling	Inspect and Repair ACU-14	4	1	C	March
21	Rooftop HVAC units need periodic tune-ups	Perform HVAC System Tune-up*	1	1	C	May
22	Walk-in refrigeration units need periodic tune-ups	Tune Walk-in Refrigeration Equipment	1	1	C	May
23	Vending machines operate 24 hours per day	Adjust Vending Machine Operation	1	1	C	April
24	Formal energy awareness program should be put in place	Implement Energy Awareness Program	3	1	N	-

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 B, a long-term care facility located in Stockton, 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 are 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 five HVAC system temperatures and operation. This data was used to develop an operating profile for the facility.

Manual Testing

PECI performed manual tests on several HVAC units. The tests included measuring supply fan and booster fan motor input voltage and current, measuring outside air flow, and measuring air flow from leaks in the ductwork. 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 "TRANE AC Unit Temperature Profile", "ACU-4 Temperature Profile", and "ACU-14 Temperature Profile", located in *Appendix C – Data Logging Trend Analysis*, indicate possible operation problems with these HVAC units. 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 $0.09533/kWh, the electrical energy cost from the utility rate schedule is $0.08761/kWh, and the average cost of natural gas is calculated at $0.71/therm. All energy savings cost calculations use either the average cost of electricity, the electrical energy cost, and/or average cost of natural gas.

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 a variety of reasons for not recommending a measure to be implemented, one being that some measures are mutually exclusive with others and a selection must be made as to which one should be installed. 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 State-wide Health Planning and Development (OSHPD) agency prior to 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

The Facility B is a long-term care facility located in Stockton, California. The building was constructed around 1986 and includes approximately 45,372 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 150 residents and approximately 40 day-time 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 20 packaged HVAC (heating, ventilating, and air conditioning) units, each with a supply fan, a booster fan, a direct expansion cooling coil, and a natural gas-fired hot air furnace. Details regarding the individual HVAC system components are outlined below.

Cooling

The cooling capacity for each of the 20 HVAC units range between 3 tons and 10 tons, for a total connected load of approximately 102 tons. The cooling efficiency (EER) for each unit has been estimated at 6.5 Btu/watt.

Heating

The heating capacity for each of the 20 HVAC furnace sections range from 60 kBtuh to 154 kBtuh, for a total connected load of approximately 1,412 kBtuh. The combustion efficiency for each unit has been estimated at 75%.

Fans

The supply fan horsepower for each of the 20 HVAC units range from 0.5 HP to 1.5 HP, for a total connected load of approximately 11.5 HP. Several of the HVAC systems also have booster fans to overcome the static pressure associated with the restrictive fire damper arrangement. The booster fan horsepower ranges from 0.5 HP to 0.75 HP, for a total connected load of approximately 11.75 HP. The total amount of air delivered to the building is estimated at 41,665 CFM, with approximately 12,932 CFM of outside air for ventilation. Supply and ventilation air values are based on building plans.

There are twelve general exhaust fans ranging from 1/6 HP to 3/4 HP, for a total connected load of approximately 2.7 HP. The kitchen grill exhaust fan is rated at 0.75 HP and the kitchen make-up air unit is rated at 0.5 HP. All of the exhaust fans operate 24 hours per day, except the kitchen grill exhaust and make-up air unit which operates about 19 hours per day, 365 days per year.

HVAC Controls

All 20 HVAC units are controlled by thermostats located throughout the facility. Heating and cooling setpoints for the 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. The kitchen HVAC unit heating and cooling setpoints are approximately 68°F and 70°F, respectively and operate 19 hours per day, 365 days per year.

ELECTRICAL SYSTEMS

Interior Lighting

The interior lighting for the facility includes fluorescent, incandescent, and compact fluorescent fixtures. Approximately 85% of the existing fixtures contain T8 lamps with electronic ballasts and the remaining fixtures contain energy savings lamps and magnetic 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, incandescent flood lights, and compact fluorescent perimeter light fixtures. There are 17 fixtures around the facility estimated to contain 250-watt high pressure sodium lamps, seven 150-watt flood lights, and three perimeter fixtures estimated to contain 26-watt compact fluorescent lamps. The total exterior lighting load is estimated at 6.2 kW.

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 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
Kitchen cooking equipment	3.4 kW
Refrigeration units	10.0 kW
Laundry washing machines	12.0 kW
Laundry dryer motors	4.8 kW
Domestic hot water circulating pumps	0.2 kW
General plug loads	12.7 kW

FOSSIL FUEL SYSTEMS

Domestic Hot Water

There are five 100 gallon natural gas-fired hot water heaters located throughout the facility that provide 120°F domestic hot water to the facility, one 50 gallon natural gas-fired hot water heater set at 160°F serving the laundry, and one 100 gallon natural gas-fired hot water heater set at 150°F serving the kitchen. The domestic hot water system includes a thermostatically controlled mixing valve to ensure domestic hot water temperature does not exceed 120°F.

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	92.4 kBtuh
Laundry dryers	130.0 kBtuh

OPERATIONS & MAINTENANCE PROCEDURES

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

ENERGY UTILIZATION

The Facility B uses electricity and natural gas to meet its energy needs. The facility used 845,280 kWh of electricity ($80,583) and 45,478 therms of natural gas ($32,283) for the 12 month period between December 1999 and November 2000. This corresponds to an energy use index (EUI) of 163,818 BTU/sq. ft./year and an energy cost index of $2.49/sq. ft./year. Energy consumption and utilization for the facility is tabulated below.

Facility Utility History
Facility B

Gross Floor Area: 45,372 SF

Read Date	Electrical				Natural Gas		
	(KWH)	(KW/KVA)	($)	(AVG. $/KWH)	(Therms)	($)	(AVG. $/Therm)
Dec-99	60,800	138	$5,119	$0.08419	4,819	$3,659	$0.759
Jan-00	61,280	101	$4,702	$0.07673	7,092	$4,778	$0.674
Feb-00	56,480	106	$4,361	$0.07721	5,868	$4,117	$0.701
Mar-00	58,720	102	$4,518	$0.07693	5,632	$3,968	$0.705
Apr-00	56,320	181	$4,473	$0.07942	3,613	$2,667	$0.738
May-00	60,320	173	$4,944	$0.08196	2,835	$1,893	$0.668
Jun-00	78,880	206	$8,487	$0.10760	2,974	$2,025	$0.681
Jul-00	90,720	219	$9,630	$0.10615	2,362	$1,700	$0.720
Aug-00	88,640	221	$9,458	$0.10670	2,288	$1,871	$0.818
Sep-00	93,760	213	$9,861	$0.10517	2,591	$2,014	$0.777
Oct-00	79,520	214	$8,598	$0.10812	2,390	$1,578	$0.660
Nov-00	59,840	171	$6,433	$0.10750	3,014	$2,013	$0.668
Totals	845,280	2,045	$80,583	N/A	45,478	$32,283	N/A
Average	70,440	170	$6,715	$0.09533	3790	$2,690	$0.710

Facility Energy Use Calculations
Facility B

Read Date	Millions of BTU's			ECI ($/SF)	EUI (Btu/SF)	Elect. Load Factor %
	Electric	Nat. Gas	Combined			
Dec-99	207.51	481.88	689.39	$0.193	15,194	59.22%
Jan-00	209.15	709.18	918.33	$0.209	20,240	90.29%
Feb-00	192.77	586.84	779.61	$0.187	17,183	71.62%
Mar-00	200.41	563.21	763.63	$0.187	16,830	79.96%
Apr-00	192.22	361.29	553.51	$0.157	12,199	41.82%
May-00	205.87	283.46	489.34	$0.151	10,785	48.43%
Jun-00	269.22	297.38	566.60	$0.232	12,488	51.47%
Jul-00	309.63	236.23	545.86	$0.250	12,031	55.68%
Aug-00	302.53	228.80	531.33	$0.250	11,711	55.71%
Sep-00	320.00	259.13	579.13	$0.262	12,764	59.17%
Oct-00	271.40	239.03	510.43	$0.224	11,250	51.61%
Nov-00	204.23	301.35	505.59	$0.186	11,143	47.04%
Totals	2884.94	4547.81	7432.75	$2.488	163,818	
Average	240.41	378.98	619.40	$0.207	13,651	59.33%

The average cost of electricity is calculated to be $0.09533/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 natural gas is calculated to be $0.71/therm, 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 natural gas.

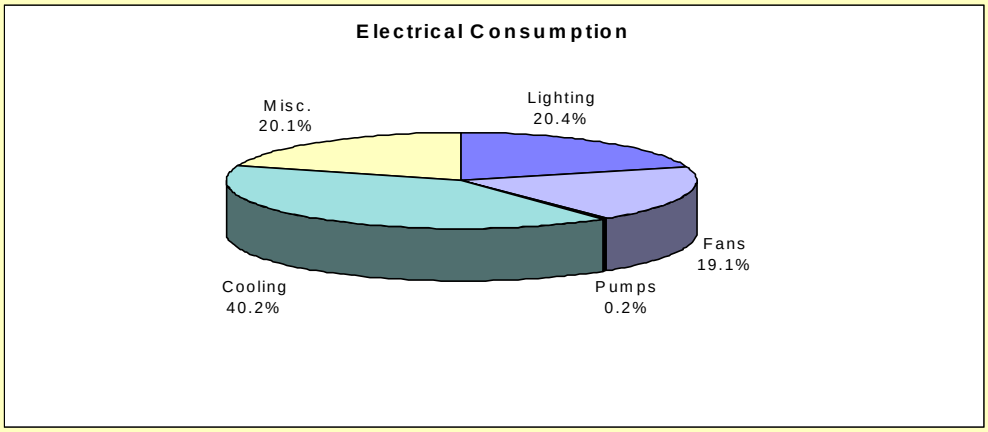
The electrical energy and natural gas usage profiles for the facility appear to be normal. The electrical energy consumption for the facility follows a typical "bell-shaped" pattern, with a rather constant load and mechanical cooling occurring mostly during the summer months. The electrical demand profile indicates that the base load is about 100 kW, with some cooling occurring during spring and fall months, and then full cooling during the summer months. The natural gas 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*.

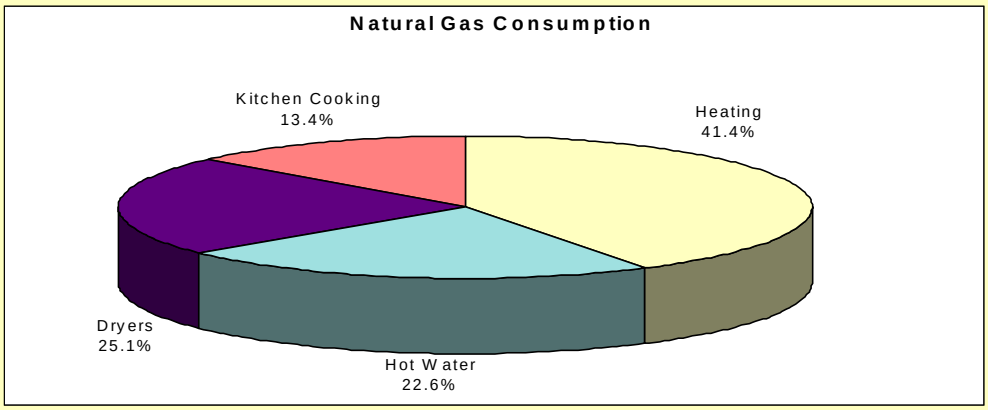
BASELINE ADJUSTMENT

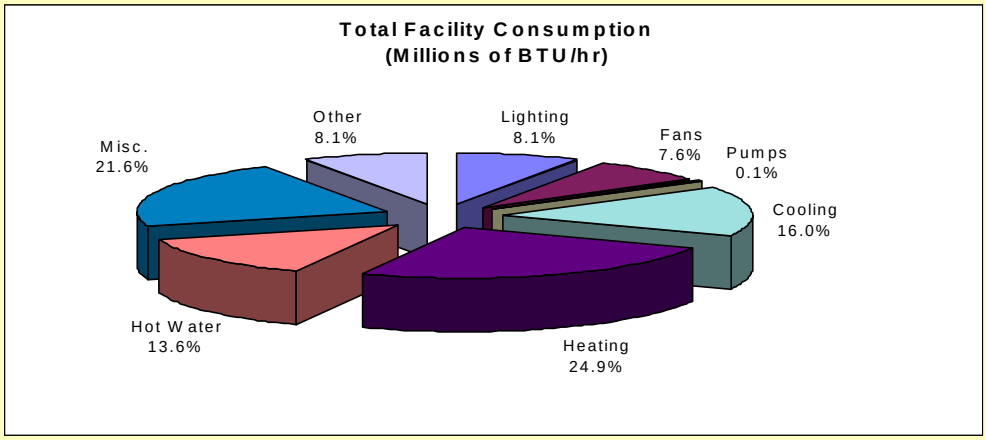
Occasionally retrocommissioning findings and recommendations may require that systems be brought up to present code requirements, which can increase energy consumption in some cases. Existing facilities that met all building codes at the time the facility was constructed are not required to meet current 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 an 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 and IMPLEMENTATION

DETAILED FINDINGS

01 Building pressure is negative

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 through the HVAC systems, and this condition can create comfort and indoor air quality problems as well as increase energy usage. One contributing factor to the problem is that the outside air intakes on several HVAC units are clogged and must be cleaned (refer to Measure 11 - Clean Outside Air Intakes).

General Finding Impacts

Energy Savings - Yes	Natural Gas Savings - Yes	Indoor Air Quality - Yes
Demand Savings - Yes	Comfort - Yes	Maintenance and reliability - Yes

Recommendation

The recommendation is made to balance the air system so that the building maintains a slightly positive pressurization, after the outside air intakes are cleaned (refer to Measure 11 - Clean Outside Air Intakes). The solution could be as simple as balancing air flow through the ducts or more complicated like modifying 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. This measure is mutually exclusive with Measure 15 - Replace Rooftop AC Units.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	9,932 kWh/yr	Estimated Annual Cost Savings -	$1,213
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$3,892
Estimated Annual Natural Gas Savings -	374 Therm/yr	Simple Payback (yrs) -	3.2

Implementation Plan

In-house personnel should have cleaned the outside air intakes first (refer to Measure 11 - Clean Outside Air Intakes). If the building is still negatively pressurized, then a test and balance contractor should be contacted. The cost associated with a test and balance on the HVAC systems can range from $2,000 to $3,000. We have assumed that a TAB will cost $2,500.

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

02 Rooftop A/C units have air leaks

Finding Description
It was noticed during the site visit that at least four HVAC units had significant air leaks from the supply duct. These leaks can result in heating/cooling capacity problems, imbalanced air flow in the building and unnecessary heating and cooling of the supply air.

General Finding Impacts

Energy Savings - Yes	Natural Gas Savings - Yes	Indoor Air Quality - Yes
Demand Savings - Yes	Comfort - Yes	Maintenance and reliability - Yes

Recommendation
It is recommended that all systems and ductwork be inspected and repaired as needed. Based on a research study analyzing energy usage associated with uncontrolled air flow, we have estimated that heating and cooling loads could be reduced by 2.5%. This measure is mutually exclusive with Measure 15 - Replace Rooftop AC Units.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	8,788 kWh/yr	Estimated Annual Cost Savings -	$1,170
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$2,100
Estimated Annual Natural Gas Savings -	468 Therm/yr	Simple Payback (yrs) -	1.8

Implementation Plan
Simple repairs can be made by in-house personnel. If larger or more complicated problems are identified, an HVAC contractor should be contacted to inspect and repair all ductwork throughout the facility.

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 – Measure Implemented
Action Taken – In house staff inspected and sealed the air leaks in the ducts.
Date Improvement Completed – March ‘01

03 Kitchen AC Unit outside air damper may need adjustment

Finding Description
During the site visit, data loggers were installed on the Kitchen AC unit to measure supply air, return air, mixed air, and outside air temperatures. The return air and mixed air temperatures were almost identical, so it appears that the unit is not bringing in much outside air. This could cause comfort and indoor air quality problems, as well as overall building pressurization issues.

General Finding Impacts

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

Recommendation
The recommendation is made for in-house personnel to adjust the outside air controls to increase the minimum amount of outside air introduced to the Kitchen AC unit. No energy savings have been estimated for this measure.

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 Natural Gas Savings -	0 Therm/yr	Simple Payback (yrs) -	Not calculated

Implementation Plan
In-house personnel should adjust the outside air controls to increase the minimum amount of outside air.

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 -	None
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Trending

Owner Action
Action Code – Measure Implemented
Action Taken – In-house staff adjusted the outside air damper.
Date Improvement Completed –March ‘01

04 Rooftop HVAC unit controls can't setback at night

Finding Description
Currently all HVAC units maintain space temperature between 73°F and 75°F, 24 hours per day.

General Finding Impacts

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

Recommendation
The recommendation is made to install programmable thermostats onto the Administration HVAC unit (AC-1) since this unit does not serve resident areas and does not need to maintain normal space temperature 24 hours per day. 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.). In addition, readjust the thermostat serving the Dining/Kitchen area so that the unit starts about 5:00 a.m. Based on trend data gathered during the site visit, the Dining/Kitchen HVAC unit shuts off at 8:00 p.m. and turns back on at midnight. Energy savings are based on the following assumptions and calculations:

1. Total cooling energy for the facility is 351,528 kWh/yr (based on EZSIM program)
2. Estimated percentage of total cooling load of systems running 24 hours is 95% (97 tons / 102 tons)
3. Total cooling capacity associated with Administration and Kitchen HVAC systems is 14% (14 tons / 97 tons)
4. Cooling savings associated with 5°F setup temperature is 4% (based on EZSIM program)
5. Total heating energy for the facility is 18,722 therm/yr (based on EZSIM program)

6. Estimated percentage of total heating load of systems running 24 hours is 92% (1,292 kBtuh / 1,412 kBtuh)
7. Total heating capacity associated with Administration HVAC system is 19% (243 kBtuh / 1,292 kBtuh)
8. Heating savings associated with 5°F setup temperature is 8% (based on EZSIM program)
9. Average electrical energy cost is $0.08761/kWh (includes taxes but not demand)
10. Average natural gas cost is $0.71/therm (includes taxes)
11. 0.5 HP supply fan on Kitchen HVAC unit can be turned off 5 hours per day

Energy savings calculations:
Cooling savings = total cooling usage x %24 hour operation x %programmable load x %savings
Heating savings = total heating usage x %24 hour operation x %programmable load x %savings
Kitchen HVAC supply fan savings = HP x 0.746 kW/HP x load factor / efficiency x operating hours

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	2,551 kWh/yr	Estimated Annual Cost Savings -	$409
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$289
Estimated Annual Natural Gas Savings -	262 Therm/yr	Simple Payback (yrs) -	0.7

Implementation Plan

An HVAC contractor should be contacted to install the new thermostat. It is recommended that a Lightstat, Carrier Debonair 220LA or equivalent thermostat be installed.

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 – Will be reconsidered later
Action Taken – None so far
Date Improvement Completed - NA

05 Hot water heater flue dampers are wired open

Finding Description

It was noticed that the hot water heaters serving the facility had automatic flue dampers but they were wired open. Staff personnel stated that the dampers had failed in the closed position and would not allow the systems to operate.

General Finding Impacts

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

Recommendation

The recommendation is made to install new automatic flue dampers on all seven hot water heaters at the facility. This measure is mutually exclusive with Measure 16 - Replace Domestic Hot Water Heaters.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	$217
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$1,070
Estimated Annual Natural Gas Savings -	306 Therm/yr	Simple Payback (yrs) -	4.9

Implementation Plan

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

All work should be performed by a mechanical 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 – Not Implemented
Date Improvement Completed - NA

06 A/C units may have fan operation set on "Auto"

Finding Description

Data loggers were used on both ACU-14 and ACU-4 to determine system operation by measuring supply and return temperatures. Based on the data, it appears that both ACU-14 and ACU-4 supply fans are cycling off (refer to graphs in the appendix for visual interpretation). One possible explanation is that the thermostats have the fan operation set in the "Auto" position.

General Finding Impacts

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

Recommendation

Cycling the fan could cause comfort or indoor air quality problems in the area served by ACU-14 and ACU-4. Since the area is occupied continually, the supply fan should always be on so that proper ventilation is provided to the space.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	Not applicable
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	Not applicable
Estimated Annual Natural Gas Savings -	0 Therm/yr	Simple Payback (yrs) -	Not applicable

Implementation Plan

Facility personnel should adjust the thermostats so the fan is in the “on” position.

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 -	none
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action
Action Code – Measure Implemented
Action Taken – In-house staff switched the fan operation to the "on" position.
Date Improvement Completed – March '01

07 Kitchen domestic hot water temperature is too high

Finding Description
Plant personnel stated that the hot water temperature for the kitchen is currently set at 150°F, primarily for the rinse cycle in the dishwasher. However, the facility has a low-temperature dishwasher which uses chemicals for sterilization in the rinse process and could use 120°F water (based on mfg.'s data).

General Finding Impacts

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

Recommendation
The recommendation is made to reduce the hot water temperature setpoint from 150°F to 120°F on the kitchen hot water heater.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	$769
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$0
Estimated Annual Natural Gas Savings -	1,084 Therm/yr	Simple Payback (yrs) -	0.0

Implementation Plan
Plant personnel can reduce the hot water temperature setpoint from 150°F to 120°F on the kitchen hot water heater.

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 – In-house staff reduced the hot water temperature setpoint from 150ºF to 120ºF.
Date Improvement Completed – March '01

08 ACU-4 has a noisy contactor

Finding Description
It was noticed during the site visit that ACU-4 made a lot of noise when the natural gas-fired furnace section was activated. The noise could be coming from a contactor that is beginning to fail.

General Finding Impacts

Energy Savings - No	Natural Gas Savings - No	Indoor Air Quality - No
Demand Savings - No	Comfort - No	Maintenance and reliability - No

Recommendation

Facility personnel should inspect ACU-4 to determine the actual cause of the noise. A mechanical contractor may be needed if plant personnel are unable to determine the cause of the problem.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	Not applicable
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	Not applicable
Estimated Annual Natural Gas Savings -	0 Therm/yr	Simple Payback (yrs) -	Not applicable

Implementation Plan

If the source of the problem can be repaired by plant personnel, then do so. Otherwise a mechanical contractor may be needed to perform the repair.

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 -	none
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Measure Implemented
Action Taken –Mechanical contractor replaced the contactor on ACU-4
Date Improvement Completed – March ‘01

09 Kitchen sinks have water leaks and need aerators

Finding Description

A persistent water leak was noticed in one of the kitchen sinks, as well as the fact that none of the sink faucets had aerators.

General Finding Impacts

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

Recommendation

The recommendation is made to repair the leak and install aerators in all of the faucets. Repairing water leaks and installing aerators will minimize water and natural gas usage. For our calculations, we have estimated that leak repair and aerators could reduce the load on the kitchen hot water heater by 6% annually. Our savings are based on natural gas only, but additional savings would be found on the water and sewer bills.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	$140
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$138
Estimated Annual Natural Gas Savings -	197 Therm/yr	Simple Payback (yrs) -	1.0

Implementation Plan

Facility personnel should repair water leaks and install aerators on kitchen faucets.

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 – In-house staff installed aerators and repaired water leaks.
Date Improvement Completed – April '01

10 Pressure relief valve on hot water heater is leaking

Finding Description

It was noticed during the site visit that the pressure relief valve on the 100 gallon domestic hot water heater was leaking, which results in a steady drip of water from the hot water heater to the drain.

General Finding Impacts

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

Recommendation

It is recommended that the pressure relief valve be replaced. For our calculations, we have estimated that the energy savings associated with the water leak will be 1.5% of the total domestic hot water load. This measure is mutually exclusive with Measure 16 - Replace Domestic Hot Water Heaters.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	$27
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$50
Estimated Annual Natural Gas Savings -	38 Therm/yr	Simple Payback (yrs) -	1.9

Implementation Plan

Facility personnel should replace the pressure relief valve.

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 – In-house staff replaced the pressure relief valve.
Date Improvement Completed – March '01

11 Rooftop A/C unit outside air is restricted

Finding Description
During the site visit, the audit team noted several outside air intake screens that were plugged with debris and preventing adequate ventilation air from entering the building. As a consequence the building was negatively pressurized.

General Finding Impacts

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

Recommendation
The recommendation is made to clean all outside air intake screens. Energy savings associated with this measure have been included in Measure 01 - Balance Air Systems.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	Refer to Measure 01
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	Refer to Measure 01
Estimated Annual Natural Gas Savings -	0 Therm/yr	Simple Payback (yrs) -	Refer to Measure 01

Implementation Plan
In-house personnel can clean the outside air intakes.

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 – In-house staff clean the outside air intakes quarterly.
Date Improvement Completed – March ‘01

12 ACU-8 is missing outside air intake screen

Finding Description
It was noticed during the site visit that ACU-8 did not have a screen covering the outside air intake.

General Finding Impacts

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

Recommendation
All outside air intakes should have screens to prevent foreign airborne material from entering the HVAC system and ultimately the conditioned space. This situation could lead to comfort or indoor air quality problems.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	Not applicable
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	Not applicable
Estimated Annual Natural Gas Savings -	0 Therm/yr	Simple Payback (yrs) -	Not applicable

Implementation Plan

Plant personnel should devise some form of screen to cover the outside air intake on ACU-8.

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 -	none
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Measure Implemented
Action Taken - In-house staff replaced the outside air intake screen.
Date Improvement Completed – March ‘01

13 Expand O&M training and procedures

Finding Description

The current operation and maintenance program could be expanded to include periodic tune-up & adjustment of equipment, filter technologies, and periodic preventive maintenance procedures.

General Finding Impacts

Energy Savings -	Yes	Natural Gas Savings -	Yes	Indoor Air Quality -	Yes
Demand Savings -	Yes	Comfort -	Yes	Maintenance and reliability -	Yes

Recommendation

O&M training courses may be available from equipment manufacturers, local community colleges, or professional trade organizations. For our calculations, we have assumed that expanded O&M training could reduce energy consumption by 1%.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	8,453 kWh/yr	Estimated Annual Cost Savings -	$1,129
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$2,459
Estimated Annual Natural Gas Savings -	455 Therm/yr	Simple Payback (yrs) -	2.2

Implementation Plan

We have assumed that various training courses or professional services could cost around $2,500.

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 -	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

14 Energy usage at the facility should be tracked

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

General Finding Impacts

Energy Savings - Yes	Natural Gas 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 -	16,906 kWh/yr	Estimated Annual Cost Savings -	$2,257
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$688
Estimated Annual Natural Gas Savings -	910 Therm/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 -	Yes	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 – Facility Staff review monthly utility bills to verify that they match the meter readings.
Date Improvement Completed - NA

15 Rooftop A/C units are near end of expected life

Finding Description
With the exception of one newer Trane unit serving the dining area, the existing rooftop A/C units are inefficient and near the end of their useful lives. These could be replaced with new energy efficient units with economizers. The new units would reduce maintenance costs, as well as improve comfort and indoor

air quality. As the existing units continue to age, maintenance costs associated with keeping the units operating will increase.

General Finding Impacts

Energy Savings - Yes	Natural Gas Savings - Yes	Indoor Air Quality - Yes
Demand Savings - Yes	Comfort - Yes	Maintenance and reliability - Yes

Recommendation

The recommendation is made to install new roof-top packaged HVAC units throughout the facility. The existing units are near the end of their expected life and are not operating very efficiently due to normal system degradation. We recommend a one-for-one replacement and assume that the new units will have the same heating and cooling capacities. Energy savings and implementation costs for this measure are based on the following assumptions:

1. Existing EER is estimated at 6.5 and proposed EER will be 11 (from mfg.'s data)
2. Heating efficiency will improve from 75% to 81% (from mfg.'s data)
3. Supply fan motor efficiency will improve from 77% to 84% (PE motor - mfg.'s data)
4. Booster fan can be eliminated since existing restrictive fire damper will no longer be adding static pressure to the system. A new fire damper will be properly sized and installed for each unit
5. Average cost of electricity is $0.09533/kWh
6. Average cost of natural gas is $0.71/therm
7. Additional engineering may be needed if existing curbs and penetrations must be modified

This measure is mutually exclusive with Measure 02 - Repair Air Leakage at AC Units, Measure 01 - Clean and Repair OSA Intakes, and Measure 21 - Perform HVAC System Tune-up.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	221,123 kWh/yr	Estimated Annual Cost Savings -	$26,521
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$145,912
Estimated Annual Natural Gas Savings -	1,498 Therm/yr	Simple Payback (yrs) -	5.5

Implementation Plan

A mechanical contractor or performance contract company should be contacted in order to implement this measure. Additional engineering outside the scope of the current project will be needed to determine exactly what equipment is needed and how it would be installed.

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

16 Hot water heaters are near end of expected life

Finding Description

It was noted during the site visit that the existing hot water heaters are reaching the end of their expected life. These could be replaced with new high efficiency units. As the units continue to age, maintenance costs associated with keeping the units operating will increase.

General Finding Impacts

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

Recommendation

New gas-fired domestic hot water heaters would have an efficiency of 94% (based on mfg.'s data) and could be installed in place of the existing gas-fired water heaters, which are assumed to be approximately 70% efficient. Energy savings would result from the higher efficiency of the new units. This measure is mutually exclusive with Measure 05 - Replace Flue Dampers on Hot Water Heaters and Measure 10 - Repair Leaking Pressure Relief Valve.

Currently there are five units serving domestic hot water loads, one unit serving the kitchen hot water loads, and one unit serving the laundry. For our calculations, we have assumed that the kitchen and laundry units would be replaced one-for-one but that the domestic hot water loads could be served by three new units. The rationale behind this is the assumption that two of the existing hot water heaters are used for redundancy and not capacity. In order to accurately determine how many new units would be needed, a thorough investigation of all hot water loads must be done and is beyond the scope of this project. Therefore, the following analysis is provided for information only and is not recommended for implementation.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	0 kWh/yr	Estimated Annual Cost Savings -	$2,419
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$30,396
Estimated Annual Natural Gas Savings -	2,552 Therm/yr	Simple Payback (yrs) -	12.6

Implementation Plan

Further engineering outside the scope of the project is required to determine exactly how many hot water heaters the facility needs and how the equipment would be installed.

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

17 Lights are on when spaces are unoccupied

Finding Description

It was noticed during the site visit that several areas in 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 physical observation during a night walk-through.

General Finding Impacts

Energy Savings - Yes	Natural Gas 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. Kitchen
4. Medical records area
5. Utility rooms
6. Club multi-room
7. Rehabilitation room
8. Speech therapy room
9. Therapeutic dining room
10. Corridor H bathrooms

PG&E will rebate $22 per occupancy sensor installed. Maintenance savings will occur because lamps will last longer and there will also be a corresponding cooling benefit and heating penalty due to the reduced lighting load. Refer to Occupancy Sensor spreadsheet for detailed calculations.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	21,892 kWh/yr	Estimated Annual Cost Savings -	$2,003
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$3,476
Estimated Annual Natural Gas Savings -	-174 Therm/yr	Simple Payback (yrs) -	1.7

Implementation Plan

Several of the areas can be retrofitted with passive infrared wall switches that will replace the existing toggle switches depending on room configuration (seven sensors total). All of the shower rooms and bathrooms should use ceiling-mounted ultrasonic occupancy sensors to ensure the lights stay on when the room is occupied (nine sensors total). The ceiling-mounted sensors will need additional wiring and conduit to connect the sensor to the lighting circuit.

All work should be performed by an electrical 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 -	Night-time site inspection

Owner Action
Action Code – Measure Implemented
Action Taken – An electrical contractor installed occupancy sensors in the shower rooms, employee lounge, kitchen, offices, and residence bathrooms.
Date Improvement Completed – July '01

18 Facility still has some T12 lamps

Finding Description
Maintenance personnel stated that approximately 15% of the fluorescent fixtures throughout the facility still contain T12 lamps and magnetic ballasts.

General Finding Impacts

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

Recommendation
The recommendation is made to change the remaining 15% of the fixtures to T8 lamps and electronic ballasts. For our calculations we have estimated that approximately 117 fixtures need to be converted, existing and proposed fixture wattage are 86 watts and 62 watts, respectively, and that the lights operate about 5,000 hours per year. There will also be a cooling benefit and heating penalty associated with this measure. Based on EZSim program the heating penalty and cooling benefit are estimated at 20% and 30%, respectively, of the total electrical energy saved due to reduced lamp wattage. The heating unit efficiency is estimated at 70% and the cooling unit efficiency is estimated at 4.5 EER. The measure could also reduce maintenance costs.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	17,235 kWh/yr	Estimated Annual Cost Savings -	$1,785
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$5,979
Estimated Annual Natural Gas Savings -	-137 Therm/yr	Simple Payback (yrs) -	3.3

Implementation Plan
A lighting contractor should be contacted to perform the 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 -	Interviews with facility staff

Owner Action
Action Code – Measure Implemented
Action Taken – 376 fixtures with T-12 lamps were replaced with T-8 lamps.
Date Improvement Completed – June'01

19 Thermostats should be calibrated

Finding Description
Mechanical thermostats should be calibrated on a regular basis to minimize energy usage.

General Finding Impacts

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

Recommendation
The dead band and heating/cooling setpoints should be checked on a regular basis as well. For our calculations, we have assumed that thermostat calibration could save 1% of the cooling and heating energy used at the facility.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	3,515 kWh/yr	Estimated Annual Cost Savings -	$468
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$293
Estimated Annual Natural Gas Savings -	187 Therm/yr	Simple Payback (yrs) -	0.6

Implementation Plan
Maintenance staff can calibrate and adjust thermostats.

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 – Thermostats were not calibrated, but maintenance staff physically leveled them.
Date Improvement Completed - NA

20 ACU-14 is short cycling

Finding Description
It was noticed during the site visit that ACU-14 was short cycling. On the day of the visit, the unit appeared to call for heat, the supply fan turned on (refer to Measure 06 - A/C unit fan operation set on "Auto"), and the gas furnace was engaged. The unit was timed and operated for less than 1 minute before the system turned off again. This does not appear to be a normal operation since such a short cycle could not even heat up the air adequately if the space was calling for heating. It is unknown if the same operation would occur if the space was calling for cooling.

General Finding Impacts

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

Recommendation
The recommendation is made to have an HVAC contractor inspect and repair ACU-14 as necessary. Short

cycling can wear out motors and compressors prematurely and can cause comfort and indoor air quality problems in the space.

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 Natural Gas Savings -	0 Therm/yr	Simple Payback (yrs) -	Not calculated

Implementation Plan

An HVAC contractor should be contacted to inspect and repair ACU-14.

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 -	none
Follow-Up By PECI Required For Implementation Under Current Scope -	No	Identification Method -	Daytime site inspection

Owner Action

Action Code – Measure Implemented
Action Taken – An HVAC contractor repaired ACU-14.
Date Improvement Completed – March '01

21 Rooftop HVAC units need periodic tune-ups

Finding Description

All packaged HVAC units should be tuned on a regular basis.

General Finding Impacts

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

Recommendation

The recommendation is made to have all packaged HVAC units tuned 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 systems 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-up 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. 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 5°F on all the units (100% x 1.0% x 5°F), for a total estimate of 8% energy savings. This measure is mutually exclusive with Measure 15 - Replace Rooftop AC Units.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	28,122 kWh/yr	Estimated Annual Cost Savings -	$3,559
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$5,855
Estimated Annual Natural Gas Savings -	0 Therm/yr	Simple Payback (yrs) -	1.6

Implementation Plan

An HVAC contractor should be contacted to perform the work. 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 -	Interviews with facility staff

Owner Action

Action Code – Measure Implemented
Action Taken – An HVAC contractor tuned the rooftop package units.
Date Improvement Completed – May '01

22 Walk-in refrigeration units need periodic tune-ups

Finding Description

All walk-in refrigeration units should be tuned on a regular basis.

General Finding Impacts

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

Recommendation

Our recommendation is to tune the walk-in refrigeration compressors on a regular basis. A system tune-up includes checking refrigerant charge, proper adjustment of thermal expansion valve, and maintaining the lowest possible condensing pressure. Recent studies indicate that many refrigeration systems are improperly charged, or have other system deficiencies, resulting in reduced efficiency and system capacity, and energy savings associated with an overall system tune-up 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. For our calculations, we will assume that the refrigeration compressors at the facility may be improperly charged (5% savings) and the average condensing temperature could be reduced by 5°F on all the units (100% x 1.0% x 5°F), for a total estimate of 10% energy savings.

Estimated Economic Impact Summary

Estimated Annual Energy Savings -	3,498 kWh/yr	Estimated Annual Cost Savings -	$334
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$586
Estimated Annual Natural Gas Savings -	0 Therm/yr	Simple Payback (yrs) -	1.8

Implementation Plan

A refrigeration contractor should be contacted to perform the work. 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 -	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 – Measure Implemented
Action Taken – A refrigeration contractor tuned the refrigeration compressors.
Date Improvement Completed – May '01

23 Vending machines operate 24 hours per day

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

General Finding Impacts

Energy Savings -	Yes	Natural Gas 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 or putting a timer on the lights so that they shut off at night would save energy. 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 Natural Gas Savings -	0 Therms/yr	Simple Payback (yrs) -	0.0

Implementation Plan
Since the vending machines are owned (or leased) by the vending provider, both parties need to come to agreement 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 vending machines lights are turned off 24 hours a day. The temperature was not adjusted.
Date Improvement Completed – April '01

24 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	Natural Gas 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 incentives to facility staff to come up with innovative ways to conserve energy on a daily basis. Education could include such things as workshops or even 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 -	16,906 kWh/yr	Estimated Annual Cost Savings -	$2,257
Estimated Peak Demand Savings -	0 kW	Estimated Implementation Cost -	$650
Estimated Annual Natural Gas Savings -	910 Therm/yr	Simple Payback (yrs) -	0.3

Implementation Plan
We assume that training and workshop resources could be available free of charge from the local utility but to be conservative we have estimated a cost of $500 (before O&P and taxes) for consulting services to train and implement a program.

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 – Employees were reminded to keep lights off when not in use, but no formal program has been implemented.
Date Improvement Completed - NA

IMPLEMENTATION OF RECOMMENDATIONS

IMPLEMENTATION

Facility staff decided which measures to implement. PECI, within their current scope with IMT, provided some limited assistance during implementation. In the state of California all projects must receive permits

and approval from the Office of State-wide Health Planning and Development (OSHPD) agency prior to 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. PECI offered limited assistance to the owners in satisfying the criteria required by OSHPD. Once approval has been received from OSHPD, the Facility performed some of the work themselves and contracted out some of the work.

PRIORITIZATION OF RECOMMENDATIONS

Each measure has been 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 will assist the owner in determining the order in which these findings might be implemented.

IMPLEMENTATION OPTIONS EXPLAINED

There are many ways a measure can be implemented. The owner can usually implement low-cost measures in-house 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. There also may be several different equipment options to consider, service contracts, measurement & verification, design, project management or other requirements to consider. If the owner has any preferences to, or is not in agreement with, what is stated in the implementation plan or elsewhere in this report, the owner is encouraged to contact PECI for discussion concerning possible modification of the approach.

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 IPMVP (International Performance Measurement and Verification Protocol) Option C – 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 show 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.

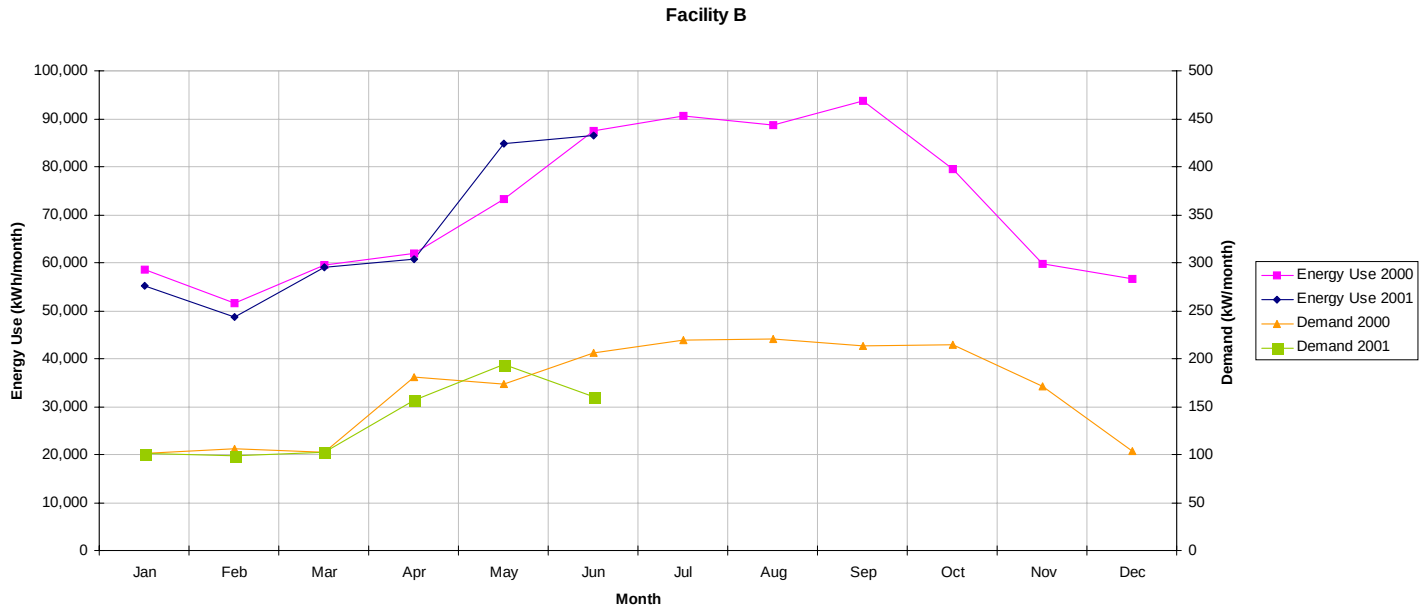
3) Compare usage before the study with post-retrocommissioning usage. Differences in energy use are likely attributable to the study and resulting implemented measures assuming there are no significant weather and facility operation differences.

MEASUREMENT & VERIFICATION RESULTS

As can be seen in the graph below, energy use and peak demand did not decrease significantly after the retrocommissioning study. This is expected, however, because although the study took place in November 2000, many of the recommendations were not implemented until May, June and July of 2001.

In addition, cleaning the outside air intakes in March increased air flow. This likely resulted in increased energy use. Increased air flow requires more energy because a larger volume of air needs to be cooled and circulated through the facility. Cleaning the air intakes was essential, however, to meet air quality requirements.

It appears that the energy savings resulting from the measures implemented in March, April and May roughly balance the increase in energy use resulting from the increased ventilation rates. Since the measures implemented in June and July account for roughly half of the predicted energy savings, additional energy and demand savings should be seen in upcoming energy bills.



MAINTENANCE OF SAVINGS

IMPLEMENTATION PERSISTENCE

Continued maintenance of savings is a key 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 amount net positive cash-flow of savings 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 be reached through 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

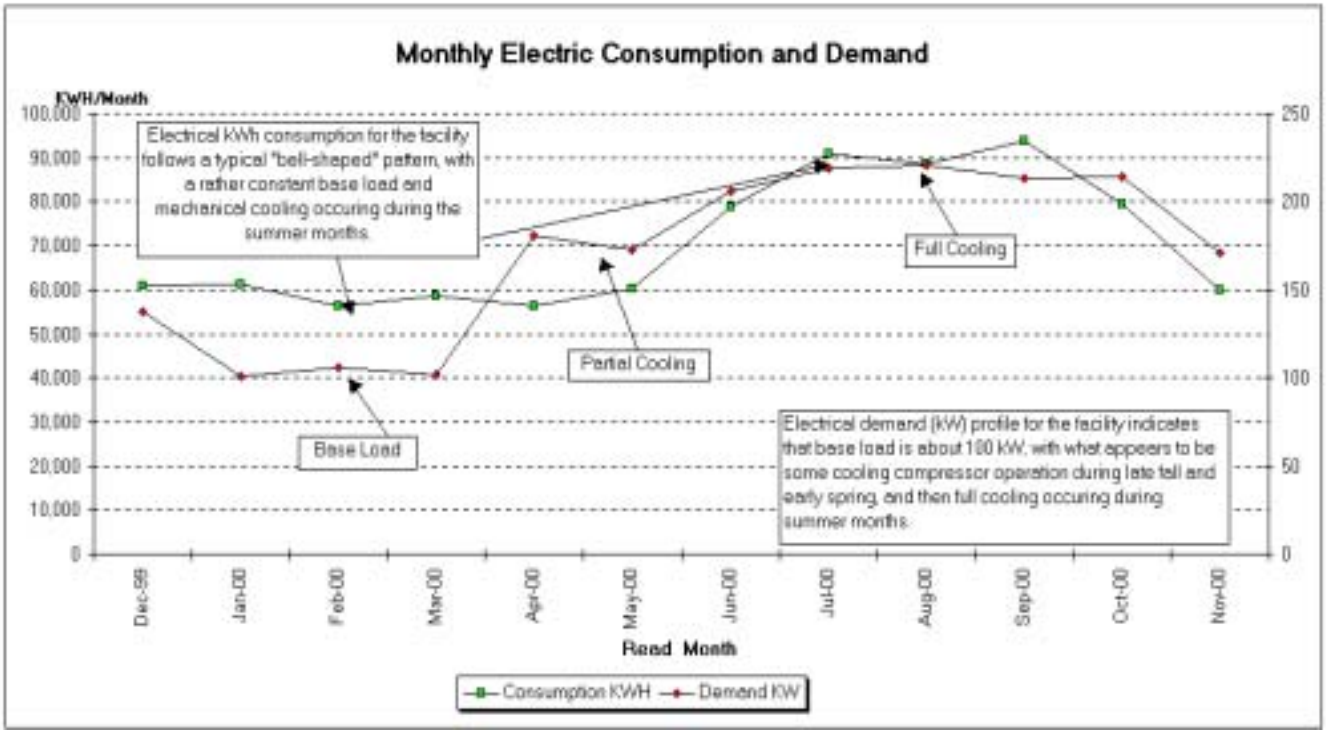
APPENDIX A. PHOTOS

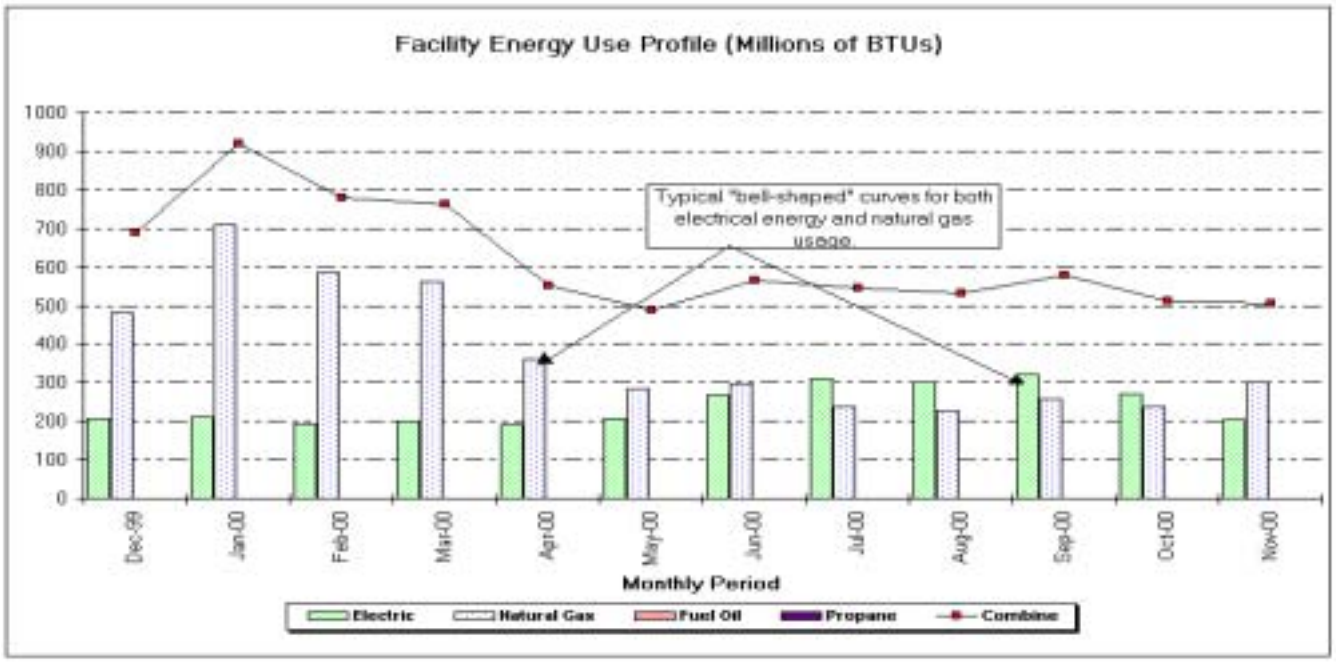
Typical air filters

Typical Fire Damper in each HVAC System

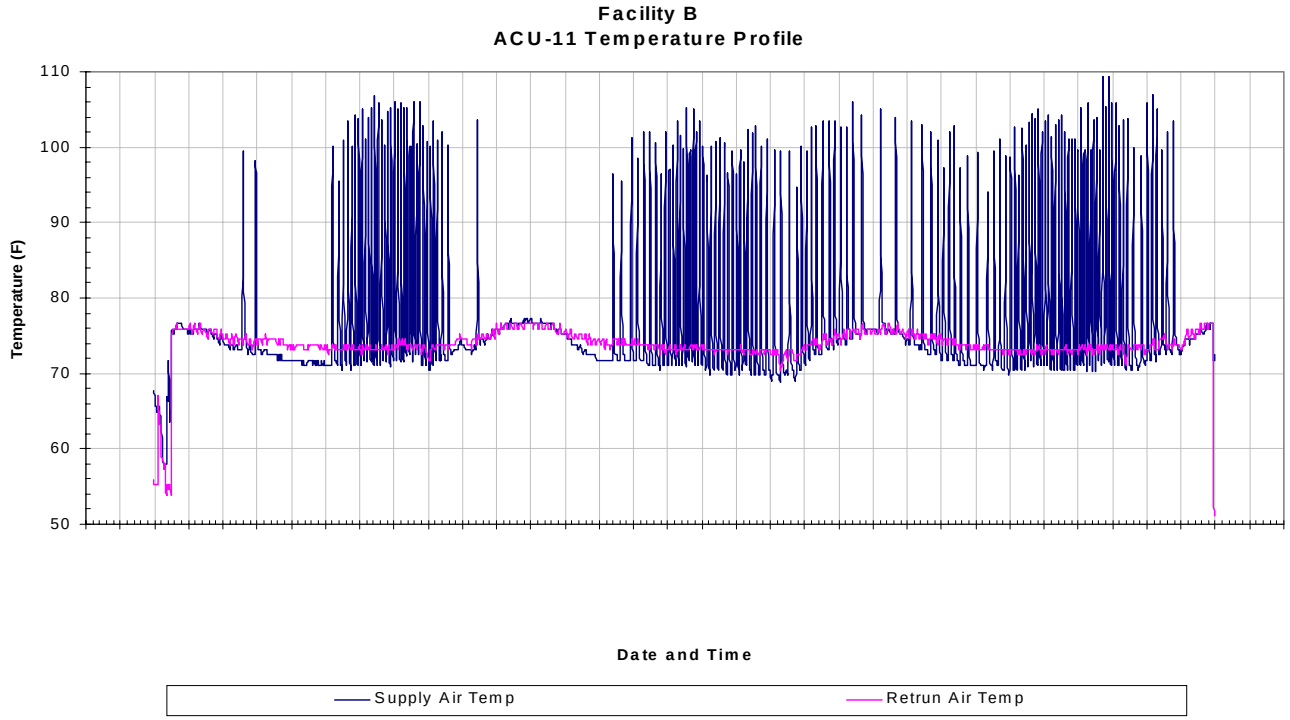
Typical HVAC System

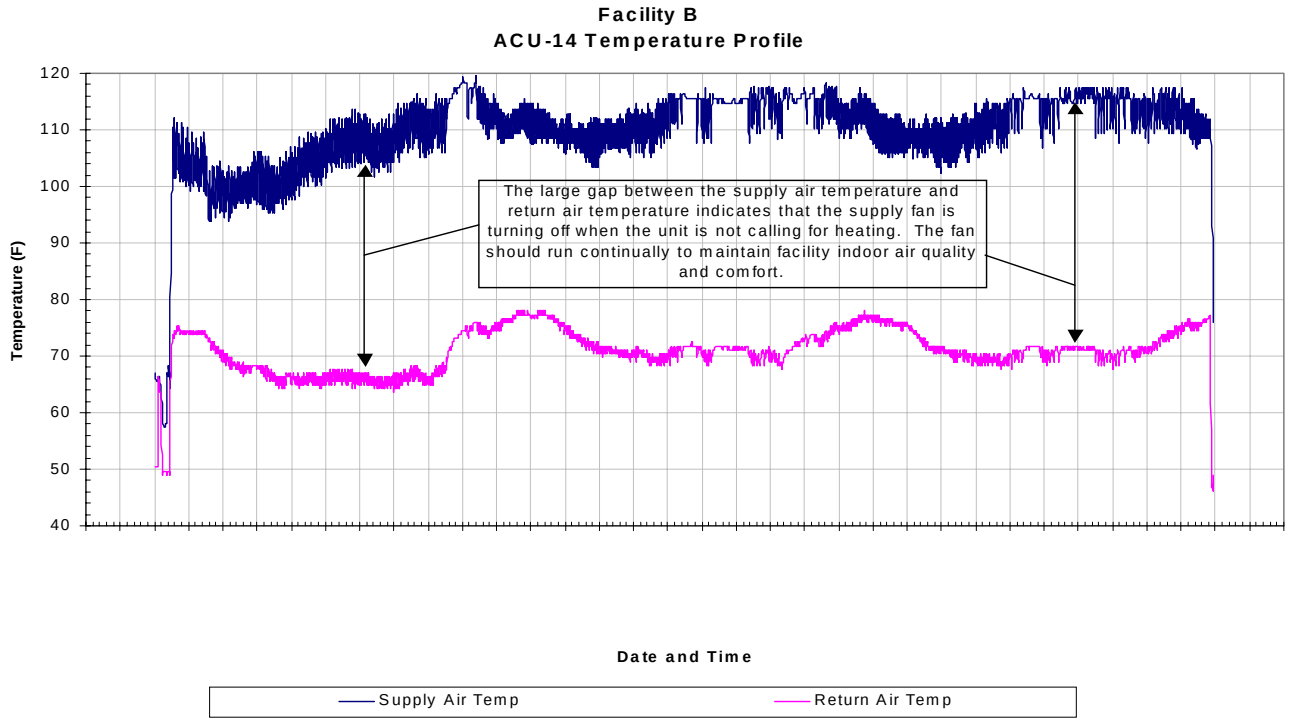
APPENDIX B. UTILITY HISTORY ANALYSIS FIGURES

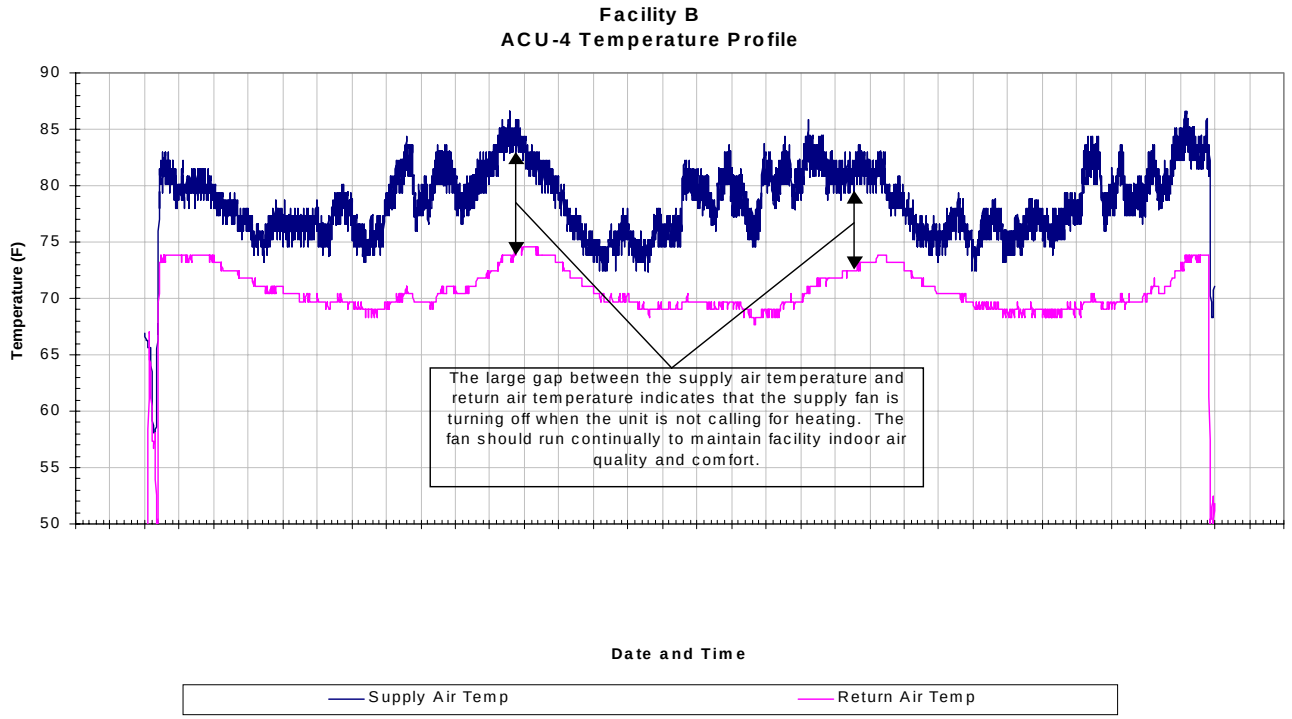


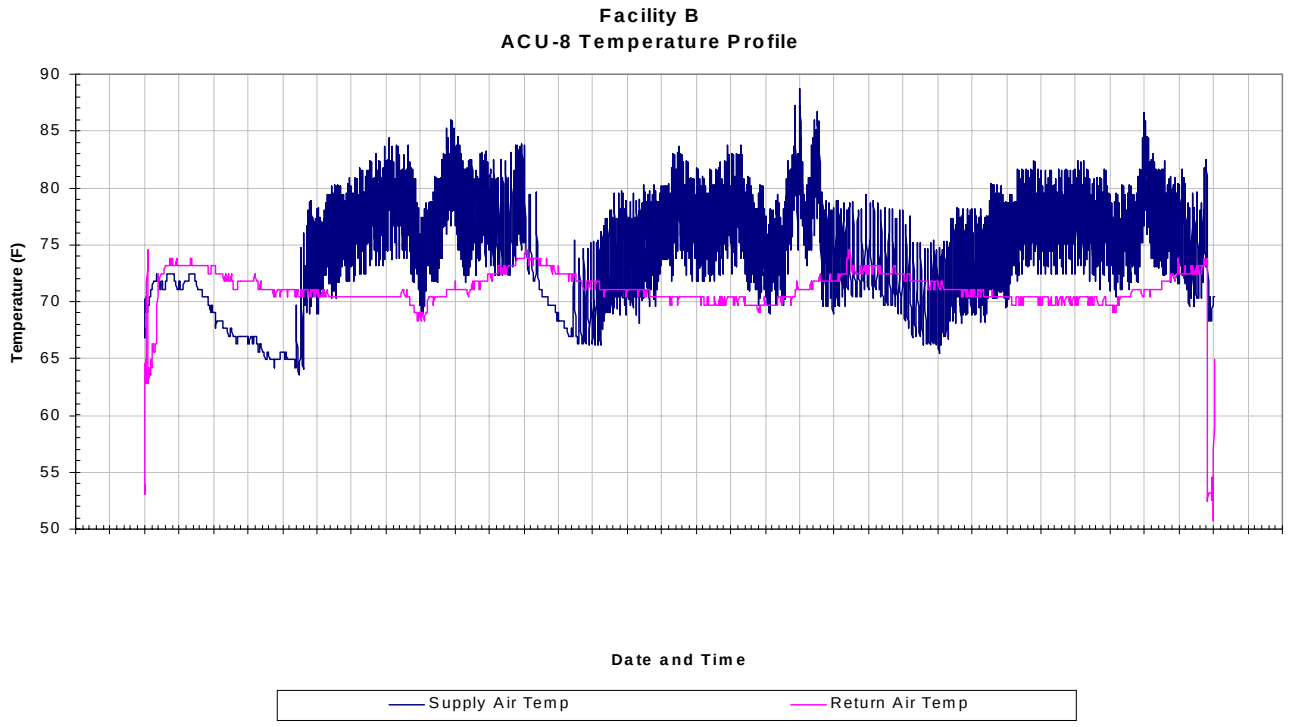


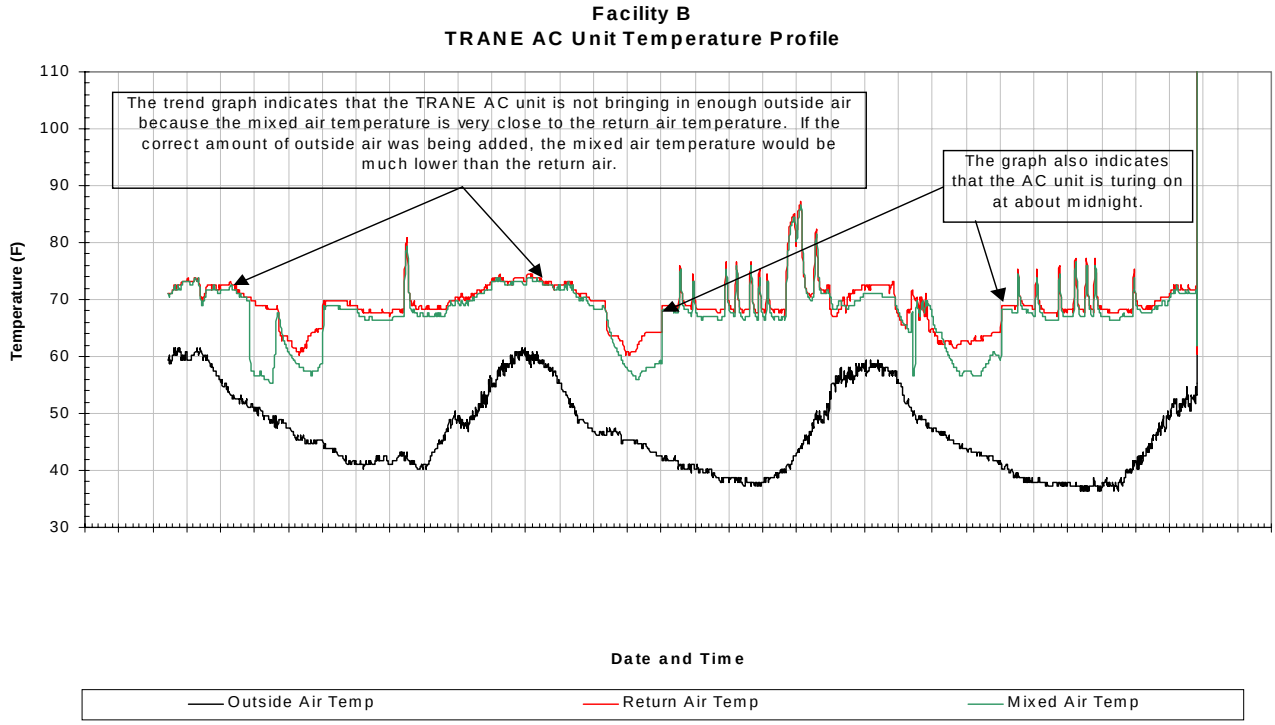
APPENDIX C. DATA LOGGING TREND ANALYSIS FIGURES






Facility B
ACU-4 Temperature Profile
Temperature (F)
90
85
80
75
70
65
60
55
50
The large gap between the supply air temperature and return air temperature indicates that the supply fan is turning off when the unit is not calling for heating. The fan should run continually to maintain facility indoor air quality and comfort.
Date and Time
Supply Air Temp
Return Air Temp


Facility B
ACU-8 Temperature Profile
Temperature (F)
90
85
80
75
70
65
60
55
50
Date and Time
Supply Air Temp
Return Air Temp


Facility B
TRANE AC Unit Temperature Profile
The trend graph indicates that the TRANE AC unit is not bringing in enough outside air because the mixed air temperature is very close to the return air temperature. If the correct amount of outside air was being added, the mixed air temperature would be much lower than the return air.
The graph also indicates that the AC unit is turing on at about midnight.
Temperature (F)
110
100
90
80
70
60
50
40
30
Date and Time
Outside Air Temp
Return Air Temp
Mixed Air Temp