Identification and Analysis of Energy Efficiency Measures at -------------------- facility --------------------

Prepared by:

-------------------- auditor --------------------

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EXECUTIVE SUMMARY

The purpose of this report is to identify and analyze energy efficiency measures (EEMs) at ----- facility ----- as part of the Pacific Gas & Electric (PG&E) Audit Program. The fourteen-story office building is approximately fifty years old and has 270,000 square feet of conditioned space. The audit results indicate that implementation of four EEMs could achieve annual energy savings of 977,000 kWh with an annual value of $156,000. The total on-peak kW demand reduction for the four measures is 362 kW. The estimated implementation cost of these EEMs is $576,000 without Standard Performance Contract (SPC) incentives. The four EEMs identified during the audit include:

1. Installation of a new high-efficiency chiller with a variable-speed-drive (VSD).
2. Conversion of constant volume air-handler units (AHUs) to variable volume systems.
3. Replacement of T12 fluorescent lights & magnetic ballasts with new T8 fluorescent lights & electronic ballasts. Replacement of incandescent exit signs with LED signs.
4. Installation of occupancy sensors to control the lights in spaces of varying occupancy such as private offices, restrooms and conference rooms.

The first EEM provides for installation of a new high efficiency chiller equipped with a VSD. The estimated simple payback for this measure, including an SPC incentive payment of $34,856, is 3.0 years. The second EEM calls for conversion of constant volume air handling units (AHUs) and has an estimated simple payback of 5.0 years. This simple payback period is based on receipt of an SPC incentive payment of $8,200. Note that the SPC incentive for this measure includes a kW demand incentive that is only available for measures installed prior to December 1, 2004. The third EEM involves an efficiency upgrade of a portion of the lighting system in the building. The estimated simple payback of this measure, including a $22,999 incentive payment is 3.5 years. Finally, the fourth measure calls for installation of occupancy sensors to reduce lighting operation in spaces with varying occupancy such as private offices, restrooms and conference rooms. The simple payback for this measure is 2.1 years after an incentive payment of $1,875 is applied. Typically, measures involving lighting systems such as the third and fourth measures are implemented simultaneously. Thus, when the savings and cost estimates for these two measures are combined, the simple payback becomes 3.3 years.

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PG&E AUDIT PROGRAM

The PG&E Audit Program was designed to identify Energy Efficient Measures (EEMs), which would provide significant energy savings to the customer. Furthermore, these EEMs are analyzed to determine if they are eligible for either the PG&E Standard Performance Contract (SPC) or the San Francisco Peak Energy Program (SF PEP). The SPC program provides an incentive to the customer based on the measure's proposed annual energy savings. SF PEP provides incentive payments for some EEMs on a per unit basis. Both of these programs are designed to help defray the upfront project costs associated with implementing the EEM.

An audit typically starts with a survey of the project site. The auditor assesses the equipment, systems, and operations at the site to identify any EEMs with energy savings potential. The site Facilities Manager is also interviewed to clarify the site information and identify any additional EEMs.

The auditor then narrows the list of EEMs to include only those that are feasible and have reasonable payback periods. For each of these EEMs the annual energy and kW demand savings are computed by comparing the estimated energy consumption and demand of the proposed case (after the EEM is implemented) to the baseline consumption (before the EEM is implemented). The auditor may utilize a combination of historical data, site monitoring, handbook calculations, and computer modeling (primarily eQuest) as needed to estimate the annual savings

The auditor also estimates the amount of any applicable SPC or SF PEP incentive payments. SF PEP or SPC program incentive payments are calculated based on measure type. Incentive payments are calculated in one of two ways. For common and measures with easily estimated savings, the incentive payment is on a per unit basis. These include, but are not limited to, most lighting retrofit applications. For more complex measures, SPC incentive payments are calculated based on the estimated kWh savings for the given measure. Incentive payments are calculated by multiplying the estimated annual savings by the applicable incentive rate. Different end-uses require different incentive rates. The following rates were used in the analysis: HVAC (typically involves compressor replacement) measures are paid at $0.14 per kWh; Lighting measures are paid at $0.05 per kWh; and "Other" measures are paid at $0.08 per kWh. Measures that result in natural gas savings are paid at $1.00 per therm. Furthermore, the SF PEP provides an additional incentive of $150 per kW for a kW demand reduction in the Winter Partial Peak Period (December-April, Weekdays 5:00PM-7:30PM).

As noted above, estimated annual energy savings are used to determine the SPC incentive payment. This savings value is an approximation, based on assumptions and/or monitoring data utilized by the auditor. Variables, such as weather conditions and site operations, which were considered at the time of the audit, may change in the future. As such, the customer should understand the limitations in using estimated annual energy savings as a predictor of future site energy consumption.

Facility Annual Energy Use

The annual electricity consumption at --- facility --- was 4,150,961 kWh during the period of January 2003 through January 2004. A maximum demand of 1,125 kW was recorded during the October 2003 billing period. Furthermore, the annual average unit cost was approximately $0.16 per kWh. These figures were derived from the electric bill usage summary (see Table 1) provided by --- name --- of PG&E.

Table 1: Electricity Usage

Month Year	Peak Demand (kW)	Energy Usage (kWh)	Average Daily Usage (kWh)	Total Cost w/ Taxes ($)	Unit Cost ($/kWh)
January 2003	NA	302,669	9,458	$38,180	$0.1261
February 2003	NA	315,054	10,502	$40,194	$0.1276
March 2003	NA	323,457	10,108	$40,354	$0.1248
April 2003	953	311,517	10,742	$39,664	$0.1273
May 2003	950	324,567	10,819	$50,727	$0.1563
June 2003	958	344,044	11,468	$65,305	$0.1898
July 2003	1,057	361,684	12,056	$69,947	$0.1934
August 2003	1,055	354,240	11,808	$69,200	$0.1953
September 2003	1,116	406,332	13,544	$76,533	$0.1884
October 2003	1,125	383,296	12,777	$74,232	$0.1937
November 2003	1,066	380,194	12,673	$62,902	$0.1654
December 2003	875	343,907	11,464	$42,465	$0.1235
Total		**4,150,961**	**11,435**	**$669,702**	**$0.1613**

The annual gas usage between 9/14/01 and 9/16/02 was 95,732 therms. This was the most recent data available (see Table 2 for monthly breakdown) at the time of the audit.

Table 2: Natural Gas Usage

Initial Date	Final Date	Gas Usage (Therms)	Average Usage (Therms/Day)	Gas Cost ($)	Unit Cost ($/Therm)
9/14/01	10/15/01	6,054	195	2,389	$ 0.39
10/15/01	11/14/01	7,053	235	2,697	$ 0.38
11/14/01	12/14/01	9,574	319	5,290	$ 0.55
12/14/01	1/15/02	10,393	325	6,504	$ 0.63
1/15/02	2/14/02	12,603	420	7,136	$ 0.57
2/14/02	3/18/02	9,801	306	4,775	$ 0.49
3/18/02	4/16/02	8,349	288	4,117	$ 0.49
4/16/02	5/16/02	8,394	280	4,225	$ 0.50
5/16/02	6/17/02	8,953	280	4,245	$ 0.47
6/17/02	7/17/02	2,875	96	1,443	$ 0.50
7/17/02	8/15/02	5,427	187	2,572	$ 0.47
8/15/02	9/16/02	6,256	196	3,136	$ 0.50
	Total	**95,732**	**261**	**48,529**	**$ 0.51**

SUMMARY OF MEASURES

The following four energy efficient measures (EEMs) were identified:

EEM #1: Replace one of the two existing 530 ton chillers with a new centrifugal 530 ton chiller with the remaining chiller used as a backup only. Additionally, equipping the new chiller with a variable speed drive (VSD) will provide additional savings. An SPC incentive can be used to offset the increased initial cost of the VSD.

EEM #2: Convert the constant volume air handler units to variable volume systems. Many of the air handling systems have already been converted. This measure provides for conversion of the remaining constant volume air handlers.

EEM #3: Replace the magnetic ballasted T-12 lamps and incandescent lamps with more efficient T-8 (electronic ballasts) and compact fluorescents. Many of the building lighting systems have already been replaced. This measure provides for upgrade of inefficient lighting that remains. Additionally, this measure provides for replacement of the existing incandescent exit signs with LED signs.

EEM #4: Install occupancy sensors to control the lights in spaces of varying occupancy, such as private offices, restroom and conference rooms. A wall switch motion sensor detects when the space is unoccupied for an extended period of time. If the lights were left on, the control device will turn them off. Thus, the lighting hours of operation are reduced.

The EEM study results are summarized in the table below:

Table 3: Summary of EEM Analysis

EEM	Description of Measure	Peak-Period Demand Savings (kW)	Annual Energy Savings (kWh)	Annual Utility Cost Savings[1]	Estimated Measure Cost	SF PEP SPC Incentive[2]	Simple Payback with SF PEP SPC	Simple Payback without SF PEP SPC
1	Chiller Retrofit[3]	230	603,700	$96,592	$305,533	$34,856	3.0 Yrs	3.4 Yrs
2	VSD on Fans	20	65,000	$10,400	$60,000	$8,200	5.0 Yrs	5.8 Yrs
3	Lighting Efficiency	56	126,163	$20,186	$94,294	$22,999	3.5 Yrs	4.7 Yrs
4	Lighting Controls	0	27,985	$4,478	$11,130	$1,875	2.1 Yrs	2.5 Yrs
3 & 4	Lighting System	56	154,148	$24,664	$105,424	$24,874	3.3 Yrs	4.3 Yrs
Totals		362	976,996	$156,320	$576,381	$92,804	3.1 Yrs	3.7 Yrs

1) Average cost of $0.16 per kWh was used for this calculation
2) Includes Winter Peak kW Reduction incentive where applicable
3) For Chiller System #2. See Description of Energy Efficiency Measures for the specifics of this system.

Recommendations

Installation of a high efficiency chiller equipped with a VSD, EEM#1, has the largest estimated kWh savings and an associated short payback period. This measure is highly recommended. EEM#2, which calls for conversion of constant volume air handlers, has an estimated payment, 5.0 years. This simple payback period is lengthy but may decrease if the implementation cost estimates can be refined, based on previous air-handler conversions in the building. Lighting system upgrades like those recommended in EEM#3 and EEM#4 are often implemented simultaneously. The simple payback of 3.3 years for these two measures (with SF PEP SPC) indicates that these measures are warranted.

Description of Facility

The building at --- facility address --- is located in ---------- area of city ---------- . Building operation is consistent with that of a typical office building. The building has a total of fourteen floors with a penthouse above grade and one floor below. The conditioned area (cooled and heated) is approximately 270,000 square feet. The rectangular shaped building has a length to width ratio of approximately three to one and is oriented with the south and east faces receiving significant solar gain. A neighboring building shades the west face.

The basement includes the central plant equipment, engineering services, some office spaces, and a 24-hour fitness locker room. The office space consists of a document copying center and includes several photocopy machines. Thus, including the fitness area, significant HVAC is required for the below grade floor. Additionally, the building storage space, mechanical engineers workshop and stock rooms are located in this area.

The first floor consists of a lobby area, retail space that includes a coffee shop, copy center, barber and hair stylist, cellular phone retailer and a 24-hour fitness center. The lobby has a high ceiling, a common office building feature. There is only one entrance to the office portion of the building, which is all glass and faces south.

The second through fourteenth floors consist of tenant office spaces. Most floors have a dedicated AHU. The eleventh floor has the remaining mechanical equipment including the elevator room.

Each side of the building has a window area of approximately 75%. The windows are single paned, one-quarter inch glass. Window film has been applied to the east and south faces to reduce the solar gain into the building. Additionally, all windows have operable horizontal blinds.

Description of Mechanical Plant

<u>Central Plant</u>
The central plant mechanical equipment is located in the basement. This area contains the majority of the mechanical equipment for the building. There are two (2) identical 530 ton York centrifugal chillers (Model #L95). These chillers were built in the late

1950's and are the original cooling equipment for the building. The chillers operate in a typical lead/lag fashion to provide chilled water to the air handling units (AHUs). According to the building engineer, one chiller is able to meet the required building cooling load on the hottest San Francisco days. The chilled water (CHW) system provides CHW to all the fan coil units, with the flow varying with demand. The two CHW loop pumps are identical Reliance 60 HP pumps.

The cooling tower located on the roof is an open tower linked to a heat exchanger in the basement to take advantage of free cooling in the mild San Francisco climate. For redundancy purposes, two (2) Reliance 60 HP condenser water pumps circulate the water.

Two (2) Lamont TJW80 (8,000,000 Btu/hr input) natural gas space heating boilers built in 1958 provide the heating for the building. Typically, only one boiler is in operation, with the other serving as a backup. These boilers deliver hot water to a number of fan coil units dedicated for each floor. All four pumps are rated at three (3) HP. The primary pumps are US Motors, Identification numbers 2805073 and 2806434. The secondary pumps are powered with identical Reliance motors (model number of 21A1A-MH).

Cold water is delivered throughout the multi-story building by three 7.5 HP pumps that operate in series. At the peak water usage, only two pumps are required to supply the necessary head, with the third pump used as a backup.

Adjacent to the space heating boilers are two smaller natural gas-fired boilers utilized for domestic hot water needs throughout the tenant spaces and the restrooms. This hot water loop is a primary-secondary type system. The primary loop circulator is a two (2) HP, high efficiency pump. Two Bell & Gossett one-half (1/2) HP pumps recirculate the loop water to maintain hot water at all times in the building.

Air Delivery System

Fresh air is delivered throughout the building via a dual duct system with a multi-zone AHU fan system. Fans serving the interior zones on eight (8) floors are controlled with VSDs while the remaining six (6) floors have constant volume fans. The variable fan systems have VAV boxes that control the amount of recirculated air. The Carrier 7.5 HP VSD equipped AHUs have been installed as floors have been remodeled and are identical units.

The constant volume fan systems are not identical and range in capacity. One seventy five (75) HP supply fan serves the perimeter zones for the third through the thirteenth floors. The fans for other zones range in size from five (5) to fifteen (15) HP. Exhaust fans are typically thirty (30) HP.

DESCRIPTION OF ENERGY EFFICIENCY MEASURES

There were four energy efficiency measures (EEMs) identified for the office building:

EEM #1 Chiller Retrofit

Replace one of the existing original chillers. Two options were considered in the analysis. One option called for a straight chiller retrofit. The second option included the chiller retrofit but also included installation of a VSD on the new chiller.

San Francisco is known for having a mild climate with few hot days in the year. Thus, the cooling equipment operates partially loaded much of the time. Both chillers at the facility are still the original equipment for the building and date from the 1950s. Chiller part load efficiencies have improved greatly in recent years making a retrofit of this equipment highly desirable.

<u>EEM#1 Option #1: Chiller Retrofit Only</u>

Since the maximum building load can be supplied by a single chiller; this EEM would provide for replacement of only one of the two existing chillers. Thus, the other original chiller would remain to serve as a back-up. The proposed centrifugal chiller for this retrofit would be a multiple stage unit with a total capacity of 530 tons. With this type of chiller, the chiller can, at any given time, alternate the internal compressor configuration to optimize the efficiency under varying cooling loads.

Advantages of this chiller option include more efficient chiller operation at all loads, especially part load, which would provide significant energy savings. The main disadvantage is the difficulty of the installation. The chillers are located in the basement and centrifugal chillers must be delivered with mostly assembled parts making the installation a time consuming and complex process.

<u>EEM#1 Option #2: Chiller Retrofit with VSD</u>

Another and even more efficient method, to provide cooling to the building is to modify the new chiller with a VSD. As with the first option, the other original chiller should remain and serve as a back-up only. The proposed centrifugal chiller for this retrofit would be a multiple stage system with a total capacity of 530 tons. Centrifugal chillers are already one of the most efficient low-load cooling options and the addition of a VSD provides even greater part load efficiency.

Advantages and disadvantages of this chiller option are similar to that of the first option with the exception that even greater part-load efficiency can be attained with the VSD equipped chiller.

An eQuest computer simulation model was developed to estimate specific end-use consumptions, annual building cooling load and electricity usage. Inputs for the computer simulation include building envelope characteristics (window area, footprint, thermal efficiency values, etc), the mechanical equipment data inputs, lighting load, operating schedules, and other building data. These data were based on the architectural, mechanical plans as well as interviews with facility engineers and inspection of equipment nameplate data.

The eQuest model was developed and refined so that the projected building annual electricity usage matched the metered electricity usage in the past year. Additionally, the end-use consumption estimates generated by the model were cross-referenced for reasonableness against typical office building benchmarking data provided in the 1999 Commercial Building Energy Consumption Survey results. The eQuest output results as well as the actual input files are available upon request

An eQuest model was developed to estimate the annual building energy use using each of the two chiller retrofit options noted above. The full load efficiency for the retrofit chiller in each case was assumed to be 0.55 kW/ton. Project costs for each option were estimated based on RS Means cost data. The applicable SPC incentive was also calculated based on the estimated savings. However, it is important to note that the baseline for the SPC incentive is the minimum efficiency standard as defined by Title 24. Title 24 chiller efficiencies have increased substantially in recent years making the retrofit chiller proposed by this EEM only marginally better than the Title-24 chiller standard. Thus, the SPC incentive for the first chiller retrofit option #1 is not very high. However, the additional improvement in part-load efficiency provided by the VSD retrofit results in an SPC incentive for chiller option #2 that exceeds the estimated increase in project cost for the installation of the VSD. This makes the option that includes the VSD even more attractive, with a simple payback of 3.0 years. The savings and financial analysis results were summarized in Table 3 earlier in this report.

EEM #2 Variable Speed AHUs

Convert the constant volume AHUs to variable volume systems.

Upon initial construction of the building, all floors and air handling systems were constant volume systems. As some floors and spaces have been built out for new tenants, some of this equipment has been replaced with new variable volume systems. VAV boxes are used to control the return air and new VSD equipped AHUs have replaced the original constant volume fans serving the internal zones. Constant volume fans still remain serving the interior zones on six (6) floors.

This EEM proposes to replace the remaining constant volume systems with VAV systems with VSD equipped AHUs. The proposed units are identical to the units already in use on the previously retrofitted floors. Use of identical equipment will facilitate installation as well as provide for more cost effective operation and maintenance activities.

An eQuest computer simulation model was developed to estimate specific end-use consumptions, annual building cooling load and electricity usage both with and without the proposed EEM. Inputs for the computer simulation include building envelope characteristics (window area, footprint, thermal efficiency values, etc), the mechanical equipment data inputs, lighting load, operating schedules, and other building data. These data were based on the architectural, mechanical plans as well as interviews with facility engineers and inspection of equipment nameplate data.

The eQuest model was developed and refined so that the projected building annual electricity usage matched the metered electricity usage in the past year. Additionally, the end-use consumption estimates generated by the model were cross-referenced for reasonableness against typical office building benchmarking data provided in the 1999 Commercial Building Energy Consumption Survey results. The eQuest output results as well as the actual input files are available upon request.

Conversion of constant volume fans to VAV is an often applied efficiency measure and the eQuest model easily accommodates analysis of this option. Thus, the model was run to estimate the savings of this EEM. In addition, the savings were substantiated with the Quickfan simulation software. This simulation software estimates the energy consumption for various fan types based on sizes and default operating characteristics. Since, the Quickfan software is not as flexible as eQuest with regard to building operating parameters the program was only used to corroborate the eQuest results.

The simulation software estimated the annual energy and utility bill savings for this measure as 65,000 kWh and $10,400, respectively (shown previously in Table 3). RS Means data were used to estimate the measure costs at approximately $12,000 per floor. Using the estimated savings and measure costs and including an estimated $8,200 incentive payment yields a relatively long 5.0 year simple payback period. However, many factors such as number of zones and complexity of ductwork can influence the overall costs for the implementation of a VAV fan system. The RS Means based cost estimate used in the analysis is a rough estimate that does not account for site specific factors such as these. Therefore, a more accurate estimate based on costs incurred for the previous VAV retrofits could be used to refine the payback estimate. Care should therefore be taken in the evaluation of the economic feasibility of this measure.

EEM #3 Lighting Efficiency Retrofit

Replace the remaining magnetic ballasted T-12 fluorescent lamps with more efficient T-8 (electronic ballasts) lamps and incandescent lamps with compact fluorescents. Additionally, replace the existing incandescent exit signs with LED signs.

The building has been retrofitting the lighting equipment with more efficient fluorescent fixtures as floors and tenant spaces get remodeled. However, there are still many areas equipped with inefficient T-12 lighting fixtures. Most of these areas are located in the basement, fifth, sixth and fourteenth floors. A retrofit of these fixtures typically reduces the kW demand and energy consumption by 40%.

Incandescent fixtures are located throughout the facility. A retrofit to compact fluorescent fixtures will yield the same lighting output with energy savings of 60 to 70%. In many instances, these fixtures are located in low use spaces such as mechanical rooms, restrooms and storage areas, which reduces the overall savings potential. Therefore, although a retrofit to a compact fluorescent fixture is recommended, the kWh savings for this change-out are modest.

Exit signs that are illuminated with dual incandescent lamps are located throughout the facility. These fixtures total either thirty (30) or forty (40) Watts per fixture depending on the model. In comparison, the kW demand of the retrofit LED fixture is less than seven (7) Watts. Since state law requires these fixtures to operate continuously, the kWh energy savings are significant.

The T12 lighting fixtures are located in both occupied tenant suites and non-tenant areas, such as halls, stairwells and mechanical spaces. Retrofit of the T12 fixtures would therefore inconvenience the tenants and as such, it may be in the best interest of the property owners to implement the measure in the non-tenant areas first with retrofits in tenant spaces occurring as leases expire or when spaces are vacant.

Savings were estimated based on fixture types and counts noted during the audit. Using standard fixture wattage ratings and typical usage patterns, the total annual savings for this measure was estimated to be 126,925 kWh (see Appendix A for calculations). Incentive payments are available on a per unit basis from the SF PEP SPC Program. Additionally, a Winter Partial Peak Demand Reduction incentive can be applied if the measure is installed prior to December 1, 2004. Table 4 below summarizes the applicable incentive payments. As shown previously in Table 3, the simple payback for this measure is 3.5 years including all applicable incentive payments.

Table 4: Summary of Incentives for Lighting Efficiency Measures

Measure Description	Incentive per Unit	Total Incentive
LED Exit Sign	$30.38/Fixture	$1,822.80
Two Foot T-8 Fluorescent Lamps	$4.31/Lamp	$17.24
Three Foot T-8 Fluorescent Lamps	$4.25/Lamp	$314.50
Four Foot T-8 Fluorescent Lamps	$7.69/Lamp	$16,541.19
Compact Fluorescent Lamps	$4.88/Lamp	$390.40
	Total	**$19,086.13**

EEM #4 Lighting Controls

Install occupancy sensors to control the lights in spaces of varying occupancy, such as private offices, restroom and conference rooms. A wall switch motion sensor detects when the space is unoccupied for an extended period of time and turns off any lights that may have been left on. Thus, occupancy sensors reduce the lighting hours of operation.

To estimate savings it is necessary to estimate the hours of operation both with and without the occupancy sensors. Typical hours of operation were applied to each space type with an assumed 15% reduction in the hours of operation, which is consistent with those used in statewide efficiency programs. Using standard fixture wattage ratings, the total annual savings for this measure was estimated to be 27,985 kWh (see Appendix A for calculations). This equates to an annual electricity cost savings of $4.477.60 when the building average electricity rate of $0.16 per kWh is applied. This measure is eligible for SF PEP Program incentive payments of $18.75 per fixture, resulting in a total incentive of $1,875.00.

The cost to purchase and install the occupancy sensors was estimated to be $11,130.00 using PUC database data for this type of measure. Therefore, the simple payback of this measure with and without the applicable SFPEP SPC incentive is estimated to be 2.1 years and 2.5 years, respectively.

DEMAND REDUCTION

The ability to reduce load during high demand periods continues to be one of the biggest challenges to customers in California and across the country. This is especially true for the San Francisco area due to local power plant issues in ---------- city area ---------- . The -name- Power Plant is scheduled to be removed from service next fall. To reduce the impact of this loss in local generation the city and PG&E are focusing attention on a continual and consistent reduction of peak period energy demands. The San Francisco Peak Energy Program (SF PEP) was initiated by the City of San Francisco to directly address this kW demand reduction problem.

Historically, San Francisco experiences peak electricity demand during hot afternoons when commercial air conditioning systems are in full operation. Though the statewide peak typically occurs in the late afternoon on a summer day, San Francisco experiences its hottest days in late spring or the fall, not during summer. Also given the more temperate climate, the peak kW demand in San Francisco is of shorter duration and occurs earlier in the day, typically between noon and 2:00 PM.

Additionally, San Francisco has a unique winter evening peak that, in some years, is greater than the hot afternoon peak. At 5:00 PM, as workers go home from office buildings, the buildings remain lit for those who remain and for janitorial work. Thus, the commercial demand drops slowly. However, the residential demand skyrockets as those same workers go home, to turn on lighting, heating, and appliances. In particular on cold evenings, 80-90 MW of electric resistance heating comes on creating a substantial peak until approximately 7:30 PM when the commercial loads drops more quickly, and the residential load levels off.

Given the unique electric demand characteristics of the San Francisco area the SF PEP strives to encourage consistent kW demand reduction in periods corresponding to the PG&E statewide Summer Peak period (May 1-September 30, Monday-Friday from Noon to 6:00 PM) as well as during the local winter peak period (December 1-April 30, Monday-Fridays from 5:00 PM to 7:30 PM

EEM #1 Chiller Retrofit

The eQuest simulation software was used to estimate the kW demand reduction for this chiller retrofit measure. Demand savings result from the overall improved chiller efficiency during maximum cooling periods. In addition, improved part-load performance due to the presence of the VSD results in lower demand during periods requiring less cooling. This measure therefore provides kW demand reduction during both the summer and winter peak periods. Table 5 summarizes the eQuest demand reduction estimates for the chiller retrofit measure, both with and without the VSD option.

Table 5: Chiller Retrofit Estimated Maximum Monthly Demand Reduction

Month	Demand Reduction for System #1: Chiller w/out VSD (kW)	Demand Reduction for System #2: Chiller with VSD (kW)
January	140	190
February	160	200
March	160	210
April	160	210
May	190	220
June	210	230
July	200	230
August	190	220
September	210	230
October	190	220
November	150	200
December	130	180

EEM #2 Variable Speed AHUs

Typically the conversion of a constant volume air handling system to a variable volume system such as that proposed in this measure does not significantly reduce the demand during the peak usage periods. It is assumed that during the summer and winter peak periods, the building is requiring the highest levels of cooled or heated air-flow, respectively. As such, this measure will not result in significant peak kW demand reduction.

EEM #3 Lighting Efficiency Retrofit

The proposed replacement of existing lighting with more efficient lighting has the effect of reducing the total connected load of the lighting system. A linear fluorescent T-12 to T-8 conversion typically saves 40% of the demand while compact fluorescents provide the same luminosity as an incandescent at 40% of the power. Thus, the kW demand reduction of the T12 fixture and incandescent lamp retrofits estimated to be 60% of the existing load. As noted earlier, there are two types of incandescent exit signs in the building, with either a thirty (30) or forty (40) Watts demand. Replacement of these signs with an LED exit sign would reduce the demand to less than seven (7) Watts.

Based on fixture counts and sizes, the total estimated kW demand reduction for this measure 56.4 kW, representing a 46% reduction. However, it is unreasonable to assume that all these lights would be operating at any given time. Thus, a coincidence factor was applied to realistically estimate the potential peak period kW demand reduction. Applying a relatively conservative coincidence factor of 0.80 results in a kW demand reduction of 45.1 kW.

EEM #4 Lighting Controls

The installation of occupancy sensors in private offices and restrooms conserves energy by reducing the total hours of operation of the lights, not by reducing the kW demand of the lighting. However, given that the occupancy sensors are used to turn off lights that are inadvertently left on, it is likely that much of the savings in the private office spaces will occur during the winter peak period, after occupants have left for the evening.

The total kW of the lighting in private offices proposed for this retrofit is 17.8 kW. If the same 15% reduction factor that was applied in the energy savings calculation is applied to this demand, then the estimated winter peak period kW demand reduction is 2.7 kW. It is assumed that restroom usage will be high enough during this period to eliminate the kW demand reduction potential associated with the installation of restroom occupancy sensors.

DEMAND RESPONSIVENESS PROGRAM

In the upcoming months and/or years, it is quite likely that energy demand in California will exceed the supply during the summer and winter peak periods. Utilities are warning customers of the potential need to quickly shed non-critical loads or face financial penalties. Additionally, real-time energy pricing will likely be in affect within the next few years providing benefits to customers that have the ability to react to swift price fluctuations. The following is a discussion of the reduction of energy demand for the identified EEMs and some additional techniques that could be employed to enhance demand responsiveness.

Interviews with building personnel were conducted to determine potential non-critical loads and other actions that could be taken to enhance a demand responsiveness. The following is a list of potential load shedding techniques:

1) Dual switching is a common lighting control method employed throughout the building that allows tenants to turn off half the lights. Tenants could therefore be notified possibly via e-mail to reduce lighting levels in their suites during curtailment periods. Additionally, building facility personnel could turn off any decorative lighting, such as lobby accent lighting. The maximum lighting kW demand reduction possible using these methods was estimated to be 300 kW using the eQuest simulation. However, this must be considered a maximum value since it is likely that some tenants may not respond. Applying a conservative estimate of 25% tenant participation yields an estimated 75kW demand reduction via this effort.
2) Temperature set-points determine how often a space calls for cooling or heating. As the temperature of the occupied space rises or falls around this set-point, the equipment responds accordingly. Therefore, an adjustment to this set-point will affect HVAC system operation, especially for a short period of time immediately following the set-point change. Studies have shown that human comfort levels are not affected by small temperatures changes (two to three degrees) over short periods. Thus, a control system that adjusts the set-point upward by a few degrees will reduce cooling equipment operation as the building temperature rises. Note

that this operational strategy may not be applicable for all spaces containing critical systems, such as computer centers.

3) Fan and pumps with variable speed drives typically have the ability to adjust the maximum speed set-point. If this set-point is adjusted downward, the fans and pumps would not be allowed to run at full load. Note that this operational strategy may not be reasonably employed in critical spaces that have significant solar gain or where sensitive equipment could be damaged.
4) Office buildings typically have non-essential equipment left on and waiting for use. These typically include, but may not be limited to, photocopy machines, computers not designated to single employees, scanning equipment, and localized printers. A notification to tenants to turn off this equipment for the curtailment period would therefore reduce the overall load. Additionally, in large offices, there are usually several printer stations. Printing could be centralized to a single printer that allows for the remaining printers in the space to be shut down.

Appendix A – EEM Calculations

The following sections describe calculations associated with measures (EEM#3, EEM#4) that did not utilize the eQuest simulation software.

EEM #3 – Lighting Efficiency Retrofit

Example savings calculation for a common T-12 to T-8 retrofit:

<u>Assumptions</u>
1) The retrofit does not affect the use pattern of the lighting equipment.
2) Industry standard average fixture wattages were used as a basis for each lamp/ballast combination.
3) Similar space types were grouped and assigned typical operating hours.
4) For spaces that include both efficiency and controls retrofits, baseline operation is used.

Sample Space – Private Office
Baseline Fixtures – Four foot, T-12, 3 lamp fixtures with magnetic ballasts
Baseline kW/fixture – 0.151 kW
Total Fixtures in Space – Two
Retrofit Fixtures – Four foot, T-8, 3 lamp fixtures with electronic ballasts
Retrofit kW/fixture – 0.083 kW
Annual Operating Hours – 2,400

Savings = (Baseline kW/fixture - Retrofit kW/fixture) * Total Fixtures in Space * Annual Operating Hours
= (0.151 kW - 0.083 kW) * 2 * 2,400 hrs
= 228 kWh

EEM #4 – Occupancy Sensors

Example savings calculation for a common lighting controls retrofit:

<u>Assumptions</u>
1) Operation reductions are based on standard percentages used within the California statewide SPC Program.
2) Industry standard average fixture wattages were used as a basis for each lamp/ballast combination.
3) Similar space types were grouped and assigned typical operating hours and reductions.
4) For spaces that include both efficiency and controls retrofits, retrofit fixture demand is used to avoid double counting.

Sample Space – Private Office
Baseline Operating Hours – 2,400
Retrofit Operating Hours – 1,680

Total Fixtures in Space – Two
Fixture Type – Four foot, T-8, 3 lamp fixtures with electronic ballasts
kW/fixture – 0.083 kW

Savings = (Baseline Operating Hours - Retrofit Operating Hours) * Total Fixtures in Space * kW/fixture

= (2,400 hrs – 1,680 hrs) * 2 * 0.083 kW

= 217 kWh

Appendix B - eQuest Inputs

```
Project 29                                                                                          DOE-B2.2D38c
9/29/2003    13:50:21  BDL RUN  2

REPORT- LV-A  General Project and Building Input                                                             WEATHER
FILE- CZ03RV2 WYEC2
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PERIOD OF STUDY

    STARTING DATE    ENDING DATE    NUMBER OF DAYS


      21 DEC 2003    21 DEC 2003                 1
      21 JUN 2003    21 JUN 2003                 1
       1 JAN 2003    31 DEC 2003               365

SITE CHARACTERISTIC DATA

                                                                         BUILDING
    STATION            LATITUDE  LONGITUDE   ALTITUDE       TIME    AZIMUTH
    NAME                  (DEG)      (DEG)       (FT)       ZONE      (DEG)


CZ03RV2 WYEC2             37.6      122.4         8.    8  PST       360.0
```

REPORT- LV-B Summary of Spaces Occurring in the Project   WEATHER FILE- CZ03RV2 WYEC2

NUMBER OF SPACES   30   EXTERIOR   15   INTERIOR   15

SPACE	FLOOR	SPACE*FLOOR MULTIPLIER	SPACE TYPE	AZIM	LIGHTS (WATT / SQFT)	PEOPLE	EQUIP (WATT / SQFT)	INFILTRATION METHOD	ACH	AREA (SQFT)	VOLUME (CUFT)
South Perim Spc	Bottom Below-Gra	1.0	INT	0.0	0.77	9.2	0.53	NO-INFILT.	0.00	1876.0	16321.2
East Perim Spc (	Bottom Below-Gra	1.0	INT	-90.0	0.77	9.2	0.53	NO-INFILT.	0.00	1876.0	16321.2
North Perim Spc	Bottom Below-Gra	1.0	INT	180.0	0.77	9.2	0.53	NO-INFILT.	0.00	1876.0	16321.2
West Perim Spc (	Bottom Below-Gra	1.0	INT	90.0	0.77	9.2	0.53	NO-INFILT.	0.00	1876.0	16321.2
Core Spc (B.C5)	Bottom Below-Gra	1.0	INT	0.0	1.75	39.2	0.73	NO-INFILT.	0.00	2504.0	21784.8
Plnm (B.6)	Bottom Below-Gra	1.0	INT	0.0	0.00	0.0	0.00	AIR-CHANGE	0.09	10008.0	30024.0
South Perim Spc	Upper Below-Grad	1.0	INT	0.0	0.77	9.2	0.53	NO-INFILT.	0.00	1876.0	16321.2
East Perim Spc (	Upper Below-Grad	1.0	INT	-90.0	0.77	9.2	0.53	NO-INFILT.	0.00	1876.0	16321.2
North Perim Spc	Upper Below-Grad	1.0	INT	180.0	0.77	9.2	0.53	NO-INFILT.	0.00	1876.0	16321.2
West Perim Spc (	Upper Below-Grad	1.0	INT	90.0	0.77	9.2	0.53	NO-INFILT.	0.00	1876.0	16321.2
Core Spc (UB.C11	Upper Below-Grad	1.0	INT	0.0	1.75	39.2	0.73	NO-INFILT.	0.00	2504.0	21784.8
Plnm (UB.12)	Upper Below-Grad	1.0	INT	0.0	0.00	0.0	0.00	AIR-CHANGE	0.09	10008.0	30024.0
South Perim Spc	Ground Flr	1.0	EXT	0.0	2.00	83.4	1.00	AIR-CHANGE	0.12	1876.0	16321.2
East Perim Spc (	Ground Flr	1.0	EXT	-90.0	2.00	83.4	1.00	AIR-CHANGE	0.12	1876.0	16321.2
North Perim Spc	Ground Flr	1.0	EXT	180.0	2.00	83.4	1.00	AIR-CHANGE	0.12	1876.0	16321.2
West Perim Spc (	Ground Flr	1.0	EXT	90.0	2.00	83.4	1.00	AIR-CHANGE	0.12	1876.0	16321.2
Core Spc (G.C17)	Ground Flr	1.0	INT	0.0	2.00	111.3	1.00	AIR-CHANGE	0.01	2504.0	21784.8
Plnm (G.18)	Ground Flr	1.0	EXT	0.0	0.00	0.0	0.00	AIR-CHANGE	0.09	10008.0	30024.0
South Perim Spc	Mid 16 Abv-Grade	16.0	EXT	0.0	0.77	9.2	0.53	AIR-CHANGE	0.12	1876.0	16321.2
East Perim Spc (	Mid 16 Abv-Grade	16.0	EXT	-90.0	0.77	9.2	0.53	AIR-CHANGE	0.12	1876.0	16321.2
North Perim Spc	Mid 16 Abv-Grade	16.0	EXT	180.0	0.77	9.2	0.53	AIR-CHANGE	0.12	1876.0	16321.2
West Perim Spc (	Mid 16 Abv-Grade	16.0	EXT	90.0	0.77	9.2	0.53	AIR-CHANGE	0.12	1876.0	16321.2
Core Spc (M.C23)	Mid 16 Abv-Grade	16.0	INT	0.0	1.75	39.2	0.73	AIR-CHANGE	0.01	2504.0	21784.8
Plnm (M.24)	Mid 16 Abv-Grade	16.0	EXT	0.0	0.00	0.0	0.00	AIR-CHANGE	0.09	10008.0	30024.0
South Perim Spc	Top Abv-Grade Fl	1.0	EXT	0.0	0.77	9.2	0.53	AIR-CHANGE	0.12	1876.0	16321.2
East Perim Spc (	Top Abv-Grade Fl	1.0	EXT	-90.0	0.77	9.2	0.53	AIR-CHANGE	0.12	1876.0	16321.2
North Perim Spc	Top Abv-Grade Fl	1.0	EXT	180.0	0.77	9.2	0.53	AIR-CHANGE	0.12	1876.0	16321.2
West Perim Spc (	Top Abv-Grade Fl	1.0	EXT	90.0	0.77	9.2	0.53	AIR-CHANGE	0.12	1876.0	16321.2
Core Spc (T.C29)	Top Abv-Grade Fl	1.0	INT	0.0	1.75	39.2	0.73	AIR-CHANGE	0.01	2504.0	21784.8
Plnm (T.30)	Top Abv-Grade Fl	1.0	EXT	0.0	0.00	0.0	0.00	AIR-CHANGE	0.09	10008.0	30024.0
						------				---------	----------
BUILDING TOTALS						1890.4				400320.1	2341872.3

DATA FOR SPACE South Perim Spc (B.S1) IN FLOOR Bottom Below-Grade Flr

LOCATION OF ORIGIN IN BUILDING COORDINATES

XB (FT)	YB (FT)	ZB (FT)	SPACE AZIMUTH (DEG)	SPACE*FLOOR MULTIPLIER	HEIGHT (FT)	AREA (SQFT)	VOLUME (CUFT)
0.00	0.00	0.00	0.00	1.0	8.70	1876.00	16321.20

TOTAL NUMBER OF SURFACES	NUMBER OF EXTERIOR SURFACES	NUMBER OF INTERIOR SURFACES	NUMBER OF UNDERGROUND SURFACES	DAYLIGHTING	SUNSPACE
6	0	4	2	NO	NO

NUMBER OF SUBSURFACES

TOTAL	EXTERIOR WINDOWS	DOORS	INTERIOR WINDOWS
0	0	0	0

FLOOR WEIGHT (LB/SQFT)	CALCULATION TEMPERATURE (F)
0.0	70.0

PEOPLE

SCHEDULE	NUMBER	AREA PER PERSON (SQFT)	PEOPLE ACTIVITY (BTU/HR)	PEOPLE SENSIBLE (BTU/HR)	PEOPLE LATENT (BTU/HR)
h	9.2	203.7	450.0	249.1	187.1

LIGHTING

SCHEDULE	LIGHTING TYPE	LOAD (WATTS/ SQFT)	LOAD (KW)	FRACTION OF LOAD TO SPACE
h	SUS-FLUOR	0.77	1.44	1.00

REPORT- LV-D Details of Exterior Surfaces in the Project   WEATHER FILE- CZ03RV2 WYEC2

NUMBER OF EXTERIOR SURFACES 25   RECTANGULAR 0   OTHER 25
(U-VALUE INCLUDES OUTSIDE AIR FILM; WINDOW INCLUDES FRAME, IF DEFINED)

SURFACE	SPACE	- - - W I N D O W S - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	-W A L L + W I N D O W S- U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	AZIMUTH
North Wall (G.N1	North Perim Spc	0.639	201.40	0.075	668.95	0.206	870.35	NORTH
North Wall (G.18	Plnm (G.18)	0.000	0.00	0.075	300.12	0.075	300.12	NORTH
North Wall (M.N2	North Perim Spc	0.546	3342.19	0.075	10583.38	0.188	13925.57	NORTH
North Wall (M.24	Plnm (M.24)	0.000	0.00	0.075	4801.92	0.075	4801.92	NORTH
North Wall (T.N2	North Perim Spc	0.546	208.89	0.075	661.46	0.188	870.35	NORTH
North Wall (T.30	Plnm (T.30)	0.000	0.00	0.075	300.12	0.075	300.12	NORTH
East Wall (M.24.	Plnm (M.24)	0.000	0.00	0.075	4801.92	0.075	4801.92	EAST
East Wall (G.E14	East Perim Spc (	0.667	156.14	0.075	714.21	0.181	870.35	EAST
East Wall (T.E26	East Perim Spc (	0.547	163.63	0.075	706.72	0.164	870.35	EAST
East Wall (M.E20	East Perim Spc (	0.547	2618.05	0.075	11307.52	0.164	13925.57	EAST
East Wall (T.30.	Plnm (T.30)	0.000	0.00	0.075	300.12	0.075	300.12	EAST
East Wall (G.18.	Plnm (G.18)	0.000	0.00	0.075	300.12	0.075	300.12	EAST
South Wall (T.S2	South Perim Spc	0.546	184.52	0.075	685.83	0.175	870.35	SOUTH
South Wall (G.18	Plnm (G.18)	0.000	0.00	0.075	300.12	0.075	300.12	SOUTH
South Wall (M.24	Plnm (M.24)	0.000	0.00	0.075	4801.92	0.075	4801.92	SOUTH
South Wall (T.30	Plnm (T.30)	0.000	0.00	0.075	300.12	0.075	300.12	SOUTH
South Wall (M.S1	South Perim Spc	0.546	2952.27	0.075	10973.30	0.175	13925.57	SOUTH
South Wall (G.S1	South Perim Spc	0.652	177.03	0.075	693.32	0.192	870.35	SOUTH
West Wall (M.W22	West Perim Spc (	0.546	2882.64	0.075	11042.93	0.173	13925.57	WEST
West Wall (T.W28	West Perim Spc (	0.546	180.16	0.075	690.18	0.173	870.35	WEST
West Wall (M.24.	Plnm (M.24)	0.000	0.00	0.075	4801.92	0.075	4801.92	WEST
West Wall (G.18.	Plnm (G.18)	0.000	0.00	0.075	300.12	0.075	300.12	WEST
West Wall (G.W16	West Perim Spc (	0.655	172.68	0.075	697.67	0.190	870.35	WEST
West Wall (T.30.	Plnm (T.30)	0.000	0.00	0.075	300.12	0.075	300.12	WEST

REPORT- LV-D Details of Exterior Surfaces in the Project WEATHER FILE- CZ03RV2 WYEC2

--(CONTINUED)--------

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.551	0.075	0.160	3752.48	17315.95	21068.42
EAST	0.553	0.075	0.142	2937.82	18130.61	21068.42
SOUTH	0.552	0.075	0.150	3313.82	17754.61	21068.42
WEST	0.552	0.075	0.148	3235.48	17832.94	21068.42
ROOF	0.000	0.042	0.042	0.00	10008.00	10008.00
ALL WALLS	0.552	0.075	0.150	13239.59	71034.11	84273.70
WALLS+ROOFS	0.552	0.071	0.138	13239.59	81042.11	94281.70
UNDERGRND	0.000	0.066	0.066	0.00	19371.74	19371.74
BUILDING	0.552	0.070	0.126	13239.59	100413.86	113653.45

NUMBER OF SCHEDULES 28 (NON DIMENSIONLESS SCHEDULES ARE GIVEN IN ENGLISH UNITS)

SCHEDULE Typ Core Occ Sch

THROUGH 31 12

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65

SCHEDULE Typ Core Ltg Sch

THROUGH 31 12

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

SCHEDULE Typ Core Eqp Sch

THROUGH 31 12

FOR DAYS SUN MON TUE WED THU FRI SAT HOL

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

SCHEDULE Typ Core Sys1 Co

THROUGH 31 12

REPORT- LV-H Details of Windows Occurring in the Project WEATHER FILE- CZ03RV2 WYEC2

NUMBER OF WINDOWS 20 RECTANGULAR 0 OTHER 20

RECTANGULAR WINDOWS (U-VALUES INCLUDE OUTSIDE AIR FILM)

WINDOW NAME	MULTIPLIER	GLASS AREA (SQFT)	GLASS HEIGHT (FT)	GLASS WIDTH (FT)	LOCATION OF ORIGIN IN SURFACE COORDINATES X (FT)	Y (FT)	FRAME AREA (SQFT)	FRAME U-VALUE (BTU/HR-SQFT-F)
South Win (G.S13	1.0	63.63	5.00	12.72	32.46	3.11	3.89	1.519
South Win (G.S13	1.0	63.63	5.00	12.72	54.87	3.11	3.89	1.519
South Door (G.S1	1.0	35.75	6.50	5.50	47.27	0.25	6.25	1.604
East Win (G.E14.	1.0	53.62	5.00	10.72	34.46	3.11	3.45	1.519
East Win (G.E14.	1.0	53.62	5.00	10.72	54.87	3.11	3.45	1.519
East Door (G.E14	1.0	35.75	6.50	5.50	47.27	0.25	6.25	1.604
North Win (G.N15	1.0	75.31	5.00	15.05	30.12	3.11	4.39	1.519
North Win (G.N15	1.0	75.31	5.00	15.05	54.87	3.11	4.39	1.519
North Door (G.N1	1.0	35.75	6.50	5.50	47.27	0.25	6.25	1.604
West Win (G.W16.	1.0	61.54	5.00	12.30	32.87	3.11	3.80	1.519
West Win (G.W16.	1.0	61.54	5.00	12.30	54.87	3.11	3.80	1.519
West Door (G.W16	1.0	35.75	6.50	5.50	47.27	0.25	6.25	1.604
South Win (M.S19	1.0	175.77	5.00	35.13	32.46	3.11	8.74	1.519
East Win (M.E20.	1.0	155.75	5.00	31.13	34.46	3.11	7.88	1.519
North Win (M.N21	1.0	199.13	5.00	39.80	30.12	3.11	9.75	1.519
West Win (M.W22.	1.0	171.60	5.00	34.30	32.87	3.11	8.56	1.519
South Win (T.S25	1.0	175.77	5.00	35.13	32.46	3.11	8.74	1.519
East Win (T.E26.	1.0	155.75	5.00	31.13	34.46	3.11	7.88	1.519
North Win (T.N27	1.0	199.13	5.00	39.80	30.12	3.11	9.75	1.519
West Win (T.W28.	1.0	171.60	5.00	34.30	32.87	3.11	8.56	1.519

WINDOW NAME	SETBACK (FT)	X-DIVISIONS	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	INFILTRATION FLOW COEFF	CENTER-OF-GLASS U-VALUE (BTU/HR-SQFT-F)	GLASS VISIBLE TRANS
South Win (G.S13	0.00	10	0.81	2	2	0.0	0.536	0.781
South Win (G.S13	0.00	10	0.81	2	2	0.0	0.536	0.781
South Door (G.S1	0.00	10	0.95	1	1	0.0	0.983	0.881
East Win (G.E14.	0.00	10	0.81	2	2	0.0	0.536	0.781
East Win (G.E14.	0.00	10	0.81	2	2	0.0	0.536	0.781
East Door (G.E14	0.00	10	0.95	1	1	0.0	0.983	0.881
North Win (G.N15	0.00	10	0.81	2	2	0.0	0.536	0.781
North Win (G.N15	0.00	10	0.81	2	2	0.0	0.536	0.781
North Door (G.N1	0.00	10	0.95	1	1	0.0	0.983	0.881
West Win (G.W16.	0.00	10	0.81	2	2	0.0	0.536	0.781
West Win (G.W16.	0.00	10	0.81	2	2	0.0	0.536	0.781
West Door (G.W16	0.00	10	0.95	1	1	0.0	0.983	0.881
South Win (M.S19	0.00	10	0.81	2	2	0.0	0.536	0.781
East Win (M.E20.	0.00	10	0.81	2	2	0.0	0.536	0.781
North Win (M.N21	0.00	10	0.81	2	2	0.0	0.536	0.781
West Win (M.W22.	0.00	10	0.81	2	2	0.0	0.536	0.781
South Win (T.S25	0.00	10	0.81	2	2	0.0	0.536	0.781
East Win (T.E26.	0.00	10	0.81	2	2	0.0	0.536	0.781
North Win (T.N27	0.00	10	0.81	2	2	0.0	0.536	0.781
West Win (T.W28.	0.00	10	0.81	2	2	0.0	0.536	0.781

REPORT- LV-I Details of Constructions Occurring in the Project WEATHER FILE- CZ03RV2 WYEC2

NUMBER OF CONSTRUCTIONS 26 DELAYED 25 QUICK 1

CONSTRUCTION NAME	U-VALUE (BTU/HR-SQFT-F)	SURFACE ABSORPTANCE	SURFACE ROUGHNESS INDEX	SURFACE TYPE	NUMBER OF RESPONSE FACTORS
EWall Constructi	0.077	0.88	3	DELAYED	9
Roof Constructio	0.043	0.60	3	DELAYED	6
Ceilg Constructi	0.361	0.70	3	QUICK	0
IWall Constructi	0.402	0.70	3	DELAYED	4
IFlr Constructio	0.567	0.70	3	DELAYED	4
UFCons (B.S1.U1)	0.010	0.70	3	DELAYED	52
UWCons (B.S1.U2)	0.010	0.70	3	DELAYED	42
UFCons (B.E2.U3)	0.010	0.70	3	DELAYED	52
UWCons (B.E2.U4)	0.010	0.70	3	DELAYED	42
UFCons (B.N3.U5)	0.010	0.70	3	DELAYED	52
UWCons (B.N3.U6)	0.010	0.70	3	DELAYED	42
UFCons (B.W4.U7)	0.010	0.70	3	DELAYED	52
UWCons (B.W4.U8)	0.010	0.70	3	DELAYED	42
UFCons (B.C5.U9)	0.010	0.70	3	DELAYED	52
UWCons (B.6.U10)	0.010	0.70	3	DELAYED	42
UWCons (B.6.U11)	0.010	0.70	3	DELAYED	42
UWCons (B.6.U12)	0.010	0.70	3	DELAYED	42
UWCons (B.6.U13)	0.010	0.70	3	DELAYED	42
UWCons (UB.S7.U1	0.223	0.70	3	DELAYED	33
UWCons (UB.E8.U1	0.223	0.70	3	DELAYED	33
UWCons (UB.N9.U1	0.223	0.70	3	DELAYED	33
UWCons (UB.W10.U	0.223	0.70	3	DELAYED	33
UWCons (UB.12.U1	0.305	0.70	3	DELAYED	30
UWCons (UB.12.U1	0.305	0.70	3	DELAYED	30
UWCons (UB.12.U2	0.305	0.70	3	DELAYED	30
UWCons (UB.12.U2	0.305	0.70	3	DELAYED	30

REPORT- SV-A System Design Parameters for Sys1 (FC) WEATHER FILE- CZ03RV2 WYEC2

SYSTEM TYPE	ALTITUDE FACTOR	FLOOR AREA (SQFT)	MAX PEOPLE	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)	HEAT PUMP SUPP-HEAT (KBTU/HR)
FC	1.000	200160.0	1890.	0.219	0.000	0.000	0.000	0.000	0.000	0.000

FAN TYPE	CAPACITY (CFM)	DIVERSITY FACTOR (FRAC)	POWER DEMAND (KW)	FAN DELTA-T (F)	STATIC PRESSURE (IN-WATER)	TOTAL EFF (FRAC)	MECH EFF (FRAC)	FAN PLACEMENT	FAN CONTROL	MAX FAN RATIO (FRAC)	MIN FAN RATIO (FRAC)
SUPPLY	119267.	0.00	0.000	0.55	0.5	0.33	0.37	BLOW-THRU	CONSTANT	0.00	0.00

ZONE NAME	SUPPLY FLOW (CFM)	EXHAUST FLOW (CFM)	FAN (KW)	MINIMUM FLOW (FRAC)	OUTSIDE AIR FLOW (CFM)	COOLING CAPACITY (KBTU/HR)	SENSIBLE (FRAC)	EXTRACTION RATE (KBTU/HR)	HEATING CAPACITY (KBTU/HR)	ADDITION RATE (KBTU/HR)	ZONE MULT
South Perim Zn (B.S1)	938.	0.	0.167	1.000	202.	32.77	0.69	19.96	-57.59	-49.14	1.
East Perim Zn (B.E2)	938.	0.	0.167	1.000	202.	32.77	0.69	19.96	-57.59	-49.14	1.
North Perim Zn (B.N3)	938.	0.	0.167	1.000	202.	32.77	0.69	19.96	-57.59	-49.14	1.
West Perim Zn (B.W4)	938.	0.	0.167	1.000	202.	32.77	0.69	19.96	-57.59	-49.14	1.
Core Zn (B.C5)	1252.	0.	0.223	1.000	391.	46.08	0.67	26.58	-82.97	-66.09	1.
South Perim Zn (UB.S7)	938.	0.	0.167	1.000	202.	32.77	0.69	19.96	-57.59	-49.14	1.
East Perim Zn (UB.E8)	938.	0.	0.167	1.000	202.	32.77	0.69	19.96	-57.59	-49.14	1.
North Perim Zn (UB.N9)	938.	0.	0.167	1.000	202.	32.77	0.69	19.96	-57.59	-49.14	1.
West Perim Zn (UB.W10)	938.	0.	0.167	1.000	202.	32.77	0.69	19.96	-57.59	-49.14	1.
Core Zn (UB.C11)	1252.	0.	0.223	1.000	391.	46.08	0.67	26.58	-82.97	-66.09	1.
South Perim Zn (G.S13)	1640.	0.	0.292	1.000	625.	60.89	0.67	35.43	-114.40	-87.05	1.
East Perim Zn (G.E14)	2119.	0.	0.377	1.000	625.	77.26	0.67	45.78	-138.61	-111.73	1.
North Perim Zn (G.N15)	1555.	0.	0.277	1.000	625.	57.96	0.66	33.59	-110.13	-82.68	1.
West Perim Zn (G.W16)	2353.	0.	0.419	1.000	625.	85.17	0.67	50.83	-150.45	-123.78	1.
Core Zn (G.C17)	1652.	0.	0.294	1.000	835.	62.59	0.66	35.69	-125.76	-88.56	1.
South Perim Zn (M.S19)	938.	0.	0.167	1.000	202.	32.78	0.69	19.96	-57.59	-49.14	16.
East Perim Zn (M.E20)	1261.	0.	0.224	1.000	202.	43.43	0.69	27.25	-74.02	-65.79	16.
North Perim Zn (M.N21)	938.	0.	0.167	1.000	202.	32.78	0.69	19.96	-57.59	-49.14	16.
West Perim Zn (M.W22)	1489.	0.	0.265	1.000	202.	50.92	0.70	32.17	-85.61	-77.54	16.
Core Zn (M.C23)	1252.	0.	0.223	1.000	391.	46.08	0.67	26.58	-82.97	-66.09	16.
South Perim Zn (T.S25)	938.	0.	0.167	1.000	202.	32.78	0.69	19.96	-57.59	-49.14	1.
East Perim Zn (T.E26)	1261.	0.	0.224	1.000	202.	43.43	0.69	27.25	-74.02	-65.79	1.
North Perim Zn (T.N27)	938.	0.	0.167	1.000	202.	32.78	0.69	19.96	-57.59	-49.14	1.
West Perim Zn (T.W28)	1489.	0.	0.265	1.000	202.	50.92	0.70	32.17	-85.61	-77.54	1.
Core Zn (T.C29)	1252.	0.	0.223	1.000	391.	46.08	0.67	26.58	-82.97	-66.09	1.
Plnm Zn (B.6)	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	1.
Plnm Zn (UB.12)	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	1.
Plnm Zn (G.18)	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	1.
Plnm Zn (M.24)	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	16.
Plnm Zn (T.30)	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	1.

REPORT- PV-A Plant Design Parameters WEATHER FILE- CZ03RV2 WYEC2

*** CIRCULATION LOOPS ***

	HEATING CAPACITY (MBTU/HR)	COOLING CAPACITY (MBTU/HR)	LOOP FLOW (GAL/MIN)	TOTAL HEAD (FT)	SUPPLY UA PRODUCT (BTU/HR-F)	SUPPLY LOSS DT (F)	RETURN UA PRODUCT (BTU/HR-F)	RETURN LOSS DT (F)	LOOP VOLUME (GAL)	FLUID HEAT CAPACITY (BTU/LB-F)
Chilled Water Loop	0.000	4.229	839.3	36.6	0.0	0.00	0.0	0.00	1259.0	1.00
Hot Water Loop	-7.338	0.000	367.1	36.6	0.0	0.00	0.0	0.00	550.7	1.00
Condenser Water Loop	0.000	2.992	594.2	61.6	0.0	0.00	0.0	0.00	891.3	1.00
Domestic Hot Water Loop	-0.347	0.000	8.5	0.0	0.0	0.00	0.0	0.00	12.8	1.00

*** PUMPS ***

ATTACHED TO		FLOW (GAL/MIN)	HEAD (FT)	HEAD SETPOINT (FT)	CAPACITY CONTROL	POWER (KW)	MECHANICAL EFFICIENCY (FRAC)	MOTOR EFFICIENCY (FRAC)
CHW Loop Pump	1 PUMP(s)							
Chilled Water Loop		800.0	43.0	37.6	VAR-SPEED	9.248	0.770	0.910
PRIMARY LOOP								
HW Loop Pump	1 PUMP(s)							
Hot Water Loop		300.4	40.0	0.0	ONE-SPEED	3.359	0.770	0.875
PRIMARY LOOP								
CW Loop Pump	1 PUMP(s)							
Condenser Water Loop		600.0	37.0	0.0	ONE-SPEED	6.390	0.770	0.850
PRIMARY LOOP								
Chlr1 (ElecCentHerm) Pump	1 PUMP(s)							
Chiller1 (ElecCentHerm)		480.0	17.0	0.0	ONE-SPEED	2.282	0.770	0.875
EVAPORATOR (RUN-AROUND)								

*** PRIMARY EQUIPMENT ***

EQUIPMENT TYPE	ATTACHED TO	CAPACITY (MBTU/HR)	FLOW (GAL/MIN)	EIR (FRAC)	HIR (FRAC)	AUXILIARY (KW)
Boiler1 (HWNatDrft)						
HW-BOILER	Hot Water Loop	-7.338	367.1	0.000	1.250	0.000
Chiller1 (ElecCentHerm)						
ELEC-HERM-CENT	Chilled Water Loop	2.400	479.6	0.239	0.000	0.000
	Condenser Water Loop	2.973	594.2			

*** COOLING TOWERS ***

EQUIPMENT TYPE	ATTACHED TO	CAPACITY (MBTU/HR)	FLOW (GAL/MIN)	NUMBER OF CELLS	FAN POWER PER CELL (KW)	SPRAY PWR PER CELL (KW)	AUXILIARY (KW)
Open Tower							
OPEN-TWR	Condenser Water Loop	2.992	597.9	1	9.206	0.000	0.000

*** DW-HEATERS ***

EQUIPMENT TYPE	ATTACHED TO	CAPACITY (MBTU/HR)	FLOW (GAL/MIN)	EIR (FRAC)	HIR (FRAC)	AUXILIARY (KW)	TANK (GAL)	TANK UA (BTU/HR-F)
GAS DW-HEATER	Domestic Hot Water Loop	-12.598	309.6	0.000	1.370			
		0.000	9452.3	393.85				

Appendix D - eQuest Outputs

REPORT- SS-D Building HVAC Load Summary WEATHER FILE- CZ03RV2 WYEC2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	375.69461	22	16	67.F	54.F	1443.696	-18.261	8	7	37.F	36.F	-301.631	192091.	258.185
FEB	442.73911	28	13	73.F	66.F	1835.556	-4.092	21	7	38.F	31.F	-238.813	173501.	258.185
MAR	558.36066	8	16	75.F	67.F	2152.450	-3.092	4	7	40.F	37.F	-180.812	192091.	258.185
APR	621.83405	27	17	82.F	72.F	2665.421	-1.208	4	6	42.F	40.F	-90.827	185894.	258.185
MAY	715.43921	13	16	85.F	68.F	2394.978	-0.042	1	6	49.F	45.F	-4.756	192091.	258.185
JUN	818.67053	9	15	85.F	72.F	2610.358	-0.001	25	5	47.F	46.F	-0.841	185894.	258.185
JUL	902.04877	12	17	74.F	70.F	2518.767	0.000	31	1	62.F	60.F	0.000	192091.	258.185
AUG	878.89758	6	14	88.F	69.F	2310.772	0.000	31	1	59.F	56.F	0.000	192091.	258.185
SEP	895.58649	25	16	83.F	71.F	2672.004	0.000	30	1	64.F	53.F	0.000	185894.	258.185
OCT	789.68640	30	15	86.F	69.F	2484.540	-0.026	20	7	47.F	45.F	-3.748	192091.	258.185
NOV	520.92377	5	16	76.F	62.F	1847.588	-3.102	30	6	39.F	33.F	-204.147	185894.	258.185
DEC	369.79553	30	15	64.F	49.F	1281.030	-22.856	28	7	35.F	32.F	-337.364	192091.	258.185
TOTAL	7889.676						-52.681						2261508.	
MAX						2672.004						-337.364		258.185

MAXIMUM DAILY INTEGRATED COOLING LOAD (DES DAY) 0.000 (KBTU)
MAXIMUM DAILY INTEGRATED COOLING LOAD (WTH FILE) 39964.800 (KBTU)

REPORT- PS-H Loads and Energy Usage for Chiller1 (ElecCentHerm) WEATHER FILE- CZ03RV2 WYEC2

EQUIPMENT TYPE	ATTACHED TO	CAPACITY (MBTU/HR)	FLOW (GAL/MIN)	EIR (FRAC)	AUXILIARY (KW)
ELEC-HERM-CENT	Chilled Water Loop	2.400	479.6	0.239	0.000
	Condenser Water Loop	2.973	594.2		

MON	SUM / PEAK	COOL LOAD (MBTU) (KBTU/HR)	HEAT LOAD (MBTU) (KBTU/HR)	ELEC USE (KWH) (KW)	AUX ENERGY (KWH) (KW)		00 10	10 20	20 30	30 40	40 50	50 60	60 70	70 80	80 90	90 100	100 +	TOTAL RUN HOURS
						-------- Number of hours within each PART LOAD range ---------												
JAN	SUM	380.588	0.000	38933.449	0.000	LOAD	178	228	167	98	53	20	0	0	0	0	0	744
	PEAK	1451.354	0.000	96.633	0.000	ELEC	0	30	356	257	82	19	0	0	0	0	0	744
	DAY/HR	22/16	0/ 0	22/16	0/ 0													
FEB	SUM	447.318	0.000	39751.758	0.000	LOAD	48	192	182	106	96	30	15	3	0	0	0	672
	PEAK	1843.215	0.000	122.039	0.000	ELEC	0	6	216	283	122	34	10	1	0	0	0	672
	DAY/HR	28/13	0/ 0	28/13	0/ 0													
MAR	SUM	563.523	0.000	47044.266	0.000	LOAD	40	171	170	160	104	67	23	8	1	0	0	744
	PEAK	2160.784	0.000	145.419	0.000	ELEC	0	1	194	287	163	74	20	4	1	0	0	744
	DAY/HR	8/16	0/ 0	8/16	0/ 0													
APR	SUM	626.961	0.000	49609.926	0.000	LOAD	21	154	147	112	116	109	32	17	6	6	0	720
	PEAK	2447.411	0.000	167.770	0.000	ELEC	0	0	151	250	156	110	30	11	7	5	0	720
	DAY/HR	27/18	0/ 0	27/17	0/ 0													
MAY	SUM	720.763	0.000	54770.473	0.000	LOAD	0	77	220	123	92	130	53	26	13	10	0	744
	PEAK	2403.911	0.000	165.345	0.000	ELEC	0	0	63	319	139	140	42	22	10	9	0	744
	DAY/HR	13/16	0/ 0	13/16	0/ 0													
JUN	SUM	824.116	0.000	59534.426	0.000	LOAD	0	14	151	169	101	100	76	61	26	22	0	720
	PEAK	2449.267	0.000	167.757	0.000	ELEC	0	0	7	273	161	118	70	46	26	19	0	720
	DAY/HR	9/19	0/ 0	9/15	0/ 0													
JUL	SUM	907.692	0.000	64530.719	0.000	LOAD	0	0	132	181	94	83	101	88	41	24	0	744
	PEAK	2430.552	0.000	167.621	0.000	ELEC	0	0	0	260	153	100	104	75	31	21	0	744
	DAY/HR	12/17	0/ 0	12/17	0/ 0													
AUG	SUM	884.499	0.000	63098.254	0.000	LOAD	0	0	131	193	117	74	83	93	37	16	0	744
	PEAK	2320.517	0.000	158.396	0.000	ELEC	0	0	0	270	173	93	94	79	25	10	0	744
	DAY/HR	6/14	0/ 0	6/14	0/ 0													
SEP	SUM	901.125	0.000	63503.922	0.000	LOAD	0	0	92	164	129	112	85	62	43	33	0	720
	PEAK	2448.378	0.000	167.694	0.000	ELEC	0	0	0	192	200	127	87	57	27	30	0	720
	DAY/HR	26/17	0/ 0	26/15	0/ 0													
OCT	SUM	795.169	0.000	58348.398	0.000	LOAD	0	44	135	197	131	89	63	51	22	12	0	744
	PEAK	2430.475	0.000	167.563	0.000	ELEC	0	0	36	273	202	98	70	36	22	7	0	744
	DAY/HR	30/15	0/ 0	30/15	0/ 0													
NOV	SUM	525.900	0.000	44522.387	0.000	LOAD	47	147	189	164	99	51	20	3	0	0	0	720
	PEAK	1855.903	0.000	122.909	0.000	ELEC	0	7	171	334	139	53	15	1	0	0	0	720
	DAY/HR	5/16	0/ 0	5/16	0/ 0													
DEC	SUM	374.796	0.000	38426.883	0.000	LOAD	168	234	173	99	67	3	0	0	0	0	0	744
	PEAK	1288.389	0.000	87.252	0.000	ELEC	0	55	325	268	94	2	0	0	0	0	0	744
	DAY/HR	30/15	0/ 0	30/15	0/ 0													

Project 29 DOE-B2.2D38c 9/29/2003 13:50:21 BDL RUN 2

REPORT- PS-H Loads and Energy Usage for Chiller1 (ElecCentHerm) WEATHER FILE- CZ03RV2 WYEC2

(CONTINUED)

YR	SUM	7952.450	0.000	622074.813	0.000	LOAD	502	1261	1889	1766	1199	868	551	412	189	123	0	8760
	PEAK	2449.267	0.000	167.770	0.000	ELEC	0	99	1519	3266	1784	968	542	332	149	101	0	8760
	MON/DAY	6/ 9	0/ 0	4/27	0/ 0													