INDUSTRIAL RETROFIT PROGRAM
EVALUATION OF LIGHTING TECHNOLOGIES

FINAL IMPACT EVALUATION REPORT

Submitted to

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P696.321

February 1996

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February 1996

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Section 1

EXECUTIVE SUMMARY

This section presents a summary of the impact results for the industrial lighting technologies offered under the Pacific Gas & Electric Company (PG&E) 1994 Nonresidential Retrofit Programs. This evaluation covered both indoor and outdoor lighting technologies for the Retrofit Express (RE) and the Customized Incentives (Customized) programs. The results are presented in three sections: evaluation results summary (covering the numerical results of the study), major findings, and major recommendations.

1.1 Evaluation Summary

The evaluation results are summarized in terms of energy savings (MWh), demand savings (kW), and realization rates, the ratio of the evaluation results (ex post) to the program design estimates (ex ante). These results are presented on a gross and net basis (i.e., before and after accounting for free riders and spillover). Exhibit 1-1 presents the gross energy and demand savings results, together with the gross realization rates.

Exhibit 1-1
Summary of GROSS Evaluation Results
Industrial Indoor and Outdoor Lighting Applications

Program and Technology Group	Number of Units	Gross Impacts			
		Energy		Demand	
		(MWh)	Realization Rate	(kW)	Realization Rate
Indoor Total	452,838	96,677	1.36	16,197	1.35
Outdoor Total	1,071	1,593	0.97	196	N.A.
Indoor and Outdoor Total	453,909	98,270	1.35	16,393	1.37

These results illustrate the following key points about the gross industrial lighting impacts:

- The vast majority of the savings are from indoor lighting applications.
- The ex post gross impacts exceeded the ex ante gross estimate for both energy and demand by about 35 percent, exclusively due to indoor lighting. This is primarily the result of higher operating factors (as determined by field inspections), in conjunction with the inclusion of the HVAC savings due to the more efficient lights, in the ex post impacts.

Exhibits 1-2 and 1-3 present the net energy and demand impact results, together with the net realization rates, at the same levels presented in Exhibit 1-1.

The net ex post energy impacts exceed the net ex ante design estimates by 61 percent for energy, and 63 percent for demand. To a certain extent, these results reflect the high gross realization rates, but they are really driven by the ex ante and ex post net-to-gross (NTG) ratios. The net to gross adjustments apply equally to energy and demand impacts, since they represent behavioral affects on the decision to purchase energy-efficient equipment. Thus the following points apply equally to Exhibits 1-2 and 1-3.

- The ex ante NTG ratio was between 0.70 and 0.77, depending upon the business segment and technology, averaging about 0.76.
- The ex post NTG ratio for combined indoor and outdoor lighting averaged 0.92.
- When 0.92 is divided by 0.77, it results in an average 19 percent increase in realized savings.
- Free ridership rates were low for these programs, contributing a 12 to 13 percent overall reduction in energy and demand impacts.
- Participant spillover rates offset the free ridership to a small extent, contributing an average of 3 to 4 percent increase in impacts
- No nonparticipant spillover effects were detected for the industrial sector in this evaluation since no nonparticipant data collection was conducted.

Exhibit 1-2
Summary of NET Evaluation ENERGY Results
Industrial Indoor and Outdoor Lighting Applications

Technology Group	Gross	NTG Adjustments			Net	
	Gross Impact (MWh)	Free Ridership Adjustment (1-FR) (Unitless)	Participant Spillover Adjustment (Unitless)	Nonparticipant Spillover Adjsutment (Unitless)	Net Impact without NP Spillover Adjustment (MWh)	Net Impact with NP Spillover Adjustment (MWh)
Ex Ante						
Indoor Lighting	71,126	0.67	0.10		54,747	
Outdoor Lighting	1,635	0.67	0.10		1,259	
Indoor & Outdoor Lighting	72,761	0.67	0.10		56,006	
Ex Post						
Indoor Lighting	96,677	0.87	0.05	0.00	88,816	88,816
Outdoor Lighting	1,593	0.76	0.05	0.00	1,290	1,290
Indoor & Outdoor Lighting	98,270	0.87	0.05	0.00	90,106	90,106
Realization Rates (ex post/ex ante)						
Indoor Lighting	1.36	NA	NA	NA	1.62	1.62
Outdoor Lighting	0.97	NA	NA	NA	1.02	1.02
Indoor & Outdoor Lighting	1.35	NA	NA	NA	1.61	1.61

Exhibit 1-2 illustrates the following key points about the net industrial lighting energy impact results:

- The ex post net energy impact exceeded the ex ante net impact by 61 percent.
- The main reasons for the high ex post energy realization rate are the high gross realization rate (due to longer hours of operation) and the fact that the measured ex post NTG adjustment was higher than that assumed in the ex ante estimates.

Exhibit 1-3 presents the net demand savings results, together with the net realization rates, at the same levels presented in Exhibit 1-1.

Exhibit 1-3
Summary of NET Evaluation DEMAND Results
Industrial Indoor and Outdoor Lighting Applications

Technology Group	Gross	NTG Adjustments			Net	
	Gross Impact	Free Ridership Adjustment (1-FR)	Participant Spillover Adjustment	Nonparticipant Spillover Adjsutment	Net Impact without NP Spillover Adjustment	Net Impact with NP Spillover Adjustment
	(kW)	(Unitless)	(Unitless)	(Unitless)	(kW)	(kW)
Ex Ante						
Indoor Lighting	12,008	0.67	0.10		9,240	
Outdoor Lighting	0	0.67	0.10		0	
Indoor & Outdoor Lighting	12,008	0.67	0.10		9,240	
Ex Post						
Indoor Lighting	16,197	0.88	0.03	0.00	14,887	14,887
Outdoor Lighting	196	0.76	0.05	0.00	159	159
Indoor & Outdoor Lighting	16,393	0.88	0.03	0.00	15,046	15,046
Realization Rates (ex post/ex ante)						
Indoor Lighting	1.35	NA	NA	NA	1.61	1.61
Outdoor Lighting	NA	NA	NA	NA	NA	NA
Indoor & Outdoor Lighting	1.37	NA	NA	NA	1.63	1.63

These results illustrate the following key points about the net industrial lighting demand impact results:

- The net ex post energy impacts exceed the net ex ante design estimates 63 percent for demand.
- These high savings estimates reflect not only the higher ex post NTG ratios, but the conservative ex ante design estimates. The high operating factors that the evaluation identified in the industrial sector, and the inclusion of the HVAC savings in the ex post evaluation impacts, contributed to the high net demand savings (*Section 4.6*).
- Realization rates for outdoor lighting demand are not applicable because the design estimate for peak demand of outdoor lighting is zero. Since some fixtures were found to be operating at peak, dividing even a small impact by the ex ante estimate of zero results in an infinite realization rate.

Detailed presentation and discussion of this data can be found in *Section 4*.

1.2 Major Findings

The key findings are best summarized as follows:

- Overall, PG&E's ex ante estimates for the industrial lighting technologies paid under the 1994 programs were conservative, resulting in net realization rates exceeding one and a half.

- For many of the business types and technologies, hours of operation and operating factors exceeded the ex ante estimated values by a significant margin. This was the main factor contributing to many high gross realization rates.

- High NTG ratios combined with lower program design NTG estimates result in a significant increase net realized savings. This finding emanate from relatively low free ridership rates, directionally offset by a small participant spillover.

- The high participation technologies of T8/electronic ballast, optical reflectors with delamping, and HID replacement of less efficient technologies represented over 85 percent of net program energy and demand savings and yielded high net realization rates (*Sections 4.3 and 4.4*).

1.3 Major Recommendations

Trade on Established Information in Future Evaluations - This evaluation developed extensive observed and measured operating factor and operating hours information on the highest participation segments. There is no reason to believe that the operating factor and operating hours information developed in this evaluation will change significantly from year to year. QC recommends that PG&E develop an understanding with the California Public Utilities Commission (CPUC) on the validity and use of this information in subsequent evaluations, thus minimizing the need to replicate operating hours and operating factor data for sectors where this information is unlikely to change. This will allow PG&E and the CPUC to maximize return on money invested in future evaluations, resulting in better estimates for sectors that have yet to be definitively documented.

Other detailed recommendations concerning measures offered and the CPUC Protocols are covered in detail in *Section 5*.

Section 2

INTRODUCTION

This report covers the impact evaluation of the industrial lighting technologies offered under the Pacific Gas & Electric Company (PG&E) 1994 Nonresidential Retrofit Programs. These technologies are covered by two separate program options, the Retrofit Express (RE) Program and the Customized Incentive (Customized) Program. These programs are summarized below.

2.1 The Retrofit Express Program

The RE program offered fixed rebates to customers who installed specific gas or electric energy-efficiency equipment in their facilities. The program covered the most common energy saving measures, and spans lighting, air-conditioning, refrigeration, motors, agricultural applications, and food service. Customers were required to submit proof of purchase with these applications, in order to receive rebates. The program was marketed primarily to small- and medium-sized commercial, industrial, and agricultural customers. The maximum rebate amount, including all measure types, was $300,000 per account. No minimum amount was required to qualify for a rebate.

In the lighting end use , the program offered rebates on the following technologies:

- Halogen lamps replacing existing lamps
- Compact fluorescent lamps replacing incandescent lamps
- Compact fluorescent and LED lamps replacing incandescent lamps in exit signs
- Electronic ballasts replacing electromagnetic ballasts
- T8 lamps and electronic ballasts replacing T12 lamps and electromagnetic ballasts in various lengths and configurations
- High-intensity discharge (HID) fixtures replacing incandescent or mercury vapor fixtures
- Installation of occupancy sensors, bypass or delay timers, photocells, and time clock controls for lighting applications

2.2 The Customized Incentives Program

The Customized program offered financial incentives to customers who undertook large or complex projects that save gas or electricity. These customers were required to submit calculations for projected first-year energy savings with their applications and prior to installation of the project. The maximum incentive amount for the Customized program was $500,000 per account, and minimum qualifying incentive was $2,500 per project. The total incentive payment for kW, kWh, and therm savings was limited to 50% of direct project cost for retrofit of existing systems. Since the program also applied to expansion projects, the new systems incentive was limited to 100% of the incremental cost to make new processes or added systems energy efficient. Customers were paid 4 cents per kWh, and 20 cents per therm for first-year annual energy savings. A $200 per peak kW incentive, and a $50 per peak kW early completion (October 31, 1994) bonus for peak demand savings required that savings be achieved during the hours PG&E experiences high power demand.

As a result of program design, many of the measures installed were similar to or the same as those for the RE program, but were installed in larger and more complex projects.

2.3 Evaluation Overview

The impact evaluation described in this report covers all lighting measures installed at industrial accounts, as determined by the program participant database—Management Decision Support System (MDSS)—sector code, which were included under the RE and Customized programs, and for which rebates were paid during calendar year 1994.

The impact evaluation results in both gross and net impacts, and compares these estimates to the program earnings claims[1].

2.3.1 Objectives

The objectives of the evaluation were originally stated in the Request for Proposals (RFP), refined during the project initiation meeting, and documented in the evaluation research plan. These research objectives are as follows:

- Determine first-year gross energy and demand impacts for RE and Customized lighting technologies paid in 1994, by technology and business type, and overall impacts for the industrial sector

[1] PG&E Annual Summary Report on DSM Programs in 1994 and 1995.

- Investigate and explain differences between evaluation and program design estimates
- Assess free ridership rates, and investigate and explain differences between evaluation and program design estimates
- Assess spillover rates, and investigate and explain differences between evaluation and program design estimates
- Provide recommendations to strengthen the realized impact of the RE program
- Create a panel of participants for future monitoring of equipment retention in the industrial sector

This report covers the methodology and the gross and net impacts for the sector, divided into indoor and outdoor lighting effects.

Results are segmented by technology and building type. Technologies are defined by measures offered by the RE and Customized programs. Building segments for the industrial market sector, as defined by PG&E, are process and assembly.

The difference between gross and net impacts is the behavior that affected customers' participation. Adjustments were made to the gross estimate of savings for customers that would have installed energy-efficient measures anyway, despite the program (free riders), and customers that installed energy efficient measures as a result of the presence of the program, resulting in savings that were beyond the program-related gross savings of the participants (spillover).

The evaluation investigated and, where possible, explains differences between program design estimates and evaluation results. This analysis resulted in recommendations for improving program design estimates (ex ante), which should, in turn, result in post-implementation evaluation savings (ex post) that are closer to ex ante estimated savings.

2.3.2 Timing

The 1994 Industrial Lighting Impact Evaluation began in December 1994, completed the planning stage in March 1995, executed data collection between late May and October 1995, and completed the analysis and reporting phase in January and February 1996.

2.3.3 Role of Protocols

This evaluation was conducted under the rules specified in the "Protocols and Procedures for the Verification of Cost, Benefits, and Shareholder Earnings from Demand Side Management Programs" (the Protocols), as adopted by California Public Utility Commission (CPUC) Decision 93-05-063, Revised January 1995

Pursuant to Decisions 94-10-063, 94-10-059, and 94-12-021. To the extent it was possible during an ongoing evaluation, many of the changes included in CPUC Decision 95-12-054[2] were incorporated into the evaluation.

The Protocols control most aspects of the evaluation. They specify the minimum sample sizes, the required precision, data collection techniques, certain minimum analysis approaches, and formats for documenting and reporting results to the CPUC. This evaluation has endeavored to meet all Protocol requirements, and where possible, enhance evaluation techniques or results to supply added value to the developed estimates.

2.4 Report Layout

This report presents the results of the above evaluation. It is divided into five sections, plus appendices. *Sections 1 and 2* are the *Executive Summary* and the *Introduction*. *Section 3* presents the *Methodology* of the evaluation. It is supported in detail by *Appendices A, B,* and *E*. *Section 4* presents detailed results and discussion and is supported by *Appendices F* and *H*. *Section 5* discusses and presents recommendations for improving the evaluation, the program measures, and the CPUC Protocols. The remainder of the appendices document the data collection efforts undertaken during the evaluation.

[2] California Public Utilities Commission Decision 93-05-063, Revised January 1995 Pursuant to Decisions 94-05-063, 94-10-059, 9412-021, and 95-12-054.

Section 3

METHODOLOGY

This methodology section begins with an overview of the evaluation approach. This is followed by a more detailed discussion of the specific engineering, and net-to-gross (NTG) analysis approaches used in the evaluation. Additional detail on these two approaches is supplied in *Appendices B* and *E*, respectively.

3.1 Integrated Evaluation Approach

This overview of the integrated evaluation approach begins by presenting the data sources and sample design approach used for the evaluation of the 1994 Pacific Gas and Electric Company (PG&E) Industrial Lighting Technologies Evaluation. It is followed by an overview of how the engineering, and NTG estimates are used together to derive the gross and net energy and demand impacts.

3.1.1 Existing Data

The PG&E Industrial Lighting Evaluation approach used all the data currently available, in particular PG&E's historical billing data, program participation data, or the Management Decision Support System (MDSS), paper copies of Retrofit Express (RE) and Customized Incentive (Customized) applications, other program-related data, and industry standards information.

- **Program Participant Tracking System** - The participant tracking system data, maintained in the PG&E MDSS, contains program project information, and technical information about measure installation. It also provides expected impact estimates based upon the ex ante engineering algorithms. This information is used to create sample designs for data collection and to leverage calibrated impact estimates from the telephone sample to the entire participant population.

- **Program Marketing Data** - PG&E program marketing data contain detailed descriptions of program marketing and application procedures, together with details on the measures offered. This data source also provides a general description of measures accepted by the program.
- **PG&E Billing Data** - The PG&E nonresidential billing database contains monthly energy-consumption information for all industrial customers in

PG&E's service territory. It also contains demographic data for all customers, and the on-peak and off-peak monthly energy usage for customers who receive services on demand or time-of-use (TOU) rates.

- **Annual Summary Report on Demand Side Management Programs in 1994 and 1995[1] (Forecast Filing)** - This report documents the ex ante earnings claims, including specific information on the derivation of per-unit ex ante savings estimates and the assumptions that go into those estimates. This documentation often includes assumptions such as operating hours and operating factors, by fixture type. This document supplies the best information available on ex ante estimates and assumptions, thus facilitating knowledge-based comparisons to ex post estimates.
- **Industry Standards/Information** - In order to establish baseline levels and new equipment performance levels, industry standards information from organizations such as the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) and American National Standards Institute (ANSI) was used, together with information from manufacturers.
- **Copies of RE and Customized Paper Application Files** - QC requested and received complete copies of application files for a random 100 RE participants and all Customized participants. The RE files were used to verify the entries in the MDSS electronic files and to identify additional information that could be extracted from the file to improve the analysis. The Customized files were used to classify these participants into categories similar to the RE program, where possible, thus allowing maximum use of the statistical billing regression analysis.

3.1.2 Evaluation Surveys and Metered Data

For lighting in the RE and Customized programs, the impact analysis plan is based upon a nested sample design, with a core of lighting loggered sites supplying calibration for the on-site sample, and the on-site audit sample being leveraged with a larger, less expensive, telephone survey. Data between these samples are leveraged through "overlapping items" between the telephone and on-site instruments. The MDSS database program application information is used to leverage results to the entire participant population. This approach, as shown in Exhibit 3-1, results in the efficient use of all information to contribute to the final impact results.

- The lighting logger data (represented by the innermost circle in Exhibit 3-1) supply the most accurate source of data for calibration of the engineering estimates. This metering, which uses lighting loggers, registers the time and date the monitored fixture is turned on or off, for periods up to two months in

[1] Advice Filing 1800-G-A/1446-E-A.

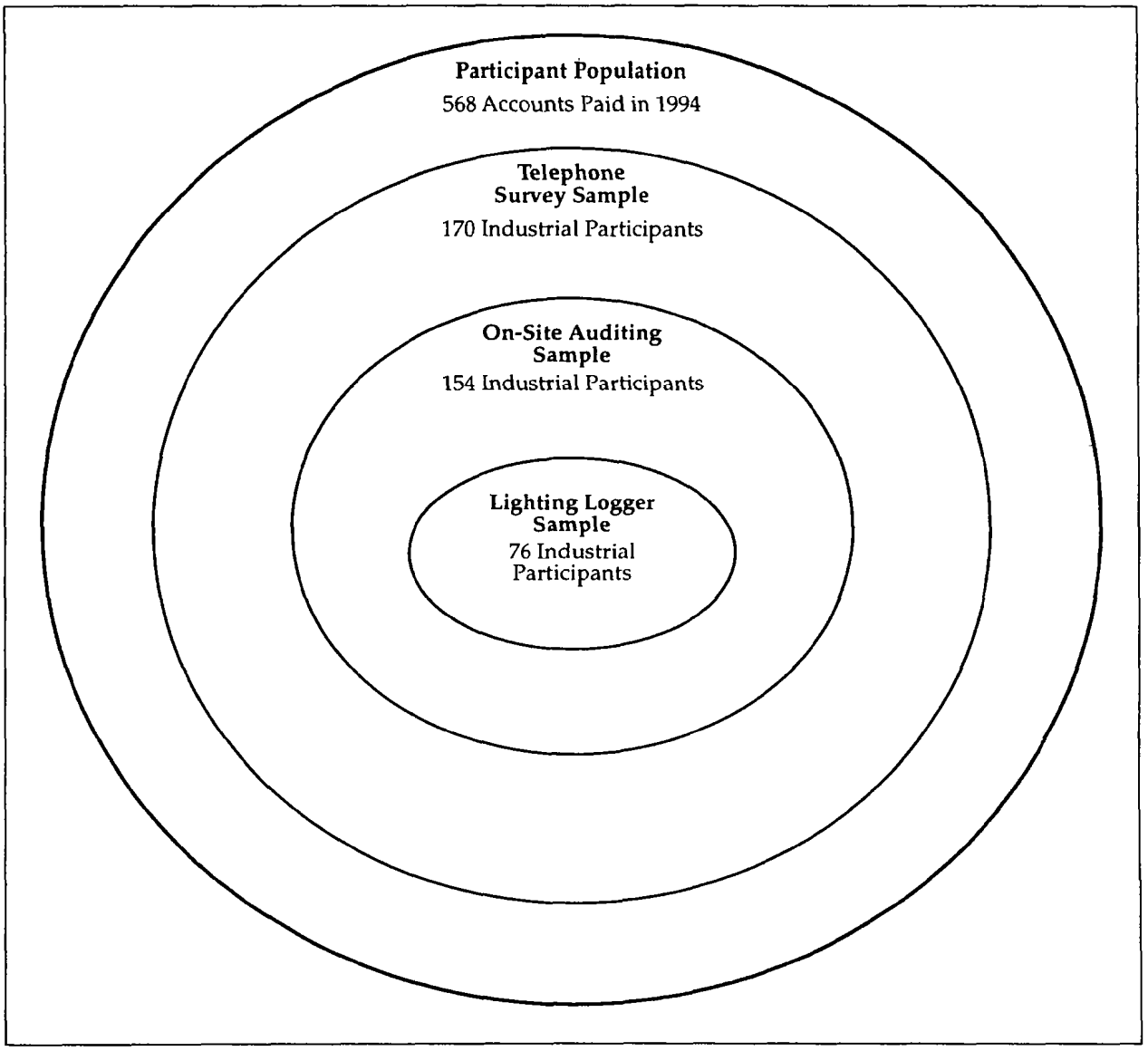
length. This information allows calibration of self-reported operating schedules collected during the telephone survey. In addition, it supplies operating information related to hours when facilities are closed, which cannot be collected during the on-site audit. When the lighting loggers are placed, one-time fixture operating wattage measurements (spot watt) are taken to confirm power consumption estimates of the operating fixtures. Loggers were placed in 76 industrial sites with an average of 3.30 loggers per site. Loggers were placed in every participant site where on-site inspections were completed and it was practical to place loggers and obtain reliable data.

- A relatively small on-site auditing sample (represented by the band around the innermost circle in Exhibit 3-1), is designed to support the telephone sample for the largest participation segments. This sample contributes equipment details that are site-specific, and better estimates of operating hours, operating factors, equipment efficiency, lamp burn-out rates, missed opportunities, and other technical factors that are difficult to collect over the telephone. The on-site sample itself is not designed to be statistically representative, but rather to support the estimate of detailed engineering parameters collected within the highest projected impact.

- A larger telephone survey sample (represented in Exhibit 3-1 by the second band from the center), is designed to be representative of the participant population in terms of technology and business type. The telephone survey supplies information on participant decision-making, and data for estimating the NTG adjustments. The comparison group telephone surveys supply information on trends in baseline equipment changes, including lighting retrofits outside the program, changes in square footage, and other trends.

- The participant population (represented by the outermost circle in Exhibit 3-1), is based upon information in the MDSS, and provides information needed to generalize estimated per-unit impact estimates for the telephone-surveyed sample to the entire population of program participants. Using the population to leverage impact estimates corrects for potential bias in the sample selection process, especially in terms of the actual distribution of installed measures.

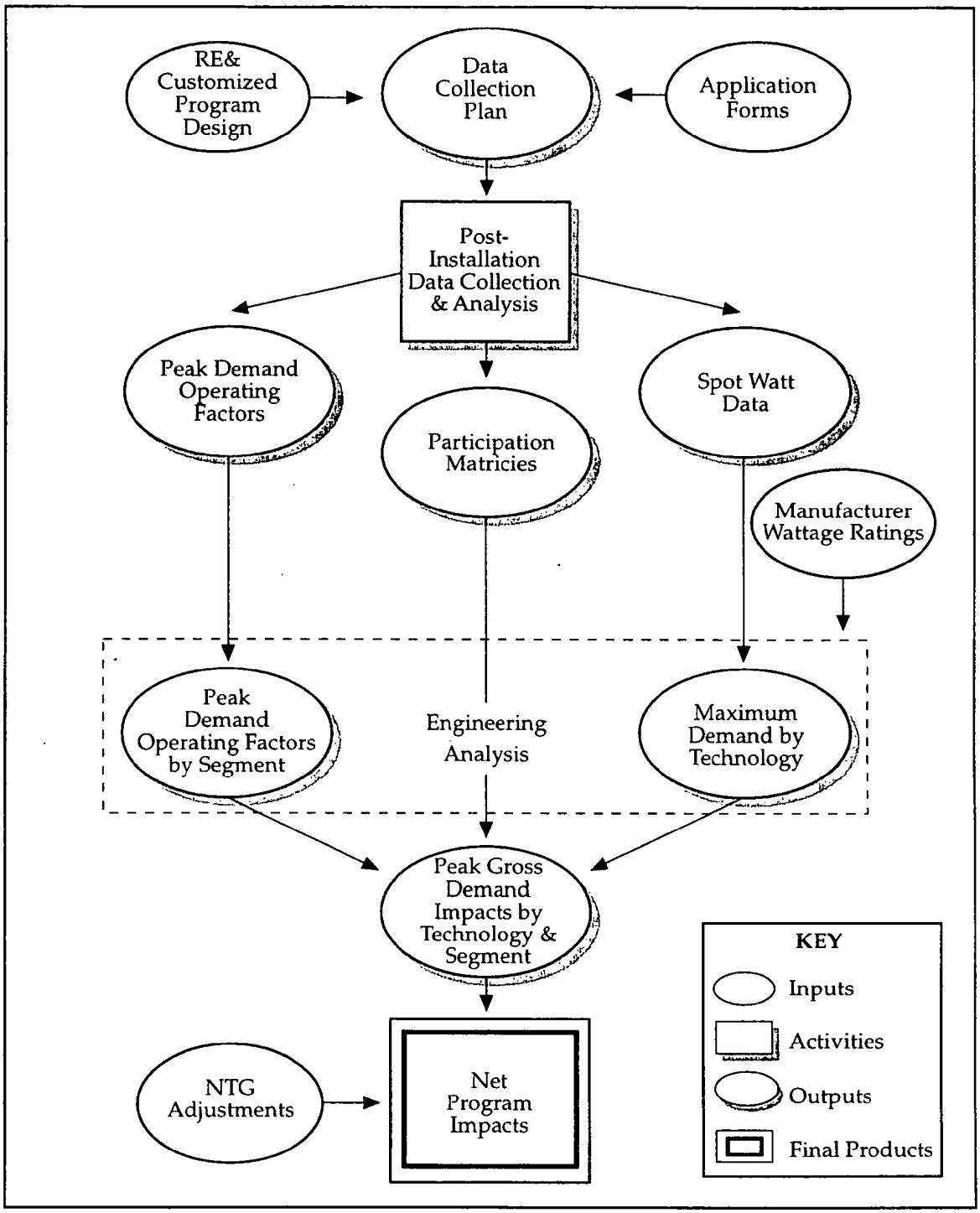
Exhibit 3-1
Nested Sample Design Approach



3.1.3 Demand Estimates

Demand estimates for the 1994 Industrial Lighting Evaluation are based upon engineering models calibrated to on-site data, metered data, and industry standards. As illustrated in Exhibit 3-2, the demand estimate method contains the following elements:

Exhibit 3-2
Method for Estimating Demand Impacts



- The program application and design data are used to create the data collection plan, which guides the data collection efforts of the evaluation (*Appendix A*, pages A1-A5).

- Post-Installation data collection efforts are targeted in a manner to produce the most efficient estimates.

  - The sample design begins with the development of participation matrices that indicate the larger and, therefore, more important segments.

  - Operating factors derived from lighting logger data and weekday operating factors, collected based upon the number of lamps operating at the time of each on-site audit, are inputs to the engineering calibration. In addition, data collected from the Commercial study comparison group on-site audit sample, and nonretrofitted equipment from Industrial study on-site audits, is used where the application of the data is deamed transferrable and appropriate. This included burned-out lamp rates and existing equipment saturation, which are used to calibrate engineering impact estimates (*Appendix B*, sections B.6.3 and B.6.4).

  - Smaller impact segments do not justify the collection of independent samples of primary data. For these segments, estimates are transferred from a similar segment, or industry standard test results—reported by the manufacturer—are used.

- Estimates of gross demand impacts are the product of the engineering analysis by technology and segment. These impact estimates are based upon the assumption that single fixtures operate according to observed operating factors for installed equipment and each building schedule.

- Program impacts are estimated by combining per-unit demand with the number of units installed, according to the participation matrices, to form the evaluation demand estimates for each segment. These results yield the estimated gross peak-demand impact for the program. They are presented as first-year impacts, accounting for the short-term effect of relamping burned-out lamps.

- The NTG adjustments for behavioral effects of participants account for free riders (participants who would have adopted similar program measures anyway), and spillover (reductions in energy consumption or demand caused by the presence of the program) (*Appendix E).*

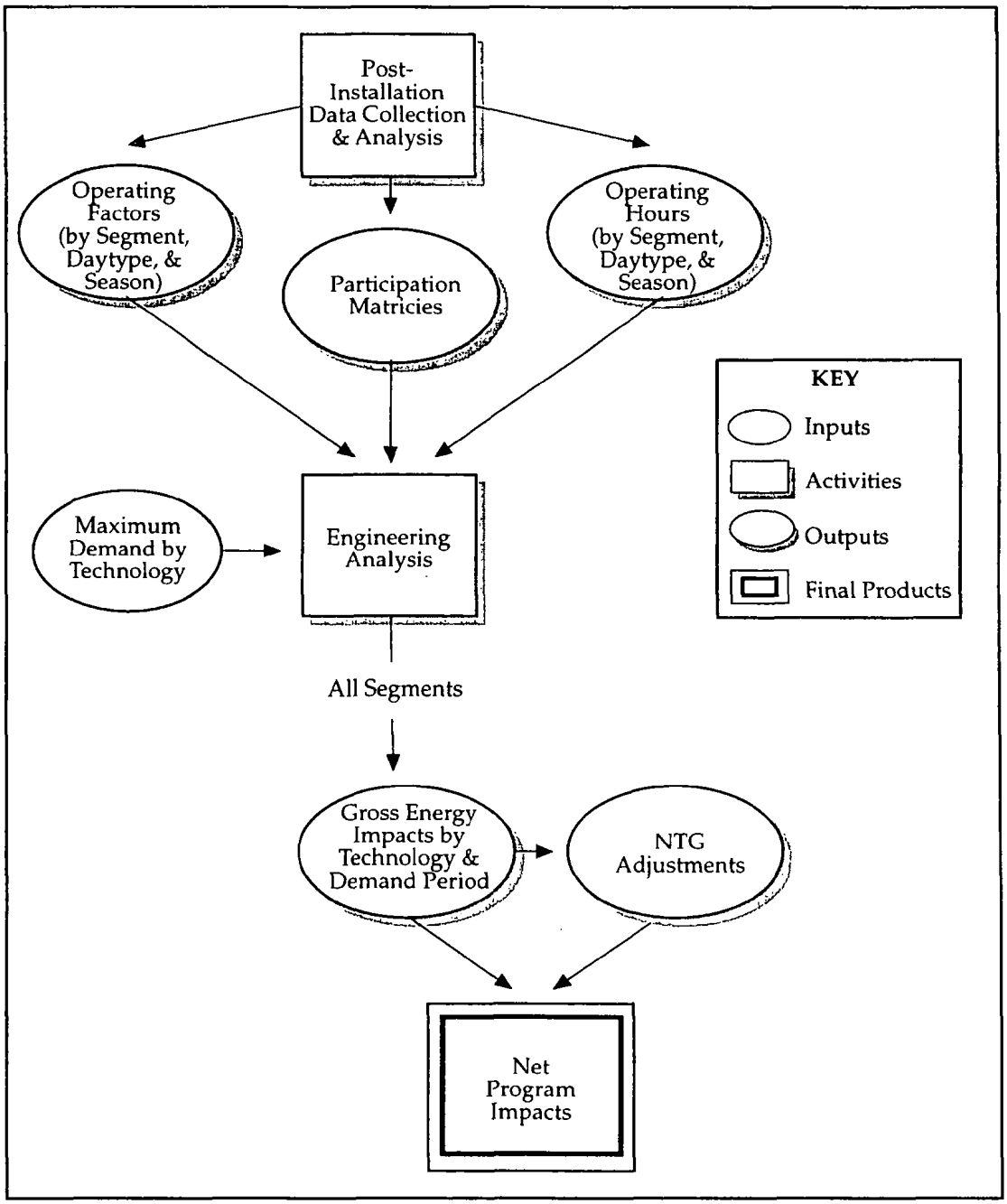
3.1.4 Energy Estimates

The energy impact estimates for the 1994 Industrial Lighting Evaluation are derived using engineering methods and statistically adjusted engineering (SAE) estimates.

As illustrated in Exhibit 3-3, the energy impact method is comprised of the following elements:

- The post-installation inspection data supply crucial lighting logger and spot kW data used to develop segment operating hours and operating factors, which are used with the participation data to create engineering estimates.

Exhibit 3-3
Method for Estimating Energy Impacts



- The per-unit engineering estimates are derived by analyzing the change in fixture connected loads in conjunction with customer operating schedules and fixture operating factors. Lighting logger data, instantaneous post-installation demand measurements, and on-site audit data are used to calibrate the engineering estimates. In addition, data collected from the Commercial study

comparison group on-site audit sample, and nonretrofitted equipment from Industrial study on-site audits, is used where the application of the data is deamed transferrable and appropriate. These data include burned-out/nonoperating lamps and operating factors (percentage of lights operating at any time) which are used to adjust the engineering per-unit savings estimates (*Appendix B*, sections B.6.3 through B.6.7).

- The per-unit engineering energy impacts are developed for each program segment. These represent savings that will be achieved, assuming that single fixtures operate according to observed on-site operating factors and calibrated operating schedules established during evaluation data collection. These results are presented as first-year impacts, accounting for the short-term effect of relamping burned-out lamps.

- Program net effects were estimated by modeling customers' decisions in the lighting market. The NTG adjustments compensate for free riders (participants who would have adopted similar program measures anyway), and participant spillover (reductions in energy consumption or demand caused by the presence of the program).

3.2 Engineering Analysis

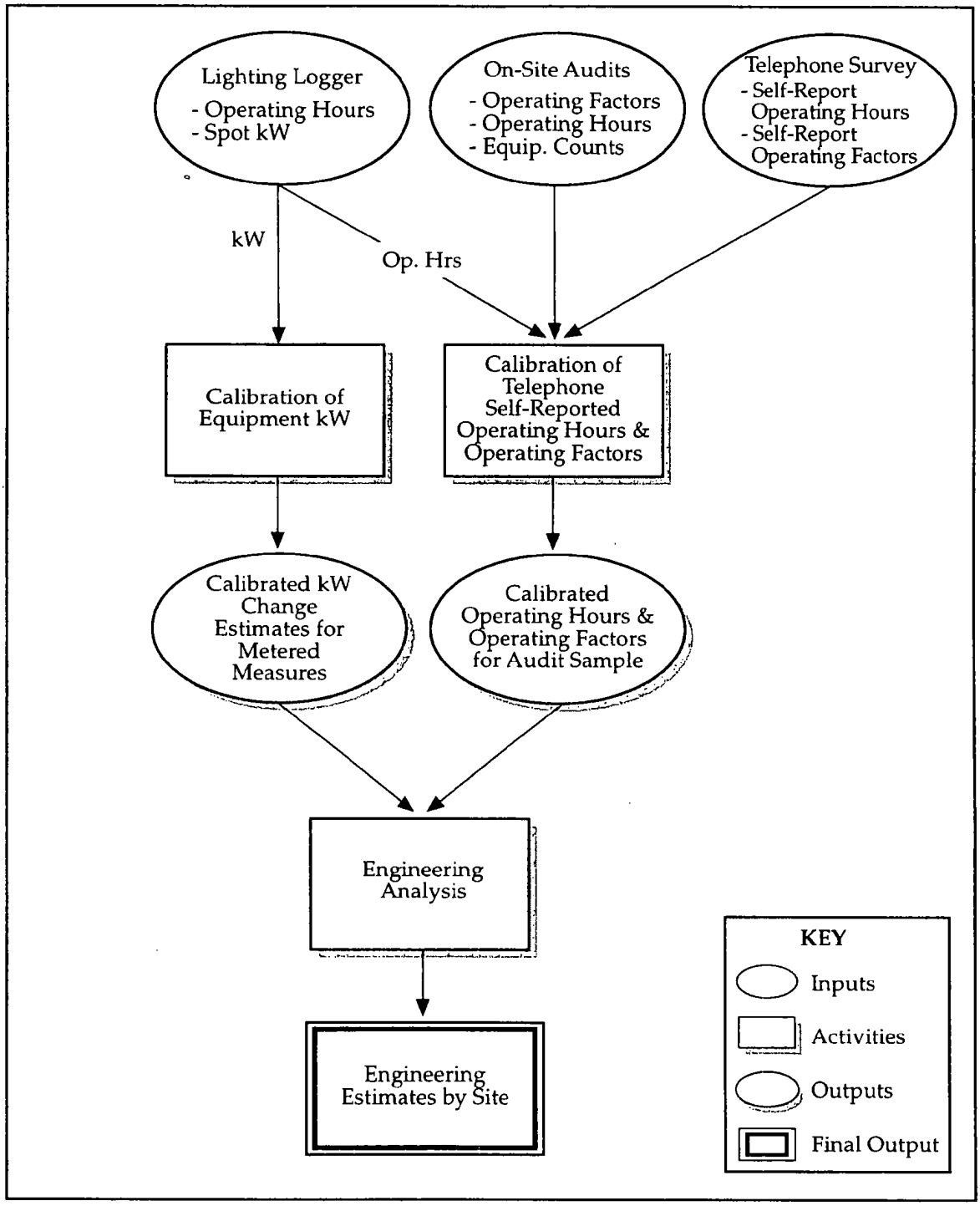
The engineering estimates combine information from the data collection effort with on-site verified program participation data in order to supply reliable engineering estimates.

Exhibit 3-4 illustrates the following features of the integrated impact analysis:

- Lighting logger data are used to:
  - Calibrate self reported building operating schedules
  - Determine whether buildings are operating at the peak hour
  - Estimate operating factors for "off" and weekend periods, since direct count information is not available from on-site audits
- On-site data and telephone surveys allow calibration of initial engineering estimates of savings by adjusting post-kW, operating hours, and operating factors to reflect actual operation for the surveyed sample.
- Calibrated per-unit engineering estimates are used in conjunction with the number of fixtures installed from the program application to estimate the impact for each site included in the telephone survey sample.
- Finally, engineering estimates either serve as final results from the calibrated models.

The details of all of the above steps are described in *Appendix B, Engineering Detailed Computational Methods.*

Exhibit 3-4
Derivation of Engineering Estimates



3.2.1 Engineering Demand Model[2]

The data described earlier are used to develop the inputs to the "load decomposition" demand impact algorithm presented in Exhibit 3-5. The strength of this model is that the key factors affecting gross demand impacts—impacts for operating hours, operating factor, HVAC adjustment factor, and diversity factor—are estimated separately, then combined to estimate overall demand impacts for each action taken by each program participant. This allows clear identification of factors controlling differences in consumption between segments, or between program design and evaluation estimates.

Exhibit 3-5
Engineering Gross Demand Impact Estimates

$$kW_{sav,j} = (\Delta UOL_j * U * OF_p * 0.001) + AC_{sav}$$

where

$kW_{sav,j}$	=	Peak demand savings for action "j" (kW)
ΔUOL_j	=	Estimated per-unit gross demand impact for action j
U	=	Number of units installed
OF_p	=	Operating at time of system peak, which is $[(Of_o \times DF) + ((Of_c \times (1-DF))]$
AC_{sav}	=	Air conditioning savings at time of system peak resulting from lighting reduction
OF_o	=	Operating factor when the facility is open
OF_c	=	Operating factor when the facility is closed
DF	=	Diversity factor at time of system peak

Each of the parameters listed in Exhibit 3-5 are developed as follows:

- The change in Unit Operating Load (ΔUOL_j) is derived by calibrating manufacturers' data with pre- and post-installation spot kW data collected during on-site audits. These data, collected by technology type, are gathered in fixture groups large enough to minimize measurement error. Differences

[2] The energy and demand engineering models are discussed in more detail in *Appendix B*, sections B.1 throughB.6.

between various manufacturers of ballasts and lamps are averaged to develop measure-specific UOLs.

- The number of units (U) of each measure type installed is verified during the post-installation on-site audit. The on-site audits also include random inspections of fixtures to confirm that newly-installed ballasts meet program specifications.

- The facility open operating factor (OF_O) is derived from lamp counts and questions asked during on-site audits. It compensates for partial operation of retrofitted lighting at sites when the facility is open. The OF, which measures the percentage of lamps operating, should not be confused with the diversity factor discussed below, which compensates for whether a site is operating at peak.

- The facility closed operating factor (OF_C) is derived from logger data, representing the percentage of fixtures operating during the hours that a facility is closed.

- Air-conditioning savings (AC_{SAV}) are the credit for reduced heat load resulting from the installation of more efficient lighting. Cooling credits and heating debits are computed using an approach that compensates for changes in lighting load based upon local heating and cooling degree days.[3] Note that heating is not an issue in estimating peak demand impacts, since PG&E's peak occurs during the summer.

- The diversity factor (DF) is the percentage of participants in any one segment operating at the time of system peak. This factor compensates for non-operating facilities at the time of system peak.

The engineering model for energy, which is based upon the same decomposition of load concept, is described below. The approach that is described in this next section illustrates a generalized approach to estimating annual lighting impacts. Actual energy impacts were generated in a fashion that is related more closely to the approach described above for demand impacts: on an hourly basis, for all hours in a year.

3.2.2 Engineering Energy Model

The model used to calculate annual energy impacts is similar to the demand impact model presented in Exhibit 3-5, except that operating factors and operating hours are incorporated for each distinct operating period. Additionally, an adjustment is

[3] Robert A Rundquist, Karl Johnson, and Donald Aumann. "Calculating Lighting and HVAC Interactions," *ASHRAE Journal*, November 1993.

made for heating usage and cooling usage. The model used, and definitions of each element of the equation, are presented in Exhibit 3-6.

Exhibit 3-6
Engineering Gross Energy Impact Estimates

$$kWh_{sav,j} = \Delta UOL_j * U * \{(OFWK_i * YWKHO_j) + (OFWE_i * YWEHO_j) + (OFBN_i * YBNO_j)\} * 0.001 + AC_{sav} - Heat_{pen}$$

where

$kWh_{sav,j}$	=	Annual energy impact for action "j" (kWh/yr.)
ΔUOL_j	=	Estimated per-unit gross demand impact for action j
U	=	Number of units installed
$OFWK_i$	=	Annual weekday operating factor for segment i
$YWKHO_j$	=	Annual weekday operating hours
$OFWE_i$	=	Annual weekends (Saturday and Sunday separately) operating factor for segment i
$YWEHO_j$	=	Annual weekends (Saturday and Sunday separately) operating hours
$OFBN_i$	=	Annual operating factor for segment i when building is closed
$YBNO_j$	=	Annual hours when building is closed
AC_{sav}	=	Air conditioning savings resulting from lighting impacts
$Heat_{pen}$	=	Heating penalty resulting from lighting impacts

Each of the parameters listed in Exhibit 3-6 are developed as follows:

- The change in Unit Operating Load (ΔUOL_j) and the number of units (U) of each measure type installed are the same as those used in the demand model (Exhibit 3-5).

- Operating factors (percentage of retrofitted lighting units operating during a specified time - OFWK, OFWE, OFBN) are derived from lamp counts, lighting logger records, and questions asked during on-site audits and telephone surveys. They compensate for partial operation of the retrofitted lighting.

- Annual operating hours for each period (YWKHO for weekdays, YWEHO for weekends, and YBNO for all building closed periods) are developed from a combination of lighting logger measurements conducted during the post-installation period, and interview questions that address seasonal variations in retrofitted lighting usage.

- Cooling credits are computed using an approach that compensates for changes in HVAC load based upon both the lighting only impacts and local heating and cooling degree days.

- The heating penalty from energy-efficient lighting installations was estimated for those customers that heat with electricity. Using the ASHRAE method[4], the heating penalty for customers with electric resistance space heat is less than 5% of the lighting impact for any customer in PG&E's service territory.

3.2.3 RE and Customized Measure Segmentation

Measures are grouped in order to develop segments representing common technologies. This approach, while establishing estimates at the measure level, maximizes leveraging of data. The comparisons made at the individual measure level are listed in Exhibit 3-7.

Since lighting technologies are generally the same in both the RE and Customized programs, the most common technology groupings can be used as common categories for both programs. For the Customized program, a thorough review of the paper files was performed in order to confirm technology types, or reassign the allocation of measures to categories that matched the RE segmentation. During this review, many of the controlling engineering parameters were extracted from the applications and entered into an electronic dataset to facilitate analysis. Exhibit 3-7 illustrates the overlap of technology categories for the RE and Customized programs.[5]

When the measure code was received from PG&E, many of the measures with clearly defined action codes were allocated to the "Lighting Other" category, so that this category represented 35% of the total population. To facilitate evaluation, QC reallocated these measures to an appropriate technology group category. As a result, The "Lighting Other" category represents only about 5% of total participation in the Customized program.

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[4]Ibid.

[5] The "PG&E Measure Code" used to define measures for both programs is also known as the "Action Code" in the MDSS system.

Exhibit 3-7
Comparison of Segmentation by Technology

RE Program		Customized Program	
Technology Segment Descriptions	PG&E Measure Code	Technology Segment Descriptions	PG&E Measure Code
Halogen		**Halogen**	
All wattages	L1	Low Voltage Halogen	182
< 45 watts	L60	Halogen Lamp Conversion	156
> 50 watts	L61		
Compact Fluorescent Lamps		**Compact Fluorescent Lamps**	102
Screw In CF			
All wattages	L2, L56		
5-13 watts	L62		
14-26 watts	L63		
Screw In CF- Reusable ballast			
All wattages	L3, L58, L59		
5-13 watts	L64		
14-26 watts	L65		
Hard Wired CF			
All wattages	L4		
5-13 watts	L66		
14-26 watts	L67		
27-50 watts	L68		
Incandescent to Fluorescent Fixture		**Incandescent to Fluorescent Fixture**	
With Energy Saving Ballast & T12 Lamps	L7	Incandescent to Fluorescent - Indoor	101
With Electronic Ballast & T8 Lamps	L8	Incandescent to Fluorescent - Outdoor	120
Exit Signs		**Exit Signs**	155
Incand. to Compact Fluorescents	L5	Incand. to LED	155
Incand. to LED or Electroluminescent Retrofit	L6		
Efficient Ballasts Changeouts		**Efficient Ballasts Changeouts**	
Electronic Ballasts		Modified Electromagnetic Ballasts	
2 Lamp Electronic Ballast	L14	Hybrid Ballasts	147
3 Lamp Electronic Ballast	L15	Primium Ballast (Core & Coil)	148
4 Lamp Electronic Ballast	L16	Electronic Ballasts	149
T8 Lamps and Electronic Ballasts		**T8 Lamps and Electronic Ballasts**	
New Fixtures			
One-Lamp Fixture	L9, L117, L121		
Two-Lamp Fixture	L10, L118, L122		
Three-Lamp Fixture	L11, L123		
Four-Lamp Fixture	L12, L120, L124		
2'-1 U Tube or 2 lamps	L69		
2'-2 U Tubes or 4 lamps	L70		
2'-3 U Tubes or 6 lamps	L71		
4'-1 lamp	L72		
4'-2 lamps	L73		
4'-3 lamps	L74		
4'-4 lamps or 8'-2 lamps	L75		
Fixture Modif.- Replace Lamps and Ballasts		Fixture Modif.- Replace Lamps and Ballasts	
Replace Lamps & Ballasts - 2' Fixture	L21	Replace Lamps & Ballasts - 2' Fixture	146
Replace Lamps & Ballasts - 3' Fixture	L22		
Replace Lamps & Ballasts - 4' Fixture	L23		
Replace Lamps & Ballasts - 8' Fixture	L24		
Delamp Fluorescent Fixtures		**Delamp Fluorescent Fixtures**	
Fixture Modif.- Delamp and Reflector		Fixture Modif.- Delamp and Reflector	
Removal - 2' Lamps & Ballasts	L17	1-F96T12 (60W) w/EE Magnetic Ballast	181
Removal - 3' Lamps	L18	Remove Lamps Reduce Lights	150
Removal - 4' Lamps	L19		
Removal - 8' Lamps	L20		
High Output T8 & T10 Conversion w/ Delamp			
T10 & Energy Saving Ballast	L76		
T10 or T8 & Electronic Ballast	L77		
High Intensity Discharge		**High Intensity Discharge**	
Interior Compact HPS from Incand.		Metal Halide Fixtures - Interior	104
0-100 watts HPS	L25	HPS/LPS - Exterior	123
0-35 watts HPS	L78		
36-70 watts HPS	L79		
71-100 watts HPS	L80		
Interior Standard MH from Merc. Vapor			
101-175 watts MH	L26		
176-250 watts MH	L27, L37		
251-400 watts MH	L81		
Exterior HPS from Merc. Vapor			
0-100 watts	L28		
101-175 watts	L29		
176 watts & greater	L30		
Reduced Wattage Lighting		**Reduced Wattage Lighting**	
T8 (32 watt) Fluorescent Lamp	L13	4' Energy Saver Fluorescent Lamps	142
		8' Energy Saver Fluorescent Lamps	143
		T8 Fluorescent Lamps	144
		Lower Wattage Incandescent Lamps	152
		Current Limiters	153
Controls		**Controls**	
Time Clocks	L31	Lighting Controls	160
Occupancy Sensors		Lighting EMS	164
72-350 watts controlled	L32	Motion/Occupancy Sensors	166
351-1000 watts controlled	L33	Photocell	168
1000 watts and greater controlled	L34	Bypass/Delay	169
Wall Mounted	L82		
Ceiling Mounted	L83		
Bypass/Delay	L35		
Photocell	L36		
		Lighting Other	
		Daylighting	191
		Optical Reflectors	193
		Lighting Other	199

As part of the process of matching the action and measure codes, and of understanding the original calculations so that differences between the final evaluation results and the ex ante estimates could be explained, QC performed a review of the ex ante estimates and the parameters that went into them. *Appendix H* summarizes the distribution of NTG ratios that were applied, by technology and building type. These factors, plus the detailed understanding of the ex ante algorithms, allowed the clear identification of reasons for ex post differences, which are presented in *Section 4* of this report.

3.2.4 Engineering Connected Load Estimates

The basis of both engineering estimates and program design estimates is the per-unit connected load computation. In both cases, estimates are created by subtracting the estimate of "on" consumption of the average new fixture from the "on" consumption of the average original fixture. The documentation and comparison of evaluation estimates to program design estimates are the first steps to understanding reasons for differences between evaluation and program estimates.

The per-unit consumption estimates for the engineering analysis are from manufacturers' literature. Values for program design estimates were taken from the 1994 RE program estimates, as supplied with the October 1993 Forecast Filing.[6] Manufacturers' estimates were then reviewed and noted as a way to explain differences between evaluation results and program design estimates.

3.2.5 Engineering Operating Hour and Operating Factor Estimates

One of the primary differences between evaluation engineering estimates and program estimates is that evaluation estimates are based upon program participant-specific operating hours and operating factors (the percentage of retrofitted lights operating at a specified time). Program design estimates, because they are created before the program is conducted, are based upon expectations or standards for typical buildings, rather than the direct measurement of program participant energy use.

The source of operating hours assumptions for the program design estimates is an Operating Hours Study conducted in 1992 by HBRS. The operating hours are calculated as full load operating hours, thus defining an "on" operating factor of 1.0. The peak load diversity factor came from the October 1993 Forecast Filing referenced above. The value of 0.67 is based upon an analysis of 50 end-use metered points, according to a study that was performed by Regional Economic Research(RER).

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[6] *Annual Summary Report on Demand Side Management Programs in 1994 and 1995,* Advice Filing 1800-G-A/1446-E-A.

The sources of premise-specific operating hours for evaluation estimates are displayed in Exhibit 3-8. Nesting of the samples (lighting logger data within on-site audits, within telephone surveys) allows calibration of less expensive data collection methods to those that are more costly.

Exhibit 3-8
Operating Hours and Operating Factors for Engineering Models
(Sources Used to Determine Each Estimate)

Source \ Parameter		Operating Hours	Operating Factors
Program Design	**Peak kW**	NA	Peak Load Diversity = 0.67
	kWh	Specified by Building Type from Operating Hours Study	Assumed to Be = 1.0
Evaluation			
Telephone Survey	**Peak kW**	NA	Determined by Premise from Customer Self-Report, Calibrated to On-Site Findings
	kWh	Determined by Premise from Customer Self-Report, Calibrated by Audit Data and/or Run-Time Meter Data	Determined by Premise from Customer Self-Report, Calibrated to On-Site Findings
On-Site Audits	**Peak kW**	NA	Determined by Actual Count at Time of Audit and Extrapolated to Peak Hour Based upon Customer Self-Reports
	kWh	Deterined by Premise and Schedule Zone, Calibrated to Run-Time Meter Data for Metered Sites	Determined by Actual Count at Time of Audit and Extrapolated to Remaining Operating Hours Based upon Customer Self-Reports of Use Patterns
Lighting Loggers	**Peak kW**	NA	Determined by Actual Count During On-Site Audit
	kWh	Determined by Run-Time Meters by Schedule Zone	Determined by Actual Count During On-Site Audit

While lighting loggers supply information about whether the building is operating at the time of peak demand, for the peak demand estimate, the operating factor is actually estimated by extrapolation of the operating factor observed during the on-site audit, and is based upon actual lamp and fixture counts.

3.2.6 Engineering Cooling Benefit Estimates

Cooling savings resulting from reduced internal heat gains (caused by the installation of more energy-efficient lighting) are a function of the contribution of lighting internal gains to cooling load, in combination with the efficiency of the cooling system.

A modified version of the approach presented in a recent issue of the *ASHRAE Journal* [7] was used in this analysis. Equations for the demand and energy adjustments used in this evaluation are presented in Exhibit 3-9, together with definitions of the elements that compose the estimates.

[7] Robert A Rundquist, Karl Johnson, and Donald Aumann. "Calculating Lighting and HVAC Interactions," *ASHRAE Journal*, November 1993.

Exhibit 3-9
Estimate of Cooling Benefit

$ACSAVJ,kW = kW_{LSAV,j}/MCOP$

$ACSAVJkWh = kWh_{LSAV,j}*RCF/MCOP$

Where

$ACSAVj,kW$	=	Additional kW savings attributed to reduced demand from lighting action "j" (kW)
$kWLSAV,j$	=	Demand savings directly attributable to action "j" (kW)
MCOP	=	Marginal coefficient of performance for cooling system, including auxiliaries and supply and returning fans (unitless)
ACSAVj,kWh	=	Additional savings attributed to reduced cooling load from lighting action "j" (kWh/yr)
kWhLSAV,j	=	Energy savings directly attributable to action "j" (kWh/yr)
RCF	=	Regional Cooling Factor—fraction of annual lighting energy that is rejected as heat and thus requires cooling. Value is dependent upon local cooling degree days, and is supplied by reference table (unitless)

The features of the ASHRAE method are as follows:

- The cooling *demand* savings are calculated by dividing the lighting energy saved ($kW_{LSAV,j}$) by the efficiency of the HVAC system (its marginal coefficient of performance – MCOP). The computation assumes that all energy saved during the peak period results in a reduction in peak demand. This methodology has the potential to increase lighting program peak demand impacts by approximately 33 percent.

- In calculating cooling *energy* savings, the lighting energy saved ($kW_{LSAV,j}$) is first multiplied by a regional correction factor (RCF) to reflect interregional differences in the percentage of lighting energy savings that affects air-conditioning energy usage over the entire cooling season.[8] The resulting adjusted energy savings are then divided by the MCOP to determine estimated

[8] In the *ASHRAE Journal* article referenced above, the regional cooling factor (RCF) is supplied in a table for selected major cities in the United States. The table reflects the number of annual cooling degree days in each region.

HVAC system energy savings. Using this approach, it is estimated that, in the PG&E service area, cooling energy savings add approximately 12 percent to lighting energy savings.

The summer cooling energy savings that result from the installation of more efficient lighting fixtures is offset by a winter heating penalty caused by reduced heat contribution during the heating season.

3.2.7 Engineering Heating Penalty Estimates

The increase in winter heating energy requirements resulting from reduced internal gains (caused by the installation of energy-efficient lighting) is computed using a method similar to that used to calculate cooling benefits. In summary, the cooling credit and heating debit together should increase peak demand impacts by approximately 33 percent, and annual energy consumption by 8 to 10 percent. The heating algorithm and its elements are described in Exhibit 3-10.

Exhibit 3-10
Estimate of Heating Increase Penalty
(Electric Heating Only)

$$Heat_{pen,j,kWh} = (kWh_{LSAV,j} * RHF * PERIM \bullet FRACTION)/HPCOP$$

Where

$Heat_{pen,j,kWh}$	=	Additional heating energy required because of the lower heat rejection of new lights (kWh/yr)
$kWh_{LSAV,j}$	=	Energy savings directly attributable to installation of lighting measure "j" (kWh/yr)
RHF	=	Regional Heating Factor – fraction of annual lighting energy savings that would have been rejected as heat, thus requiring additional heating. The value is dependent upon local heating degree days, and is supplied by a reference table (unitless)
HPCOP	=	Efficiency of the electric heating system -- default of 1.0 for electric resistance heat or 2.0 for heat pumps (unitless)
PERIM•FRACTION	=	Fraction of the floor area that is within 15 feet of the perimeter wall (unitless)

The *ASHRAE Journal* method for calculating increases in heating *energy* savings entails multiplying the lighting energy saved (kWhLsav,j) by a regional correction factor (RCF) for heating to reflect interregional differences in the percentage of

lighting energy savings that result in increases in heating energy requirements.[9] This product is then multiplied by the fraction of building floor area within 15 feet of the perimeter of the building, as this is where most heat loss occurs. Finally, the mechanical system efficiency parameter, HPCOP is applied to adjust for a conversion from building heat load to heating system energy use. In addition, three considerations are reflected in this model.

- The electric heating energy debit is smaller than the cooling credit, and is less than 1 percent of the lighting energy savings, depending upon the perimeter fraction.
- The heating *demand* savings is not addressed because PG&E is a summer peaking utility, and no heating occurs during the summer peak period.
- The heating penalty is only a factor if heating is electric.

3.3 Net-to-Gross

Net effects are estimated through market analysis which involves the development of a model analyzing customer decisions in the lighting market. The market analysis models how participants first decided to purchase lighting equipment, and then, how they decided to purchase measures that correspond to those promoted by PG&E's program.

The approach used to calculate program net effects uses self-reported responses from telephone survey data to estimate free ridership and spillover for lighting program participants. Results from each separate subanalysis are combined to generate NTG ratios.

3.3.1 Free Ridership

A logistic regression model predicting free ridership was developed using self-report data in a pooled model incorporating data from all surveyed lighting program participants.[10] The multivariate purchase decision model attempts to estimate the probability that a customers' revealed choices are consistent with those of a free rider or net participant.

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[9] As is the case for cooling, the regional heating factor is supplied in a table in the *ASHRAE Journal* article for selected major cities in the United States. The table reflects the number of annual heating degree days in each region.

[10] Given the number of variables planned to be included in the initial models and the maximum available sample size (N=161), we felt the logistic regressions would be under-powered if they were run separately for each measure group. Using a rule of thumb of 20 observations per model variable, none of the groupscould have supported its own logistic regression. Additionally, we believed that the behavioral model should hold for all purchase decisions, regardless of technology, since decision-making processes should be consistent across technologies.

Exhibit 3-11
Self-Reported Free Ridership: Superset of Model Variables

Model Variable	Wording of Question	Predicted Direction: Net Participant	Predicted Direction: Free Rider	In Final Model
	TIMING OF PLANS			
PERIOD_ BEFORE_ AWARE	How long were you considering <the measure> before you heard about the program?	short-moderate period	longer period	
NO_PLANS	Wasn't planning on purchase until approached	yes	no	
PERIOD_ AFTER_ AWARE	How long did you take to decide to participate after becoming aware of the program?	longer period	shorter period	
WAIT_NO_ PGM	How long would you have waited to <take the measure> without the program?	longer period	shorter period	x
WAIT_FOR_ PGM	Did you delay a retrofit in order to participate?	no	yes	
	OPTIONS			
QUOTES	How many estimates or quotes did you obtain before purchasing your new equipment?	few	many	x
STD_EQUIP	Did you consider purchasing standard-efficiency equipment?	yes	no	x
BROKEN	(Did the customer mention broken equipment?)	yes	no	
	PROGRAM INFORMATION AND BENEFITS			
PGE_CONTAC	How many times a year do you have contact with your PG&E rep?	few	many	
REBATE	(Did the customer mention the rebate?)	yes	no	
BILL_ SAVINGS	(Did the customer mention bill savings?)	yes	no	x
FREE_RIDE	Before you knew about the program, which of the following statements best describes your company's plans to <take the measure>?	had considered, but no plans	planning to do it within the next 12 months	

The dependent variable in the model is based upon customer-reported plans in the absence of the program. A customer is coded as a net participant if reported plans indicate that the retrofit would not have been completed in the absence of the program, or would have occurred at a later date.[11]

Independent variables included in the initial model are also shown, along with their predicted effects, in Exhibit 3-11. Three categories of variables are used to explain free ridership. The first category consists of variables that involve the timing of a customer's plans for completing a retrofit, and the timing of their awareness of PG&E's programs. The second category captures variables that characterize the choices customers faced in considering a retrofit. Finally, the third category describes some of the benefits provided by PG&E's program and how they relate to a customer's purchase behavior. Exhibit 3-11 lists the variables that were considered for the free rider model and indicates those variables included in its final specification.

Timing of Plans - Four questions addressing the decision-making process and the length of time spent in various decision-making stages were included in the telephone survey. A question addressing length of time spent considering various equipment options, before becoming aware of the program, PERIOD_BEFORE_AWARE , was included in the model. Customers spending less time researching equipment before becoming aware of the program can be distinguished from free riders who had researched and chosen products before becoming aware of the program. While risk-averse customers may also have spent considerable time considering options, net participants (as a group) should spend less time seeking information than free riders. Contractor-driven net participants were expected to have spent no time shopping for lighting equipment before becoming aware of the program (NO_PLANS).

A second question addressing the length of time the customer spent considering the benefits provided by the program was also included in the model (PERIOD_AFTER_AWARE). Free riders, because they have essentially already made up their minds, should spend a short period of time assessing the benefits provided by the program. When presented with the option to install equipment or take some other efficiency action through the program, they are eager to do so. Contractor-driven net participants may also spend a relatively short period of time reaching a decision, but taken as a whole, net participants are expected to take more time to reach a decision to participate than free riders.

[11] Customers who accelerated a decision to retrofit were considered net participants.

The third decision-making question included in the model addressed the number of years a customer would have delayed the equipment retrofit had the program not existed (WAIT_NO_PROGRAM). This question is intended to differentiate decision-accelerated net participants from free riders.

A final question, WAIT_FOR_PROGRAM, was intended to serve as a flag identifying free riders based on prior purchase plans.

Options - In programs with aggressive target marketing by contractors and division representatives, participants may obtain few quotes for their prospective lighting purchases. Many customers will only obtain one quote from their initial program contact (often a lighting contractor) and then stay with one contractor. The number of quotes obtained (QUOTES) should discriminate between those customers who were driven into the program by tactical program marketing efforts versus those who were already active in the marketplace.

Customers who never considered standard-efficiency lighting measures prior to their purchase (STD_EQUIP) are likely free riders since the program was not a prime driver in their purchase of high-efficiency lighting equipment. Customers with older, failing equipment (BROKEN) may be driven into the market by the condition of their equipment, but once in the market, their equipment selection can be greatly affected by the program's contribution to the increased supply of energy-efficient lighting.

Program Information and Benefits - Customers in close contact with their division representatives have increased access to information about the benefits of participating (PGE_CONTACT). Customers in frequent communication with representatives may be "repeat" program participants whose likelihood of free ridership increases over time.

Program marketing efforts create a market for lighting retrofits and influence customer plans. Many customers indicated that they were drawn into the market by program marketing efforts. Program participants, more so than nonparticipants who also made lighting purchases, were more likely to echo program marketing messages such as a desire for bill savings (BILL_SAVINGS) or the program rebate (REBATE). These customers were drawn into the program by key program benefits, which provide the necessary motivation for customers who might not otherwise adopt program qualifying measures. These variables should be associated with decreasing likelihood of free ridership.

Details of the model-building process and final model selection appear in *Appendix E*. Pooled model results (the regression coefficients) were used to generate average free ridership rates for each technology group.

3.3.2 Spillover

The program spillover estimate contains one main component: a contribution from program participants.

Participants - Participant spillover effects were measured through simple self-report questions such as, "Since participating in the program, have you adopted any additional energy-efficiency recommendations?" Customers were asked about specific program-qualifying technologies such as T-8 lamps with electronic ballasts. Responses were tallied, and the rates of the actions in the participant population were calculated and multiplied by ex post estimates of measure savings (average percentage reductions in usage per account). These were then credited to the RE program as additional program kWh savings. This was done for each lighting technology group and the program as a whole.

General Methods. All intermediate effects were expressed as percentage reductions in annual usage. These were multiplied by each groups' average annual account size[12], and the impacts (in kWh) were summed to yield a final net kWh. This was then divided by the ex post gross kWh estimate to yield the final NTG ratio. Exhibit 3-12 shows an example of the spillover effects included for compact fluorescent lamps. Percentages shown in the exhibit are annual usage reductions used in the net energy calculations. Note the participant spillover effects (in this case for compact fluorescent lamps) apply to the NTG for the technology under which a customer participated.[13]

[12] Participant spillover effects were calculated as percentage reductions multiplied times the average *post-program* annual usage.

[13] Customers who installed multiple measures were categorized based on the measure that supplied the greatest impact on avoided cost.

Exhibit 3-12
Example: Spillover Effects Used for Compact Fluorescent Lamps

Technology	Spillover Effects	
	Participants' Within Measure Spillover	Participants' Other Measure Spillover
Compact Fluorescent	0.25%	
Incandescent to Fluorescent		1.74%
Efficient Ballast		0.51%
T8 Lamps and Electronic Ballasts		0.71%
Optical Reflectors w/ Fluor. Delamp		2.91%
High Intensity Discharge		1.22%
Halogen		0.45%
Exit Signs		0.19%
Controls		0.38%

Caveats. In order to accurately measure the program's market effects, data from additional sources, in addition to self-reports, would be required. This stems from a major drawback of self-report data: namely, that there is no reason to believe that customers who made program qualifying retrofits outside the program would be able to accurately gauge the program's effect on structuring their choices. In other words, participants and nonparticipants[14] who make a program-qualifying purchase may have no idea of the program's effect on the pricing and availability of equipment they purchase outside the program. The same can be said of nonparticipants or participants who report that they "would have adopted the measure without the program. " This is a common dilemma in measuring program net effects when relying solely on self-reports. The solution to the problem does not lie in increasingly detailed probes of participants and nonparticipants. Rather, the solution lies in looking elsewhere for data and in adopting multi-level models or approaches that capture the program's macro-level effects on the distribution, availability, and pricing of energy efficiency options.

3.3.3 Integrated Estimate of NTG Adjustments

The final step in constructing the NTG ratio is to sum up all contributing effects into one index. Program gross impacts are adjusted for free ridership and spillover to produce the combined best-estimate of program net impacts. These net impacts are estimated by adding together the net effect of program participants,[15] and program participant spillover effects, as follows:

[14]Note that no nonparticipant spillover was quantified for this analysis.

[15] Taking free ridership into consideration

$$NTG = \frac{GI * (1 - FR) + Spillover_{Part}}{GI}$$

where,

NTG	=	the Net-to-Gross Ratio
GI	=	the Program Gross Impact
FR	=	the Free Ridership Rate
$Spillover_{Part}$	=	the estimated impact of participants' nonprogram energy conservation actions

Section 4 gives three separate estimates of the NTG among the industrial sector:. the lower-bound estimate, the midpoint, and the 90 percent upper-bound. Summary tables in *Section 1* show the decomposition.of the final program NTG ratio into the following components:

- 1-FR
- Participant Spillover Effects

The process of applying the NTG adjustments to the gross energy and demand impacts is illustrated in Exhibits 3-13 and 3-14 below. The second column presents a summary of the gross ex ante impacts, and the gross ex post (evaluation) impacts. These impacts are then adjusted, on a row-by-row basis, by summing the appropriate free rider and participant spillover adjustments and multiplying the sum times the gross impacts, to derive the net impacts in the two net columns. The realization rates, in the bottom section, are then generated by dividing the ex post impact by the ex ante impact.

While Exhibits 3-13 and 3-14 present results by end-use elements, the same method is used to estimate gross and net impact estimates that are presented by technology group in *Section 4*, Evaluation Results Summaries.

Exhibit 3-13
Net Energy Impact Summary

Technology Group	Gross	NTG Adjustments			Net	
	Gross Impact	Free Ridership Adjustment (1-FR)	Participant Spillover Adjustment	Nonparticipant Spillover Adjsutment	Net Impact without NP Spillover Adjustment	Net Impact with NP Spillover Adjustment
	(MWh)	(Unitless)	(Unitless)	(Unitless)	(MWh)	(MWh)
Ex Ante						
Indoor Lighting	71,126	0.67	0.10		54,747	
Outdoor Lighting	1,635	0.67	0.10		1,259	
Indoor & Outdoor Lighting	72,761	0.67	0.10		56,006	
Ex Post						
Indoor Lighting	96,677	0.87	0.05	0.00	88,816	88,816
Outdoor Lighting	1,593	0.76	0.05	0.00	1,290	1,290
Indoor & Outdoor Lighting	98,270	0.87	0.05	0.00	90,106	90,106
Realization Rates (ex post/ex ante)						
Indoor Lighting	1.36	NA	NA	NA	1.62	1.62
Outdoor Lighting	0.97	NA	NA	NA	1.02	1.02
Indoor & Outdoor Lighting	1.35	NA	NA	NA	1.61	1.61

Exhibit 3-14
Net Demand Impact Summary

Technology Group	Gross	NTG Adjustments			Net	
	Gross Impact	Free Ridership Adjustment (1-FR)	Participant Spillover Adjustment	Nonparticipant Spillover Adjsutment	Net Impact without NP Spillover Adjustment	Net Impact with NP Spillover Adjustment
	(kW)	(Unitless)	(Unitless)	(Unitless)	(kW)	(kW)
Ex Ante						
Indoor Lighting	12,008	0.67	0.10		9,240	
Outdoor Lighting	0	0.67	0.10		0	
Indoor & Outdoor Lighting	12,008	0.67	0.10		9,240	
Ex Post						
Indoor Lighting	16,197	0.88	0.03	0.00	14,887	14,887
Outdoor Lighting	196	0.76	0.05	0.00	159	159
Indoor & Outdoor Lighting	16,393	0.88	0.03	0.00	15,046	15,046
Realization Rates (ex post/ex ante)						
Indoor Lighting	1.35	NA	NA	NA	1.61	1.61
Outdoor Lighting	NA	NA	NA	NA	NA	NA
Indoor & Outdoor Lighting	1.37	NA	NA	NA	1.63	1.63

Section 4

EVALUATION RESULTS SUMMARIES

This section summarizes the results of this evaluation, starting with the gross impact results, then discussing the net-to-gross (NTG) adjustments, and concluding with the program realization rates (ratio of evaluation findings to the ex ante program design estimates) for both gross and net program impacts. Reasons for the deviations from the ex ante estimates are discussed in the presentation of program realization.

Where segment analysis could be supported, results are presented by technology and building segment. All results are segmented by program, Retrofit Express (RE) and Customized Incentives (Customized), and by indoor and outdoor applications. All results are aggregated to the entire program.

4.1 Gross Energy Impact Results

Exhibits 4-1 and 4-2 present the gross energy and demand impact (respectively) from the evaluation for the RE and Customized programs for indoor and outdoor applications. The gross evaluation impacts for energy and demand by PG&E costing period are covered in *Appendix G*.

Exhibit 4-1
Gross ENERGY IMPACTS
By Business Type and Technology Group
Industrial Indoor and Outdoor Lighting Applications

Business Type / Program and Technology Group	Industrial Sector First Year ENERGY IMPACTS (MWh)		
	Process	Assembly	Total
Indoor Lighting			
RE Program			
Compact Fluorescent	56	771	827
Incandescent to Fluorescent	20	219	239
Efficient Ballast	6	752	758
T8 Lamps and Electronic Ballasts	647	20,021	20,669
Optical Reflectors w/ Fluor. Delamp	445	27,593	28,037
High Intensity Discharge	8,154	28,222	36,376
Halogen	-----	202	202
Exit Signs	-----	245	245
Controls	55	7,724	7,779
Other	-----	-----	0
RE Program Indoor Total	9,384	85,750	95,133
Customized Program			
Compact Fluorescent	-----	-----	0
Standard Fluorescent	-----	1,399	1,399
High Intensity Discharge	-----	139	139
Exit Signs	-----	-----	0
Controls	-----	6	6
Other	-----	-----	0
Customized Program Indoor Total	0	1,544	1,544
Indoor Total	9,384	87,293	96,677
Exterior Lighting			
RE Program Exterior HID	427	1,166	1,593
Customized Program Exterior HID	-----	-----	0
Customized Program Traffic Lights	-----	-----	0
Outdoor Total	427	1,166	1,593
Indoor and Outdoor Total	9,811	88,459	98,270

Exhibit 4-2
Gross DEMAND* IMPACTS
By Business Group and Technology Type
Industrial Indoor and Outdoor Lighting Applications

Business Type / Program and Technology Group	Industrial Sector First Year DEMAND IMPACTS (kW)		
	Process	Assembly	Total
Indoor Lighting			
RE Program			
Compact Fluorescent	8	120	128
Incandescent to Fluorescent	3	37	40
Efficient Ballast	1	136	137
T8 Lamps and Electronic Ballasts	97	3,467	3,564
Optical Reflectors w/ Fluor. Delamp	67	4,832	4,899
High Intensity Discharge	1,212	4,862	6,075
Halogen	-----	35	35
Exit Signs	-----	30	30
Controls	7	1,020	1,027
Other	-----	-----	0
RE Indoor Total	1,396	14,539	15,935
Customized Program			
Compact Fluorescent	-----	-----	0
Standard Fluorescent	-----	244	244
High Intensity Discharge	-----	17	17
Exit Signs	-----	-----	0
Controls	-----	1	1
Other	-----	-----	0
Customized Program Indoor Total	0	261	261
Indoor Total	1,396	14,801	16,197
Exterior Lighting			
RE Program Exterior HID	53	144	196
Customized Program Exterior HID	-----	-----	0
Customized Program Traffic Lights	-----	-----	0
Outdoor Total	53	144	196
Indoor and Outdoor Total	1,449	14,945	16,393

*Summer On-Peak demand impacts are defined for weekdays during the hour 3:00-4:00 PM, May 1-October 31.

Exhibits 4-1 and 4-2 illustrate the following findings:

- RE indoor technologies represented over 95 percent of the energy and demand impacts.

- The assembly business type represents over 90 percent of the demand and energy impacts for the industrial sector.

- The three technologies that made the largest contributions to impacts were the replacement of standard efficiency fluorescent lamps and ballasts with modern T-8 lamps and electronic ballasts, the installation of optical reflectors in combination with delamping in fluorescent fixtures, and the installation of high intensity discharge (HID) lamps and ballasts for less efficient technologies. These three technologies represented over 85 percent of the program energy and demand savings.

- The Customized program plays a small role in the overall impact with just over 1 percent of the energy savings and approximately 2 percent of the demand savings being attributable to this program.

- Similar to Customized, outdoor lighting is a small contributor with just about 2 percent of the energy savings and approximately 1 percent of the demand savings.

4.2 Net to Gross Adjustments

The NTG results account for free ridership and participant spillover effects but no nonparticipant spillover.[1] Results are given for technology groups, and the RE and Customized programs. The estimate shown for Customized is the ex ante NTG result. The market analysis NTG approach is discussed in *Section 3.*

Exhibit 4-3 presents the NTG values by technology, along with the 90 percent confidence intervals. These NTG values are higher than the ex ante estimates of NTG, which were 0.77 for the RE program and 0.76 for the Customized program. Thus the differences between these NTG estimates result in a 0 to 79 percent higher average net realized savings.

[1] Nonparticipant spillover is not applicable to this evaluation because no industrial comparison group was surveyed, therefore nonparticipant spillover could not be assessed.

Exhibit 4-3
NTG Adjustments by Technology Type

Technology	Without NP Spillover		
	Lower 90%	Midpoint	Upper 90%
Compact Fluorescent	0.69	1.01	1.34
Incandescent to Fluorescent	NA	0.87	NA
Efficient Ballast	0.90	1.38	1.85
T8 Lamps and Electronic Ballasts	0.50	0.97	1.44
Optical Reflectors w/ Fluor. Delam	0.75	0.99	1.24
High Intensity Discharge	0.24	0.81	1.37
Halogen	NA	0.87	NA
Exit Signs	NA	0.87	NA
Controls	0.24	0.99	1.73
Other	NA	0.87	NA
RE Program	0.82	0.92	1.01
Customized Program	NA	0.76	NA

Two of the technology specific estimates deserve individual discussion:

- **HID** - As in the commercial lighting evaluation, HID lighting participants gave indications of higher than average free ridership rates. These can in part be attributed to the maturity of the technology and its acceptance among customers.

- **Electronic Ballasts** - Customers who installed electronic ballasts reported lower than average free ridership. Additionally, customers who installed electronic ballasts through the program also reported installing T8 lighting outside the program, after participating. These combined effects yielded a high NTG value for electronic ballasts: 1.38.

4.3 Net Impacts

Exhibits 4-4 and 4-5 present the net energy and demand impact (respectively) from the evaluation for the RE and Customized programs for indoor and outdoor applications.

Exhibit 4-4
Net ENERGY IMPACTS
By Business Type and Technology Group
Industrial Indoor and Outdoor Lighting Applications

Business Type / Program and Technology Group	Industrial Sector First Year ENERGY IMPACTS (MWh)		
	Process	Assembly	Total
Indoor Lighting			
RE Program			
Compact Fluorescent	57	779	836
Incandescent to Fluorescent	18	191	208
Efficient Ballast	8	1,036	1,044
T8 Lamps and Electronic Ballasts	627	19,396	20,023
Optical Reflectors w/ Fluor. Delamp	442	27,401	27,843
High Intensity Discharge	6,601	22,847	29,448
Halogen	-----	176	176
Exit Signs	-----	213	213
Controls	54	7,617	7,671
Other	-----	-----	0
RE Program Indoor Total	7,807	79,657	87,463
Customized Program			
Compact Fluorescent	-----	-----	0
Standard Fluorescent	-----	1,226	1,226
High Intensity Discharge	-----	122	122
Exit Signs	-----	-----	0
Controls	-----	5	5
Other	-----	-----	0
Customized Program Indoor Total	0	1,353	1,353
Indoor Total	7,807	81,009	88,816
Exterior Lighting			
RE Program Exterior HID	346	944	1,290
Customized Program Exterior HID	-----	-----	0
Customized Program Traffic Lights	-----	-----	0
Outdoor Total	346	944	1,290
Indoor and Outdoor Total	8,153	81,953	90,106

Exhibit 4-5
Net DEMAND* IMPACTS
By Business Type and Technology Group
Industrial Indoor and Outdoor Lighting Applications

Business Type / Program and Technology Group	Industrial Sector First Year DEMAND IMPACTS (kW)		
	Process	Assembly	Total
Indoor Lighting			
RE Program			
Compact Fluorescent	8	122	130
Incandescent to Fluorescent	3	32	35
Efficient Ballast	1	187	188
T8 Lamps and Electronic Ballasts	94	3,359	3,453
Optical Reflectors w/ Fluor. Delamp	67	4,798	4,865
High Intensity Discharge	982	3,936	4,918
Halogen	-----	30	30
Exit Signs	-----	26	26
Controls	7	1,006	1,013
Other	-----	-----	0
RE Program Indoor Total	1,161	13,497	14,658
Customized Program			
Compact Fluorescent	-----	-----	0
Standard Fluorescent	-----	214	214
High Intensity Discharge	-----	15	15
Exit Signs	-----	-----	0
Controls	-----	1	1
Other	-----	-----	0
Customized Program Indoor Total	0	229	229
Indoor Total	1,161	13,726	14,887
Exterior Lighting			
RE Program Exterior HID	43	116	159
Customized Program Exterior HID	-----	-----	0
Customized Program Traffic Lights	-----	-----	0
Outdoor Total	43	116	159
Indoor and Outdoor Total	1,204	13,842	15,046

*Summer On-Peak demand impacts are defined for weekdays during the hour 3:00-4:00 PM, May 1-October 31.

Overall, Exhibits 4-4 and 4-5 show an 8 percent decrease in ex post program energy savings and a 10 percent decrease in demand savings (when compared to Exhibits 4-1 and 4-2, gross impacts) as a result of the application of the NTG adjustments presented in Exhibit 4-3. The NTG adjustments modified the general impact picture very little. T-8/electronic ballast, optical reflectors with decamp, and HID replacements for less efficient lamps still dominate the savings representing over

two thirds of the energy and demand impacts. On a business type basis, the assembly segment still dominates impacts with over 90 percent of the total impact for both energy and demand.

Close examination of these results identifies only one significant finding:

- **HID** - The share of the impact contributed by the HID technology decreased significantly because of its low NTG adjustment factor, relative to the T8/electronic ballasts and optical reflector/delamping technologies.

4.4 Realization Rates

Exhibits 4-6 through 4-9 present the gross and net realization rates for energy and demand impacts for the RE and Customized program indoor and outdoor applications. The four realization rate exhibits are analyzed in order so that factors that contributed to the results can be discussed in order of impact and then market analysis results.

4.4.1 Gross Realization Rates for Energy Impacts

The gross energy realization rates are presented in Exhibit 4-6. These values represent, by segment, the ratio of gross impact evaluation findings to the gross ex ante program design estimate of savings. These realization rates illustrate how well the ex ante estimates were at predicting energy savings, before taking into account participant behavioral effects.

Exhibit 4-6
Gross ENERGY Impact REALIZATION RATES
By Business Type and Technology Group
Industrial Indoor and Outdoor Lighting Applications

Program and Technology Group \ Business Type	Industrial Sector ENERGY Impact REALIZATION RATES#		
	Process	Assembly	Average
Indoor Lighting			
RE Program			
Compact Fluorescent	0.81	0.94	0.93
Incandescent to Fluorescent	1.29	1.32	1.31
Efficient Ballast	0.89	0.73	0.73
T8 Lamps and Electronic Ballasts	1.23	1.21	1.21
Optical Reflectors w/ Fluor. Delamp	1.51	1.47	1.47
High Intensity Discharge	1.31	1.35	1.34
Halogen	-----	2.28	2.28
Exit Signs	-----	1.07	1.07
Controls	2.32	1.73	1.73
Other	-----	-----	-----
RE Program Indoor Average	1.31	1.36	1.36
Customized Program			
Compact Fluorescent¥			
Standard Fluorescent¥			
High Intensity Discharge¥			
Exit Signs¥			
Controls¥			
Other¥			
Customized Program Indoor Average			1.54
Indoor Average			1.36
Exterior Lighting			
RE Program Exterior HID	0.97	0.97	0.97
Customized Program Exterior HID			-----
Customized Program Traffic Lights			-----
Outdoor Average			0.97
Indoor and Outdoor Average			1.35

 # The program design gross impact realization rates are defined as the ratio of evaluation impact to MDSS impact.

¥ Customized Incentives Program results are not reported by technology group because measure classifications are not carefully tracked in the MDSS.

Overall, Exhibit 4-6 shows that the ex ante are close to the gross impact estimates. The average realization rate for RE indoor applications is 1.36, Customized indoor is 1.54, resulting in a program realization rate of 1.36 for indoor lighting applications. When this is combined with the 0.97 realization rate for outdoor lighting, a weighted overall program realization rate of 1.35 results.

Segment level realization rates were not possible for Customized because the MDSS did not track ex ante estimates by measure technology.

The results presented in Exhibit 4-6 can be explained using information from the review of the ex ante estimates in conjunction with the impact analysis results. Explanations of the results by technology are:

- **Compact Fluorescents** - The lower than average program realization rates for compact fluorescent technology result was caused by:
  - Low observed operating factors from the field data collection effort.
  - Compact fluorescents typically replace incandescent lamps in locations were occupancy is inconsistent.
- **Efficient Ballast** - The low gross program realization rates for the efficient ballast technology is a result of an error in the MDSS. The MDSS applied the per fixture ex ante savings value to lamp counts for a portion (1993 program applicants) of the measures tracked. This resulted in ex ante estimates in the MDSS that was approximately 100% higher than they should have been.
- **Halogen** - The high realization rate for the halogen technologies are a result of the ex ante estimates for this technology assuming a short lamp life, with the lamp being replaced with a conventional light at the end of the original lamp life. No evidence of this practice was found in the field nor detected in the billing regression analysis. These high realization rates have a small effect on the overall realization rates because the energy impact of this technology accounts for only 2 percent of the total.
- **Controls** - Controls realization rates are high because the run time loggers used during the evaluation identified a much greater reduction in operating hours than that used in the ex ante estimates for this technology.

4.4.2 Gross Realization Rates for Demand Impacts

The gross demand realization rates are presented in Exhibit 4-7. These values represent, by segment, the ratio of gross impact evaluation findings to the gross ex ante program design estimate of savings. These realization rates illustrate how well the ex ante estimates are at predicting demand savings, before taking into account customers' actions within the lighting market.

Exhibit 4-7
Gross DEMAND* Impact REALIZATION RATES
by Business Type and Technology Group
Industrial Indoor and Outdoor Lighting Applications

Business Type / Program and Technology Group	Industrial Sector DEMAND Impact REALIZATION RATES#		
	Process	Assembly	Average
Indoor Lighting			
RE Program			
Compact Fluorescent	0.68	0.88	0.86
Incandescent to Fluorescent	1.17	1.32	1.31
Efficient Ballast	0.76	0.78	0.78
T8 Lamps and Electronic Ballasts	1.11	1.28	1.27
Optical Reflectors w/ Fluor. Delamp	1.16	1.40	1.40
High Intensity Discharge	1.16	1.39	1.34
Halogen	-----	1.61	1.61
Exit Signs	-----	1.16	1.16
Controls	1.44	2.22	2.21
Other	-----	-----	-----
RE Program Indoor Average	1.16	1.38	1.36
Customized Program			
Compact Fluorescent¥			
Standard Fluorescent¥			
High Intensity Discharge¥			
Exit Signs¥			
Controls¥			
Other¥			
Customized Program Indoor Average			0.90
Indoor Average			1.35
Exterior Lighting			
RE Program Exterior HID	-----	-----	-----
Customized Program Exterior HID			-----
Customized Program Traffic Lights			-----
Outdoor Average			-----
Indoor and Outdoor Average			1.37

*Summer On-Peak demand impacts are defined for weekdays during the hour 3:00-4:00 PM, May 1-October 31.

The program design gross impact realization rates are defined as the ratio of evaluation impact to MDSS impact.

¥ Customized Incentives Program results are not reported by technology group because measure classifications are not carefully tracked in the MDSS.

Overall, the gross demand estimates presented in Exhibit 4-7 are higher than the ex ante values by 37 percent. The two primary reasons for this difference is higher operating factors (through lamp counts) than the operating factors used in the ex

ante estimates were observed. Also, the evaluation estimates include the of HVAC interaction which was not accounted for in the ex ante values.

Some of the results presented in Exhibit 4-7 can be explained using information from the review of the ex ante estimates and the evaluation engineering analyses. Specific comments and justifications for the results presented in Exhibit 4-7 are:

- **Compact Fluorescents** - The lower realization rates are due to lower operating factors observed for this technology during field inspections. These operating factors are closer to the operating factors used in the ex ante estimates.

- **Efficient Ballast** - The low gross realization rates reported for the efficient ballast technology is a result of an error in the MDSS. The MDSS applied the per fixture ex ante savings value to lamp counts for a portion (1993 program applicants) of the measures tracked. This resulted in ex ante estimates in the MDSS that was approximately 100% higher than it should have been.

- **Halogen** - As previously discussed, the high realization rate for the halogen technologies result from ex ante estimates for this technology which are based on a short lamp life, with the lamp being replaced with a conventional light at the end of the original lamp life.

- **Controls** - Controls realization rates are high because the run time loggers used during the evaluation identified a much greater reduction in operating hours than that used in the ex ante estimates for this technology.

4.4.3 Net Realization Rates for Energy Impacts

The difference between the gross and net realization rates is substantial. This is due to the *difference* between the ex ante and the ex post estimates of NTG adjustment. The ex ante estimate were 0.77 for RE and 0.76 for Customized. As can be seen from Exhibit 4-3 above, the NTG estimates vary between 0.81 and 1.38 dependent upon the technology, resulting in an overall estimate of 0.92 for RE. As Exhibit 4-1 and 4-2 show, RE represents in excess of 95 percent of the lighting impact for both energy and demand. These NTG adjustment *differences* result in a 19 percent increase in both energy and demand impact realization rates as the gross realization rates are converted to net realization rates.

The net energy realization rates are presented in Exhibit 4-8. These values represent, by segment, the ratio of net impact evaluation findings to the net ex ante program design estimate of savings. The realization rates illustrate how well the ex ante estimates were at predicting energy savings, after taking into account participant actions within the lighting market.

Exhibit 4-8
Net ENERGY Impact REALIZATION RATES
By Business Type and Technology Group
Industrial Indoor and Outdoor Lighting Applications

Business Type / Program and Technology Group	Industrial Sector ENERGY Impact REALIZATION RATES#		
	Process	Assembly	Average
Indoor Lighting			
RE Program			
Compact Fluorescent	1.06	1.23	1.22
Incandescent to Fluorescent	1.46	1.49	1.49
Efficient Ballast	1.58	1.31	1.31
T8 Lamps and Electronic Ballasts	1.55	1.53	1.53
Optical Reflectors w/ Fluor. Delamp	1.95	1.90	1.90
High Intensity Discharge	1.38	1.42	1.41
Halogen	-----	2.58	2.58
Exit Signs	-----	1.21	1.21
Controls	2.97	2.22	2.22
Other	-----	-----	-----
RE Program Indoor Average	1.42	1.64	1.62
Customized Program			
Compact Fluorescent¥			
Standard Fluorescent¥			
High Intensity Discharge¥			
Exit Signs¥			
Controls¥			
Other¥			
Customized Program Indoor Average			1.80
Indoor Average			1.62
Exterior Lighting			
RE Program Exterior HID	1.02	1.02	1.02
Customized Program Exterior HID			-----
Customized Program Traffic Lights			-----
Outdoor Average			1.02
Indoor and Outdoor Average			1.61

The program design gross impact realization rates are defined as the ratio of evaluation impact to MDSS impact.

¥ Customized Incentives Program results are not reported by technology group because measure classifications are not carefully tracked in the MDSS.

Overall, given the difference between the NTG adjustment factors discussed above, and the generally high gross realization rates discussed earlier, it is not surprising that the all technology and building segment average realization rates are above 1.0.

As discussed previously, some of the results presented in Exhibit 4-8 can be explained using information from the review of the ex ante estimates and the

evaluation engineering and NTG analyses. Most of the comments discussed in relation to the gross realization rate estimates apply to the net realization rates. Some are repeated here for completeness. Specific comments and justifications for the net realizations presented in Exhibit 4-8 are:

- **Compact Fluorescents and Efficient Ballast** - The lower gross realization rates discussed earlier for compact fluorescent and efficient ballast technologies have been more than offset by the difference between the ex ante and ex post NTG adjustments. It must be remembered that the low gross realization rates reported for the efficient ballast technology is a result of an error in the MDSS. The MDSS applied the per fixture ex ante savings value to lamp counts for a portion (1993 program applicants) of the measures tracked.

- **Halogen** - The high realization rates for the halogen technologies are driven by the gross impact results.

4.4.4 Net Realization Rates for Demand Impacts

The net demand realization rates are presented in Exhibit 4-9. These values represent, by segment, the ratio of net impact evaluation findings to the net ex ante program design estimate of savings. These realization rates illustrate how well the ex ante estimates were at predicting demand savings, after taking into account participant actions within the lighting market.

Exhibit 4-9
Net DEMAND* Impact REALIZATION RATES
By Business Type and Technology Group
Industrial Indoor and Outdoor Lighting Applications

Business Type / Program and Technology Group	Industrial Sector DEMAND Impact REALIZATION RATES#		
	Process	Assembly	Average
Indoor Lighting			
RE Program			
Compact Fluorescent	0.90	1.15	1.13
Incandescent to Fluorescent	1.32	1.49	1.48
Efficient Ballast	1.36	1.40	1.40
T8 Lamps and Electronic Ballasts	1.40	1.61	1.60
Optical Reflectors w/ Fluor. Delamp	1.50	1.81	1.80
High Intensity Discharge	1.22	1.46	1.40
Halogen	-----	1.82	1.82
Exit Signs	-----	1.31	1.31
Controls	1.84	2.84	2.83
Other	-----	-----	-----
RE Program Indoor Average	1.25	1.67	1.62
Customized Program			
Compact Fluorescent¥			
Standard Fluorescent¥			
High Intensity Discharge¥			
Exit Signs¥			
Controls¥			
Other¥			
Customized Program Indoor Average			1.05
Indoor Average			1.61
Exterior Lighting			
RE Program Exterior HID	-----	-----	-----
Customized Program Exterior HID			-----
Customized Program Traffic Lights			-----
Outdoor Average			-----
Indoor and Outdoor Average			1.63

*Summer On-Peak demand impacts are defined for weekdays during the hour 3:00-4:00 PM, May 1-October 31.

The program design gross impact realization rates are defined as the ratio of evaluation impact to MDSS impact.

¥ Customized Incentives Program results are not reported by technology group because measure classifications are not carefully tracked in the MDSS.

As with the net energy estimates discussed above, the overall effect of the NTG adjustments results in high realization rates, especially since the gross realization rates estimates were already greater than 1.0.

Most of the specific comments applied to the net energy and gross realization rate discussions apply to the net realization rates also. Those reasons that were not summarized in the previous section are listed here:

- **Compact Fluorescents, Efficient Ballasts, Halogens and Controls** - See previous sections.

4.5 Overview of Realization Rates

Overall, the net energy and demand impacts and realization rates are higher than predicted by the ex ante impact estimates. These high realization rates are, however, well documented and supportable based upon the information developed during the evaluation. The ex post estimates are higher than the ex ante values because:

- The evaluation field data collection established generally higher operating factors and longer operating hours than had been assumed in the ex ante estimates.

- The ex post evaluation estimates are based upon engineering calculations (as specified by the protocols) which have been calibrated using telephone survey, on-site lamp counts, spot-watt measurements for fixture loads, and run-time meters for calibrated operating hours. These are compared to fixture wattages, hours of operation and diversity factors that were chosen as conservative best estimates during the development of the ex ante estimates.

- The NTG adjustment estimation resulted in a mean estimate 26 percent higher than the conservative estimates use in the ex ante values.

In summary, PG&E's ex ante estimate of energy savings was 61 percent below the ex post estimate of net energy savings and the ex ante estimate of demand savings was 63 percent below the ex post estimate of net demand.

4.6 Program Design Estimates

The evaluation team offers the following comments and recommendations regarding the methods used to generate program design estimates:

- The realization rate estimates in *Section 4* (ratio of the evaluation estimated savings to the ex ante savings on a gross and net basis) allow for the identification of technologies or building types that either exceed or fall below expectations. Across the board the industrial lighting technologies offered exceeded program design expectations on both a gross and net basis. This is primarily a result of the ex ante estimates being based upon hours of operation shorter than those measured during the evaluation, and the application of ex ante NTG adjustments that were lower than the evaluation established values.

An extensive review of the program design algorithms and collected field data on building segment specific operating hours and operating factors provided insights into these parameters. These full load hours account only for lighting system operation, not total impact -- thus isolating the lighting technology impacts from the HVAC program impact contributions. This information should be incorporated in the PG&E design estimates by substituting the following adjusted full load hours into the current design algorithm by business type:

Exhibit 4-10
Full Load Hours by Business Type

Industry Group	Indoor Lighting Annual Hours of Operation	
	Evaluation Estimate	Program Design Estimate
Assembly	4,900	4,000
Process	5,300	4,000

- The coincident diversified operating factors (CDOFs) generated by business type — for use in predicting demand during the on-peak season at the system peak hour — should be incorporated in the PG&E design estimates. That is, these estimates should be substituted for applicable measures that currently have a coincident diversity factor (CDF) of 0.67. The following are recommended CDOFs by business type:

Exhibit 4-11
CDOFs by Business Type

Industry Group	Indoor Lighting Peak Hour CDOF	
	Evaluation Estimate	Program Design Estimate
Assembly	0.80	0.67
Process	0.78	0.67

- Program design first year energy impact estimates for Halogen lamps are generated under the assumption that these fixtures will burnout within the first year and then either remain burned out or get replaced with another technology. On-site audit results have clearly shown that the burnout rates in halogen lamps are small (less than 1% of the halogen lamps inspected were burned out), leading to the conclusion that halogen lamp failure rates are not abnormally prevalent one year after the initial installation. We recommend that retention studies carefully record the fate of halogen retrofit technologies and that based upon these results, consideration should be given to analyzing program design estimates using hours of operation that extend beyond the life of a halogen lamp.

- Program design demand impact estimates for exterior lighting systems assume no operation during daylight hours, and thus generally predict zero demand

during the summer on-peak hour. Both on-site audit schedules and on-site lamp counts have discounted this hypothesis, showing that exterior lights in the industrial sector operate a considerable amount of time during daylight hours. Data supporting or discounting these findings should continue to be gathered in order to better define the probability of exterior fixture operation during daylight hours.

- Program design demand impact estimates recorded in the MDSS (for customers participating in the Customized Incentives indoor lighting measures) were typically found to contain the difference in connected load between the retrofit and existing system. This record of demand impact is inconsistent with the indoor lighting demand recorded for Retrofit Express customers, where the difference in connected load is adjusted by a coincident diversity factor (the MDSS CDF adjustment for most measures is 0.67). We recommended that demand impacts for applicable Customized Incentives measures be adjusted in a similar fashion to ensure consistency in these MDSS records.

Section 5

RECOMMENDATIONS

Recommendations that would enhance future program performance and evaluation are presented in this section. These are followed by recommendations regarding the Protocols.

5.1 Evaluation Methods

The evaluation team offers the following comments and recommendations regarding methods used in the 1994 evaluation:

- **General Issues for Quantifying Spillover Effects** - The evaluation team recommends collecting additional data (such as trade ally surveys) every second or third year to gauge the program's market movement effects. This second source of data will help support the program's cost recovery claims for spillover effects.

- **Trade on Established Information in Future Evaluations** - This evaluation developed extensive observed and measured operating factor and operating hours information on the highest participation segments, in order to obtain the best estimates of savings for the largest contributors to savings. Less robust information was developed on medium- and low- participation segments. There is no reason to believe that the operating factor and operating hours information developed in this evaluation will change from year to year. QC recommends that PG&E develop an understanding with the CPUC on the validity and use of this information in subsequent evaluations, so that the resources dedicated to subsequent evaluations can be used to improve information on the medium- and low- participation segments, or to develop information on other parameters, rather than just measuring the same parameters over again.

5.2 Protocols

After working with the ex post application of the Protocols for over a year, QC would like to offer the following recommendations:

- **Rationalize Sample Size Constraints to Reflect the Data Collection Success Rates - Table 5, *Section C*** - Sample Design for First Year Load Impact: Third bullet states

"If the number of program participants is greater than 450, a sample must be randomly drawn and be sufficiently large to achieve a minimum precision of plus/minus 10% at the 90% confidence level, based on total annual energy use. A minimum of 450 must be included in the analysis dataset for each end use." This specification requires that a minimum of 450 participants must be included in the analysis dataset even if there are only 500 participants. Over the years, QC has completed more than 40,000 surveys, and expects, for most projects, only a 25% completion rate. This implies that a *minimum* of 1,800 participants are necessary to complete a 450 point survey effort. Additionally, it should be noted that PG&E usually specifies its evaluations based upon telephone surveys as the primary data collection mechanism.

There is an alternative approach for programs with greater than 450 participants, based upon using on-sties as the primary method of site-specific data collection, which allows fewer than 450 participants in the final dataset. However, this approach is based upon a different analysis/sample design approach, focused primarily upon on-site data collection.

QC recommends that the Protocols be modified to include language indicating that the analysis dataset should include "450 or a census" for programs with participation levels of less than 2,000 unique participants, when the primary data collection mechanism is telephone surveys.

- **Clarify the Sample Size for the Retention Panel - Table 9A** - Table 9A states as part of the footnote that "The utility should select the top ten measures ranked by net resource value or the number of measures that constitute the first 50% of the estimated resource value, whichever number of measures is less." The Protocols do not specify the size of the sample required to satisfy this "top ten or 50%" requirement. PG&E has specified a retention panel size of 150 sites (probably based upon the number of on-sites that are being executed). Without a Protocol-based sample size, it is always a guessing game between the consultant and PG&E as to what will satisfy the Protocol requirements for Table 9A.

- **Coordinate Table 11 and Table 6** - The new Table 6 and Table 11 are inconsistent in their application in that Table 11 does not include the footnote indicating the optional nature of some of the inclusions. Tables 6 and 11 should be made consistent with the rest of the Protocols.

- **Clarify Basis, Meaning, and Purpose for Square Footage Estimates (Table 6, C-4, C-5)** - Tables C-4 and C-5 request reporting of results in "Designated Unit(s) of Measurement" for lighting of "load impacts per square foot per 1000 hours of operation." Under Participant Group, point 4 the square footage estimates is defined as "Square footage estimates (conditioned space and lighted area) used in the end use model(s) to produce estimates of pre installation usage, base year usage, and first year impacts must be based on (a) premise-specific data collected and used for purposes of establishing the terms and conditions of financial

assistance, or, if not available; (b) premise-specific data collected on-site from all remaining customers in the participant group evaluation sample." This definition does not identify whether the square footage to be used in the computation is the retrofitted square footage, or the total facility square footage. In consultation with the PG&E project manager, the total rather than retrofitted square footage, based upon on-site data collection, was applied. It may well be that other contractors are basing computations on retrofitted facility square footage, in which case they will develop totally different estimates. The definition and purpose of the square footage estimates should be clarified to assist the utilities and contractors in developing useful, meaningful Protocol-compliance estimates.

- **Identify Meaningful Designated Units for Controls Measures** - Designated units of load impact per square foot per 1000 hours of operation have no meaning for controls measures where the connected load does not change. These measures include time clocks, photo-cell controls, energy management systems, occupancy sensors, and any other control-oriented measures. While these represent a small portion of the program, it is unclear how the results should be reported. Modifications to the Protocols should be made to clarify how they should be reported.

1994 INDUSTRIAL RETROFIT PROGRAM
EVALUATION OF LIGHTING TECHNOLOGIES

FINAL IMPACT EVALUATION REPORT
APPENDICES

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February 1996

LIST OF APPENDICES

Appendix A

SAMPLE DESIGN PROTOCOLS

APPENDIX A

EXISTING DATA SOURCE AND SAMPLE DESIGN

This appendix presents the existing data sources and the sample design approach used for the evaluation of Pacific Gas and Electric Company's (PG&E's) 1994 Industrial Lighting Technologies Evaluation. The current sample design follows the rules in the Evaluation and Measurement Protocols (the Protocols) established by the California Public Utilities Commission (CPUC).

Data Sources for Sample Design

Program Participant Tracking System

The participant tracking system for the Retrofit Express (RE) and Customized Incentives (Customized) programs was maintained as part of the PG&E Management Decision Support System (MDSS). It contains program application, rebate and technical information about installed measures, including measure description, quality, rebate amount, and ex ante demand, energy and therm saving estimates. The MDSS extract used in this evaluation is consistent with the data used in the PG&E March 31 AEAP report.

For the RE/Customized Programs, the program participation was tracked at both application and measure levels and they are physically stored in two separate databases, linked by application code and program year. Each application can cover multiple measures and each measure is linked to a PG&E electrical or gas service location where the measures were supposedly installed. The account location can be identified either by the account number or a unique 7-digit identification number called PG&E control number. The control numbers were used to identify customer service locations and serve as the key fields to link different datasets because they will not be reassigned or changed like the customer account numbers.

PG&E Billing Data

Two billing data installments were received for the Evaluation. The first billing dataset, received in March 1995, covers the period between January 1992 and February 1995. The second billing dataset was received in late November 1995 covering the period from September 1994 through September 1995. Depending on the time period, the number of unique control numbers in the billing dataset ranges from 723k in 1992 to 758k in 1995 and it contains monthly energy-consumption information for all

nonresidential electric accounts in the PG&E service territory. It also contains other billing related information such as customer name, service location, rate schedule, and SIC code. The final integrated multiyear billing dataset contains a total of 761,669 unique control numbers.

Sampling Strategy

Because of the small total number of industrial accounts participating in the 1994 program (a total of 704 participant accounts) relative to the desired telephone survey and on-site audit sample sizes required by Table 5, item C, data collection for the evaluation was undertaken as a census. A total of 136 accounts were removed from the sample frame due to changes in such key aspects of their billing data as services addresses, account numbers, account SIC codes, or premise and corporation identifiers between billing years. Attempts were made to contact all of the remaining 568 industrial customers who participated in the Industrial Lighting Program and received rebates in 1994.

The industrial participant census meets the Protocols sample requirements (Table 5, Item C). Protocols require that a program having more than 450 participants, have a randomly drawn analysis dataset sample that is sufficiently large to achieve minimum energy use precision of ±10% at the 90% confidence level – and have at least 150 contributing points in the analysis dataset when primary site-specific data are collected on-site (Table 5, Item C, paragraph 4). The industrial sector samples were driven by a primary data collection activity with an on-site audit sample of 154 accounts (Exhibit A-1 below) serving as the primary site-specific data collection element contributing to the industrial segment analysis dataset. The relative precision at the 90% confidence level in terms of the annual energy usage was estimated to be 9.5% for the indoor lighting on-site audit sample. A detailed discussion on the sample relative precision calculation is presented at the end of this appendix.

Data collection efforts were further strengthened by collecting telephone survey data for all on-site participants. Also, lighting loggers were installed at some audited sites, serving to calibrate self-reported lighting operating schedules.

The Protocols state that comparison group samples are not required for the Industrial Sector, as per Table C-5, Comparison Group, paragraph 1.

Final Sample Sizes

The final sample sizes for the telephone, on-site, and logger samples that were collected for the evaluation are presented in this section. Exhibit A-1 details the telephone and on-site audit distributions by program (Retrofit Express or Customized Incentives) and an indoor/outdoor technology classification.

Exhibit A-1
Telephone and On-site Audit Data Collected by Program and Indoor/Outdoor Participation

Program	Total Surveys	On-Site Audits	On-Site Without Surveys	Analysis Dataset
Indoor Lighting (RE)	162	147	19	181
Indoor Lighting (Customized)	4	3	0	4
Outdoor Lighting (RE)	4	4	1	5
Outdoor Lighting (Customized)	0	0	0	0
Total	170	154	20	190

Telephone Survey Sample

Telephone surveys were collected for a total of 170 accounts, 134 of which also had corresponding on-site audit data collected, and the remaining 36 of which did not. The telephone survey data was designed to provide insight into changes in the quantity and usage patterns of electrical equipment present at an account. The final sample allocation of the telephone survey sample by technology and business type is detailed in Exhibit A-2.

Exhibit A-2
Telephone Survey Sample Sizes by Business Type and Technology

Business Type ** / Lighting Technology	Industrial Sector		
	Process	Assembly	Total
RE Indoor Measures			
Halogen	0	4	4
Compact Fluorescent Lamps	5	39	44
Incandescent to Fluorescent Fixture	0	2	2
Exit Signs	0	15	15
Efficient Ballasts Changeouts	1	30	31
T8 Lamps and Electronic Ballasts	10	155	165
Delamp Fluorescent Fixtures	1	64	65
High-Intensity Discharge	22	93	115
Reduced Wattage Lighting	0	13	13
Controls	5	29	34
Other Lighting	0	0	0
Customized Indoor Measures	0	4	4
RE/Customized Outdoor Measures	2	2	4
Participant Sample Total*	26	144	170

* Sum may exceed the total sample size because of participation in multiple measures.
** Survey self-report business type.

On-site Audit Sample

A total of 154 on-site audits were conducted for the evaluation. In accordance with the nested sample approach, 134 of these 154 surveys were conducted with customers who also completed a telephone survey. An additional 20 on-site audits were conducted with customers who were later unwilling to complete the telephone survey. The distribution of the on-site audit sample by business and technology type is presented in Exhibit A-3 below.

Exhibit A-3
On-Site Audit Sample Sizes by Business Type and Technology

Business Type ** / Lighting Technology	Industrial Sector		
	Process	Assembly	Total
RE Indoor Measures			
Halogen	0	2	2
Compact Fluorescent Lamps	1	36	37
Incandescent to Fluorescent Fixture	0	2	2
Exit Signs	0	14	14
Efficient Ballasts Changeouts	0	26	26
T8 Lamps and Electronic Ballasts	6	137	143
Delamp Fluorescent Fixtures	1	62	63
High-Intensity Discharge	20	88	108
Reduced Wattage Lighting	0	12	12
Controls	3	26	29
Other Lighting	0	0	0
Customized Indoor Measures	0	3	3
RE/Customized Outdoor Measures	1	3	4
Participant Sample Total *	19	135	154

* Sum may exceed the total sample size because of participation in multiple measures.
** Survey self-report business type.

Logger Sample

A total of 252 loggers were installed within the sample of 154 on-site audited accounts, with 27 being installed at Process Industrial sites, and the remaining 225 being installed at Assembly Industrial sites.

Relative Precision

Given a sample design, the relative precision, based upon total annual energy use, reflects the uncertainty regarding the extent to which the allocated sample sizes are large enough to control for the population variance in terms of annual energy usage. The final achieved on-site audit sample (indoor lighting technology) is expected to yield an overall relative precision of 9.5 percent in terms of annual energy consumption.

Precision for the on-site audit sample is calculated using the following procedure:

- First, the 1994 annual energy consumption is computed for all participants in the analysis dataset. Since the Protocols' requirement for relative precision of samples is

only applicable to the indoor lighting end use, only on-site audited indoor lighting participants (a total of 150 customers) were used in the calculation.

- Next, four strata are constructed based on customers' annual usage. Customers with annual usage in 0-40, 40-70, 70-90, and 90+ percentiles of the sample population are grouped into different strata. Exhibit A-4 presents the stratum-level sample size, sample weight, sample mean, and estimated standard errors. The standard errors were adjusted by the finite population correction (fpc) factors in each stratum. [1]

- Then, the program level mean and standard error are calculated using classic stratified sample techniques (see Cochran, pp 91-95). The functional relation can be best described in the following equations:

$$\bar{m} = \Sigma_i w_i * \bar{m}_i = 2{,}354{,}819 \text{ kWh} \quad \text{with } w_i = \frac{n_i}{n}$$

$$\text{StdErr} = \Sigma_i (w_i)^2 * \frac{\text{StdErr}_i}{n_i} = 135{,}927 \text{ kWh}$$

- Finally, the relative precision at 90 percent confidence level is calculated as

$$RP = \frac{1.645 * \text{StdErr}}{\bar{m}} = 9.5\%$$

Exhibit A-4
On-Site Audit Sample - Relative Precision Levels

Stratum	Sample Size	Segment Weight	1994 Mean MWh Usage	Sample Est. Stderr
1	60	0.40	68,903	6,544
2	45	0.30	555,388	36,494
3	30	0.20	2,347,053	154,120
4	15	0.10	16,634,962	5,259,515
Total	150	1.00	2,354,819	135,927

[1] Cochran, W.G., *Sampling Techniques*, Third Edition, John Wiley & Sons, 1977. pp 24-25.

Appendix B

ENGINEERING DETAILED COMPUTATIONAL METHODS

Appendix B

ENGINEERING DETAILED COMPUTATIONAL METHODS

The technical approach and intermediate engineering results that support realized gross impacts in the 1994 Pacific Gas and Electric Company (PG&E) Industrial Lighting Technologies Evaluation (Industrial Lighting Evaluation) are presented in this section. The purpose of a presentation of the engineering computations is to provide detailed intermediate results that either compliment or dispel significantly the current methods used to generate program design demand and energy impact estimates. Results are presented to ensure that future program design and evaluation activities will benefit from the engineering parameters generated during the 1994 program evaluation effort.

B.1 Appendix B Structure

This appendix is structured as follows:

- The appendix begins with a presentation of the general approach used to generate both evaluation results and program design estimates. The purpose of a presentation of the engineering approach is to:
  - Summarize and define each of the lighting end-use impact components that were used to generate final impact results
  - Demonstrate key differences between the evaluation methods and those used to derive program design estimates
  - Provide intermediate engineering results and discuss the data sources and methods used to derive each parameter
- Next, program design estimate methods that were used to generate impacts for the majority of the 1994 program applications are introduced. This discussion focuses on the methods used to derive impacts for the Retrofit Express (RE) Program.
- The evaluation approach is then presented, incorporating both of the general methodologies from *Section 3* of this report, but simplifying that approach by introducing an hourly impact model.

- Then, detailed derivations are presented for several key engineering parameters, including premise operating schedules, technology- and business type-dependent operating factors, and impacts caused by the interaction between lighting system heat gain, and heating and cooling system energy use.

- Next, engineering intermediate results that PG&E may elect to incorporate in future program design efforts are presented.

  - First, database estimates of fixture connected load are compared against measured fixture connected loads that were sampled during on-site audit activities. The purpose ofd this analysis was to determine if adjustments to database estimates of connected load were necessary, because of differences between field-measured fixture operating loads and those claimed in manufacturers' product literature.

  - Then, the frequency of observed lamp burn-out is explored to highlight the importance of including these adjustments in all future program design estimates.

  - Next, the existing fixture frequency is explored, both as observed during on-site data collection activities, and also according to assumed fixture replacement under program design guidelines.

  - Then, evaluation estimates of annual fixture hours of operation are compared against parameter estimate assumptions, yielding results by technology group.

  - Next, evaluation estimates of Summer On-peak coincident diversified operating factor (CDOF) are presented, yielding significant results by technology group.

  - Lastly, evaluation estimate results are presented for heating and cooling energy and demand impacts caused by the retrofit of standard-efficiency lighting systems with high efficiency systems offered under the program.

- Then, the methods are described that were used to both classify and analyze 1994 program impacts for lighting retrofits installed under the Customized Incentives (Customized) Program.

- Finally, to summarize the engineering effort, RE-selected hourly impact profiles are presented by daytype, business type, and time-of-use (TOU) costing period.

B.2 Overview of the Evaluation Approach

This overview of the engineering approach will address the generic methodology used to estimate impacts for the majority of the lighting retrofits covered under the RE and Customized programs, and the data sources contributing to these estimates of energy and demand impact. More specifically, the following are addressed as follows:

- Lighting end-use parameters, which contribute to energy and demand impact estimates, are introduced using the impact decomposition approach.
- Data sources that contributed to each component of impact are then discussed. This introduction focuses on the accuracy of these contributing data elements, and the concept of the nested sample design that was used to transfer accurate data elements.

B.2.1 Introduction to the Impact Decomposition Approach

The general lighting model used to estimate most of the impacts under the RE and Customized programs were founded on the decomposition of lighting impacts into manageable engineering parameters. The impact decomposition was used to estimate unadjusted engineering impacts (UEI's) over a specified period of time—by season/daytype/hour—and is defined as follows:

$$UEIt = [(\Delta UOL \times U \times OFt) \times T] \times [1+HVAC]$$

Where:

ΔUOL = the technology level maximum change in connected kW associated with a particular measure.

U = the number of measure units installed for a particular application.

OFt = the operating factor which describes the percentage of full load used by a group of fixtures during a prescribed period of time, t.

T = the time interval for which an impact is estimated; for most measures, the OF term is the engineering parameter that changes significantly over time. Time intervals for lighting estimates were single hours, segmented by hours "on" (open operating factor) and hours "off" (closed operating factor) schedules.[1]

[1] Although there are periods of time when lights are generally considered off, many lights are either accidentally or purposely left on during these periods. The effective hours of lighting operation

HVAC = the component of impact associated with both a net energy savings due to cooling and a net energy increase due to heating.

The process of analyzing each contributing element in this relationship with respect to time dependency is referred to in this approach as engineering model calibration. Premise-specific estimates were calibrated to either premise self-reports, business type segment-level results, and/or technology group segment-level results. Calibration of the lighting end-use engineering parameters yielded typical lighting hourly load shapes by daytype and season. We recommend incorporating these calibrated results in all future lighting program evaluation activities, specifically the engineering-based program design calculations prepared for cost-recovery activities.

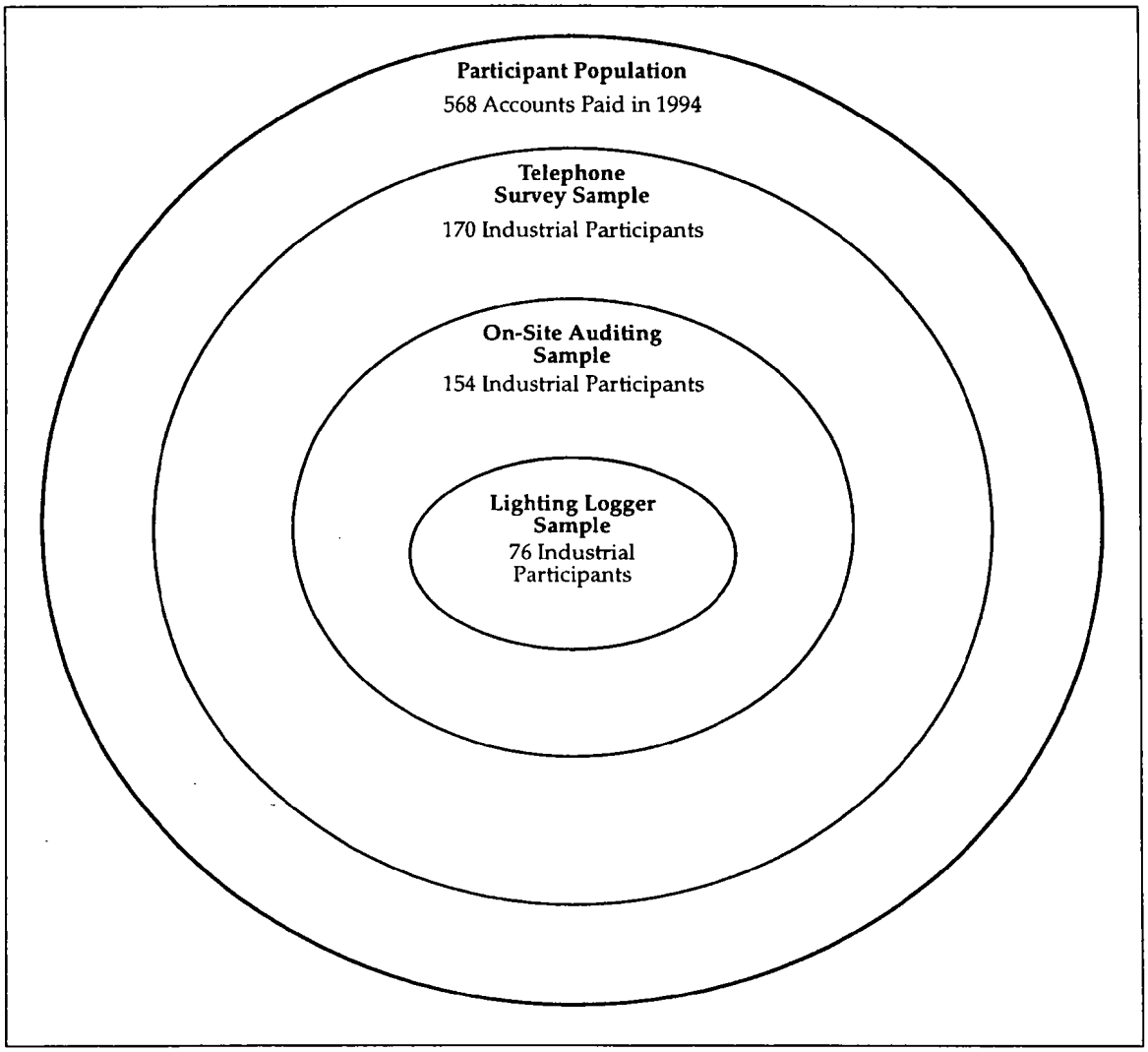
Note that neither program design demand nor energy impact estimates include claimed credits for the indirect HVAC impacts associated with a reduction in internal heat gain (as a result of an efficient lighting retrofit).

B.2.2 Data Sources and the Nested Sample Design

The impact approach used several data sources to collect similar engineering parameters. The purpose of gathering like information from several sources was to ensure calibration of engineering parameters using the most accurate data gathered. Exhibit B-1 depicts the nested sample design that was used to generate the most accurate estimate of engineering parameters, given certain constraints imposed by limited resources.

captured during these off periods were applied using the operating factor term (the probability that lights operate during a particular time interval).

Exhibit B-1
Schematic of the Industrial Lighting Program
Data Collection Nested Sample Design



Resource constraints required that the most accurate, and therefore valuable, analytical data were gathered at a relatively small sample of sites, and that these data were then transferred to a larger samples of participants using leveraging techniques, whenever possible.

A good example of this calibration process using the nested sample design involves the use of logger information to calibrate on-site self-report lighting schedules, and likewise, the use of calibrated on-site self-report lighting schedules to calibrate the telephone sample self-report lighting schedules. The lighting logger sample provided information regarding typical daytype lighting profiles for fixtures operated within the on-site sample, by schedule group. Schedule groups are defined as groups of rooms and/or fixtures at a site that operate on a similar and unique

schedule. Details regarding the derivation of calibrated operating schedules is covered in detail on pages B-14 and B-15 of this appendix.

B.3 Program Design Impact Estimate Overview

The methods implemented to achieve 1994 RE program design impacts are introduced in this section[2]. The gross program design impacts that were generated using these methods are recorded in the Management Decision Support System (MDSS) database. These methods are introduced at this early stage in the engineering approach to enable the direct comparisons between evaluation and program design engineering parameters that appear throughout the remainder of this section. In this section, engineering parameters that were used to generate program design impact estimates are defined, including the following:

- Measure-specific, per-unit noncoincident demand impacts (the difference in fixture connected load pre- and post-retrofit) were used as inputs to both the energy and demand impact estimates.
- A Coincident Diversity Factor (CDF) is described, a parameter applicable to demand impact estimates.
- Annual hours of operation, defined by business type, were used to generate annual energy impact estimates.

Results are presented based on an effort to regenerate program design estimates by applying the methods described in this section. Several important discrepancies were found between the intended application of these impact methods and the gross impacts stored in the MDSS.

B.3.1 Noncoincident Demand Impact Calculations

All lighting estimates require the use of pre- and post-retrofit fixture connected loads or more typically, the change in fixture connected. This engineering parameter represents the ΔUOL term in the impact decomposition approach. This change in lighting system connected load is referred to as the noncoincident demand impact, which is defined for each RE measure using the following formula:

$$kW_{NCP} = kW_E - kW_R \quad (1)$$

[2] These methodologies are described in a document titled "1994 Lighting Retrofit Express Program", submitted by Darrell Hall and Sam Cohen. They resulted in the values presented in the *Annual Summary Report on Demand Side Management Programs in 1994 and 1995,* Advice Filing 1800-G-A/1446-E-A.

Where:

kW_{NCP} = Per-unit noncoincident demand impact by measure

kW_E = Per-unit existing measure demand

kW_R = Per-unit retrofit measure demand

Exhibit B-2 provides a summary of the assumed change in connected load for the measures installed according to the 1994 RE document cited above. This difference in connected load is based upon both the measure definition specified under the RE program (and typical customer installations for each measure), and an assumed existing system that represents a typical customer configuration prior to retrofit. Each individual fixture connected load, both pre- and post-retrofit, was carefully scrutinized and compared with manufacturers' data for the technologies and lamp wattage specified. In all cases, manufacturers' data supported the pre- and post-retrofit connected load assumptions used to produce program design estimates. In addition, fixture connected loads were field tested using spot-watt metering devices to determine the accuracy of manufacturers' data for fixture connected loads. Spot metering results, which also support manufacturers' data for fixture connected loads, are provided on page B-26 of this appendix.

Exhibit B-2
Fixture Assumptions Used to Generate
Retrofit Express Industrial Lighting Program Design Estimates

Generic Measure Group Descriptions	Code Application Year	Measure Code in the MDSS Database	1994 Per-Unit NC Impact§ (Watts)	Coincident Diversity Factor	Per-Unit Peak Demand MDSS Impact (Watts)	Per-Unit Annual Energy MDSS Impact¥ (kWh)
Halogen						
< 45 watts	1994	L60	30.0	0.67	20.1	60
> 50 watts	1994	L61	50.0	0.67	33.5	150 / 105
Compact Fluorescent Lamps						
Screw in CF						
5-13 watts	1994	L62	45.0	0.67	30.2	
14-26 watts	1994	L63	45.0	0.67	30.2	
Screw in CF- Reusable ballast						
5-13 watts	1994	L64	45.0	0.67	30.2	
14-26 watts	1994	L65	45.0	0.67	30.2	
Hard Wired CF						
5-13 watts	1994	L66	45.0	0.67	30.2	
14-26 watts	1994	L67	45.0	0.67	30.2	
27-50 watts	1994	L68	52.0	0.67	34.8	
Incandescent to Fluorescent Fixture						
With Energy Saving Ballast & T12 Lamps	1993&4	L7	212.0	0.67	142.0	
With Electronic Ballast & T8 Lamps	1993&4	L8	240.0	0.67	160.8	
Exit Signs						
Incand. to Compact Fluorescents	1993&4	L5	29.0	1.00	29.0	254
Incand. to LED or Electroluminescent Retrofit	1993&4	L6	33.0	1.00	33.0	289
Efficient Ballasts Changeouts						
Electronic Ballasts						
2 Lamp Electronic Ballast	1993&4	L14	19.0	0.67	12.7	
3 Lamp Electronic Ballast	1993&4	L15	29.0	0.67	19.4	
4 Lamp Electronic Ballast	1993&4	L16	38.0	0.67	25.5	
T8 Lamps and Electronic Ballasts						
New Fixtures						
2'-1 U Tube or 2 lamps	1994	L69	21.0	0.67	14.1	
2'-2 U Tubes or 4 lamps	1994	L70	43.0	0.67	28.8	
2'-3 U Tubes or 6 lamps	1994	L71	78.0	0.67	52.3	
4'-1 lamp	1994	L72	22.0	0.67	14.7	
4'-2 lamps	1994	L73	22.0	0.67	14.7	
4'-3 lamps	1994	L74	37.0	0.67	24.8	
4'-4 lamps or 8'-2 lamps	1994	L75	45.0	0.67	30.2	
Fixture Modif.- Replace Lamps and Ballasts						
Replace Lamps & Ballasts - 2' Fixture	1993&4	L21	10.5	0.67	7.0	
Replace Lamps & Ballasts - 3' Fixture	1993&4	L22	13.0	0.67	8.7	
Replace Lamps & Ballasts - 4' Fixture	1993&4	L23	11.8	0.67	7.9	
Replace Lamps & Ballasts - 8' Fixture	1993&4	L24	22.5	0.67	15.1	
Delamp Fluorescent Fixtures						
Fixture Modif.- Delamp and Reflector						
Removal - 2' Lamps & Ballasts	1993&4	L17	32.0	0.67	21.4	
Removal - 3' Lamps	1993&4	L18	43.0	0.67	28.8	
Removal - 4' Lamps	1993&4	L19	46.0	0.67	30.8	
Removal - 8' Lamps	1993&4	L20	96.0	0.67	64.3	
High Output T8 & T10 Conversion w/ Delamp						
T10 & Energy Saving Ballast	1994	L76	31.0	0.67	20.8	
T10 or T8 & Electronic Ballast	1994	L77	45.0	0.67	30.2	
High Intensity Discharge						
Interior Compact HPS						
0-35 watts HPS	1994	L78	107.0	0.67	71.7	
36-70 watts HPS	1994	L79	112.0	0.67	75.0	
71-100 watts HPS	1994	L80	155.0	0.67	103.9	
Interior Standard MH from Merc. Vapor						
101-175 watts MH	1993&4	L26	240.0	0.67	160.8	
176-250 watts MH	1993&4	L27	528.0	0.67	353.8	
251-400 watts MH		L81	620.0	0.67	415.4	
Exterior HPS from Merc. Vapor						
0-100 watts	1993&4	L28	113.0	0.00	0.0	463
101-175 watts	1993&4	L29	240.0	0.00	0.0	984
176 watts & greater	1993&4	L30	610.0	0.00	0.0	2,501
Controls						
Time Clocks	1993&4	L31	N/A	N/A	0.0	439
Occupancy Sensors			N/A	N/A		
72-350 watts controlled	1993	L32	N/A	N/A	62.0	277
351-1000 watts controlled	1993	L33	N/A	N/A	212.0	824
1000 watts and greater controlled	1993	L34	N/A	N/A	280.0	1409
Wall Mounted	1994	L82	N/A	N/A	62.0	277
Ceiling Mounted	1994	L83	N/A	N/A	212.0	824
Bypass/Delay	1993&4	L35	N/A	N/A	106.0	412
Photocell	1993&4	L36	N/A	N/A	0.0	99

§ Non-coincident demand impact – the difference between the non-coincident existing (assumed) measure and retrofit measure demand.
¥ Most program design (MDSS) energy impact estimates vary as a function of business type.

The Retrofit Express connected load figures were carried over into the evaluation analyses of program savings, though modified wherever possible for lamp burn-out rates in both the new and existing systems. Typical lamp burn-out rates were determined for specific technology groups, based upon data gathered during on-site

audit activities. Burned-out lamp rates and methodologies are presented in an upcoming section of this appendix.

The largest potential error in estimating noncoincident demand estimates is made in the assumptions regarding the existing lighting system prior to the adoption of retrofit measures. Technology group saturations for existing systems were gathered on-site that largely support the systems specified in these program assumptions. The results of these analyses are provided in an upcoming section of this appendix.

Also provided in Exhibit B-2 are the specific CDFs and nonsegment-specific annual energy savings estimates used in generating program design estimates. These terms are described in detail in the following two sections.

B.3.2 Coincident Demand Impact Calculations

Engineering estimates of noncoincident demand impact from equation (1) are multiplied by a CDF, which was developed based upon PG&E load research data, as part of the Commercial End-Use Metering Project performed by Regional Economic Research (RER). CDF is mathematically defined as:

$$CDF = Coincidence\ Factor \times Diversity\ Factor$$

Where:

Coincidence Factor is the ratio of the measure demand reduction at system peak and the noncoincident demand impact

and

Diversity Factor is the probability that a given measure is on at the time of system peak

The value of CDF for most lighting end-use program design estimates is 0.67. Hence, coincident demand impacts are typically estimated as follows:

$$Coincident\ Demand\ Impact = 0.67 \times kW_{NCP}$$

As shown in Exhibit B-2, the CDF does vary for certain measures, specifically exit lights and exterior lights. Evaluation results did not use this CDF value to estimate impacts, using instead detailed evaluation methods. Evaluation methods used customer-specific schedules in conjunction with business type and technology group operating factors to generate program impacts at the hourly level, as discussed on page B-12 of this appendix.

B.3.3 Annual Energy Impact Calculations

Per-unit program design energy impacts are typically calculated based upon the product of the per-unit non-coincident demand impact and industry group annual hours of fixture operation, as shown in the following equation:

$$kWh_{ANNUAL} = kW_{NCP} \times hrs_z \quad (2)$$

Where:

kWh_{ANNUAL} = Per-unit annual energy impact by measure

hrs_z = Annual hours that a given measure operates in industry group z

B.3.4 Annual Hours of Operation by Business Type

Annual hours of fixture operation are based upon results from a PG&E study (HBRS and BCI 1992) and negotiations regarding impact estimates, according to a 1991 PG&E Advice Filing with the CPUC. Hours of operation vary by business type, except in cases where all sectors share identical estimates for hours of operation, such as exit lighting or exterior lighting. Exhibit B-3 provides assumed hours of operation for various business types, as specified in the majority of the program design estimates. Refer to Exhibit B-2 for additional information regarding measures that are assumed to have the same energy impacts, independent of business type.

Exhibit B-3
Annual Fixture Operating Assumptions Used to Generate
Retrofit Express Industrial Lighting Program Design Estimates

Business Type	Annual Operating Hours*
Process Industrial	4,000
Assembly Industrial	4,000
All Other	4,000

* All exterior lights are assumed to operate 4,100 hours per year regardless of business type.

Exterior lights are assumed to have the same annual hours of operation across all business types, even across sectors. They are assumed to be controlled by a combined time clock and photocell system, resulting in 4,100 operating hours per year. This figure assumes that lights operate 12 hours a day, except during summer, when the photocell reduces operation by another three hours per day.

The evaluation results do not use the operating hours specified in the program design methodology, yielding instead to customer schedules derived using self-reported telephone survey responses, on-site schedule group responses, and lighting

logger data to calibrate those responses. Again, unique customer lighting profiles were generated at the hourly level by daytype and season, in order to accurately estimate impacts according to PG&E-specified TOU periods. This methodology ensured consistency between hourly impacts and energy impacts, where energy is derived by simply adding across specific hours.

B.3.5 Reproduction of Program Design Estimates

In an attempt to verify both the methods used to generate program design impacts and the impact estimates stored in the MDSS, RE program design impacts were reproduced. Although the methods were generally found to be applied correctly in the MDSS, in several instances, differences were found between the reproduced values and those stored in the MDSS. Further investigation showed that for specific cases, impact estimates in the MDSS were calculated incorrectly. Those particular instances are summarized below.

- L14-L16: Electronic ballast measure energy and demand impact estimates, that were applied for under the 1993 RE program application form, were inadvertently over-estimated by two to four times, depending upon the measure installed. The unit of rebated measure under the 1993 program was lamps and not ballasts, causing this error in estimated impact.

- L21: Energy estimates for a subset of this 2' T8 lamp and ballast replacement measure were overestimated by approximately 40 percent. The cause of this error appears to be related to business type classification.

- L20: Energy estimates for a subset of this 8' reflector and lamp removal measure were underestimated by approximately 60 percent. The cause of this error appears to be related to business type classification.

- L61: Energy estimates for a small subset of this halogen retrofit measure were overestimated by approximately 40 percent. The cause of this error appears to be related to program design assumptions that should have been implemented for schools.

In addition, other spurious MDSS impact estimates were infrequently detected. The source of these other events could not be specifically isolated.

B.4 Evaluation Approach

To satisfy the requirements of PG&E for impact estimates by TOU costing periods, all impact estimates were generated at an hourly level. Engineering estimates that were used as inputs to the SAE were additionally estimated according to each particular customer's self-reported operating schedule.

To estimate impacts for each hour, customer operating schedules were developed by daytype, hour and season, and expressed as numeric values between zero and one, where one indicates that the probability of being open is 100 percent, and zero represents a closed premise. Impacts utilize distinct operating factors by daytype for both the closed periods and the open periods (operating factors are also dependent upon business type and technology group, but that is not important to this discussion). To estimate impacts for each hour, fixture noncoincident demand connected loads are used along with the applicable schedule and operating factors, according to the following equation:

$$UEI_{ijzdhs} = \Delta UOL_i \times U_{ij} \times [(PO_{jdhs} \times OOF_{izd}) + ((1 - PO_{jdhs}) \times COF_{izd})] \times [1 + HVAC_{ijs}]$$

Where:

$UEIijzdhs$	=	the unadjusted engineering impact for measure i, customer j, business type z, for daytype d, hour h and season s.
$\Delta UOLi$	=	the change in connected load for technology measure i.
Uij	=	the number of units of technology type i installed by customer j.
$POjdhs$	=	the schedule defined probability that customer j will be open on daytype d during the hour h and season s.
$OOFizd$	=	the open operating factor which describes the percentage of full load during normal business hours used by a group of fixtures of type i, in business type z, during daytype d.
$COFizd$	=	the closed operating factor which describes the percentage of full load during non-business hours used by a group of fixtures of type i, in business type z, during daytype d.
$HVACijs$	=	the contribution of impact caused by both heating and cooling interaction for technology measure i, installed by customer j, during the season s.

Impacts for each measure/season/daytype/hour (and often by customer) were derived and applied to a 1994 calendar, yielding demand profiles for all 8760 hours in a year.

B.5 Detailed Engineering Derivations

The following sections provide detailed derivations of specific intermediate engineering results, including customer operating schedules, lighting system

operating factors, and the interaction between HVAC energy use and lighting system internal gains.

B.5.1 Customer Operating Schedule Derivation

The calibration of customer lighting schedules was achieved using the following approach:

- Within the larger on-site sample, self-reported schedules (or profiles) were gathered at the schedule group level by daytype, allowing analysis of schedule group self-report accuracy using the lighting logger sample. The detected bias in customer self-reported hours of operation at the schedule group level was then applied to the larger sample of schedule group self-reports by business type, thus calibrating all schedule group lighting schedules. The following key points describe the details of the calibration process for schedule groups:

  - Self-reported schedule group profiles were generated that consist of hourly values generally consisting of one's and zero's, though "shoulder" hours (when a building transitions from on to off) may have intermediate values. These values represent the probability for any given hour of the day that lights are operating, according to the on-site contact. Schedule group hourly profiles were generated for each of three daytypes, Weekday, Saturday and Sunday.

  - Loggers that were installed within schedule groups at a selected number of audits, are placed with the intention of gathering a measured equivalent of the schedule group operating schedule. Each logger stores a continuous date and time-stamped transition record of lights being turned on or turned off during the monitoring period. The data from each logger was then transformed into a useful format for analytical purposes, specifically, each 15-minute interval during the monitoring period was assigned a value between one and zero that specifies the percentage of time during each interval that a particular light operated. Then, for each logger, hourly mean values were generated by daytype using aggregating hourly results across the entire monitoring period. This yielded an hourly/daytype operating factor for the fixture monitored, or the percentage of time that each monitored fixture operated during the course of the monitoring effort, or the probability of operation.

  - Lastly, logger and self-reported operating schedules were compared to each other at the business segment level to detect bias in the self report transitions from on to off. All loggers and schedule groups that contributed to a particular segment were independently combined using a weighted mean, where weights were applied based upon the total retrofit technology connected load within each particular schedule group. For logger data, the transition from on to off was set to be half the distance between the maximum hour-specific observation and the minimum hour-specific

observation. All schedule group self-reports were then adjusted according to these results, by moving the periods of transition from on to off, and the transitions from off to on, according to segment mean bias detected within the logger sample. In general the results of these analyses showed that customer self-reports were highly accurate. Therefore, in the absence of well behaved segment-specific results, unadjusted customer self-reports were used.

- Then, self-reported lighting schedules from the telephone sample were calibrated based upon more precise schedule group profiles gathered onsite. A weighting scheme was devised (based upon total new fixture connected load) within each schedule group to attain premise level schedules within the on-site sample. The detected bias in customer self-report hours of operation from the telephone response was then applied to the larger sample of telephone survey self-reports by business type, thus calibrating all telephone survey lighting schedules. The details of this load shape comparison and adjustment are very similar to the methods used in adjusting schedule group self-reports. For that reason, greater detail is not provided regarding the specifics steps implemented to adjust the telephone survey self-reports.

- Lastly, business type segment level adjusted fixture operating schedules were generated for use in MDSS impacts outside the survey and on-site audit samples. These segment mean business type schedules incorporate two distinct calibration steps, bias in on-site self-reported schedules, and bias in telephone survey self-reported schedules, calibration steps that are grounded on the best available information gathered in this research effort: lighting logger data. All schedules derived, whether customer-specific or business type segment-specific, were hourly/daytype/seasonal probabilities that a customer operates their lighting system, stored in this fashion to enable impact calculations at the hourly level.

B.5.2 Business Type and Technology Group Operating Factors

Operating factors, the percentage of lights operating during a specified time interval, were generated by business type and technology group, for facility operating and non-operating periods by daytype. The operating factors that are applied to the probability that a given facility is operating comprise the open operating factor (OOF), and those that are applied to one minus the probability that a given facility is operating comprise the closed operating factor (COF). The data sources contributing to these estimates were taken primarily from two sources: new technology lamp counts performed at the time of each audit, and lighting logger data used in conjunction with the calibrated schedule group profiles. The steps that were implemented to derive operating factors are presented below.

- OOFs were primarily supported by lamp counts that were taken during each on-site audit. Lamp counts were conducted for each retrofit technology installed, and segmented into lamps that were on and lamps that were off, representing a

technology-specific instantaneous OOFs. Since on-site audits were conducted on weekdays during normal facility business hours, lamp counts were used to estimate OOFs for weekdays. These customer results were then weighted across customers, yielding a single business type and technology group operating factor that was used consistently for all retrofit estimates falling into that particular segment. For business type and technology group segments with relatively low numbers of lamps counted, weighted mean values were generated across a number of business type segments to strengthen those mean values.

- COFs were estimated by daytype and business type using logger data, calibrated schedule group profiles, and weights by technology that are based upon retrofit fixture connected load. A simplified description of the procedure implemented is that all hourly logger observations categorized as non-operating, for a particular business and daytype segment, were used to generate a single mean value. This is roughly true, though a weighting scheme was implemented based upon the total schedule group retrofit technology connected load.

- It was also necessary to produce both Saturday and Sunday operating factors for the facility operating condition, with no supporting lamp count data. The loggers were used to generate OOFs by daytype, during the facility operating period. The ratio of resulting Saturday or Sunday operating factors to weekday provided a business type operating factor adjustment. These adjustments were then applied to the operating factors generated using lamp count data, yielding Saturday and Sunday OOFs. This analysis step also allowed for a comparison by business type of OOFs that were generated using lamp counts with those generated using logger data. These comparisons strongly support the operating factors generated for weekdays using lamp counts, which, in turn, support the operating factors generated using logger profiles.

B.5.3 HVAC Interactive Effects

B.5.3.1 Introduction to HVAC Interactive effects

In addition to the direct effects of lighting retrofits on premise energy and demand, the contribution of impact caused by cooling and heating system use is described in this section. Internal gains affect both the air-conditioning and heating loads in buildings, and thus HVAC equipment run-time and consumption. Lighting retrofits modify the heat gain in buildings, and thus heating system and air-conditioner usage. When high-efficiency lighting systems replace standard-efficiency systems, cooling loads are decreased while heating loads increase. This section presents the method used to quantify those impacts.

The engineering data sources used to evaluate the 1994 industrial lighting program are identified in Exhibit B-4. Shaded regions identify the primary data sources contributing to HVAC interactive estimates.

Exhibit B-4
Data Sources Contributing to Heating and Cooling Interactive Estimates

Research Objectives \ Data Sources	Billing Data			Telephone Survey		On-Site Audit		P/NP Metering	
	Usage Metered	Demand Metered	MDSS Database	Lighting Participant	Program Non-Participant	Lighting Participant	Program Non-Participant	Spot Watt	TOU Metering
IMPACT ANALYSIS									
Unit Operating Load/Impact									
Old Wattage			●			●	●	●	
New Wattage			●			●		●	
Impact (UOI)			●			●		●	
Hours of Operation									
Operating Factor (OF)				●	●	●	●		●
Operating Hours (OH)				●	●	●	●		●
Measure Installation									
Unit Installed (U)			●			●			
Retention						●			
Burned-Out Lamps						●	●		
Impact Adjustment									
SAE Demand Realization Rate									
SAE Energy Realization Rate									
H-Factor by Cost Periods									
Net-to-Gross Ratio									
Interactions									
Cooling Savings				●	●	●			
Heating Penalty				●	●	●			

Survey responses and calibration data gathered on-site were the most important data sources contributing to the HVAC interactive analyses of energy and demand.

The interactive effects of HVAC appliances were estimated using methods developed by ASHRAE, and published in the *ASHRAE Journal*.[3] This article explores the use of HVAC energy as a function of energy-efficient lighting design, and potential savings and penalties resulting from efficient technology retrofits.

This section includes a thorough overview of the steps required to implement interactive adjustments to lighting technology-level impacts. Flowcharts are used to depict key decisions that must be made for each contributing customer, and equations are supplied that were used to estimate the interactive benefits (savings) and costs (penalties) for each lighting participant.

[3] Rundquist, R., *et al.* 1993. "Calculating Lighting and HVAC Interactions", ASHRAE Journal, November 1993, pages 28-37.

B.5.3.2 Cooling Energy Equations

The algorithm that was used to estimate cooling energy interactive savings is presented in Exhibit B-5. To estimate the annual cooling energy contribution from the HVAC system, two new terms are introduced in addition to those already required to estimate the lighting technology-only contribution.

Exhibit B-5
Gross Annual Cooling Energy Impact Algorithm

$$COOLSAV_j = \left[HGANNUAL_j \times \frac{1}{MCOP_j} \right] \times \left[\sum_{t=1}^{Tj} \Delta kWh_{tjz} \right]$$

where:

$COOLSAVj$	=	Annual HVAC savings resulting from lighting reduction for premise j
$HGANNUALj$	=	Annual fraction of internal heat gain removed mechanically for premise j
$MCOPj$	=	Marginal coefficient of performance of cooling equipment for premise j
ΔkWh_{tjz}	=	Technology t annual energy savings for premise j, a member of industry group z
Tj	=	The number of lighting technologies installed in premise j

The first term, HGANNUALj, describes the fraction of heat gain removed mechanically from the building, as defined in the ASHRAE method Table 1 (from the ASHRAE article, appended to this report). The fraction of heat gain removed mechanically is a function of building size, and whether or not the building is served by an economizer (a device that uses outside air rather than mechanically chilled air to cool buildings when the outside temperature is sufficiently low). The reduced heat gain caused by an energy-efficient lighting retrofit can only benefit cooling system energy use when lighting waste heat is mechanically cooled. Additionally, the fraction of heat gain that is mechanically cooled is always less than one, because of outdoor air ventilation (including the use of economizers), exhaust fans (that mechanically remove heat), and building envelope infiltration.

Table 1 inputs are weather normalized for various locations throughout the United States, including three cities within PG&E's service territory. Either Santa Barbara, San Francisco, or Sacramento was used as a proxy for each participant site.

The second term, MCOPj, defines the marginal cooling system efficiency, a variable describing the efficiency (including all auxiliaries, and supply and return fans) applicable to the incremental cooling load. A default system efficiency is supplied by the ASHRAE method for estimates that involve the retrofit of lighting systems. The MCOP term serves as a conversion constant in the HVAC energy equation, producing an estimate of electricity consumption needed to mechanically cool lighting waste heat.

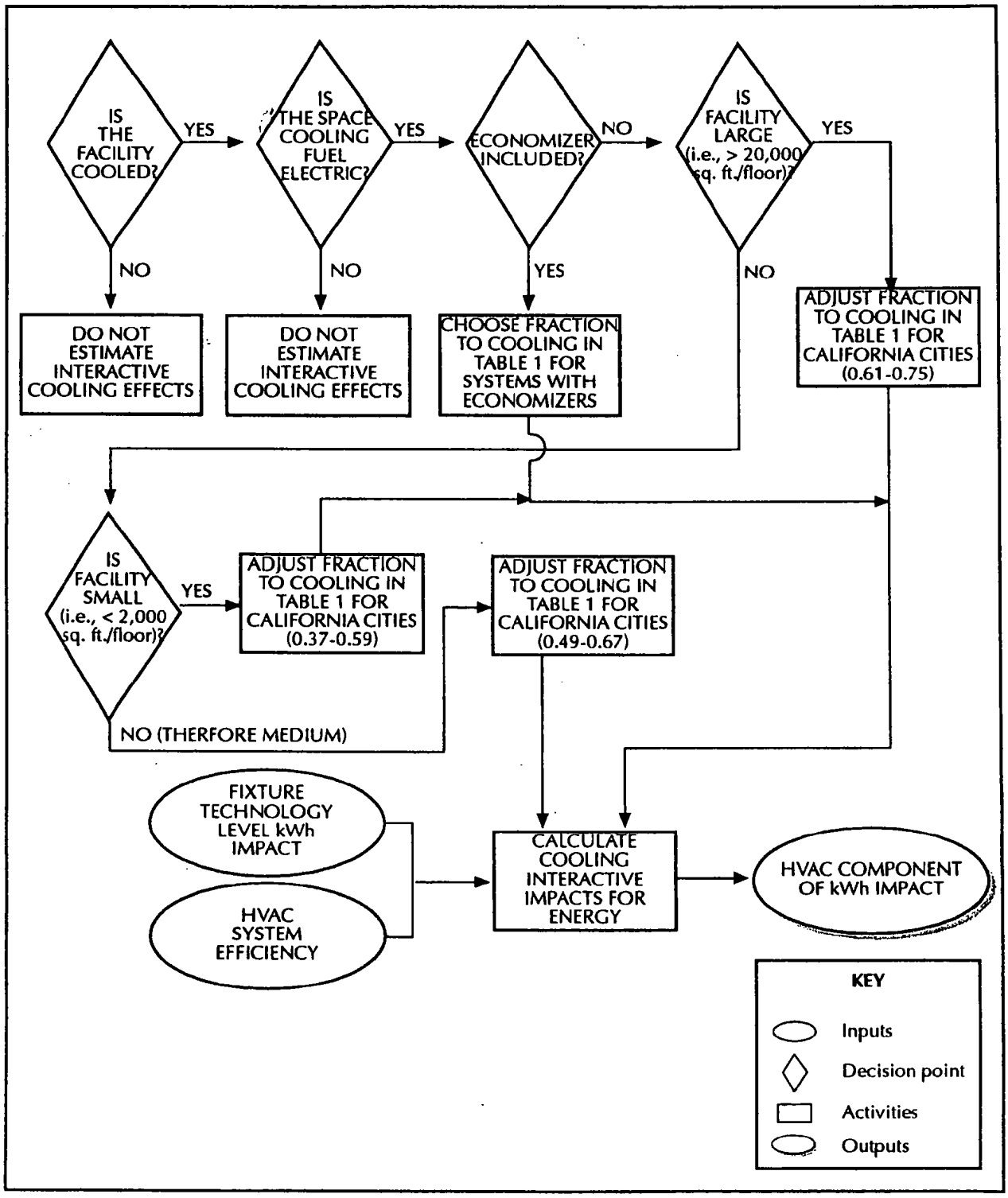
Next the methods used to determine the cooling interactive terms used in the ASHRAE method are described in greater detail.

B.5.3.3 Application of the ASHRAE Cooling Energy Method

Exhibit B-6 introduces the decision-making processes leading to the calculation of annual cooling energy impacts. This exhibit illustrates several key points.

- First, cooling impacts were estimated only for premises with cooling systems.
- Second, engineering impacts were estimated only for sites served by electric-powered cooling systems, since engineering impacts served as inputs to SAE analyses, which were supported by electric billing data. Engineering impacts were estimated in two ways.
  - For premises served by HVAC systems that included an economizer mode, ASHRAE article Table 1 HGANNUALj values were selected.
  - For premises without economizers, values for HGANNUALj were calculated based upon the building size per floor.

Exhibit B-6
Determining the Cooling Interactive Contribution to Energy Impacts



Buildings are classified into three size categories: large, medium, and small, with relatively large to small values of HGANNUALj, respectively. Premises served by economizers have the smallest relative values of HGANNUALj, thus implying that less lighting system heat is mechanically cooled on an annual basis when economizers are present.

ASHRAE HVAC impacts are achieved by multiplying the heat gain fraction removed mechanically (HGANNUALj) and the marginal coefficient of performance (MCOPj) with annual fixture-level energy impacts for indoor lighting systems, on a per-premise basis. The resulting cooling energy savings are used as inputs to the SAE analyses, along with both technology-level impacts and heating penalty estimates (as described below).

B.5.3.4 Heating Energy Equations

To estimate the annual heating energy penalty from HVAC system electric heating, three new terms are introduced in addition to those already required to estimate the lighting technology-only impacts. The algorithm presented in Exhibit B-7 was used to estimate heating energy interactive penalties, and includes the following distinctive terms:

- HVAC interactive heating estimates include a term that describes the fraction of internal heat gain contributing to the building heating loads (HLANNUALj), as defined in the ASHRAE publication, Table 1. The following points must be considered :

  - Because of the typical reduction in internal gains associated with lighting efficiency upgrades, more heat is needed from the HVAC system to meet building losses.

  - This input is weather normalized for various locations throughout the United States, including three cities located within PG&E's service territory. A particular city is used as a proxy for each participant site.

- The contribution to the heating system is also influenced by the dimensions of each building. The fraction of each retrofit on the exterior 15-foot perimeter, PERIMETERj, is used to define the fraction of fixture heat contributing to the annual heating load. The internal "core" zones are always assumed to require cooling, never heating.

- HVAC interactive estimates also include a term that describes the heating system efficiency (HPCOPj), which depends upon system type for estimates of electric energy penalties, specifically, whether heat pump or resistance heat. Resistance heaters are assumed to have an HPCOP of 1.0, whereas an HPCOP of 1.5 is recommended for heat pump systems.

Exhibit B-7
Gross Annual Heating Energy Impact Algorithm

$$HEATPEN_j = \left[HLANNUAL_j \times PERIMETER_j \times \frac{1}{HPCOP_j} \right] \times \left[\sum_{t=1}^{T_j} \Delta kWh_{tjz} \right]$$

Where:

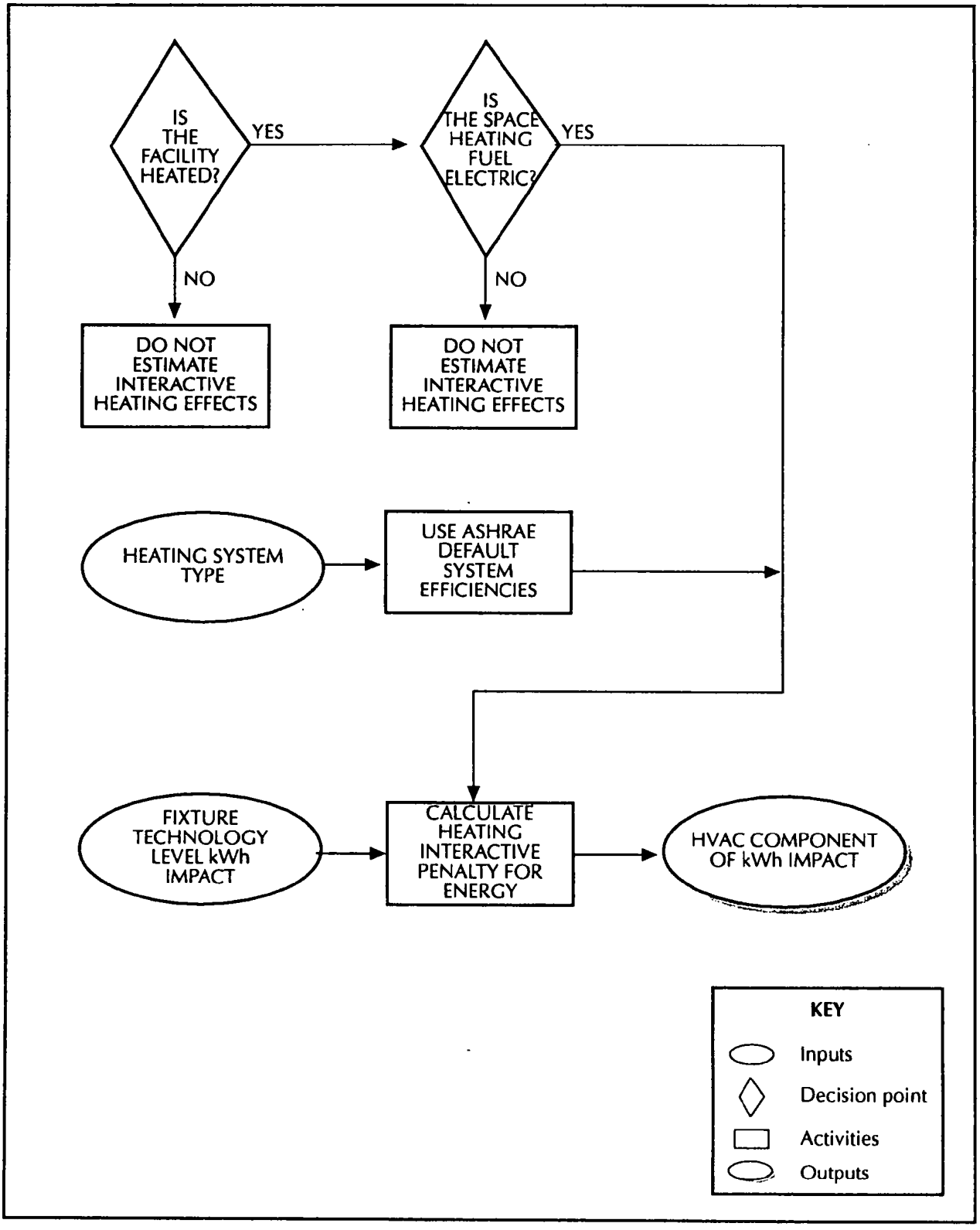
$HEATPEN_j$	=	Annual HVAC penalty resulting from lighting retrofit for premise j
$HLANNUAL_j$	=	Annual fraction of internal heat gain contributing to building heating load for premise j
$PERIMETER_j$	=	Fraction of lighting retrofit on the perimeter area for premise j
$HPCOP_j$	=	Heat pump coefficient of performance of heating equipment for premise j
ΔkWh_{tjz}	=	Technology t annual energy savings for premise j, a member of industry group z
T_j	=	The number of lighting technologies installed in premise j

Next the logic used to determine heating interactive estimates (according to the ASHRAE method) are described in greater detail.

B.5.3.5 Application of the ASHRAE Heating Energy Method

As described earlier, the efficient lighting technologies installed under the lighting program caused a reduction in internal heat gains in buildings, and a related increase in the energy required to heat internal spaces. The flow chart shown in Exhibit B-8 establishes the general decisions used to estimate heating impacts using the ASHRAE method. To apply the ASHRAE method requires determining the heating system fuel and, if electric, whether or not the system is a heat pump.

Exhibit B-8
Determining the Heating Interactive Contribution to Energy Impacts



Presented next are the methods used to determine the distribution of annual cooling impacts and heating penalties among each hour of the year.

B.5.3.6 Hourly HVAC Impacts

PG&E requires that impacts be generated according to costing periods related to TOU customer rates. Since the ASHRAE impacts predict a reduction in cooling energy use and increased heating energy use on an annual basis, a methodology had to be developed to distribute the annual impacts determined using the ASHRAE method to each customer on an hourly basis. This section describes the method that was developed.

The distribution of impacts to each hour of the day was accomplished while maintaining several key constraints.

- HVAC impacts were applied during selected days in proportion to hourly lighting system impacts.
- Cooling impacts were applied to selected days as a function of summed daily temperature.
- Heating impacts were applied to selected days as a function of summed daily temperature.
- HVAC impacts for any given hour were applied based upon mechanical system efficiency parameters supported by the ASHRAE method.

Details regarding the methodology are described below, with special consideration of the constraints described above.

In applying both cooling and heating impacts, certain parameters introduced in exhibits B-5 and B-7 specify the fraction of annual fixture heat gain that must be either mechanically cooled or mechanically heated. For cooling impacts, the term HGANNUALj describes the customer-specific fraction of fixture heat gain that requires cooling, and for heating impacts, HLANNUALj x PERIMETERj describes the customer-specific fraction of the fixture heat gain that contributes to annual heating loads. The method of distributing HVAC impacts over each hour of the year relies upon these terms to identify the fraction of days in each year to which HVAC impacts were applied. To select specific days (to which HVAC impacts are applied), all days in a year were ranked according to summed daily temperatures, for each of three applicable weather tapes, WYEC Santa Barbara, San Francisco, and Sacramento. Dry bulb temperatures were used for this procedure.

For cooling impacts, the selected days to which impacts were applied on an hourly basis are those days with the highest summed daily temperatures. The number of days applied per customer is always HGANNUALj x 365. Hourly impacts for applicable indoor measures were generated using the following formula:

$$HVAC_{ijzdhs} = \frac{UEI_{ijzdhs}}{MCOP_j}$$

Likewise, for heating impacts, the selected days to which impacts were applied on an hourly basis are those days with the lowest summed daily temperatures. The number of days applied per customer is always HLANNUALj x PERIMETERj x 365. Hourly impacts for applicable indoor measures were generated using the following formula:

$$HVAC_{ijzdhs} = \frac{UEI_{ijzdhs}}{HPCOP_j}$$

B.5.3.7 HVAC Demand

The distribution of hourly estimates of HVAC impact during the summer on-peak period and system peak hour, vary day-to-day with changes in fixture operating schedule and outdoor temperature. To arrive at a single program figure for any particular business type and lighting technology segment, mean values were calculated for the peak hour across the entire summer on-peak period, thus providing a diversified estimate of HVAC impact.

This concludes the derivation of HVAC interactive engineering parameters.

B.6 Evaluation Results

B.6.1 Overview

This section provides the reader with detailed engineering results for parameters that contributed to unadjusted gross evaluation impact estimates. PG&E should consider adopting many of the results presented to improve the accuracy of program design estimates.

B.6.2 Measured Fixture Connected Loads

Noncoincident change in fixture connected load for each measure installed was determined based upon manufacturers' product literature for both the retrofit technologies, and for assumed existing technologies. To test the accuracy of manufacturers' literature, instantaneous fixture connected loads were measured during on-site activities. Equipped with a spot-watt metering device called a watt probe, both new and existing fixture connected loads were measured. Measurements were taken by locating a switch with just a single type of fixture served on that particular circuit. An attempt was always made to take measurements on circuits with as many new fixtures as possible, thus ensuring high precision for circuits drawing more than 200 watts.

Individual measurements were grouped based upon several selected technology groups. Technologies were grouped to attain a single result that represents a diverse group of fixture configurations (i.e., the T8 technology group contained measurements for 2', 4', and 8' fixtures, in 1-, 2-, 3-, and 4-lamp configurations). Furthermore, the measurements were all normalized for these groupings per total lamp wattage in each fixture. This allowed the calculation of confidence bounds surrounding measurements from a diverse group of fixture configurations that all fall into a particular technology group.

Measured fixture connected load results, normalized to total lamp watts served, are provided in Exhibit B-9. At the top of the exhibit, mean normalized measurements are presented by technology group, along with the lower and upper confidence bounds, calculated at the 95 percent confidence interval.

Exhibit B-9
Technology Group Spot-Watt Results

Technology Group	Normalized Spot Watt Measurement Results					
	Number of Spot Watt Measurements per Technology Group	Mean Ratio of Measured Watts to Lamp Watts	Standard Deviation	95% Confidence Interval	Lower Bound	Upper Bound
T-12 Fixtures	27	1.04	0.08	0.03	1.01	1.07
T-8 Fixtures	85	0.94	0.15	0.03	0.91	0.97
CF Fixtures	13	1.11	0.20	0.12	0.99	1.23
Metal Halide Fixtures	7	1.19	0.18	0.17	1.02	1.36
HPS Fixtures	5	0.92	0.31	0.39	0.53	1.31
Mercury Vapor Fixtures	2	1.19	0.03	0.29	0.90	1.49

Technology Group	Program Design Fixture Description	Tested Program Design Fixture Connected Loads			
		Watts per fixture	Total Lamp Watts	Ratio MDSS/Lamp Watts	Within the 95% C.I. for the Specific Technology Group?
T-12 Fixtures	2L 4' T-12 w/ ES MB	80	80	1.00	Yes
T-12 Fixtures	3L 4' T-12 w/ 2 ES MB	121	120	1.01	Yes
T-12 Fixtures	2L 8' T-12 w/ 2 ES MB	151	150	1.01	Yes
T-8 Fixtures	2L 4' T-8 w/ EB	58	64	0.91	Yes
T-8 Fixtures	3L 4' T-8 w/ EB	84	96	0.88	No
T-8 Fixtures	2L 8' T-8 w/ EB	106	118	0.90	Yes
CF Fixtures	13 Watt Compact Fl.	15	13	1.15	Yes
CF Fixtures	2 23 Watt Compact Fl.	30	26	1.15	Yes
CF Fixtures	44 Watt Compact Fl.	48	44	1.09	Yes
Metal Halide Fixtures	175 Watt Metal Halide	210	175	1.20	Yes
Metal Halide Fixtures	250 Watt Metal Halide	292	250	1.17	Yes
Metal Halide Fixtures	400 Watt Metal Halide	455	400	1.14	Yes
HPS Fixtures	35 Watt Int HPS	43	35	1.23	Yes
HPS Fixtures	70 Watt Int HPS	88	70	1.26	Yes
HPS Fixtures	100 Watt Int HPS	130	100	1.30	Yes
HPS Fixtures	100 Watt Ext HPS	130	100	1.30	Yes
HPS Fixtures	400 Watt Ext HPS	465	400	1.16	Yes
Mercury Vapor Fixtures	250 Watt Mercury Vapor	285	250	1.14	Yes
Mercury Vapor Fixtures	400 Watt Mercury Vapor	450	400	1.13	Yes
Mercury Vapor Fixtures	750 Watt Mercury Vapor	820	750	1.09	Yes
Mercury Vapor Fixtures	1000 Watt Mercury Vapor	1075	1000	1.08	Yes

To test the accuracy of fixture connected load levels that were assumed for both the calculation of evaluation results and program design estimates, selected fixture connected loads from each technology group were tested to determine whether or not the normalized connected loads for those fixtures fall within the measured 95 percent confidence interval. These tests were carried out based upon the technology group to which each measure belongs, as summarized in the bottom portion of Exhibit B-9. These results show that in all but one of the selected cases, the fixture connected loads used to derive impacts fell within the 95 percent confidence interval for a particular technology group. This result suggests that fixture connected loads based upon manufacturers' product literature are accurate and should continue to be used.

B.6.3 Burned Out Lamp Rates

When retrofit lighting programs are implemented, burned-out lamps are often replaced. For those particular lamps, the first year impacts yield an increase in energy use, though the program saves energy across all observations. In addition, new fixtures often fail a short time after installation, resulting in a decrease in energy use for those particular fixtures. In an effort to quantify these impacts, burned-out lamps were counted during the on-site audits (in addition to the total number of lamps observed). All such counts were categorized as either retrofit technologies or existing technologies, to allow separate analysis of the pre- and post-retrofit burned-out lamp rates.

Total lamp counts yielded significant burned-out lamp results in four fixture categories, as provided in Exhibit B-10 below:

Exhibit B-10
Observed Burned Out Lamp Rates

Pre- or Post-Retrofit	Technology Group	Observed Burned Out Lamp Rate
Pre-Retrofit	Incandescent	2.16%
Pre-Retrofit	Standard Fluorescent	3.05%
Post-Retrofit	Compact Fluorescent	0.37%
Post-Retrofit	Standard Fluorescent	0.26%

These burned-out lamp observations were applied to the pre- and post-retrofit connected load assumptions based upon the following rules:

- Burned-out lamp rates were only applied within the RE program because of the diversity of measures that were applied within the Customized program.
- Burned-out lamp rates were only applied to measures where both the pre- and post-retrofit technologies had supporting burned-out lamp data, never just pre- or just post-retrofit fixture loads.

The following equation was used to incorporate burn-out rates within the estimated change in connected load pre- to post-retrofit:

$$kW_{NCP} = [(1 - BO_E) \times kW_E] - [(1 - BO_R) \times kW_R]$$

Where:

BO_E = Estimated burn-out rate for the existing measure system

BO_R = Estimated burn-out rate for the retrofit measure system

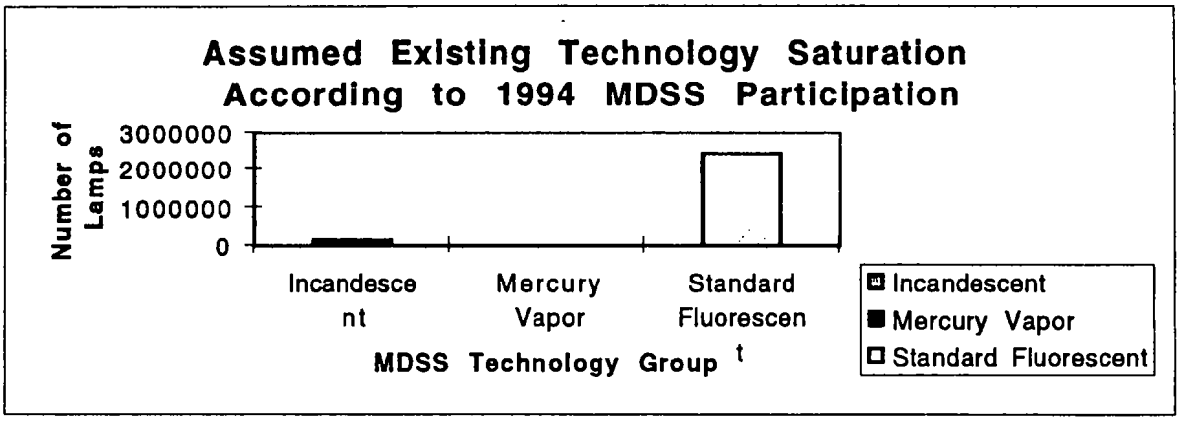
B.6.4 Existing Fixture Saturation by Technology Group

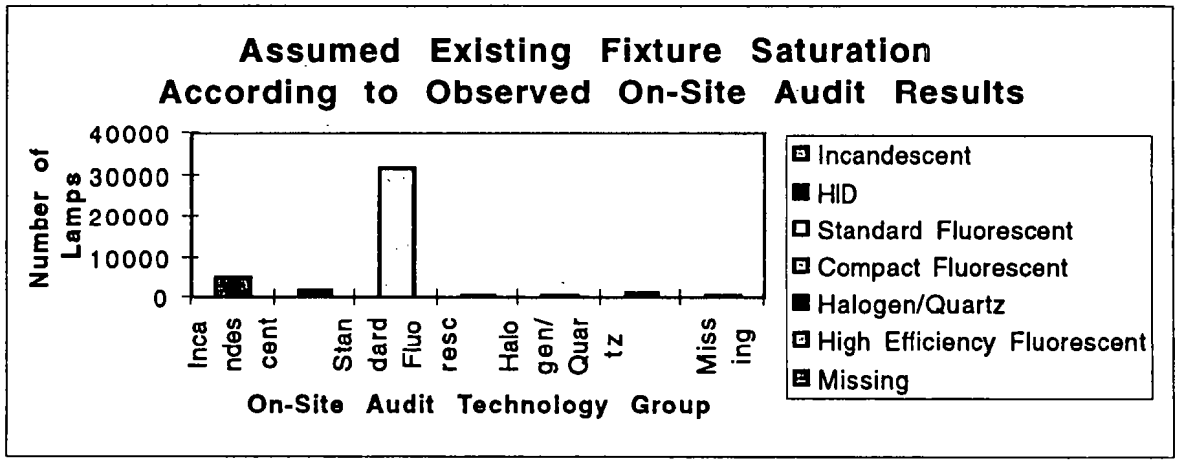
All RE evaluation impacts utilize program design assumptions regarding the fixtures removed at the time of retrofit. These assumptions were tested using observed existing technology saturations recorded during implementation of the on-site audits.

Exhibit B-11 provides the results of existing fixture saturation comparisons, according to both participation in the RE program and on-site results. Estimates of the total number of lamps replaced were derived using participation data and assumed fixture configurations for replaced systems, yielding total lamps by technology group. Estimates from the on-site audits were derived by mapping each existing system observation to a particular technology group, and then subsequently summing the total number of lamp observations recorded during on-site activities within each technology group.

The existing system fixture saturation recorded on site agrees in general with the assumed program design saturation, though the fixture types are more diverse in the actual population. The change in connected load pre- to post-retrofit is a very important parameter used to estimate program savings, and yet little is actually known about the type or frequency with which particular systems are replaced. This is a weakness in the MDSS we recommend correcting.

Exhibit B-11
Observed Existing Fixture Saturation vs. Program Design Replacement Assumptions





B.6.5 Hours of Fixture Operation by Business Type and Technology Group

Exhibit B-12 presents a summary of the annual hours of fixture operation applied in generating RE energy impacts in the commercial sector.

Exhibit B-12
Industrial Sector Annual Fixture Hours of Operation by Business Type and Technology Group

Program and Technology Group \ Business Type	Industrial Sector Hours of Fixture Operation	
	Process	Assembly
Indoor Lighting		
Retrofit Express Program		
Compact Fluorescent	3,800	3,700
Standard Fluorescent	5,300	4,900
High Intensity Discharge	5,300	5,000
Halogen	—	5,000
Exit Signs	—	8,200
Controls (Occ. Sens Only)†	2,900	2,700
Exterior Lighting		
Retrofit Express Exterior HID	4,000	4,000

† Hours presented for occupancy sensors reflect the net reduction in hours of operation.

Although the hours presented are at the detailed level of business type and technology group, providing details from the engineering methods applied, we cannot recommend at this time that results at this detailed level be applied to other samples of participants.

The annual fixture operating figures presented here are based upon the combined application of customer operating schedules by daytype and season, and open and closed operating factors developed by daytype, business type, and technology group. To prevent unnecessary reporting and tables, presentation of the operating factors and operating schedules has been replaced with information at levels of detail more suitable for PG&E's use, i.e., the annual fixture operating hours summaries just presented, and the summer on-peak coincident diversified operating factors that follow.

B.6.6 Coincident Diversified Operating Factors by Business Type and Technology Group

Exhibit B-13 presents a summary of the commercial sector peak-hour coincident diversified operating factors (CDOF's), the percentage of connected load use

estimated for the peak hour on a mean basis across the summer on-peak period. This term incorporates diversity as a function of both customer operating schedules, and weekday open and closed operating factors that were developed by business type and technology group. These terms are presented for the purpose of providing PG&E with detailed customer retrofit performance during the critical on-peak hour.

Exhibit B-13
Industrial Sector Summer On-Peak CDOF's

Business Type / Program and Technology Group	Industrial Sector CDOF	
	Process	Assembly
Indoor Lighting		
Retrofit Express Program		
Compact Fluorescent	0.53	0.54
Standard Fluorescent	0.78	0.80
High Intensity Discharge	0.78	0.80
Halogen	—	0.80
Exit Signs	—	0.94
Exterior Lighting		
Retrofit Express Exterior HID	0.49	0.49

We cannot recommend at this time that CDOF results, which were derived at the technology group and business type level, be transferred to other retrofit customers based upon this study alone.

B.6.7 HVAC Impact Results

Exhibit B-14 presents commercial sector mean HVAC energy and summer on-peak demand adjustment factors by business type that describe the ratio of total fixture and HVAC impact to fixture-only impact. These adjustments could be applied by business type to future estimates of technology-only lighting impacts, yielding estimates of total impacts that include the HVAC component.

Exhibit B-14
Industrial Sector HVAC Adjustments

Industry Group	Indoor Lighting HVAC Adjustments	
	Energy Adjustment	Demand Adjustment
Assembly	1.10	1.19
Process	1.02	1.04

B.6.8 Customized Incentives Methodology

Hard copy application forms for Customized program participants were obtained from PG&E, providing a critical source of information used to derive program impacts. Key engineering data from the forms were entered into a database to classify each impact by technology group, and to generate critical information regarding the retrofit system installed and the existing system removed. Classifying impacts was an important part of this analysis, since impacts tracked in the MDSS for Customized program measures are often not categorized. The method used to generate impacts (for most of the technology groups) required an estimate of the change in connected load for each measure retrofit. With these two parameters and any customer-specific schedule information, impacts were estimated using methods that are consistent with those used for the measures in the RE program. In the absence of hard copy form data, it was found that the MDSS demand impact could be used to approximate change in fixture connected load. In all cases investigated (with the exception of exterior HID lights, refrigerator case door anti-sweat devices, and EMS systems), change in connected load was tracked in the MDSS variable PKW1.

B.7 Indoor Impact Profiles by Business Type and Costing Period

To conclude this engineering appendix, hourly/daytype unadjusted gross energy profiles are presented for selected business types. by costing period, for all indoor lighting technologies installed under the RE program. The following profiles demonstrate the detailed information supplied to PG&E through the application of engineering estimates on an hourly basis.

Exhibit B–15

Indoor Lighting Impact Profiles for the Process Segment During the Summer Season

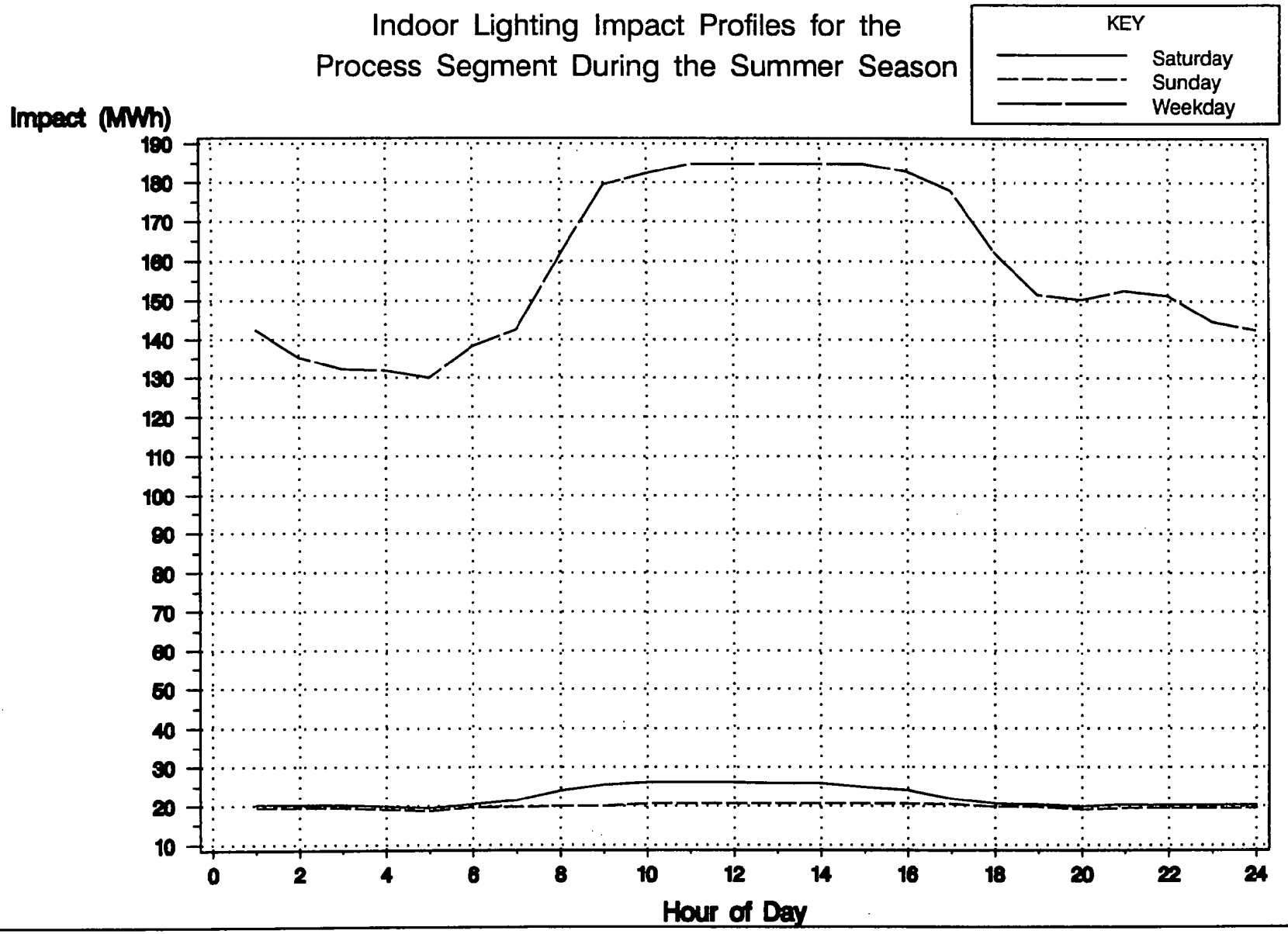


Exhibit B-16

Indoor Lighting Impact Profiles for the Assembly Segment During the Summer Season

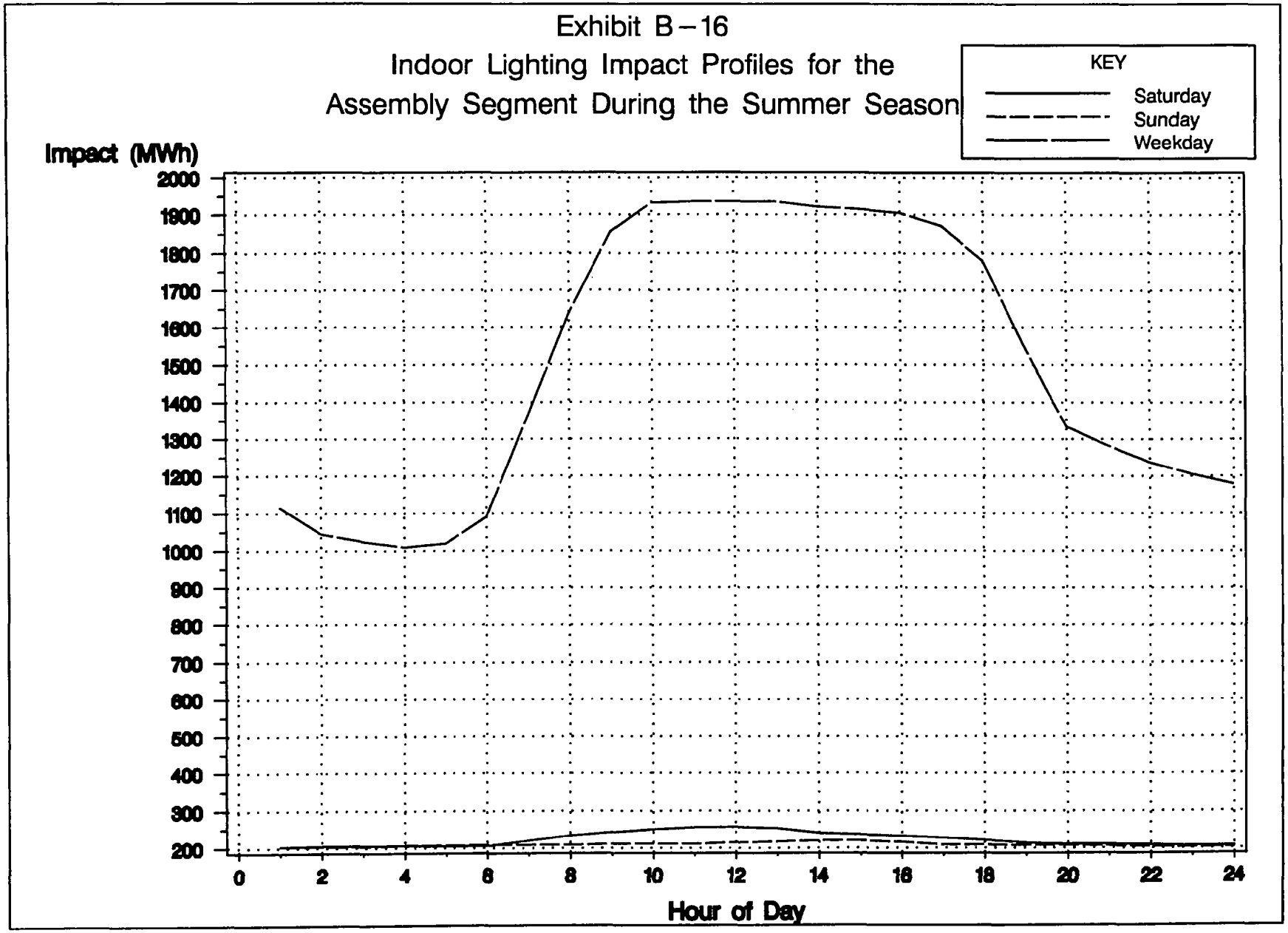


Exhibit B–17

Indoor Lighting Impact Profiles for the Process Segment During the Winter Season

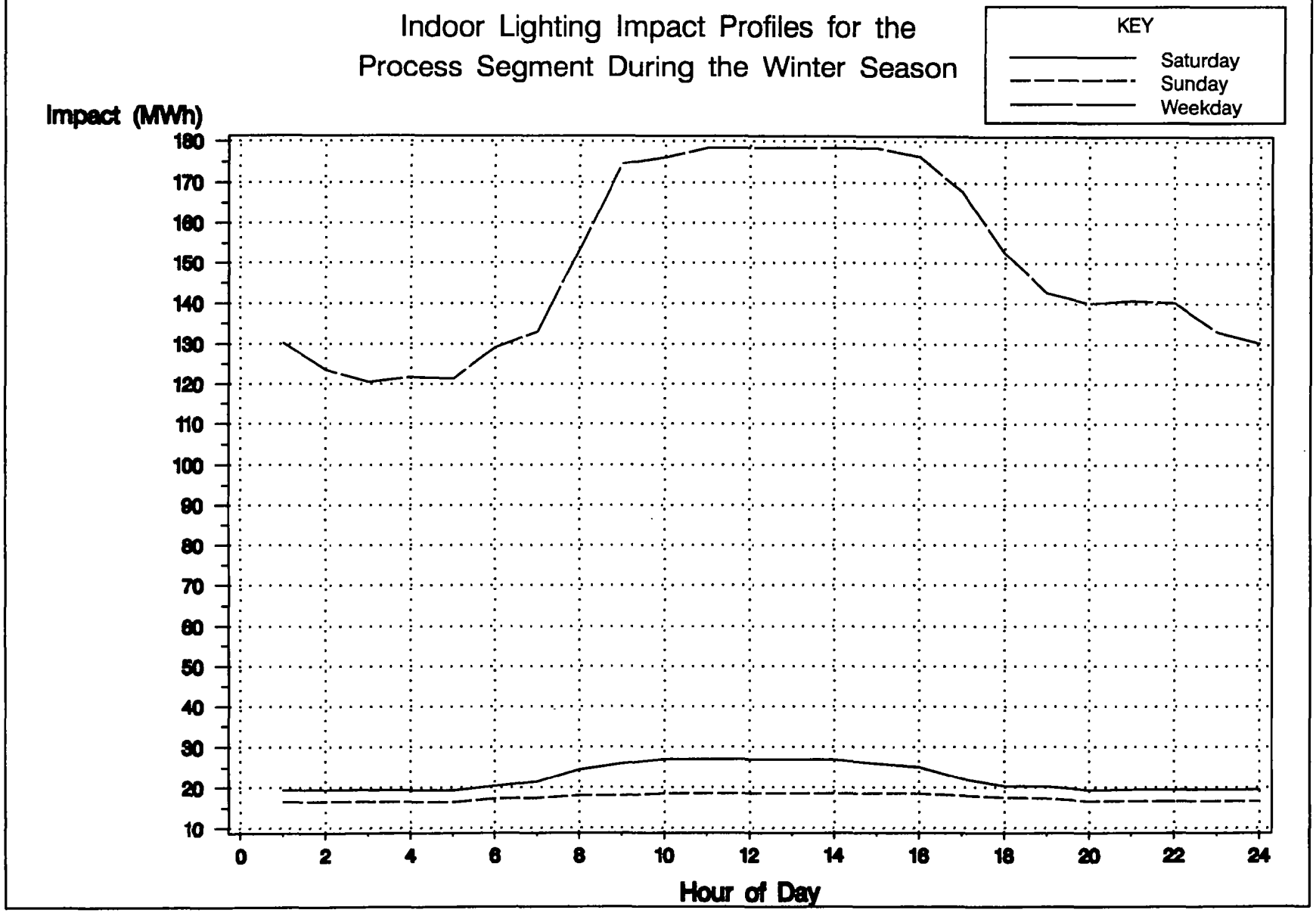
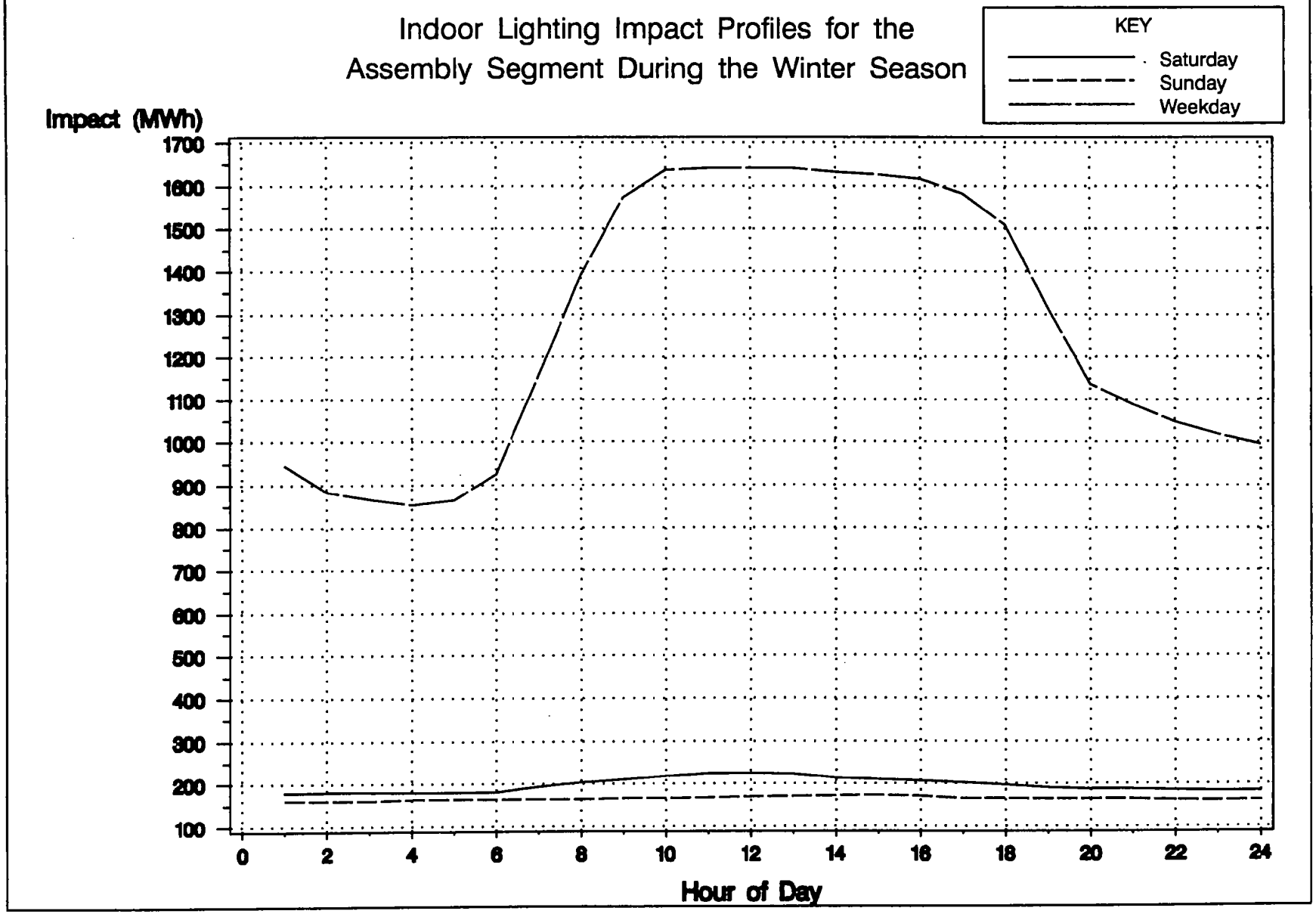


Exhibit B–18

Indoor Lighting Impact Profiles for the Assembly Segment During the Winter Season



Appendix C

FINAL PARTICIPANTS ON-SITE INSTRUMENT

On-site ID FRJ

Inspector 04

Is this a logger site Y

On-site date 6/5/95

Company nam

Address

City and ZIP

Appointment date

Participant -1

Appointment tim

Contact name

Actual contact:

Contact title

Actual phone #:

Contact phone #:

Actual title

Facility Function Assembly Industri

Update

PG&E account #

Verify: Y

PG&E control #

Verify: N

New Technologies

Tech grp	T-8 Lamps and Electronic Ballasts	Msr Cd	L73
Msr dscp	fixture: 4 ft t-8 w/elec blst 2 32-watt t-8 lamps	# Instld	4
Blst dscp		Retr dscp	
Tech grp	T-8 Lamps and Electronic Ballasts	Msr Cd	L74
Msr dscp	fixture: 4 ft t-8 w/elec blst 3 32-watt t-8 lamps	# Instld	25
Blst dscp		Retr dscp	

SIC Code	2752	Verify:	N
No. of stories	1	Year built	1980
No. of people @4pm	3	% of all lights retro'	98%
Total sq. ft	2100	% of sq. ft. heated	100%
% of sq. ft. air con	100%	Sq. ft. of retrofit	2000

Is retrofitted area heated	Y	
Is retrofitted area air conditioned	Y	
Primary function of retrofit area:	18	
Heating fuel	11	
Cooling fuel	11	
Heating system typ	10	
Cooling system type	10	
% of retrofit on outer 15' perimet	10%	
Economizer?	?	
Does the facility replace all flourescent lamps routinely	N	
If yes, how often does relamping occur?		
How often are burned out lamps replaced?	17	

On-site ID FRJ Total # of Zones 1

Total tenant square footage 2100 New Zone

Weekday lights schedule 08:30am - 06:00p

Saturday lights schedule: N

Sunday lights schedule: N

Sched Zone 1

Percent of tenant square footage 95%

Percent of kW of night or safety lights 0%

Primary us 18 Work manufacturing or production area

Description ALL BUT RR

Select Tech: T-8 Lamps and Electronic Ballasts,fixture: 4 ft t-8 w/elec bls TID 11937

On-site ID FRJ

Technology group: T-8 Lamps and Electronic Ballasts

Measure descriptio fixture: 4 ft t-8 w/elec blst 2 32-watt t-8 lamps

Measure Code L73

No. Installed 4 Verify: Y Yes

Watts per fixture Fixture Location

Ballast Descriptio

Retrofit Description

Location / measure notes: 2 FIXT. EACH BOTH OFFICES

Lamp informatio

Brand: 10 Sylvania

Model # FO32/735

Lamps per fixtur 02 2

Lamp type: 21 4' T-8

Notes:

Lamp wattage 32

Controller Informatio

Controller Brand:

Controller Model #

Controller Device:

Lamps Controlled

Ballast informatio

Brand	10	Magnetek
Ballast Capacit	02	2 lamps
Model #	2P32-RH-TP	
Volts	11	120
Amps	14	0.495
Wiring	10	Within fixture
Notes		
Ballasts per fixtur	11	1
Dual switching	N	No

Power Factor: 19 High

Second Ballast information (if any

Brand		
Model #		
Amps		

Measurements

Instantaneous load measurement (in kW):	# of fixtures	# of Non-Op lamps:	Power factor

Site ID	FRJ	Weekday:	08:30am - 06:00p	ZoneDescription
Schedule Zone	☐	Saturday	N	ALL BUT RR
Schedule zone	1	Sunday	N	

New Tech

	Working Lamps		Non-Working Lamps	
	Num. Lamps Inspected:	Num. Lamps Turned On:	Num. burned out lamps:	Num. lamps in burned out fixtures:
'L73 . 4. T-8 Lamps and Electronic Ballasts . fixture: 4 ft t-8 w/elec blst 2 32-watt t-8 lamps	4	4	0	0
'L74 . 25. T-8 Lamps and Electronic Ballasts . fixture: 4 ft t-8 w/elec blst 3 32-watt t-8 lamp	25	25	0	0

On-site ID FRJ

Building plans secured N No

New Area

Area Number 1

Area description FRONT LOBBY REAR PRODUCTION-3L.
FRONT OFFICES-2L

Use area 18 Work, manufacturing or production area

New Tech

Count:

'L73 . 4. T-8 Lamps and Electronic Ballasts . fixture: 4 ft t-8 w/elec blst	4
'L74 . 25. T-8 Lamps and Electronic Ballasts . fixture: 4 ft t-8 w/elec blst	25

Site ID FRJ

Logger ID	297	Site ID FRJ
Primary schedule zone	1	
Primary us	18	Work, manufacturing or production area
Date initiated	6/5/95	
Time initiated	01:30pm	TechEra
Occupancy sensor	N	No
Floor #	01	1
Technology Loggered		0
Placement description	IN REAR PRINT SHOP AREA CORNER FIXT. NEAR RACK AND DESK TO THE LEFT UPON ENTERING SHOP.	

Sal | Site | Zone | Tech | EXT | Comp | Set | Loc | Not | Oth

On-site ID FRJ

THE FIRST TANDEM WIRED I'VE SEEN. 2 BAL. IN ONE FIXT. NONE IN NEXT. BAL. FOR MIDDLE TUBE OF 3L SAME AS 2L TECH. SECONDARY ON 3L TECH. REVIEWED DL 9-26-95

Appendix D

FINAL PARTICIPANTS TELEPHONE SURVEY

```
&S1_____  &S2_____  QC: &QC__  Screen: &S_
Name: &NAME_____ DCOMP: &D_  LCOMP: &L_  TCOMP: &T_
Latest Interviewer: &LI  Interviewer 1: &I1  Date: &IDATE1_ Time 1: &TIM1
PG&E C/I L DIVCODE &DVC_ Interviewer 2: &I2  Date: &IDATE2_ Time 2: &TIM2
P696180  P CATI: &CN__   Interviewer 3: &I3  Date: &IDATE3_ Time 3: &TIM3
ACCNT #: &ACCOUNT_____   Interviewer 4: &I4  Date: &IDATE4_ Time 4: &TIM4
MEASTYP: &MEASTYP        Interviewer 5: &I5  Date: &IDATE5_ Time 5: &TIM5
Control: &CONTROL_____ Interviewer 6: &I6  Date: &IDATE6_ Time 6: &TIM6
Business Name &BUSINESS_____ BUS TYP: &BUSTYPE_____
Name: &NAME2_____          Business Phone: ( &HA ) &HP - &HL_
Address: &ADDRESS_____        Corr. Phone: ( &CA ) &CP - &CL_
City: &CITY_____ Zip: &ZIP____ Contact: &CONTACT_____
Callback Date: &CBD____  Callback Time: &CBT_____
Comment: &COMMENT1_____
         &COMMENT2_____
  Res1: &R1   Res2: &R2   Res3: &R3   Res4: &R4   Res5: &R5   Res6: &R6
1=Complete-CB OS 6=Refusal     11=Wrong #     16=T&T wrng adr 31=Comp ALL
2=Partial/Refusd 7=Answr Mach  12=Moved       17=Other        32=Multi-Site
3=Call Back      8=Busy Signal 13=Fax, Modem  18=Part Comp/CB 33=IND OS/CB S
4=No Answr       9=Not Elig    14=No Dir List ONSITE RESULTS:
5=On Vacation    10=Disconn #  15=T&T sc020   OS1: &O1  OS2: &O2  OS3: &O3

CONTACT INFO:
&CONIFO1_____
&CONIFO2_____
&CONIFO3_____
&CONIFO4_____
&CONIFO5_____
&CONIFO6_____
&CONIFO7_____
&CONIFO8_____
```

CONTACT INFO SCREEN:

ENTER PERSON ATTEMPTING TO CONTACT: &RESP

1 = Initial attempt to find contact
2 = Decision maker
3 = Technical
4 = Lighting
5 = Property Manager

PARTICIPATION CONTACT &DNAME_____
(&DAC___) &DPRE__ - &DLAST__ Ext. &DEXT_____
CALLBACK DATE &DCBD__ CALLBACK TIME &DCBT_____ Def: &DDEF_
FIRM: &DBUSNAM_____ (1=def callback 0=general)
&NOTED1_____
&NOTED2_____
&NOTED3_____
&NOTED4_____
&NOTED5_____

TECHNICAL CONTACT &TNAME_____
(&TAC__) &TPRE__ - &TLAST__ Ext. &TEXT_____
CALLBACK DATE &TCBD___ CALLBACK TIME &TCBT_____ Def &TDEF_
FIRM &TBUSNAM_____ (1=Def callback 0=general)
&NOTET1_____
&NOTET2_____
&NOTET3_____
&NOTET4_____
&NOTET5_____
ALWAYS ENTER 1 TO SKIP FORWARD ====> &SKIP

PROPERTY MANAGEMENT CONTACT &PMNAME_____
(&PMAC__) &PMPRE__ - &PMLAST__ Ext. &PMEXT_____
CALLBACK DATE &PMCBD_____ CALLBACK TIME &PMCBT_____ Def &PMDEF_
FIRM: &PMBUSNAM_____ (1=Def callback 0=general)
&NOTEPM1_____
&NOTEPM2_____
&NOTEPM3_____
&NOTEPM4_____
&NOTEPM5_____

LIGHTING CONTACT &LNAME_____
(&LAC__) &LPRE__ - &LLAST__ Ext. &LEXT_____
CALLBACK DATE &LCBD___ CALLBACK TIME &LCBT_____ Def &LDEF_
FIRM: &LBUSNAM_____ (1=Def callback 0=general)
&NOTEL1_____
&NOTEL2_____
&NOTEL3_____
&NOTEL4_____
&NOTEL5_____
ALWAYS ENTER 1 TO SKIP FORWARD ===> &SKIP

Hello. This is &LI__ . I'm with Quantum Consulting, a management consulting firm in Berkeley, California. We're assisting PG&E in evaluating its (Customized Incentives / Retrofit Express) Program. We'd like to ask some general questions about your firm's participation in the program.

MN001. Before we start, I would like to inform you that for quality control purposes, this call may be monitored by my supervisor. Would this be OK with you?

&MN001
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

DECISION MAKER: IF RESPOND = . OR D THEN ASK: RESPOND = &RESPOND
This survey will cover equipment installed at &ADDRESS_____ ?

SC001d. Do you own the building at &ADDRESS2_____ ?
&SC001D
1 = Yes 8 = (Refused)
0 = No --> SKIP FI002 9 = (Don't Know)

FI001d. Does your firm occupy the space at
&ADDRESS3_____ ?
&FI001D 1 = Yes --> SKIP FI003
0 = No --> SKIP SC016
8 = (Refused) --> SKIP FI003
9 = (Don't Know)--> SKIP FI003

FI002d. Does your firm manage the property at &ADDRESS4_____ ?
&FI002D 1 = Yes --> SKIP FI004
0 = No --> SKIP FI003
8 = (Refused) --> SKIP FI004
9 = (Don't Know) --> SKIP FI004

TECHNICAL: ASK WHERE RESPOND = T: RESPOND = &RESPOND
This survey will cover equipment installed at
&ADDRESS_____ .
SC001t. Do you own the building at &ADDRESS2_____ ?
&SC001T
1 = Yes 8 = (Refused)
0 = No --> SKIP FI002t 9 = (Don't Know)

FI001t. Does your firm occupy the space at
&ADDRESS3_____ ?
&FI001T 1 = Yes --> SKIP SC005
0 = No --> SKIP SC016
8 = (Refused) --> SKIP SC005
9 = (Don't Know)--> SKIP SC005

FI002t. Does your firm manage the property at &ADDRESS4_____ ?
&FI002T 1 = Yes --> SKIP FI003
0 = No --> SKIP SC005
8 = (Refused) --> SKIP SC005
9 = (Don't Know) --> SKIP SC005

LIGHTING: ASK WHERE RESPOND = L: RESPOND = &RESPOND
This survey will cover equipment installed at
&ADDRESS_____ .
SC001l. Do you own the building at &ADDRESS2_____ ?
&SC001L
1 = Yes 8 = (Refused)
0 = No --> SKIP FI002l 9 = (Don't Know)

FI001l. Does your firm occupy the space at
&ADDRESS3_____ ?
&FI001L 1 = Yes --> SKIP SC006
0 = No --> SKIP SC016
8 = (Refused) --> SKIP SC006
9 = (Don't Know)--> SKIP SC006

FI002l. Does your firm manage the property at &ADDRESS4_____ ?
&FI002L 1 = Yes -->SC006
0 = No
8 = (Refused)
9 = (Don't Know)

ASK ONCE:
SC016. Is there a property management firm for this building?
&SC016
1 = Yes
0 = No --> SKIP FI003/SC005/SC006
8 = (Refused) --> SKIP FI003/SC005/SC006
9 = (Don't Know) --> SKIP FI003/SC005/SC006

SC017.- Could you please give me the name and telephone
SC024. number of someone at the property management firm who would be able to answer questions about the building and electrical equipment at the premise?

PROPERTY CONTACT NAME: &PMNAME_____
PROPERTY CONTACT COMPANY: &PMBUSNAM_____
PROPERTY CONTACT PHONE: (&PMAC) &PMPRE - &PMLAST_ Extension: &PMEXT
PROPERTY CONTACT TITLE: &PMTITLN
1 = President/Owner
2 = Senior Manager
3 = Financial Manager
4 = Energy Manager
5 = Operations Manager
6 = Building Manager
7 = Other SPECIFY: &PMTILOTR_____

Comment1 &PMCOM1_____
Comment2 &PMCOM2_____
ENTER 1 TO SKIP FORWARD ====> &SKIP

FI003. Are you the sole occupant of the building?
&FI003 1 = Yes 8 = (Refused)
0 = No 9 = (Don't Know)

FI004. Is any part of &ADDRESS_____ leased space?
&FI004 1 = Yes 8 = (Refused)
0 = No 9 = (Don't Know)

SC003. This survey will cover the equipment installed at &ADDRESS2_____ . Are you the best person to talk to about &BUSINESS_____ 's decision to participate in the program and answer questions about economic decision making?
&SC003
1 = Yes-->SKIP TO SC005 8 = (Refused)
0 = No 9 = (Don't Know)

SC004. Who would be the best person to talk to about &BUSINESS_____ decision to participate in the program?

PARTICIPATION CONTACT NAME &DNAME_____
PARTICIPATION CONTACT PHONE (&DAC_) &DPRE____ - &DLAST_____ Ext. &DEXT_
PARTICIPATION ORGANIZATION NAME &DBUSNAM_____
PARTICIPATION CONTACT TITLE &DTITLN
1 = President/Owner
2 = Senior Manager
3 = Financial Manager
4 = Energy Manager
5 = Operations Manger
6 = Building Manger
7 = Other SPECIFY: &DTITLOTR_____
Comment1 &DCOMM1_____
Comment2 &DCOMM2_____
ENTER 1 TO SKIP ===> &SKIP

ASK SC005 IF SC016~=1:

SC005. Are you the best person to answer questions about the size of the facility, and the type size and age of your major electrical equipment?
&SC005
1 = Yes --> SKIP SC006
0 = No
8 = (Refused) --> SKIP SC006
9 = (Don't Know) --> SKIP SC006

SC007. Who would be the best person to talk to about
&BUSINESS_____ 's major electricity end uses?

LIGHT CONTACT NAME &LNAME_____
LIGHT CONTACT PHONE (&LAC_) &LPRE__ - &LLAST__ Ext. &LEXT_
LIGHT ORGANIZATION NAME &LBUSNAM_____
LIGHT CONTACT TITLE &LTITLF_____
IF NOT LIGHT CONT ENTER 1 AND GET NEW TECH CONTACT, ELSE IF LIGHT ENTER 2
===> &WHOTECH
TECHNICAL CONTACT NAME &TNAME_____
TECHNICAL CONTACT PHONE (&TAC_) &TPRE__ - &TLAST__ Ext. &TEXT_
TECHNICAL ORGANIZATION NAME &TBUSNAM_____
TECHNICAL CONTACT TITLE &TTITLN

1 = President/Owner
2 = Senior Manager
3 = Financial Manager
4 = Energy Manager
5 = Opertions Manager
6 = Building Manager
7 = Other SPECIFY:
&TTITLOTR_____

Comment1: &TCOMM1_____
Comment2: &TCOMM2_____
ENTER 1 TO SKIP FORWARD ==> &SKIP

ASK IF SC001~=1:
SC006. Are you the best person who can answer questions about the hours of lighting equipment operation at
&ADDRESS_____ ?
&SC006
1 = Yes --> SKIP SC010
0 = No --> SKIP SC008
8 = (Refused) --> SKIP SC010
9 = (Don't Know) --> SKIP SC010

SC008. Who would be the best person on site to talk to about
&BUSINESS_____ 's hours of lighting operation?

DECIS CONTACT NAME &DNAME_____
DECIS CONTACT PHONE (&DAC_) &DPRE_ - &DLAST___ Ext. &DEXT___
DECIS ORGANIZATION NAME &DBUSNAM_____
DECIS CONTACT TITLE &DTITLF_____

TECH CONTACT NAME &TNAME_____
TECH CONTACT PHONE (&TAC_) &TPRE_ - &TLAST___ Ext. &TEXT___
TECH ORGANIZATION NAME &TBUSNAM_____
TECH CONTACT TITLE &TTITLF_____

IF DECIS CONTACT ENTER 1, IF TECH CONTACT ENTER 2 ELSE ENTER 3 AND GET NEW INFO ===> &WHOLIT

ENTER NEW LIGHTING CONTACT INFORMATION:

HOURS CONTACT NAME &LNAME_____
HOURS CONTACT PHONE (&LAC_) &LPRE_ - &LLAST___ Ext. &LEXT___
HOURS ORGANIZATION NAME &LBUSNAM_____
HOURS CONTACT TITLE &LTITLN
1 = President/Ownwer
2 = Senior Manager
3 = FInancial Manager
4 = Energy Manager
5 = Operations Manager
6 = Building Manager
7 = Other SPECIFY: &LTITLOTR_____

Comment1: &LCOMM1_____
Comment2: &LCOMM2_____
ENTER 1 TO SKIP ===> &SKIP

I'd like to start by confirming some information in PG&E's program database.
SC010. Our records show that &BUSINESS_____
had high efficiency lighting installed at
&ADDRESS_____ through PG&E's
&PROG_____ Program. Is this correct?
&SC010
1 = Yes-->SKIP TO SC033/SC035 0 = No 2 = SPECIAL CASE 8 = (Ref) 9 = (DK)
(CONFIRM QUANTITIES AND MEASURES. IF RADICALLY DIFFERENT: CONFIRM ADDRESS)
QTY Measure
&SCQ1 &SCM1_____
&SCQ2 &SCM2_____
&SCQ3 &SCM3_____
&SCQ4 &SCM4_____
&SCQ5 &SCM5_____
&SCQ6 &SCM6_____
&SCQ7 &SCM7_____
&SCQ8 &SCM8_____
&SCQ9 &SCM9_____
&MULTAD ENTER 1 IF MULTIPLE ADDRESS; ELSE 0
&MULTIM ENTER 1 IF INSTALLED IN MULTIPLE TIME FRAMES; ELSE 0

SC020. Pacific Gas and Electric's (Customized Incentives/Retrofit Express) Program provides rebates to encourage customers to install energy-efficient lighting. Do you recall &BUSINESS_____ having lighting installed as part of PG&E's program?
&SC020
1 = Yes
0 = No--> THANK AND TERMINATE
8 = (Refused)-->THANK AND TERMINATE
9 = (Don't Know)-->THANK AND TERMINATE

SC031. What is the correct address for the facility where &BUSINES2_____ 's lighting retrofit occured?
&CORRADDR_____ Correct Address
&CORRCITY_____ Correct City
&CORRZIP_____ Correct Zip
T&T IF ADDRESS IS COMPLETELY DIFFERENT, OTHERWISE CONTINUE
&SC031 1 = SIMILAR ADDRESS -->SKIP TO SC035/SC037
0 = DIFFERENT ADDRESS ---> T&T

DECISION MAKER:
SC035. When was the installation of your retrofitted lighting equipment completed?
(ENTER MONYYYY)
&SC035__ (MONYYYY) IF NOT BETWEEN JUL1993 AND SEP1994 -> T&T
&SC036 (8 = Refused 9 = Don't Know) --> T&T

ALWAYS ENTER 1 TO SKIP FORWARD ====> &SKIP

TECHNICAL:
SC037. When was the installation of your retrofitted lighting equipment completed?
(ENTER MONYYYY)
&SC037__ (MONYYYY) IF NOT BETWEEN JUL1993 AND SEP1994 -> T&T
&SC038 (8 = Refused 9 = Don't Know) --> T&T

ALWAYS ENTER 1 TO SKIP FORWARD ====> &SKIP2

LIGHTING:
&SC039A__ (MONYYY)
&SC039B (8 = Refused 9 = DK)
ALWAYS ENTER 1 TO SKIP FORWARD ===> &SKIP3

ALL:
FI005. Does the PG&E account &ACCOUNT__ located at the service address &ADDRESS_____ cover multiple buildings or does it cover only one building?
&FI005
1 = One Building --> SKIP TO FI025
2 = Multiple Buildings
3 = Portion of a building
8 = (Refused)--> SKIP TO FI025
9 = (Don't Know)--> SKIP TO FI025

FI007. Are there multiple PG&E accounts for this address?
&FI007 1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

FI010. How many buildings are covered under this service address?

&FI010 # buildings 888 = (Refused)

IF FI010 = 1 or REF/DK SKIP FI025 999 = (Don't Know)

FI015. Are there separate PG&E bills for the individual buildings?

&FI015

1 = Yes 8 = (Refused)

0 = No 9 = (Don't Know)

FI025. How many other firms occupy space in the building?

&FI025 Number of firms 888 = (Refused)

999 = (Don't Know)

BC021. How many other locations of your business are participating in the program?

&BC021 Locations 888 = (Refused)

999 = (Don't Know)

ALL

EI010. Approximately how many people are currently employed at the facility, including both full- and part-time employees?

&EI010 Number of Employees

888 = (Refused)

999 = (Don't Know)

EI020. Since January 1992, has the number of people employed at this facility changed?

&EI020

1 = Yes

0 = No--->SKIP TO FI040

8 = (Refused)--->SKIP TO FI040

9 = (Don't Know)--->SKIP TO FI040

EI030. In what month and year did this change in the number of employees occur?

(ENTER MONTH/YEAR)

EI030. &EI030___ MONYYYY

EI031. &EI031__ YYYY (8 = Refused 9 = Don't Know)

IF DK ASK FOR BEST GUESS OR YEAR

EI040. Approximately how many people were employed at this facility before the change occurred, including both full and part-time employees?

&EI040 Number of Employees

777 = Seasonal Workforce --> ENTER COMMENTS BELOW

888 = (Refused)

999 = (Don't Know)

&EI041_____

&EI042_____

&EI043_____

ENTER 1 TO SKIP FORWARD --> &SKIP

FI040. Which of the following descriptions best characterizes your firm's organizational structure?

&FI040
1 = Chain or multifacility (owned or managed by a parent corporation operating other locations)
2 = Franchise (owns a branch or subsidiary) --> SKIP TO FI050
3 = Independent-->SKIP TO FI050
8 = (Refused) --> SKIP TO FI050
9 = (Don't Know) --> SKIP TO FI050

FI045. What is the name of your parent company?
&FI045_____

FI050. What is the legal tax status of your firm, that is what is your tax status for federal tax reporting purposes?
&FI050
1 = Proprietary or investor-owned, (i.e., a for-profit organization)
2 = Public: federal, state or municipal agency
3 = 501(c3): Private, nonprofit
8 = (Refused)
9 = (Don't Know)

ASK IF FI040=1; ELSE SKIP FI060:
FI055. What is the tax status of your parent company?
&FI055
1 = Proprietary or investor-owned, (i.e., a for-profit organization)
2 = Public: federal, state or municipal agency
3 = 501(c3): Private, nonprofit
8 = (Refused)
9 = (Don't Know)

DECISION MAKER:

FI060. Where are decisions regarding energy-related investments for &BUSINESS_____ made?
&FI060
1 = Made locally, on site
2 = Made at regional head office
3 = Made at national head office
4 = Made at international head office
5 = Made by PM firm/building owner
6 = Other FI062.
Specify: &FI062_____
8 = (Refused)
9 = (Don't Know)

FI070. What were the &REVTYPE_____ fiscal 1992 revenues for your firm?
&FI070

```
   &S1_  1 = Less than $50,000
   &S2_  2 = $50,000 to $99,999
   &S3_  3 = $100,000 to $249,999
   &S4_  4 = $250,000 to $499,999
   &S5_  5 = $500,000 to $999,999
   &S6_  6 = $1 million to $2.49 million
   &S7_  7 = $2.5 million to $4.99 million
   &S8_  8 = $5 million to $9.99 million
   &S9_  9 = $10 million to $49.99 million
 &S10_  10 = $50 million or more
        88 = (Refused)
        99 = (Don't Know)
RECORD LEVEL OF REVENUE:
FI075.    &FI075      1 = Local          3 = National
                      2 = Regional       4 = Worldwide
```

IF LEASE=1 THEN ASK; ELSE SKIP TO EI010: LEASE = &L

FI080. Do the tenants at &ADDRESS_____ pay all, none, or a portion of their electric utilities through their lease?
&FI080
1 = ALL utilities INCLUDED in lease --> SKIP TO FI110
2 = Pay some utilities through lease and others directly to PG&E
3 = Pays ALL utilities directly to PG&E--> SKIP FI110
8 = (Refused) --> SKIP FI110
9 = (Don't Know) --> SKIP FI110

IF (LEASE=1 AND FI080 = 2): LEASE = &L FI080 = &FI080

FI090. Which of the following utilities are paid for through the
-FI100. lease? (ENTER '1' FOR ALL THAT APPLY)
(8 = Refused 9 = Don't Know)

&FI090 Indoor Lighting	&FI095 Outdoor Lighting
&FI091 Heating	&FI096 Cooling
&FI092 Ventilation	&FI097 Water Heating
&FI093 Electricity to Wall Outlets	&FI098 Refrigeration
&FI094 Cooking	&FI099 Other SPECIFY:
	&FI100_____

FI110. What is the length of the current lease at &ADDRESS_____ ?
&FI110 Number of years 888 = (Refused)
999 = (Don't Know)

FI115. How many years are left on the lease?
&FI115 Number of years 888 = (Refused)
999 = (Don't Know)

FI120. Is this the current tenant's first lease at this address?
&FI120
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

Now I'd like to ask some questions about your experience with the Lighting Retrofit program.

IS001. Do you have a lighting contractor that you regularly use/rely on?
&IS001
1 = Yes
0 = No SKIP --> SKIP IS010
8 = (Refused) --> SKIP IS010
9 = (Don't Know) --> SKIP IS010

IS002. Did this person tell you about the Retrofit Lighting Program?
&IS002
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

IS010. How did you FIRST learn about the Retrofit Lighting Program?
&IS010 (DO NOT READ)
CUSTOMER APPROACHED SOMEONE:
1 = Respondent approached vendor/contractor
2 = Respondent approached PG&E concerning another matter and found out about program
SOMEONE APPROACHED THE CUSTOMER:
3 = Contacted by PG&E account rep
4 = Contacted by lighting contractor
5 = Contacted by electrical contractor
6 = PG&E Brochure in mail
7 = Bill Insert
8 = Word of mouth from friends or co-workers within the organization
9 = Word of mouth from friends or other business people outside of company
10 = Television, Radio, Newspaper ad
11 = Other SPECIFY: IS020. &IS020_____
88 = (Refused) 99 = (Don't Know)

PP010. Has your firm participated in any other PG&E sponsored energy conservation programs besides the Retrofit Lighting Program?
&PP010
1 = Yes
0 = No--->SKIP TO DS020
2 = Not aware of other programs--->SKIP TO DS020
8 = (Refused)--->SKIP TO DS020
9 = (Don't Know)--->SKIP TO DS020

PP020. In what year did you participate in the other program(s)?
(ENTER YEAR)
PP020. &PP020__ YYYY
(8 = Refused 9 = Don't Know)

Now I'd like to get your opinion of key aspects of the Retrofit Lighting Program.

DS020. Was the retrofit project delayed for any reasons, once you had decided to participate?
(DO NOT READ; ENTER 1 FOR ALL THAT APPLY; 0 FOR THOSE THAT DO NOT)
(8 = Refused 9 = Don't Know)
&DS019 No Delays ---> SKIP SR080
&DS020 Equipment supply problems
&DS021 Contractor delays
&DS022 Financial Limitations/Cash flow
&DS023 Delays within the organization
&DS024 Decided to spend money on something else
&DS025 Other SPECIFY: &DS026_____

SR080. If you had to make your equipment selection again, would you install the same equipment?
&SR080
1 = Yes --> SKIP EA010
0 = No
8 = (Refused)--> SKIP EA010
9 = (Don't Know)--> SKIP EA010

SR090. What would be your main reason for selecting other equipment?
&SR090
1 = Increase the quantity of light
2 = Improve the color rendition
3 = Reduce glare
4 = Eliminate ballast failure
5 = Other : SPECIFY : &SR091_____
8 = (Refused)
9 = (Don't Know)

EA010. Have you altered how energy is used at the facility since you installed the new lighting?
&EA010
1 = Yes
0 = No --> SKIP PD010
8 = (Refused) --> SKIP PD010
9 = (Don't Know) --> SKIP PD010

EA020. What are you doing differently?
(ENTER 1 FOR ALL THAT APPLY ELSE ENTER 0)
&EA020 Turning on fewer lights
&EA021 Running HVAC less
&EA022 Decreased lighting hours
&EA023 Other SPECIFY: &EA024_____
&EA025 Other SPECIFY: &EA026_____
&EA027 Other SPECIFY: &EA028_____
&EA029 Other SPECIFY: &EA030_____
(8 = Refused 9 = Don't Know)

PD010. When you were making your decision to purchase new lighting equipment through the program, what was the most important factor in your decision to install the new lighting?
(READ CATEGORIES IF NECESSARY)
&PD010
1 = Acquiring the latest technology
2 = Saving money on electric bills
3 = Obtaining a rebate
4 = Replacing old or broken equipment
5 = Knowing that the program was sponsored by PG&E
6 = Improving the quality of light for employees and customers
7 = Helping to protect the environment
8 = Previous experience with other PG&E programs
9 = Obtaining advice from another branch of your firm
10 = Obtaining advice from PG&E account rep
11 = Obtaining advice from contractors
12 = Other SPECIFY: PD011: &PD011_____
88 = (Refused)
99 = (Don't Know)

FR100. Why had you not previously installed high efficiency lighting equipment prior to participating in the program?
(DO NOT READ LIST; ENTER 1 FOR ALL THAT APPLY, ELSE ENTER 0)
FR100. &FR100 Lack of money to invest in it.
FR101. &FR101 Payback/return on investment not attractive enough.
FR102. &FR102 Concerned that it might not save as much as claimed
FR103. &FR103 Didn't know enough about EE lighting before
FR104. &FR104 Didn't know where/how to obtain EE lighting.
FR105. &FR105 Hadn't had time.
FR106. &FR106 Concerned about light quality/brightness
FR107. &FR107 Tenants didn't want a change
FR108. &FR108 Decision made elsewhere
FR109. &FR109 Was planning to install when heard about program
FR110. &FR110 No Need/Not a Priority
FR111. &FR111 Just remodeled
FR112. &FR112 Just moved in/moving out soon
FR113. &FR113 Did it less than 5 years ago.
FR114. &FR114 Other1 SPECIFY: FR115 &FR115_____
FR116. &FR116 (Refused)
FR117. &FR117 (Don't Know)

SR020. If you had not replaced this equipment under the program, how long would you have waited to replace it?
&SR020 Years
777 = (Would not have replaced)
888 = (Refused)
999 = (Don't Know)

FR010. How long had you been shopping for new lighting equipment before you found out about the program?
0 = (Not Shopping; approached by vendor/contractor)
&FR010 weeks (888 = Refused 999 = Don't Know)

FR011. How many estimates or quotes did you obtain before purchasing your new equipment?
&FR011 Estimates
888 = (Refused)
999 = (Don't Know)

FR012. Had you also considered purchasing and installing standard efficiency lighting equipment?
&FR012
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

FR013. How long did it take to decide what to purchase once you found out about the program?
&FR013 weeks (0 = less than 1 week)
(888 = Refused 999 = Don't Know)

NG019. Did you delay a lighting purchase in order to participate in the Retrofit Program?
&NG019
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

FR020. Before you knew about the Lighting Program, which of the following statements best describes your company's plans to install lighting fixtures? (READ RESPONSES.)
&FR020

1 = You hadn't even considered purchasing new lighting equipment.
2 = You were interested in installing lighting equipment, but hadn't yet decided on energy efficent lighting. (I.e. you were considering all your options.)
3 = You had already decided to install HIGH efficiency lighting, but probably not within the year.
4 = You had already decided to install HIGH efficiency lighting within the year, and you had already selected equipment.
8 = (Refused)
9 = (Don't Know)

FR014. How many people were involved in the decision to participate?
&FR014 People
888 = (Refused) 999 = (Don't Know)

FR015. Were you the person who made the final decision?
&FR015
1 = Yes --> SKIP FR017
0 = No
8 = (Refused)--> SKIP FR017
9 = (Don't Know)--> SKIP FR017

FR016. What is the job title of the person who made the final decision?
&FR016N
1 = President/Owner 2 = Senior Manager
3 = Financial Manager 4 = Energy Manager
5 = Operations Manager 6 = Building Manager
7 = Other SPECIFY: &FR016OTR_____

FR017. How long did it take to reach a decision to participate in the program?
&FR017 weeks
88 = Refused
99 = Don't Know

ASK IF LEASE=1 Lease= &L
FI065. How active a role do tenants take in making equipment purchase decisions for the property at
&ADDRESS_____ ?
&FI065
1 = Very active: they are involved in every aspect of the purchase and you possess veto power
2 = Somewhat active: they approve all decisions
3 = Slight role: they have a voice but it's a single vote among many
4 = None
8 = (Refused)
9 = (Don't Know)

DC010. Which of the following financial criteria do you consider when evaluating lighting investments?
(READ LIST; ENTER 1 FOR ALL THAT APPLY; ELSE ENTER 0)
(8 = (Refused) 9 = (Don't Know))
DC010. &DC010 Payback
DC011. &DC011 Internal Rate of Return
DC012. &DC012 Net Present Value
DC013. &DC013 Other SPECIFY: DC014. &DC014_____

IF DC010=1 THEN ASK DC020
DC020. What is the payback period you require?
&DC020
1 = 1 year or less
2 = 2 years or less
3 = 3 years or less
4 = 4 years or less
5 = 5 years or less
6 = 6 years or less
7 = 7 years or less
8 = 8 years or less
9 = 9 years or less
10 = 10 years or less
11 = Other SPECIFY: DC021. &DC021_____
88 = (Refused)
99 = (Don't Know)

IF DC011=1 THEN ASK DC030
DC030. What is your organization's required internal rate of return?

&DC030 Percent
888 = (Refused)
999 = (Don't Know)

IF DC012=1 THEN ASK DC040
DC040. What is the discount rate you use when determining the net present value of an investment?
&DC040 Percent
888 = (Refused)
999 = (Don't Know)

ASK ALL:
DC050. Do you use a different &CRITERIA_____ for evaluating energy efficient equipment purchases than you use for general investments?
&DC050
1 = Yes
0 = No --> SKIP TR030
8 = (Refused) --> SKIP TR030
9 = (Don't Know) --> SKIP TR030

ASK DC051 IF DC010=1 OR DC011=1 OR DC012=1, ELSE SKIP TR030
DC051. Is the &CRITERI2_____ you use for energy efficent purchases &TYPE1_____ or &TYPE2_____ than that which you use for other general investments?
&DC051
1 = Higher/Shorter
2 = Lower/Longer
8 = (Refused)
9 = (Don't Know)

PG&E is considering redesigning some aspects of the program. I'd like to get your opinion of some possible program options.

TR030. Would you have installed the same high efficiency &EQUIP_____ equipment if rebates were eliminated, but PG&E offered financing at 1 percentage point below the prime rate?
&TR030
1 = Yes--->SKIP TO TR070
0 = No
8 = (Refused)
9 = (Don't Know)

ASK IF TR030~=1
TR040. What if the interest rate were 1.5 percentage points below the prime rate?
&TR040
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)
TR050. What if rebates were reduced by 50% and PG&E offered financing at 1 percentage point below the prime rate?
&TR050
1 = Yes

0 = No
8 = (Refused)
9 = (Don't Know)

TR070. What if rebates were reduced by 50%, but PG&E conducted an on-site audit of the facility, and provided you with detailed engineering analyses and recommendations?
&TR070
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

FUTURE SERVICES:

PR020. Would you be interested in having PG&E operate or maintain the lighting equipment at the facility?
(i.e. routine replacement of burned out bulbs)
&PR020
1 = Yes
0 = No
2 = Depends on price
8 = (Refused)
9 = (Don't Know)

PR040. Would you be interested in having all of the building's systems checked out to ensure proper operation and efficient use of energy? (i.e. building recommissioning)
&PR040
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

PR060. Would you be interested in having PG&E help you with any future equipment selection?
&PR060
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

PR001. How frequently do you have contact with your PG&E account rep?
-PR002 (CODE NUMBER OF TIMES AND PERIOD IT IS IN)
&PR001 Times
&PR002 Time Period --> IF NOT 0 SKIP PR090
0 = Never
1 = Day
2 = Week
3 = Month
4 = Year
8 = (Refused)
9 = (Don't Know)

PR005. Does someone else in the firm have contact with your PG&E rep?
&PR005
1 = Yes
0 = No --> SKIP PR090

8 = (Refused)--> SKIP PR090
9 = (Don't Know)--> SKIP PR090

PR010-11. How often does this person have contact with your PG&E account rep?
&PR010 Times --> IF 0, 8, 9 SKIP PR090
&PR011 Time Period
0 = Never
1 = Day
2 = Week
3 = Month
4 = Year
8 = (Refused)
9 = (Don't Know)

PR015. What is the name, title, and phone number of this person?
NAME: &REPNAME_____
(&REPAC) &REPPRE - &REPLAST Ext &REPEXT Phone
TITLE: &REPTITN
1 = President/Owner
2 = Senior Manager
3 = Financial Manager
4 = Energy Manager
5 = Operations Manger
6 = Building Manger
7 = Other SPECIFY: &REPTIOTR_____
ENTER 1 TO SKIP ===> &SKIP

PR090. Are there any additional services you would like to see PG&E provide?
(ENTER 1 FOR ALL THAT APPLY)
(8 = Refused 9 = Don't Know)
&PR090 other SPECIFY: &PR091_____
&PR092 other SPECIFY: &PR093_____
&PR094 other SPECIFY: &PR095_____

ENTER 1 TO SKIP FORWARD ===> &SKIP

FUTURE PLANS:

FR070. Are you currently planning on making any further lighting retrofits within the next two years?
&FR070
1 = Yes
0 = No --> SKIP DS070
8 = (Refused)--> SKIP DS070
9 = (Don't Know)--> SKIP DS070

FR075. Will the new lighting be high or standard efficiency?
&FR075
1 = High efficiency
0 = Standard efficiency
8 = (Refused)
9 = (Don't Know)

FR077. Are you planning to make this change through one of PG&E's Retrofit programs?
&FR077
1 = Yes

0 = No
8 = (Refused)
9 = (Don't Know)

FR080. What type and how many fixtures are you planning to install?
(READ LIST IF NECESSARY; ENTER NUMBER OF FIXTURES TO BE CHANGED; IF NONE THEN ENTER 0)
888 = (Refused) 999 = (Don't Know)

(READ LIST IF NECESSARY; ENTER NUMBER OF FIXTURES TO BE ADDED)

FR080.	&FR080	4 Foot T8 fluorescent
FR081.	&FR081	8 Foot T8 fluorescent
FR082.	&FR082	4 Foot Energy saver fluorescent
FR083.	&FR083	8 Foot Energy saver fluorescent
FR084.	&FR084	4 Foot T12 fluorescent
FR085.	&FR085	8 Foot T12 fluorescent
FR086.	&FR086	Incandescent
FR087.	&FR087	Compact Fluorescent
FR088.	&FR088	High pressure sodium
FR089.	&FR089	Electronic Ballasts
FR090.	&FR090	Magnetic Ballasts
FR091.	&FR091	Metal Halide

CONTINUED ===> ENTER 1 TO SKIP ===> &SKIP

ENTER TYPE AND NUMBER OF FIXTURES PLANNING TO ADD:
IF NONE ENTER 0
888 = (Refused) 999 = (Don't Know)

FR092.	&FR092	Mercury Vapor
FR093.	&FR093	Quartz
FR094.	&FR094	Reflectors (w/Delamping)
FR095	&FR095	LED Exit Lighting
FR096	&FR096	Watt Saver/Power Choke Devices
FR097.	&FR097	Other SPECIFY: FR098. &FR098_____
FR099r.	&FR099R	(Refused)
FR099d.	&FR099D	(Don't Know)

ENTER 1 TO SKIP FORWARD ===> &SKIP

DS070. On a 1 to 7 scale, where 1 means Extremely DISsatisfied and 7 means Extremely Satisfied, how satisfied are you, overall, with PG&E's Lighting Program?
&DS070 (ENTER NUMBER BETWEEN 1 AND 7)
88 = (Refused)
99 = (Don't Know)

DS080. Are you DISsatisfied with the program for any reason?
&DS080
1 = Yes --> ATTEMPT TO CATEGORIZE; ELSE FILL IN OPEN ENDED
0 = No--->SKIP TO DS090

8 = (Refused)--->SKIP TO DS090
9 = (Don't Know)--->SKIP TO DS090

(DO NOT READ, ENTER 1 FOR ALL THAT APPLY; ELSE ENTER 0)
8 = (Refused) 9 = (Don't Know)
DS081 &DS081 problems with contractor
DS082 &DS082 rebate too small
DS083 &DS083 problems with equipment
DS084 &DS084 not seeing any bill savings
DS085 &DS085 unresolved problems
DS086 &DS086 problems with getting rebate in a timely manner
DS087 &DS087 problems with the contracting representative

DS088 &DS088_____
DS089 &DS089_____
IF NO COMMENT OR TO SKIP; ENTER 1 ===> &SKIP

DS090. Do you have any suggestions for improving PG&E's Retrofit Lighting Program?
&DS090
1 = Yes
0 = No--->SKIP TO BC011/BH010/SCREEN 137
8 = (Refused)--->SKIP TO BC011/BH010/SCREEN 137
9 = (Don't Know)--->SKIP TO BC011/BH010/SCREEN 137

(ENTER 1 FOR ALL THAT APPLY, 0 FOR THOSE THAT DO NOT; ELSE OPEN ENDED)
DS091 &DS091 Better/More Information
DS092 &DS092 Post-Installation Inspection
DS093 &DS093 Improve Quality of light
DS094 &DS094 Larger Rebates
DS095 &DS095 Smaller Rebates
DS096 &DS096 Change Qualifying Measures
DS097 &DS097 Closer Supervision of Contractors
DS100 &DS100_____
DS101 &DS101_____
DS102 &DS102_____
IF NO COMMENT, OR TO SKIP FORWARD, ENTER 1 ====> &SKIP

The following questions refer to your "FACILITY," which means ALL the buildings and tenants SERVICED BY PG&E UNDER THE FOLLOWING Billing Name: &BUSINESS_____ ADDRESS: &ADDRESS_____
ACCOUNT # : &ACCOUNT_____

BC011. What is the main business ACTIVITY at the facility?
&BC011

1	= Office	88	= (Refused)
2	= Retail (non-food)	99	= (Don't Know)
3	= Manufacturing/Assembly		
4	= Warehouse		
5	= Restaurant		
6	= Grocery Store		
7	= School		
8	= Hotel or Motel		
9	= Hospital		
10	= College/University		
11	= Health Care		
12	= Municipality		
13	= Industrial Process		
14	= Other SPECIFY: BC012 &BC012_____		

FC060. In what year was the facility built?
&FC060

1 = 1992-Pres	5 = 1979-1982	9 = 1950-1959	
2 = 1988-1991	6 = 1975-1978	10 = 1940-1949	
3 = 1986-1987	7 = 1970-1974	11 = 1930-1939	
4 = 1983-1985	8 = 1960-1969	12 = 1929 or earlier	

88 = (Refused)
99 = (Don't Know)

FC070. How many stories does the building have?
&FC070 Stories
88 = (Refused)
99 = (Don't Know)

FC080. What is the square footage per floor of the building at &ADDRESS_____ .
(exclude enclosed garage spaces, basements, stairwells, elevator shafts,etc)
&FC080 SQ FT
8 = (Refused)
9 = (Don't Know)

FC081. On each floor, what percentage of the space is conditioned?
&FC081 percent
888 = (Refused)
999 = (Don't Know)

FC095. Is the retrofitted area located in a conditioned space?
&FC095
1 = Yes
0 = No
2 = Split conditioned/non-conditioned
8 = (Refused)
9 = (Don't Know)

ASK FC100 IF FC095=2: ELSE SKIP FC110:

FC100. What percentage of the retrofitted area is in a conditioned space?
&FC100 percent 888 = (refused) 999 = (Don't Know)

FC110. Since January 1992, has the square footage covered by account # &ACCOUNT_____ increased, decreased, or stayed the same?
&FC110
1 = Increased floor space
2 = Decreased floor space
3 = Stayed the same-->SKIP TO FR034
8 = (Refused)-->SKIP TO FR034
9 = (Don't Know)-->SKIP TO FR034

FC120. What is the approximate area, in square feet, of this change?
&FC120 Square Feet
8 = (Refused)
9 = (Don't Know)

FC130. In what month and year did this change in floor space occur?
(ENTER MONTH/YEAR)
FC130. &FC130__ MONYYYY
FC131. &FC131 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

ASK IF FC110=1; ELSE.SKIP TO FR033

FC140. In what month and year was this additional floor space occupied?
(ENTER MONTH/YEAR)

FC140. &FC140__ MONYYYY
FC141. &FC141 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

ASK WHERE FC110 IS NOT 1:

FR033. When was your last major space remodel?
(ENTER MONTH/YEAR IF DON'T KNOW MONTH, ASK FOR BEST GUESS AND/OR YEAR)
FR033. &FR033__ MONYYYY
FR034. &FR034 YYYY
(7 = Never Remodeled 8 = Refused 9 = Don't Know)
(IF 7, 8, or 9 THEN --> SKIP LF030/IL001)

FR035. Did this remodel include space covered by the retrofit?
&FR035
1 = Yes --> SKIP LF030/IL001
0 = No --> SKIP LF030/IL001
8 = (Refused) --> SKIP LF030/IL001
9 = (Don't Know) --> SKIP LF030/IL001

LF030. How many weekdays per year are you closed for holidays?
&LF030 Days 888 = (Refused)
999 = (Don't Know)

LF040. How many Saturdays per year are you closed for holidays?
&LF040 Days 777 = Never open on Saturdays
888 = (Refused)
999 = (Don't Know)

LF050. How many Sundays per year are you closed for holidays?
&LF050 Days 777 = Never open on Sundays
888 = (Refused)
999 = (Don't Know)

Now, I'd like to ask about operating hours at &ADDRESS_____

BH010. Are the hours that you operate your lighting equipment different from the hours that you operate your facility?
&BH010
1 = Yes
0 = No--->SKIP TO LF001
8 = (Refused)--->SKIP TO LF001
9 = (Don't Know)--->SKIP TO LF001

BH015. Do you know the hours that you operate your lighting equipment at your facility?
&BH015
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

LF001-LF013. Could you please tell me the facility's &HOUR_____ hours during the following times, and what percentage of the facility's lights are on at these times?
66 = On 24 Hours 888 = (Refused)
77 = Never On 999 = (Don't Know)

	Month	Day	Code	Same As	From	AM/PM	To	AM/PM	% ON
LF001.	DECEMBER	WEEK	&LF1_	&E1_	&LF1F_	&LF1M_	&LF1T_	&LF1N_	&LW1_
LF002.	DECEMBER	SAT	&LF2_	&E2_	&LF2F_	&LF2M_	&LF2T_	&LF2N_	&LW2_
LF003.	DECEMBER	SUN	&LF3_	&E3_	&LF3F_	&LF3M_	&LF3T_	&LF3N_	&LW3_
LF004.	APRIL	WEEK	&LF4_	&E4_	&LF4F_	&LF4M_	&LF4T_	&LF4N_	&LW4_
LF005.	APRIL	SAT	&LF5_	&E5_	&LF5F_	&LF5M_	&LF5T_	&LF5N_	&LW5_
LF006.	APRIL	SUN	&LF6_	&E6_	&LF6F_	&LF6M_	&LF6T_	&LF6N_	&LW6_
LF007.	AUGUST	WEEK	&LF7_	&E7_	&LF7F_	&LF7M_	&LF7T_	&LF7N_	&LW7_
LF008.	AUGUST	SAT	&LF8_	&E8_	&LF8F_	&LF8M_	&LF8T_	&LF8N_	&LW8_
LF009.	AUGUST	SUN	&LF9_	&E9_	&LF9F_	&LF9M_	&LF9T_	&LF9N_	&LW9_
LF010.	OCTOBER	WEEK	&LF10	&E10	&LF10F	&LF10M	&LF10T	&LF10N	&LW10
LF011.	OCTOBER	SAT	&LF11	&E11	&LF11F	&LF11M	&LF11T	&LF11N	&LW11
LF012.	OCTOBER	SUN	&LF12	&E12	&LF12F	&LF12M	&LF12T	&LF12N	&LW12
LF013.	HOLIDAY	ALL	&LF13	&E13	&LF13F	&LF13M	&LF13T	&LF13N	&LW13

The next questions refer to the facility's conditioned floor space. That is, the areas of the facility that are heated or cooled.

LF014. Excluding exit signs, what percent of the retrofitted lights are night lights or safety lights that remain on twenty-four hours per day?

&LF014 Percent

888 = (Refused)
999 = (Don't Know)

LF025. Again excluding exit lights, but considering night lights, saftey lights, lighting used by custodial staff, and general lighting, what percentage of the facility's indoor lights are on during NON-operating hours?

&LF025 Percent

888 = (Refused)
999 = (Don't Know)

LF017. What percent of the retrofitted lights are on during the following SUMMER WEEKDAY hours?

888 = (Refused) 999 = (Don't Know)

12	AM	&LF017X	Percent				
1	AM	&LF017A	Percent	12	PM	&LF017L	Percent
2	AM	&LF017B	Percent	1	PM	&LF017M	Percent
3	AM	&LF017C	Percent	2	PM	&LF017N	Percent
4	AM	&LF017D	Percent	3	PM	&LF017O	Percent
5	AM	&LF017E	Percent	4	PM	&LF017P	Percent
6	AM	&LF017F	Percent	5	PM	&LF017Q	Percent
7	AM	&LF017G	Percent	6	PM	&LF017R	Percent
8	AM	&LF017H	Percent	7	PM	&LF017S	Percent
9	AM	&LF017I	Percent	8	PM	&LF017T	Percent
10	AM	&LF017J	Percent	9	PM	&LF017U	Percent
11	AM	&LF017K	Percent	10	PM	&LF017V	Percent
				11	PM	&LF017W	Percent

ENTER 1 TO MOVE FORWARD ===> &SKIP

LF018. Do you follow the same schedule in the WINTER?

&LF18

1 = Yes --> SKIP IL001/SCREEN 137
0 = No
8 = (Refused)--> SKIP IL001/SCREEN 137
9 = (Don't Know)--> SKIP IL001/SCREEN 137

LF020. What percent of the retrofitted lights are on during the following WINTER WEEKDAY hours?
888 = (Refused) 999 = (Don't Know)

12	AM	&LF020X	Percent				
1	AM	&LF020A	Percent	12	PM	&LF020L	Percent
2	AM	&LF020B	Percent	1	PM	&LF020M	Percent
3	AM	&LF020C	Percent	2	PM	&LF020N	Percent
4	AM	&LF020D	Percent	3	PM	&LF020O	Percent
5	AM	&LF020E	Percent	4	PM	&LF020P	Percent
6	AM	&LF020F	Percent	5	PM	&LF020Q	Percent
7	AM	&LF020G	Percent	6	PM	&LF020R	Percent
8	AM	&LF020H	Percent	7	PM	&LF020S	Percent
9	AM	&LF020I	Percent	8	PM	&LF020T	Percent
10	AM	&LF020J	Percent	9	PM	&LF020U	Percent
11	AM	&LF020K	Percent	10	PM	&LF020V	Percent
				11	PM	&LF020W	Percent

ENTER 1 TO MOVE FORWARD TO IL001/SCREEN 137 ===> &SKIP

Now, I'd like to ask about the type of lighting equipment at your facility before and after participating in the program.

IL001. What percentage of your facility lighting equipment was replaced through the program?
&IL001 888 = (Refused)
999 = (Don't Know)

IL005. Of the bulbs that were replaced through the program, what percent were burned out or not working before the retrofit?
&IL005 Percent
888 = (Refused)
999 = (Don't Know)

SR010. What was the average age of the lighting fixtures you replaced?
&SR010 Years
888 = (Refused)
999 = (Don't Know)

IL010. Since January 1992, have you made any changes in indoor lighting at your facility other than changes through the program or routine replacement of burned out bulbs?
&IL010
1 = Yes
0 = No--->SKIP TO LP010/DS030
8 = (Refused)--->SKIP TO LP010/DS030
9 = (Don't Know)--->SKIP TO LP010/DS030

```
     IL020.  In what months and years did you make these
             changes?
             (ENTER MONTH/YEAR)
     IL020. &IL020__   MONYYYY
     IL021. &IL021     YYYY (8 = Refused 9 = Don't Know)
            (SECOND MONTH AND YEAR IF APPLICABLE)
             (ENTER MONTH/YEAR)
     IL025. &IL025__   MONYYYY
     IL026. &IL026     YYYY (8 = Refused 9 = Don't Know)
     IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR
ENTER 1 TO SKIP FORWARD ===> &SKIP


     IL040.  What type and how many fixtures were affected?
     (READ LIST IF NECESSARY; ENTER NUMBER OF FIXTURES ADDED OR REMOVED,
      IF NONE THEN 0)
       888 = (Refused)  999 = (Don't Know)
          (0 = NO CHNG)
          (1 = ADDED)     NUMBER
          (2 = REMOVED)
     IL040.    &IL040      &IL040N     4 Foot T8 fluorescent
     IL041.    &IL041      &IL041N     8 Foot T8 fluorescent
     IL042.    &IL042      &IL042N     4 Foot Energy saver fluorescent
     IL043.    &IL043      &IL043N     8 Foot Energy saver fluorescent
     IL044.    &IL044      &IL044N     4 Foot T12 fluorescent
     IL045.    &IL045      &IL045N     8 Foot T12 fluorescent
     IL046.    &IL046      &IL046N     Incandescent
     IL047.    &IL047      &IL047N     Compact Fluorescent
     IL048.    &IL048      &IL048N     High pressure sodium
     IL049.    &IL049      &IL049N     Metal Halide

 CONTINUED, ENTER 1 TO MOVE FORWARD ===> &SKIP


 ENTER TYPE AND NUMBER OF FIXTURES AFFECTED, IF NONE THEN 0
 888 = (Refused)   999 = (Don't Know)
        0 = No Chng
        1 = Added    NUMBER
        2 = Removed
 IL050.    &IL050      &IL050N     Mercury Vapor
 IL051.    &IL051      &IL051N     Quartz
 IL052.    &IL052      &IL052N     Reflectors (w/Delamping)
 IL053.    &IL053      &IL053N     Electronic  Ballasts
 IL054.    &IL054      &IL054N     Magnetic  Ballasts
 IL055     &IL055      &IL055N     LED Exit Lighting
 IL056     &IL056      &IL056N     Watt Saver/Power Choke Devices
 IL057.    &IL057      &IL057N     Other  SPECIFY: IL058 &IL058_____


ENTER 1 TO SKIP FORWARD ===> &SKIP
GOTO DS030/LP010
```

ASK WHERE BALLASTS=1: &BALLAST ELSE ASK LP010

DS030. After completing the lighting retrofit, did you experience any problems with the new ballasts?
&DS030
1 = Yes
0 = No --> SKIP LP010
8 = (Refused) --> SKIP LP010
9 = (Don't Know) --> SKIP LP010

DS045. How were your equipment problems finally resolved?
&DS045
1 = Equipment was replaced by the contractor
2 = Equipment was replaced by the customer
3 = Problem still exists.
4 = Other SPECIFY: DS046: &DS046_____
8 = (Refused)
9 = (Don't Know)

LP010. Has any of the lighting equipment that was installed as part of the lighting program been removed?
&LP010
1 = Yes
0 = No--->SKIP TO SR050
8 = (Refused)--->SKIP TO SR050
9 = (Don't Know)--->SKIP TO SR050

LP020. In what months and years did you make these changes?
(ENTER MONTH/YEAR)
LP020. &LP020__ MONYYYY
LP021. &LP021 YYYY (8 = Refused 9 = Don't Know)
(SECOND MONTH AND YEAR)
(ENTER MONTH/YEAR)
LP025. &LP025__ MONYYYY
LP026. &LP026 YYYY (8 = Refused 9 = Don't Know)

ENTER 1 TO SKIP FORWARD ===> &SKIP

LP030. What type and how many fixtures were removed?
(READ LIST IF NECESSARY; ENTER NUMBER OF FIXTURES REMOVED, IF NONE THEN 0)
888 = (Refused) 999 = (Don't Know)

	NUMBER	
LP030.	&LP030	4 Foot T8 fluorescent
LP031.	&LP031	8 Foot T8 fluorescent
LP032.	&LP032	4 Foot Energy saver fluorescent
LP033.	&LP033	8 Foot Energy saver fluorescent
LP034.	&LP034	4 Foot T12 fluorescent
LP035.	&LP035	8 Foot T12 fluorescent
LP036.	&LP036	Incandescent
LP037.	&LP037	Compact Fluorescent
LP038.	&LP038	High pressure sodium
LP039.	&LP039	Metal Halide

CONTINUED, ENTER 1 TO SKIP FORWARD ===> &SKIP

ENTER NUMBER OF FIXTURES REMOVED, IF NONE THEN 0
888 = (Refused) 999 = (Don't Know)

	NUMBER	
LP040.	&LP040	Mercury Vapor
LP041.	&LP041	Quartz
LP042.	&LP042	Reflectors (w/Delamping)
LP043.	&LP043	Electronic Ballasts
LP044.	&LP044	Magnetic Ballasts
LP045	&LP045	LED Exit Lighting
LP046	&LP046	Watt Saver/Power Choke Devices
LP047.	&LP047	Other SPECIFY: LP048 &LP048_____

ENTER 1 TO SKIP FORWARD ===> &SKIP

LP050. Why did you remove the equipment?
(DO NOT READ LIST; ENTER 1 FOR ALL THAT APPLY,ELSE ENTER 0)
LP050. &LP050 Did not like light quality.
LP051. &LP051 Not enough light.
LP052. &LP052 Equipment not reliable.
LP053. &LP053 Harmonics problems.
LP054. &LP054 Ballasts Failed
LP055. &LP055 Other SPECIFY: LP056 &LP056_____
LP057. &LP057 (Refused)
LP058. &LP058 (Don't Know)

LP060. Did you replace the lighting equipment that you removed?
&LP060
1 = Yes
0 = No--->SKIP TO SR050
8 = (Refused)--->SKIP TO SR050
9 = (Don't Know)--->SKIP TO SR050

LP070. What type and how many fixtures replaced the equipment that was removed? 888 = (Refused) 999 = (Don't Know)
(READ LIST IF NECESSARY; ENTER NUMBER OF FIXTURES ADDED)
LP070. &LP070 4 Foot T8 fluorescent
LP071. &LP071 8 Foot T8 fluorescent
LP072. &LP072 4 Foot Energy saver fluorescent
LP073. &LP073 8 Foot Energy saver fluorescent
LP074. &LP074 4 Foot T12 fluorescent
LP075. &LP075 8 Foot T12 fluorescent
LP076. &LP076 Incandescent
LP077. &LP077 Compact Fluorescent
LP078. &LP078 High pressure sodium
LP079. &LP079 Electronic Ballasts
LP080. &LP080 Magnetic Ballasts
LP081. &LP081 Metal Halide

CONTINUED, ENTER 1 TO SKIP FORWARD ==> &SKIP

ENTER TYPE AND NUMBER OF FIXTURE WHICH REPLACED THOSE REMOVED
0 = NONE OF THAT TYPE
888 = (Refused) 999 = (Don't Know)

LP082. &LP082 Mercury Vapor
LP083. &LP083 Quartz
LP084. &LP084 Reflectors (W/ Delamping)
LP085 &LP085 LED Exit Lighting
LP086 &LP086 Watt Saver/Power Choke Devices
LP087. &LP087 Other SPECIFY: LP088. &LP088_____

ENTER 1 TO SKIP FORWARD ===> &SKIP

SR050. Compared to the old lighting equipment, would you say the amount of light has increased, decreased, or remained the same?
&SR050
1 = Increased --->SKIP TO SR070
2 = Decreased
3 = Same --->SKIP TO SR070
8 = (Refused)--->SKIP TO SR070
9 = (Don't Know)--->SKIP TO SR070

IF SR050 = 2 ASK:
SR060. Are you turning on more lights to compensate?
&SR060
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

SR070. Compared to the old lighting equipment, would you say the color rendition is better, worse, or the same?
&SR070
1 = Better
2 = Worse
3 = Same
8 = (Refused)
9 = (Don't Know)

SR075. Compared to the old lighting equipment, would you say the new lighting gives off less, more or the same amount of glare?
&SR075
1 = Less
2 = More
3 = Same
8 = (Refused)
9 = (Don't Know)

OL010. Is OUTDOOR lighting included on the facility's utility bill?
&OL010
1 = Yes
0 = No--->SKIP TO CE010
8 = (Refused)--->SKIP TO CE010
9 = (Don't Know)--->SKIP TO CE010

OL020. Since January 1992, have you made any changes in OUTDOOR lighting at your facility?
&OL020
1 = Yes
0 = No--->SKIP TO CE010
8 = (Refused)--->SKIP TO CE010
9 = (Don't Know)--->SKIP TO CE010

OL030. In what month and year did you make these changes?
(ENTER MONTH/YEAR)
OL030 &OL030__ MONYYYY
&OL031 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

OL040. Did you ADD TO, REPLACE, or REMOVE outdoor lighting?
&OL040
1 = Added lighting
2 = Replaced lighting
3 = Added AND Replaced lighting
4 = Removed
8 = (Refused)
9 = (Don't Know)

COOLING EQUIPMENT:

The next series of questions pertain to the cooling equipment at the facility.

CE010. What type of system is used to air condition this facility?
[If there is more than one system, enter the one used to cool the largest portion of this facility.]
&CE010
0 = No A/C--->SKIP TO CE080
1 = Central plant
2 = Small Packaged Systems (i.e. Rooftop or Ground)
3 = Wall or window units
4 = Heat pump
5 = Other SPECIFY: CE011 &CE011_____
8 = (Refused)
9 = (Don't Know)

CE015. What is the primary fuel used to cool your facility?
&CE015
1 = Electricity
2 = Natural Gas
3 = Other SPECIFY: CE016. &CE016_____
8 = (Refused)
9 = (Don't Know)

CE030. Does this system include an economizer?
&CE030
1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

CE050. What percent of the facility is air conditioned at 4PM on Summer weekdays?
(ASK OPEN ENDED, THEN PROBE WITH CATEGORIES)

&CE050 Percent

100=100%	222=60-79%	444=20-39%	0=0%	888 = (Refused)
111=80-99%	333=40-59%	555=1-19%		999 = (Don't Know)

CE060. During what months is the cooling system operated?
(READ LIST IF NECESSARY; ENTER NUMBER 1 FOR ALL THAT APPLY)

CE059. &CE059 All Year --> SKIP CE080
CE060. &CE060 January
CE061. &CE061 February
CE062. &CE062 March
CE063. &CE063 April
CE064. &CE064 May
CE065. &CE065 June
CE066. &CE066 July
CE067. &CE067 August
CE068. &CE068 September
CE069. &CE069 October
CE070. &CE070 November
CE071. &CE071 December
CE072. &CE072 (Refused)
CE073. &CE073 (Don't Know)

TO SKIP FORWARD ENTER 1: ===> &SKIP

CE080. Since January 1992, have you ADDED TO, REMOVED, or REPLACED an older cooling system?
&CE080
0 = No Change-->SKIP TO HE015
1 = Added
2 = Replaced
3 = Added and Replaced
4 = Removed
8 = (Refused)-->SKIP TO HE015
9 = (Don't Know)-->SKIP TO HE015

CE090. In what month and year did you make these changes?
(ENTER MONTH/YEAR)

CE090. &CE090__ MONYYYY
CE091. &CE091 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

IF CE080=1 THEN SKIP TO CE120; ELSE ASK:

CE110. What fuel was used to power the old system?
&CE110
1 = Electricity
2 = Natural Gas
3 = Other SPECIFY: CE111. &CE111_____
8 = (Refused)
9 = (Don't Know)

IF CE080=2 or 4 THEN SKIP TO HE015

CE120. What fuel does the cooling system addition use?
&CE120
1 = Electricity
2 = Natural Gas
3 = Other SPECIFY: CE121. &CE121_____
8 = (Refused)
9 = (Don't Know)

HEATING EQUIPMENT

HE015. What is the main type of heating system used to heat your facility?

&HE015

1 = Central electric furnace
2 = Central heat pump
3 = Central gas furnace
4 = Gas boiler
5 = Electric boiler
6 = Fuel oil furnace or boiler
7 = Electric strip heat
8 = Baseboard electric heating
9 = Room or wall AC with electric strip heat
10 = Permanent, non-electric room heaters
11 = Whole-house wall or floor electric furnace
12 = Whole-house wall or floor gas furnace
13 = Portable electric heater
14 = Portable kerosene heater
15 = Wood or coal burning stove or fireplace
16 = Solar collector
17 = Propane heating system
18 = Other HE016. &HE016_____
19 = None
88 = (Refused)
99 = (Don't Know)

HE020. What is the primary fuel used to heat your facility?
&HE020
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: HE021 &HE021_____
8 = (Refused)
9 = (Don't Know)

HE050. What percent of your facility is heated at 8AM on WINTER weekdays?
(ASK OPEN ENDED, THEN PROBE WITH CATEGORIES)

&HE050 Percent

100=100%
111=80-99%
222=60-79%
333=40-59%
444=20-39%
555=1-19%
0=0%
888 = (Refused)
999 = (Don't Know)

HE060. During what months is the heating system operated?
(READ LIST IF NECESSARY; ENTER NUMBER 1 FOR ALL THAT APPLY)
HE059. &HE059 All Year ---> SKIP HE080
HE060. &HE060 January
HE061. &HE061 February
HE062. &HE062 March
HE063. &HE063 April
HE064. &HE064 May
HE065. &HE065 June
HE066. &HE066 July
HE067. &HE067 August
HE068. &HE068 September
HE069. &HE069 October
HE070. &HE070 November
HE071. &HE071 December
HE072. &HE072 (Refused)
HE073. &HE073 (Don't Know)
TO SKIP FORWARD ENTER 1: ==> &SKIP

HE080. Since January 1992, have you ADDED TO, REPLACED, OR REMOVED an older heating system?
&HE080
0 = No Change-->SKIP TO OE010
1 = Added
2 = Replaced
3 = Added and Replaced
4 = Removed
8 = (Refused)-->SKIP TO OE010
9 = (Don't Know)-->SKIP TO OE010

HE090. In what month and year did you make these changes?
(ENTER MONTH/YEAR)
HE090. &HE090__ MONYYYY
HE091. &HE091 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

IF HE080=1 THEN SKIP TO HE120, ELSE ASK:

HE110. What fuel was used to power the old system?
&HE110
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Steam
5 = Electricity
6 = Other SPECIFY: HE111. &HE111_____
8 = (Refused)
9 = (Don't Know)

IF HE080=2 OR 4 THEN SKIP TO OE010

HE120. What fuel does the heating system addition use?
&HE120
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: HE121. &HE121_____
8 = (Refused)
9 = (Don't Know)

OTHER EQUIPMENT:

OE010. Since January 1992, have you changed other equipment that makes up 10% or more of the facility's annual electric bill?
&OE010
1 = Yes
0 = No-->SKIP TO OC010
8 = (Refused)-->SKIP TO OC010
9 = (Don't Know)-->SKIP TO OC010

OE011. Which of the following types of equipment were changed?
(READ FIRST THREE THEN ASK FOR OTHER)
(READ LIST; ENTER 1 FOR ALL THAT APPLY)
OE012. &OE012 Water heating
OE013. &OE013 Cooking
OE014. &OE014 Refrigeration
Were there any other end uses changed? (RECORD BELOW)
OE015. &OE015 Other1 SPECIFY: OE016. &OE016_____
OE017. &OE017 Other2 SPECIFY: OE018. &OE018_____
OE019. &OE019 (Refused) ---> SKIP to OC010
OE011. &OE011 (Don't Know) ---> SKIP TO OC010

ASK OE020-OE050 IF OE012=1
OE020. In what month and year did you change your water heating equipment?
(ENTER MONTH/YEAR)
OE020. &OE020__ MONYYYY
OE021. &OE021 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

OE030. Did you ADD TO, REMOVE, or REPLACE water heating equipment?
&OE030
1 = Added--->SKIP TO OE050
2 = Replaced
3 = Added and Replaced
4 = Removed
8 = (Refused)--->SKIP TO OE060/OE100/OE140/OE180/OC010
9 = (Don't Know)--->SKIP TO OE060/OE100/OE140/OE180/OC010

OE040. What fuel was used to power the old water heating equipment?
&OE040
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE041. &OE041_____
8 = (Refused)
9 = (Don't Know)

IF OE030= 4 THEN SKIP TO OE060/OE100/OE140/OE180/OC010

OE050. What fuel does the water heating equipment addition use?
&OE050
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE051. &OE051_____
8 = (Refused)
9 = (Don't Know)

ASK OE060-OE090 IF OE013=1

OE060. In what month and year did you change your cooking equipment?
(ENTER MONYYYY)
OE060. &OE060__ MONYYYY
OE061. &OE061 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

OE070. Did you ADD TO, REMOVE, or REPLACE cooking equipment?
&OE070
1 = Added--->SKIP TO OE090
2 = Replaced
3 = Added and Replaced
4 = Removed
8 = (Refused)--->SKIP TO OE100/OE140/OE180/OC010
9 = (Don't Know)--->SKIP TO OE100/OE140/OE180/OC010

OE080. What fuel was used to power the old cooking equipment?
&OE080
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE081. &OE081_____
8 = (Refused)
9 = (Don't Know)

IF OE070= 4 THEN SKIP TO OE100/OE140/OE180/OC010

OE090. What fuel does the cooking equipment addition use?
&OE090
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE091. &OE091_____
8 = (Refused)
9 = (Don't Know)

ASK OE100-OE130 IF OE014=1
OE100. In what month and year did you change your refrigeration equipment?
(ENTER MONTH/YEAR)

OE100. &OE100__ MONYYYY
OE101. &OE101 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

OE110. Did you ADD TO, REMOVE, or REPLACE refrigeration equipment?
&OE110
1 = Added--->SKIP TO OE130
2 = Replaced
3 = Added and Replaced
4 = Removed
8 = (Refused)--->SKIP TO OE140/OE180/OC010
9 = (Don't Know)--->SKIP TO OE140/OE180/OC010

OE120. What fuel was used to power the old refrigeration equipment?
&OE120
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE121. &OE121_____
8 = (Refused)
9 = (Don't Know)

IF OE110=2 OR 4 THEN SKIP TO OE140/OE180/OC010

OE130. What fuel does the refrigeration equipment addition use?
&OE130
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE131. &OE131_____
8 = (Refused)
9 = (Don't Know)

ASK OE140-OE170 IF OE015=1

OE140. In what month and year did you change your &EQUIP_____
(ENTER MONTH/YEAR)

OE140. &OE140__ MONYYYY
OE141. &OE141 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

OE150. Did you ADD TO, REMOVE, or REPLACE &EQUIP2_____
equipment?
&OE150
1 = Added--->SKIP TO OE170
2 = Replaced
3 = Added and Replaced
4 = Removed
8 = (Refused)--->SKIP TO OE180/OC010
9 = (Don't Know)--->SKIP TO OE180/OC010

OE160. What fuel was used to,power the old &EQUIP_____
equipment?
&OE160
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE161. &OE161_____
8 = (Refused)
9 = (Don't Know)

IF OE150=2 OR 4 THEN SKIP TO OE180/OC010

OE170. What fuel does the &EQUIP_____ equipment
addition use?
&OE170
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE171. &OE171_____
8 = (Refused)
9 = (Don't Know)

ASK OE180-OE210 IF OE017=1

OE180. In what month and year did you change your
&EQUIP_____ equipment?
(ENTER MONTH/YEAR)
OE180. &OE180__ MONYYYY
OE181. &OE181 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

OE190. Did you ADD TO, REMOVE, or REPLACE &EQUIP2_____ equipment?
&OE190
1 = Added--->SKIP TO OE202
2 = Replaced
3 = Added and Replaced
4 = Removed
8 = (Refused)--->SKIP TO OC010
9 = (Don't Know)--->SKIP TO OC010

OE200. What fuel was used to power the old &EQUIP_____ equipment?
&OE200
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE201. &OE201_____
8 = (Refused)
9 = (Don't Know)

IF OE190=2 OR 4 THEN SKIP TO OC010

OE202. What fuel does the &EQUIP_____ equipment addition use?
&OE202
1 = Natural Gas
2 = Propane or Bottled Gas
3 = Oil
4 = Electricity
5 = Other SPECIFY: OE203. &OE203_____
8 = (Refused)
9 = (Don't Know)

OC010. Since January 1992, have you made any other changes that would affect energy usage at this facility?
&OC010
1 = Yes
0 = No--->SKIP TO EM010
8 = (Refused)--->SKIP TO EM010
9 = (Don't Know)---> SKIP TO EM010

OC020. What type of changes were made?
&OC020_____
&OC021_____

OC030. In what month and year were these changes made?
(ENTER MONTH/YEAR)
OC030. &OC030__ MONYYYY
OC031. &OC031 YYYY (8 = Refused 9 = Don't Know)
IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

EM010. Do you have an in-house Energy Management System at this facility?
&EM010
1 = Yes
0 = No-->SKIP TO CP010
8 = (Refused)-->SKIP TO CP010
9 = (Don't Know)-->SKIP TO CP010

EM020. In what month and year was the Energy Management System installed?
(ENTER MONTH/YEAR)
EM020. &EM020__ MONYYYY
EM021. &EM021 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

CP010. Do you have a cogeneration plant at this facility?
&CP010
1 = Yes
0 = No --> SKIP
8 = (Refused) --> SKIP
9 = (Don't Know) --> SKIP

CP020. In what month and year did the cogeneration plant begin operating?
(ENTER MONTH/YEAR)

CP020. &CP020__ MONYYYY
CP021. &CP021 YYYY (8 = Refused 9 = Don't Know)

IF DOESN'T KNOW, ASK FOR BEST GUESS AND/OR YEAR

Those are all of the questions I have for you at this time. Before you go I'd like to get your job title.
USE JOB KEY TO CODE ALL:
1 = President/Owner 2 = Senior Manager
3 = Financial Manager 4 = Energy Manager
5 = Operations Manager 6 = Building Manager
7 = Other SPECIFY

DECISION TITLE CF009. Job Title: &DTITLN
SPECIFY: &DTITLOTR_____
TECHNICAL TITLE CF010. Job Title: &TTITLN
SPECIFY: &TTITLOTR_____
LIGHTING TITLE CF011. Job Title &LTITLN
SPECIFY: &LTITLOTR_____
==> &DIV_COD2 <== ==> &SERVCITY <== ==> &OSFLAG <== 1 = OK OS
0 = NO OS
TO SKIP TO ON-SITE RECRUITMENT ENTER 1: MEASTYP: &MEASTYP
TO SKIP TO COMMENT FIELDS ENTER 2: BUSTYP: &BUSTYP
TO SKIP FORWARD ENTER 1 OR 2 HERE ==> &SKIP

DE1. Do you have any additional comments at this time?
&DE1 1 = Yes 0 = No 8 = (Refused) 9 = (Don't Know)
&DECOMM1_____
&DECOMM2_____

&DECOMM3_____

IF THERE ARE ANY COMMENTS ABOUT THE ANSWERS WITHIN THIS SURVEY
ENTER 1 HERE, THEN ENTER YOUR COMMENTS==> &COMM

&NOTE1_____

&NOTE2_____

&NOTE3_____

&NOTE4_____

&NOTE5_____

&NOTE6_____

IF THE RESPONDENT ASK FOR PG&E REP'S PHONE # ENTER 1, AND THEN REASON &REP

&NOTREP1_____

&NOTREP2_____

Those are all the questions I have for today. On behalf of Pacific Gas and Electric, thank you very much for your time and cooperation.

F4 TO FIRST SCREEN AND CODE RESULT

At present we are surveying PG&E customers who HAVE participated in the Efficient Indoor Lighting Program. Since you have not participated in this PG&E program, we have no further questions for you at this time. On behalf of PG&E, I'd like to thank you very much for your cooperation today.

At present we are surveying PG&E customers who had their equipment installed between Jan 1994 and Sep 1994, and who's equipment was installed in an area cover by only one account. On behalf of PG&E, I'd like to thank you for your time.

(F4 TO FIRST SCREEN AND CODE RESULT)

BEGIN ON SITE RECRUITMENT. ASK OF PARTICIPATION CONTACT:

A subsample of customers who complete telephone surveys are being asked to participate in an additional on-site follow up visit. Your site has been selected for one of these follow up visits. These on-site visits provide additional data that is used to evaluate and verify the savings achieved by the new lighting equipment. Would you be interested in having one of our qualified technicians come and conduct an on-site inspection?

OS001. &OS001
1 = Respondent will continue
0 = Respondent will not continue

OS005. Are you the best person who can allow us access to physically inspect the retrofitted electrical equipment?
&OS005 1 = Yes --> SKIP TO 2nd CONTACT
0 = No
8 = (Refused)
9 = (Don't Know)

Who would be the best person who could allow us access to physically inspect the retrofitted electrical equipment?
READ CONTACTS, OR GET ADDITIONAL CONTACT INFO:

DECIS NAME: &DNAME_____
DECIS TITLE: &DTITLF_____
DECIS BUSINESS: &DBUSNAM_____
DECIS PHONE: (&DAC_) &DPRE - &DLAST Ext: &DEXT

TECH NAME: &TNAME_____
TECH TITLE: &TTITLF_____
TECH BUSINESS: &TBUSNAM_____
TECH PHONE: (&TAC_) &TPRE - &TLAST Ext: &TEXT

LIGHT NAME: &LNAME_____
LIGHT TITLE: &LTITLF_____
LIGHT BUSINESS: &LBUSNAM_____
LIGHT PHONE: (&LAC_) &LPRE - &LLAST Ext: &LEXT

IF DECIS ENTER 1, ELSE IF TECH ENTER 2, ELSE IF LIGHT ENTER 3,
ELSE IF NEW ON-SITE CONTACT ENTER 4: ===> &WHOOS

ENTER INFO FOR ON-SITE CONTACT:

OS NAME: &OSNAME_____
OS BUSINESS: &OSBUSNAM_____
OS PHONE: (&OSAC) &OSPRE - &OSLAST Ext: &OSEXT
OS TITLE: &OSTITLN
1 = President/Owner
2 = Senior Manager
3 = Financial Manager
4 = Energy Manager
5 = Operations Manager
6 = Building Manager
7 = Other SPECIFY: &OSTILOTR_____

ENTER 1 TO SKIP FORWARD: ==> &SKIP

Who would be an additional person who can allow us access and be knowlegable about the electrical equipment at the facility?
READ CONTACT NAMES, IF NOT ONE OF THESE, GET ADDITIONAL CONTACT INFO:

DECIS NAME: &DNAME_____
DECIS TITLE: &DTITLF_____
DECIS BUSINESS: &DBUSNAM_____
DECIS PHONE: (&DAC) &DPRE - &DLAST Ext: &DEXT

TECH NAME: &TNAME_____
TECH TITLE: &TTITLF_____
TECH BUSINESS: &TBUSNAM_____
TECH PHONE: (&TAC) &TPRE - &TLAST Ext: &TEXT

LIGHT NAME: &LNAME_____
LIGHT TITLE: &LTITLF_____
LIGHT BUSINESS: &LBUSNAM_____
LIGHT PHONE: (&LAC) &LPRE - &LLAST Ext: &LEXT

IF DECIS ENTER 1, ELSE IF TECH ENTER 2 , ELSE IF LIGHT ENTER 3
IF OTHER THAN THESE THEN ENTER 4 ===> &WHOOS2

GET SECONDARY ON-SITE CONTACT INFORMATION;

SECOND CONTACT NAME &OSNAM2_____
SECOND CONTACT BUSINESS: &OSBUSNM2_____
SECOND CONTACT PHONE: (&OSAC2) &OSPRE2 - &OSLAST2 EXT: &OSEXT2
SECOND CONTACT TITLE: &OSTITN2
1 = President/Owner
2 = Senior Manager
3 = Financial Manager
4 = Energy Manager
5 = Operations Manager
6 = Building Manager
7 = Other SPECIFY: &OSTIL2OT_____

COMMENTS: &OSCOM21_____
COMMENTS: &OSCOM22_____
ENTER 1 TO SKIP FORWARD ==> &SKIP

IF YOU WISH TO SCHEDULE AN APPOINTMENT WITH THE PERSON ON THE PHONE ENTER 1, ELSE READ BELOW THEN ENTER 2 AND CODE OS RESULT;

===> &SKIP

Those are all of the questions I have for you at this time. I will contact &OSNAME_____ to schedule the on-site audit. On behalf of PG&E, thank you for your time and cooperation.

At this time, we would like to schedule an appointment for one of our representatives to meet with you at your facility to conduct the survey and inspect the building's new lighting equipment.

OS020. Can we schedule a time now for one of our representatives to meet with you at your facility?
&OS020 1 = Yes --> SKIP OS030
0 = No
8 = (Refused)
9 = (Don't Know)

OS030. How high off the floor is the highest lighting which was retrofitted under the program?
&OS030 feet (ENTER ESTMATED LIGHTING HEIGHT)
888 = (Refused)
999 = (Don't Know)

OS040. Do you have ladders at the facility high enough to reach this height, which could be available to the auditor?
&OS040 1 = Yes
0 = No
8 = (Refused)
9 = (Don't Know)

OS045. What is the closest cross street to the facility at
&ADDRESS_____ ?

Cross Street: &XSTREET_____

ENTER 1 TO SKIP FORWARD: &SKIP

ENTER DAY: &VISDAY___ DISTRICT: &DIV_COD2
ENTER DATE: &VISDAT2__ BUSTYPE: &BUSTYPE_____
ENTER START TIME: &VISTIM1 WHO: 1 = Kevin Shovah CODE: &MAILV____
END TIME: &VISTIM2 2 = Joe O'Mally
ENTER WHO: &VISWHO 3 = Paul William
IS THE INFORMATION CORRECT &CORR 4 = Denis Ley
USE 24HR CLOCK!!!! 1 = Yes 5 = Chuck Bennett
0 = No

I'll give you the following 800 number, should you need to reschedule or cancel the appointment. The number is 1-800-540-7201.
If at the time of the audit, you could have a recent PG&E bill available for the auditor, it would be very helpful.

DO NOT READ
Did the customer ask us to provide a Certificate of Insurance, or Proof of Insurance?
&INSURE 1 = Yes 0 = No

Did the customer have any concerns about sensitive issues or processes at their facility?
&TIPTOE 1 = Yes 0 = No

Appendix E

NET-TO-GROSS DETAIL METHODOLOGY

Appendix E

PURCHASE DECISION LOGISTIC REGRESSION MODEL

A logistic regression model predicting free ridership was developed using self-report data in a pooled model incorporating data from all surveyed Lighting Program participants in the industrial sector. *Section 3 (Methodology)* contains a description of the superset of variables included in the model and rationale for their inclusion. This appendix describes the analytical steps undertaken in the model selection, building, and refinement process and presents the final model results.

Exhibit E-1 presents the variables used in the decision logistic regression model.

Exhibit E-1
Self-Reported Free Ridership: Superset of Model Variables

Model Variable	Wording of Question	Predicted Direction: Net Participant	Predicted Direction: Free Rider	In Final Model
	TIMING OF PLANS			
PERIOD_ BEFORE_ AWARE	How long were you considering <the measure> before you heard about the program?	short-moderate period	longer period	
NO_PLANS	Wasn't planning on purchase until approached	yes	no	
PERIOD_ AFTER_ AWARE	How long did you take to decide to participate after becoming aware of the program?	longer period	shorter period	
WAIT_NO_ PGM	How long would you have waited to <take the measure> without the program?	longer period	shorter period	x
WAIT_FOR_ PGM	Did you delay a retrofit in order to participate?	no	yes	
	OPTIONS			
QUOTES	How many estimates or quotes did you obtain before purchasing your new equipment?	few	many	x
STD_EQUIP	Did you consider purchasing standard-efficiency equipment?	yes	no	x
BROKEN	(Did the customer mention broken equipment?)	yes	no	
	PROGRAM INFORMATION AND BENEFITS			
PGE_CONTAC	How many times a year do you have contact with your PG&E rep?	few	many	
REBATE	(Did the customer mention the rebate?)	yes	no	
BILL_ SAVINGS	(Did the customer mention bill savings?)	yes	no	x
FREE_RIDE	Before you knew about the program, which of the following statements best describes your company's plans to <take the measure>?	had considered, but no plans	planning to do it within the next 12 months	

E.1 Variables Excluded from Model

With the exclusion of PERIOD_BEFORE_AWARE, PERIOD_AFTER_AWARE, and BROKEN, bivariate relationships between independent variables and FREE_RIDE (examined through cross-tabs and bivariate logistic regressions) showed them to be sufficiently associated. (I.e., they were at least marginally statistically significant.) These variables were therefore included in initial model runs. Variable PERIOD_BEFORE_AWARE was dichotomized, classifying customers into two groups: those who were and those who were not in the market for energy efficient lighting equipment before they heard about the program (NO_PLANS).

E.2 Functional Form of Variables Included in Free Ridership Model

"Yes" or "No" questions were entered into the initial model as dummy variables coded either "1" or "0." Continuous variables WAIT_NO_PGM, QUOTES, and PGE_CONTACT were initially entered as continuous covariates with Box-Tidwell transformation terms. The Box-Tidwell terms allow one to test for nonlinearity in the logit; they are formed by creating an additional variable, "xlnx," for each continuous variable. A logisitic regression is then run with just two covariates: x and xlnx. When the xlnx term is statistically significant, there is evidence of nonlinearity. This data screening process was carried out for each of the continuous variables in the model. Results of these tests showed that variables PGE_CONTACT and QUOTES could be entered as a continuous variable, but WAIT_NO_PGM demonstrated nonlinear components and needed recoding. Techniques following Hosmer and Lemeshow[1] were used to identify the correct functional form of WAIT_NO_PGM. An additional quadratic term for WAIT_NO_PGM was created and included in the initial model.

E.3 Variables Dropped from Model During Model Building

The initial, full model contained all variables mentioned previously. The model-building process involved testing subsets of variables until stable results were obtained. Criteria used to drop variables from the model included nonsignificant regression coefficients (e.g., the Wald Chi-Square test was not significant in a multivariate model) and nonsignificant change in model log-likelihood ratios with the inclusion or omission of the variable.[2]

The NO_PLANS, WAIT_FOR_PGM, PGE_CONTACT, and REBATE variables proved nonsignificant in the full, stable model and were dropped.

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[1] Hosmer, D., and Lemeshow, S. (1989). *Applied Logistic Regression.* Wiley, New York.

[2] Hosmer, D., and Lemeshow, S. (1989). *Applied Logistic Regression.* Wiley, New York.

E.4 Goodness-of-Fit Tests: Outliers, High Leverage Values, and Influential Observations

Pearson residuals, deviance residuals, and hat values resulting from the later model specifications were examined. In the final model, Pearson residuals had an average value of 0.03, and a variance of 1.20. This quantity is thought to be N(0,1)[3] when the model is correctly specified. Deviance residuals followed the same pattern as the Pearson residuals, with the same observations showing extreme values. Overall, seven cases had Pearson or deviance residuals greater than 2 or less than -2. This represents just over 6% of the sample used in the final model. Hat values showed that high-leverage values were not also influential outliers. Large hat values indicate points with undue weight on regression results and/or parameter estimates. Using a criterion of hat values exceeding 2k/n [where k is the number of independent variables and n is the number of observations in the model], only 10% of the cases demonstrated high leverage. One of the seven outliers (or <1% of the sample) had leverage values greater than the criterion.

An examination of outliers revealed that the model tended to underpredict free ridership by anywhere from 4% to 13%. For this reason, an adjustment was made to the predicted free ridership values using the following adjustments: If 13% of the H.I.D. cases were underpredicted, the "adjusted" free ridership value for the H.I.D technology group was increased by 13%.

E.5 Collinearity

Correlations between the continuous independent variables were checked, as well as the correlation matrix of regression coefficients.

E.6 Missing Data

Because many of the survey questions used in the model required the customer to recall various decision-making stages, there was a fair amount of missing data. Rather than including missing data with mean or median values, the model was run with fewer observations. If the sample size had permitted, cross-validation of model results on a hold-out dataset would have been performed, but these data were not available. The final model was run with sample weights. The weighted model was statistically significant and showed the same pattern of results as the unweighted model. Final free ridership estimates were made using the coefficients obtained from the weighted industrial model.

[3] Normally distributed with a mean=0 and a variance=1.

E.7 Precision of Results

Results presented in *Section 4* are shown with 90% confidence intervals. Error levels used correspond to predicted average values for the technology group.

E.8 Descriptive Statistics

All but one of the independent variables in the model are continuous. Mean values for dummy variables are the percentage of customers reporting, "yes," or otherwise responding affirmatively.

Exhibit E-2
Descriptive Statistics for Variables Included in Final Model

Variable	N	Mean	Std	Min	Max
BILL_SAVINGS (0,1)	158	0.434	0.497	0	1
WAIT_NO_PGM (years)	118	7.015	5.461	0	12
WAIT_NO_PGM_SQ (years^2)	118	78.781	69.206	0	144
STD_EQUIP (0,1)	153	0.271	0.446	0	1
QUOTES (#)	154	1.991	1.016	1	7
FREE_RIDE (0,1)	156	0.142	0.350	0	1

Source: Telephone Survey Data

As shown in Exhibit E -2, many customers mentioned bill savings as a main motivator for purchasing new lighting equipment (BILL_SAVINGS = 43%). Evidence that the program is contractor driven is provided by the retrofit plans of program participants: customers on average would have waited over 7 years to replace their lighting equipment. Consistent with these results is a low univariate self-reported free ridership rate: according to question FREE_RIDE, fewer than 14% of the sample members were classified as free riders.

Exhibit E-3
Final Model Results

Unweighted

Variable	B	SE	Wald Chi-Square	P
BILL_SAVINGS	-1.0774	0.7501	2.0629	0.1509
STD_EQUIP	-1.4687	0.8112	3.2778	0.0702
WAIT_NO_PGM	-1.8875	0.7411	6.4866	0.0109
WAIT_NO_PGM_SQ	0.1371	0.0604	5.1606	0.0231
QUOTES	0.6906	0.3290	4.4063	0.0358
INTERCEPT	-0.5840	0.7744	0.5688	0.4507
N	112			
-2LLR	34.017			
P	0.0001			

Weighted

Variable	B	SE	Wald Chi-Square	P
BILL_SAVINGS	-1.3506	0.7949	2.8867	0.0893
WAIT_NO_PGM	-2.2029	0.8746	6.3439	0.0118
WAIT_NO_PGM_SQ	0.1624	0.0716	5.1497	0.0233
STD_EQUIP	-1.1314	0.7649	2.1879	0.1391
QUOTES	0.4897	0.3132	2.4453	0.1197
INTERCEPT	-0.0738	0.7882	0.0088	0.9254
N	112			
-2LLR	34.730			
P	0.0001			

Source: Telephone Survey Data

E.9 Model Results

Results shown in Exhibit E-3 show the logisitic regression coefficients (B), their standard errors (SE), Wald Chi-Square values[4], and the probability associated with the parameter estimate for each variable included in the model. All variables retained in the final unweighted model were significant at the p<.10 level, except BILL_SAVINGS which was marginally significant. The overall weighted model -2 log-likelihood ratio, a measure of goodness-of-fit, was 34.730, with five degrees of freedom (p<.0001). This indicates a statistically significant model. Data contributed to the final model came from 112 customers, from a possible 161 customers. As stated above, we elected to run the model with fewer data points rather than drop interesting variables with higher percentages of missing data. As with all behavioral models, results should be considered provisional and viewed in context. Cross-validation of the model on a separate dataset would test the reliability of the model in predicting free ridership and help strengthen conclusions.

All variables showed effects in the direction predicted (see *Section 3.3.1*). The quadratic form of WAIT_NO_PGM had a positive coefficient (showing a "U" shaped effect for the variable). That is, customers who reported extreme values for retrofit delay periods (shorter or longer than average) were more likely to be free riders.

E.10 Predicted Free Ridership

Model results were used to obtain probabilities of free ridership for each lighting technology group. These probabilities were calculated in SAS using Proc Logistic. The probability of being a free rider, for any given technology group is

$$\hat{p} = \frac{e^{bX}}{1+e^{bX}}$$

where *b* is a vector of regression coefficients and *X* is a vector of mean values for the different explanatory variables. A probability for free ridership was assigned to each technology group by calculating the mean values for all the independent variables included in the model, for that technology group. These were then multiplied by their respective regression coefficients to yield the term "bX". This term was exponentiated and the ratio of $e^{bX}/(1+e^{bX})$ formed the predicted probability of free ridership for each technology group. These were then combined with participant spillover estimates (as described in *Section 3*) to yield NTG ratios.

[4] analogous to a t statistic

Note

No Customized Incentives participants were interviewed. The NTG results applied to Customized Incentives gross impacts are NTG values from the Retrofit Express program.

Appendix G

GROSS ENERGY AND DEMAND IMPACTS BY COSTING PERIOD

Appendix G

SUMMARY OF GROSS PROGRAM IMPACTS BY COSTING PERIOD

Unadjusted program gross demand and energy impacts are summarized by time-of-use (TOU) costing periods in Exhibit G-1, yielding important H-factor information in support of Pacific Gas and Electric Company's (PG&E's) cost-effectiveness calculations. The following hours were selected from the PG&E costing periods when generating demand figures:

- Summer on-peak is defined as the weekday hour 3:00 PM to 4:00 PM.
- Summer partial-peak is defined for two distinct weekday hours: 11:00 AM to noon, and 6:00 PM to 7:00 PM.
- Summer off-peak is defined as the weekday hour 8:30 AM to 9:30 AM. To estimate this impact for this hour, a mean impact was generated using the hours 7:00 AM to 8:00 AM, and 8:00 AM to 9:00 AM.
- Winter partial-peak is defined as the weekday hour 5:00 PM to 6:00 PM.
- Winter off-peak is defined as the weekday hour 8:30 AM to 9:30 AM. To estimate this impact for this hour, a mean impact was generated using the hours 7:00 AM to 8:00 AM, and 8:00 AM to 9:00 AM.

The results presented in Exhibit G-1 were generated using evaluation program impact estimates for every hour in a year (8,760 hours). In general, the estimates provided are based upon only those specific hours that comprise a particular row (or costing period) in the exhibit. Whether demand or energy, the impacts presented reflect all contributing hours during that period, a mean or total, respectively. The following describes in greater detail how each column in the exhibit was calculated using evaluation impact results:

- Program gross unadjusted kW impacts are presented in the first column for a single specified hour of the day. In all cases, the hour specified occurs on a weekday. Each impact is the mean impact for a particular hour of the day, across all contributing days and customers. To achieve this, customer- or measure-specific mean estimates were taken across all contributing days; these intermediate mean estimates were then summed across all contributing customers and/or measures.

- The second column, the kW adjustment factor, is the ratio of each program demand impact (column 1 kW savings) to the summer on-peak demand estimate.

- The third column, kWh savings, is the sum of all hourly impacts during each costing period for all applicable daytypes. Note that some costing periods only contain weekdays, while others include both weekdays and weekends. The sum of all contributing rows is equal to the annual program impact.

- The fourth column, kWh adjustment factor, is the ratio of each program energy impact (column 3 kWh savings) to annual total energy savings.

Exhibit G-1
Gross Demand and Energy Savings by Costing Period
For INDUSTRIAL Indoor and Outdoor Lighting Measures

PG&E Cost Period	INDOOR Lighting				OUTDOOR Lighting			
	Program kW Savings Coin. with System Max in Period	kW Adjustment Factor	kWh Savings	kWh Adjustment Factor	Program kW Savings Coin. with System Max in Period	kW Adjustment Factor	kWh Savings	kWh Adjustment Factor
Summer On-Peak: May 1 to Oct. 31 12:00 - 6:00 PM Weekdays	62,389	1.00	48,148,944	0.16	782	1.00	782,958	0.04
Summer Partial Peak: May 1 to Oct. 31 8:30 AM - 12:00 PM Weekdays	63,075	1.01	27,823,952	0.09	1,884	2.41	857,913	0.05
Summer Partial Peak: May 1 to Oct. 31 6:00 PM - 9:30 PM Weekdays	41,847	0.67	15,178,433	0.05	502	0.64	832,926	0.05
Summer Off-Peak: May to Oct. 31 Other	46,227	0.74	72,952,950	0.24	2,030	2.59	6,628,869	0.37
Winter Partial Peak: Nov. 1 to April 31 8:30 AM - 9:30 PM Weekdays	47,804	0.77	79,112,554	0.26	933	1.19	2,436,030	0.13
Winter Off-Peak: Nov. 1 to April 31 9:30 PM - 8:30 AM Other	41,394	0.66	61,163,621	0.20	2,030	2.59	6,519,670	0.36

Appendix H

EX ANTE NET-TO-GROSS RATIOS

Appendix H

EX ANTE NET-TO-GROSS RATIOS

The attached print outs list the net-to-gross ratios that are being applied in the MDSS as a function of the business type, the application (indoor vs. outdoor) and the technology. Also listed is the frequency of occurrence.

These are enclosed to document discussions of varying MDSS net-to-gross ratios in *Sections 4* and *5* of the main body of the report.

The SAS System 13:48 Sunday, January 21, 1996 1

FIN_BTYP	PNTG1	MEAS_CD2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Assembly	0.75	Indoor	9	0.0	9	0.0
Assembly	0.7699999809	01) Comp Flor	131	0.7	140	0.7
Assembly	0.7699999809	02) Ind to Flor	9	0.0	149	0.7
Assembly	0.7699999809	03) Eff Ball	84	0.4	233	1.2
Assembly	0.7699999809	04) T8/Ball	792	3.9	1025	5.1
Assembly	0.7699999809	05) Delamp	305	1.5	1330	6.6
Assembly	0.7699999809	06) Int HID	310	1.5	1640	8.2
Assembly	0.7699999809	07) Halogen	20	0.1	1660	8.3
Assembly	0.7699999809	08) Exit Sign	63	0.3	1723	8.6
Assembly	0.7699999809	09) Controls	141	0.7	1864	9.3
Assembly	0.7699999809	11) Ext HID	88	0.4	1952	9.7
Col/Univ	0.6999998093	Indoor	1	0.0	1953	9.7
Col/Univ	0.75	Indoor	2	0.0	1955	9.7
Col/Univ	0.7699999809	01) Comp Flor	74	0.4	2029	10.1
Col/Univ	0.7699999809	02) Ind to Flor	6	0.0	2035	10.1
Col/Univ	0.7699999809	03) Eff Ball	30	0.1	2065	10.3
Col/Univ	0.7699999809	04) T8/Ball	213	1.1	2278	11.3
Col/Univ	0.7699999809	05) Delamp	50	0.2	2328	11.6
Col/Univ	0.7699999809	06) Int HID	15	0.1	2343	11.7
Col/Univ	0.7699999809	07) Halogen	17	0.1	2360	11.7
Col/Univ	0.7699999809	08) Exit Sign	20	0.1	2380	11.8
Col/Univ	0.7699999809	09) Controls	34	0.2	2414	12.0
Col/Univ	0.7699999809	11) Ext HID	14	0.1	2428	12.1
Grocery	0.6999998093	10) Other	1	0.0	2429	12.1
Grocery	0.75	Indoor	63	0.3	2492	12.4
Grocery	0.7699999809	01) Comp Flor	86	0.4	2578	12.8
Grocery	0.7699999809	02) Ind to Flor	8	0.0	2586	12.9
Grocery	0.7699999809	03) Eff Ball	79	0.4	2665	13.3
Grocery	0.7699999809	04) T8/Ball	399	2.0	3064	15.3
Grocery	0.7699999809	05) Delamp	117	0.6	3181	15.8
Grocery	0.7699999809	06) Int HID	12	0.1	3193	15.9
Grocery	0.7699999809	07) Halogen	8	0.0	3201	15.9
Grocery	0.7699999809	08) Exit Sign	18	0.1	3219	16.0
Grocery	0.7699999809	09) Controls	22	0.1	3241	16.1
Grocery	0.7699999809	11) Ext HID	65	0.3	3306	16.5
Health Care	0.6999998093	01) Comp Flor	4	0.0	3310	16.5
Health Care	0.6999998093	04) T8/Ball	1	0.0	3311	16.5
Health Care	0.6999998093	09) Controls	1	0.0	3312	16.5
Health Care	0.6999998093	Indoor	3	0.0	3315	16.5
Health Care	0.7699999809	01) Comp Flor	289	1.4	3604	17.9
Health Care	0.7699999809	02) Ind to Flor	18	0.1	3622	18.0
Health Care	0.7699999809	03) Eff Ball	59	0.3	3681	18.3
Health Care	0.7699999809	04) T8/Ball	548	2.7	4229	21.1
Health Care	0.7699999809	05) Delamp	168	0.8	4397	21.9
Health Care	0.7699999809	06) Int HID	11	0.1	4408	21.9
Health Care	0.7699999809	07) Halogen	25	0.1	4433	22.1
Health Care	0.7699999809	08) Exit Sign	72	0.4	4505	22.4
Health Care	0.7699999809	09) Controls	82	0.4	4587	22.8
Health Care	0.7699999809	11) Ext HID	66	0.3	4653	23.2
Hotel/Motel	0.6999998093	09) Controls	1	0.0	4654	23.2
Hotel/Motel	0.6999998093	11) Ext HID	1	0.0	4655	23.2

FIN_BTYP	PNTG1	MEAS_CD2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Hotel/Motel	0.6999998093	Indoor	3	0.0	4658	23.2
Hotel/Motel	0.75	Indoor	1	0.0	4659	23.2
Hotel/Motel	0.7699999809	01) Comp Flor	312	1.6	4971	24.7
Hotel/Motel	0.7699999809	02) Ind to Flor	24	0.1	4995	24.9
Hotel/Motel	0.7699999809	03) Eff Ball	8	0.0	5003	24.9
Hotel/Motel	0.7699999809	04) T8/Ball	113	0.6	5116	25.5
Hotel/Motel	0.7699999809	05) Delamp	22	0.1	5138	25.6
Hotel/Motel	0.7699999809	06) Int HID	8	0.0	5146	25.6
Hotel/Motel	0.7699999809	07) Halogen	25	0.1	5171	25.7
Hotel/Motel	0.7699999809	08) Exit Sign	27	0.1	5198	25.9
Hotel/Motel	0.7699999809	09) Controls	118	0.6	5316	26.5
Hotel/Motel	0.7699999809	11) Ext HID	181	0.9	5497	27.4
Misc. Comm	0.75	Indoor	3	0.0	5500	27.4
Misc. Comm	0.75	Outdoor	77	0.4	5577	27.8
Misc. Comm	0.7699999809	01) Comp Flor	55	0.3	5632	28.0
Misc. Comm	0.7699999809	02) Ind to Flor	2	0.0	5634	28.0
Misc. Comm	0.7699999809	03) Eff Ball	17	0.1	5651	28.1
Misc. Comm	0.7699999809	04) T8/Ball	107	0.5	5758	28.7
Misc. Comm	0.7699999809	05) Delamp	29	0.1	5787	28.8
Misc. Comm	0.7699999809	06) Int HID	45	0.2	5832	29.0
Misc. Comm	0.7699999809	07) Halogen	6	0.0	5838	29.1
Misc. Comm	0.7699999809	08) Exit Sign	13	0.1	5851	29.1
Misc. Comm	0.7699999809	09) Controls	110	0.5	5961	29.7
Misc. Comm	0.7699999809	11) Ext HID	212	1.1	6173	30.7
Office	0.6999998093	04) T8/Ball	2	0.0	6175	30.7
Office	0.6999998093	Indoor	4	0.0	6179	30.8
Office	0.6999998093	Outdoor	1	0.0	6180	30.8
Office	0.75	Indoor	26	0.1	6206	30.9
Office	0.7699999809	01) Comp Flor	981	4.9	7187	35.8
Office	0.7699999809	02) Ind to Flor	62	0.3	7249	36.1
Office	0.7699999809	03) Eff Ball	183	0.9	7432	37.0
Office	0.7699999809	04) T8/Ball	2117	10.5	9549	47.5
Office	0.7699999809	05) Delamp	660	3.3	10209	50.8
Office	0.7699999809	06) Int HID	150	0.7	10359	51.6
Office	0.7699999809	07) Halogen	122	0.6	10481	52.2
Office	0.7699999809	08) Exit Sign	270	1.3	10751	53.5
Office	0.7699999809	09) Controls	529	2.6	11280	56.1
Office	0.7699999809	11) Ext HID	391	1.9	11671	58.1
Process	0.7699999809	01) Comp Flor	12	0.1	11683	58.2
Process	0.7699999809	02) Ind to Flor	2	0.0	11685	58.2
Process	0.7699999809	03) Eff Ball	3	0.0	11688	58.2
Process	0.7699999809	04) T8/Ball	42	0.2	11730	58.4
Process	0.7699999809	05) Delamp	11	0.1	11741	58.4
Process	0.7699999809	06) Int HID	83	0.4	11824	58.9
Process	0.7699999809	09) Controls	15	0.1	11839	58.9
Process	0.7699999809	11) Ext HID	30	0.1	11869	59.1
Restaurant	0.6999998093	Indoor	1	0.0	11870	59.1
Restaurant	0.75	Indoor	4	0.0	11874	59.1
Restaurant	0.7699999809	01) Comp Flor	203	1.0	12077	60.1
Restaurant	0.7699999809	02) Ind to Flor	7	0.0	12084	60.1
Restaurant	0.7699999809	03) Eff Ball	15	0.1	12099	60.2

FIN_BTYP	PNTG1	MEAS_CD2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Restaurant	0.7699999809	04) T8/Ball	133	0.7	12232	60.9
Restaurant	0.7699999809	05) Delamp	43	0.2	12275	61.1
Restaurant	0.7699999809	06) Int HID	5	0.0	12280	61.1
Restaurant	0.7699999809	07) Halogen	24	0.1	12304	61.2
Restaurant	0.7699999809	08) Exit Sign	21	0.1	12325	61.3
Restaurant	0.7699999809	09) Controls	34	0.2	12359	61.5
Restaurant	0.7699999809	11) Ext HID	66	0.3	12425	61.8
Retail	0.6999998093	04) T8/Ball	12	0.1	12437	61.9
Retail	0.6999998093	10) Other	12	0.1	12449	62.0
Retail	0.6999998093	Indoor	5	0.0	12454	62.0
Retail	0.75	Indoor	16	0.1	12470	62.1
Retail	0.7699999809	01) Comp Flor	339	1.7	12809	63.8
Retail	0.7699999809	02) Ind to Flor	37	0.2	12846	63.9
Retail	0.7699999809	03) Eff Ball	143	0.7	12989	64.7
Retail	0.7699999809	04) T8/Ball	1541	7.7	14530	72.3
Retail	0.7699999809	05) Delamp	538	2.7	15068	75.0
Retail	0.7699999809	06) Int HID	298	1.5	15366	76.5
Retail	0.7699999809	07) Halogen	141	0.7	15507	77.2
Retail	0.7699999809	08) Exit Sign	120	0.6	15627	77.8
Retail	0.7699999809	09) Controls	190	0.9	15817	78.7
Retail	0.7699999809	11) Ext HID	293	1.5	16110	80.2
School	0.6999998093	04) T8/Ball	4	0.0	16114	80.2
School	0.6999998093	06) Int HID	1	0.0	16115	80.2
School	0.6999998093	11) Ext HID	1	0.0	16116	80.2
School	0.75	Indoor	2	0.0	16118	80.2
School	0.7699999809	01) Comp Flor	690	3.4	16808	83.7
School	0.7699999809	02) Ind to Flor	61	0.3	16869	84.0
School	0.7699999809	03) Eff Ball	151	0.8	17020	84.7
School	0.7699999809	04) T8/Ball	1150	5.7	18170	90.4
School	0.7699999809	05) Delamp	279	1.4	18449	91.8
School	0.7699999809	06) Int HID	118	0.6	18567	92.4
School	0.7699999809	07) Halogen	19	0.1	18586	92.5
School	0.7699999809	08) Exit Sign	185	0.9	18771	93.4
School	0.7699999809	09) Controls	181	0.9	18952	94.3
School	0.7699999809	11) Ext HID	203	1.0	19155	95.3
Warehouse	0.75	Indoor	4	0.0	19159	95.4
Warehouse	0.75	Outdoor	4	0.0	19163	95.4
Warehouse	0.7699999809	01) Comp Flor	80	0.4	19243	95.8
Warehouse	0.7699999809	02) Ind to Flor	7	0.0	19250	95.8
Warehouse	0.7699999809	03) Eff Ball	30	0.1	19280	96.0
Warehouse	0.7699999809	04) T8/Ball	355	1.8	19635	97.7
Warehouse	0.7699999809	05) Delamp	115	0.6	19750	98.3
Warehouse	0.7699999809	06) Int HID	141	0.7	19891	99.0
Warehouse	0.7699999809	07) Halogen	13	0.1	19904	99.1
Warehouse	0.7699999809	08) Exit Sign	28	0.1	19932	99.2
Warehouse	0.7699999809	09) Controls	71	0.4	20003	99.6
Warehouse	0.7699999809	11) Ext HID	87	0.4	20090	100.0

Appendix I

PARTICIPANTS: REASONS FOR REFUSING THE SURVEY

OBS	COMMENT1
1	CONTACTED SUE MC LELLAN PROP.MANAGERS FOR CAROUSEL SHE CONNOT GIVE*
2	SCHEDULED OS FOR 6/21@2PM, W/ KEVIN, AFTER WHICH GOT A PARTIAL:**SG
3	ONSITE 6/5 8AM PAUL. STOPPED AT SC62 WITH SEC. MR. NEWHALL GOT ON P
4	KELLEY SEARS THE MANAGER DOES NOT THINK SHE WOULD CARE TO PARTICIP
5	APPT SCHEDULED ON MONDAY 6/5 @13:00 WITH DENIS***JMT
6	LORI COMPLETED LIGHTING/TECH Q'S BUT HAD NO TIME TO DO THE LAST**MY
7	HANS SAYS LIGHTING WAS INSTALLED AT THEIR 1765 ADDISON WAY SITE;
8	START ON SC3...LEFT 800# ON VOICE MAIL***MYT**MYT
9	SPIKE IS VERY BUSY, HE'LL CALL US BACK ON THE 800#.**JRC
10	CHARLES BOLES CALLED 800# AND SAID TO CANCEL THE APPOINTMENT***JRC
11	John says he's too busy, today & tomorrow, but he did say to C/B;**
12	Dennis is the business owner; was in a meeting Thursday p.m.
13	John said he doesn't have time to do a 20-25 min. survey. He also
14	CRAIG SAID, "WE'RE VERY BUSY AND I DON'T WANT TO DO A SURVEY."
15	Bus. phone is for Mad River Ind. Complex. Steve declined On-Site,
16	Mr. Smith says he would never have 25 minutes for a phone survey.**
17	Tony called our 800 #, & declined to participate.
18	JUST TO BUSY TO TAKE THE TIME**CJG
19	MR. SMITH REFERRED ME TO DAVID MAR, ENGINEER. HE SAID HE THOUGHT IT
20	WOULD LIKE TO CHECK LEGITIMACY FIRST THEN WILL TALK TO US
21	**SGW
22	DIDN'T WANT THE ON-SITE VISIT SO THE SURVEY WAS TERMINATED.**DSH
23	MR. LEEKLEY IS PROPERTY OWNER HE LEASES IT OUT TO SANTA CLARA FOAM*
24	FIRST MR. BISS SAID HE WOULD ANSW. QUEST. AND THEN HE SAID HE SAID*
25	GEORGE DECLINED AN ON-SITE, AND ISN'T REALLY INTERESTED...

OBS	COMMENT2
1	OUT INFORMATION ON THIS SITE. LIGHTS ARE OPPERATED FOR 30HRS.SCR.2*
2	DENNIS DID THROUGH SCREEN 103, THEN BROKE OFF" DO NOT CALL BACK".**
3	HONE AN SAID THEY HAD NO TIME FOR THE SURVEY. REFUSED..**ALS
4	ATE IN AN ONSITE
5	CANCELLED THE APPT..OWNER DOESN'T WANT US THERE.***JMT
6	SECTION, SHE SAID SHE'S REALLY BUSY**MYT**MYT
7	THE PLANT'S MAIN OFFICE *IS* AT 1809. see sc. 2**JCM
8	STEVE SAID THAT HE DIDN'T WANT TO DO THE SURVEY IF NOT OBLIGATED TO
9	**JRC SPIKE ended the call ON ME, DIDN'T WANT TO TALK**KAY**KAY
10	
11	would prefer calls only in the late afternoon, mornings too busy.**
12	Dennis declined On-Site, got T&T'd.
13	said we've called him about 3 times and he has absolutely no time.
14	
15	was T & T'd.
16	
17	Inadvertant entry, 6/2 did not call twice, just coded it same.
18	**CJG
19	WOULD BE A WASTE FOR US TO COME THERE. SEE SC. 2**JCM
20	DO NOT CALL
21	carolyn refused; too busy, no time, not interested...
22	
23	AND DID TECHNICAL PORTION OF SURVEY.// Mr. Haug refused On-Site.**B
24	THAT HE DIDN'T WANT TO BECAUSE HE DIDN'T KNOW (GO TO SCR.2 FOR INFO
25	ADDRESS IS ACTUALLY: 402 DEWEY, NOT 404...

OBS	COMMENT1
26	**AD
27	Richard declined an On-Site visit, so its a T & T.
28	"HAS NO TIME TO DO INTERVIEWS" mr. Larry Day**CG
29	She said they had the lights put in about THREE years ago, but only
30	Mr. DaSilva was unwilling to look up date and felt it was a waste**
31	WILLIAM POHL REFUSED THE ON-STIE INSPECTION, SAYING HE WAS VERY**JC
32	Refusal, per Dante and note on sc. 2.
33	MARCY RUONA IS NOT IN THIS PARTICULAR OFFICE. SPOKE TO OWNER ROBIN*
34	REFUSED ONSITE BECAUSE THE BUSINESS IS A BRIDAL SHOP AND THERE'S A*
35	MR. MUSGROVE had asked for a hard copy BUT SAID THAT EVEN IF HE GOT
36	MR.PERTTULA SAID HE WASN'T INTERESTED, HE SAID ALL WE NEED TO KNOW*
37	WALTER IS USUALLY THE ONLY PERSON AT HIS COMPANY, SO HE'S ***DSH
38	**KAY
39	He was pleased w/his lights but upset about how much he is now payi
40	Gill said "You're welcome to take a look @ the lights, but I
41	SHE ASKED WHAT WAS THE SURVEY ABOUT EXPLAINED TO HER AND SHE SAID**
42	SHE SAID THAT SHE WAS HAPPY WITH THE PROJECT BUT SHE WILL NEVER HAV
43	RECEPTIONIST SAID HE HAS NO INTEREST IN DOING THE SURVEY
44	Received call from Mr. Moura. Stated was disappt with program, say
45	james is a doctor his son who runs this business says all he had do
46	REFUSED ONSITE SO SURVEY WAS TERMINATED.**ALS
47	**CJG
48	DOES NOT HAVE TIME .**CG
49	Alex Finlay said that he really didn't want to do the survey**KAY
50	HIS ADMINISTRATIVE ASSISTANT SAID THAT THEY WOULDN'T BE INTERESTED.

OBS	COMMENT2
26	**AD
27	
28	
29	applied for the rebate a couple years ago... May be a T&T...
30	of time to find out to complete survey**REJ
31	BUSY.**JCM
32	
33	HE SAID HE DID NOT HAVE TIME TO DO THE SURVEY. TO CALL IN WINTER.
34	CONCERN THAT THE SINCE THE AUDITORS HAVE TO GO UP ON- SEE SC2******
35	THE HARD COPY THAT HE WOULD PREFER NOT TO DO THE SURVEY**KAY
36	IS THAT HE'S VERY WELL PLEASED.**RRF
37	VERY BUSY AND CAN'T FIND TIME TO DO SURVEY.**DSH
38	He absolutely refused to spend 20 minutes doing the survey**KAY**KA
39	ng so he refused to do the survey or visit.**HEM
40	don't have time to complete the survey."
41	THAT SHE REALLY WASN'T INTERESTED AND SHE WOULD JUST PASS**RRF
42	E TIME TO SPEND ON THE PHONE
43	
44	ing bill has increased and felt it is a gimmick by PGE.**SMB
45	ne is change 2 lights 3 years ago and did not wish to continue.**CG
46	DID NOT HAVE TIME.**ALS
47	
48	
49	
50	

OBS	COMMENT1
51	MR. SCHMIDT STATED THAT 15-20 MINUTES ON THE PHONE WAS ENTIRELY TOO
52	GAVE 800 NUM.
53	"I participated 2 years ago and I really don't have time for your
54	ASKED FOR HARD COPY NOT REAL HAPPY ABOUT DOING A SURVEY**CG
55	Rick said he's already had an on-site audit done. He's not sure if*
56	MR. MARSALIS REFUSED ON-SITE SO SURVEY WAS TERMINATED.
57	GOES WITH QC. 146**
58	HAS NO TIME TO DO AN ON SITE VISIT.
59	Dillon Olson wasn't interested in the on-site survey**REJ
60	JEFF STEBER SAID, "I DON'T HAVE ANY TIME," AND ended the call.
61	WRONG ADDRESS, AND THEN MR. ABERCROMBIE SAID THEY INSTALLED WHEN**C
62	DID NOT FEEL THE NEED TO HAVE ONSITE.
63	DOES NOT HAVE TIME .**ANY
64	DID NOT HAVE TIME FOR SURVEY TOO BUSY.**ALS
65	By screen 146 she felt she had given more than enough time to the**
66	HE SAID THE SURVEY IS TOO LONG AND THEY DIDN'T SAVE ENOUGH MONEY TO
67	THEY WOULD NEVER HAVE TIME FOR THE ONSITE AUDIT & THIS IS ALSO A ST
68	ANOTHER MAN IN THE OFFICE SAID THAT GEORGE TILLEY AND THE REST OF**
69	**JRC
70	Peter said that he doesn't have the time, the roofing business is
71	Refused on-site inspection, so had to T & T.
72	MS. MOORE REFUSED THE ON-SITE SO THE SURVEY WAS TERMINATED. SHE**DS
73	He didn't really want to take the time to do the on-site inspection
74	HAS 800 NUMBER**CG ON THE DO NOT CALL LIST**CG
75	Richard didn't feel the on-site was necessary for three lighting

OBS	COMMENT2
51	LONG, AND HE WAS TO BUSY. HE HAD A GOOD DISPOSITION THOUGH.
52	
53	survey this morning." Got answering mach. twice today.
54	
55	Quantum or the other company conducted it. Rick said he (Sc 2)**JAF
56	
57	
58	
59	**REJ
60	
61	THEY MOVED IN AND WE COULD NOT VERIFY ANY SAVINGS, NO REFERENCE**CG
62	
63	
64	
65	survey. Nice about it, but couldn't see the need for more questions
66	JUSTIFY SPENDING THAT MUCH TIME ON THE PHONE.**DSH
67	EEL FABRICATION SHOP & NO ONE CAN JUST WANDER AROUND UNSUPERVISED**
68	THE COMPANY IS VERY BUSY IF WE FAX IT THEY WILL COMPLETE IT**JMT**J
69	**JRC
70	hectic & would remain so unitl it rains again.
71	
72	STATED THAT THERE WOULDN'T BE A PURPOSE FOR ONE BECAUSE IT WOULD
73	
74	DO NOT CALL DO NOT CALL DO NOT CALL**CG
75	fixtures. He refused the on-site.**REJ

OBS	COMMENT1
76	Phil says it is a moot issue, as they are moving, in
77	said this is very busy season she does not have anytime to talk to*
78	Mr. Trimble says they're "quite satisfied," doesn't think anything
79	HE SAID THAT HE DOES NOT HAVE THE TIME AND HE IS NOT INTERESTED SO*
80	TERRY EARLS CONTACT PERSON DID NOT WANT TO TAKE SURVEY. SAID SHE DO
81	NORM DIDN'T HAVE TIME FOR A TEL. SURVEY, TURNED DOWN ON-SITE. (REF)
82	They rec'd the Hard-copy, but just don't have the time to help us.*
83	GARY THE OWNER SAID THEY WERE VERY BUSY THIS TIME OF YEAR AND THEY
84	REFUSED ONSITE SO THE SURVEY WAS TERMINATED.
85	HE SAID THAT HE IS NOT INTERESTED AT ALL IN HAVING ANYONE COME TO
86	**CG
87	He says it is a small company and they are all very busy. He is the
88	BILL SAID HE DID NOT HAVE TIME TO DO SURVEY OR ON-SITE.
89	BOB DID NOT WANT ONSITE.**ALS
90	Rod Martin declined an On-Site, so coded as a Refusal.**SGW
91	HAS JUST COMPLETED A WALK THRU SURVEY WITH ANOTHER COMPANY**CG
92	He stated that 25 minutes was too long to spend even if we did the*
93	GOES WITH QC 44**
94	HE STATED THAT MORE THAN 5 MINUTES ON THE PHONE IS TOO MUCH
95	HE SaID THAT HE IS BELLYUP WITH PG&E HE WANTS TO TALK TO KNOW ONE A
96	HE SAID THAT HE DOES NOT HAVE ANYTIME FOR ANYONE'S SURVEYS**JMT
97	SUSAN FISH (SHE'S MARRIED NOW) SAID THAT THEY WOULDN'T BE INTERESTE
98	On-Site was apparently refused.**SGW
99	Neither he nor anyone else there would have time for 25 min survey.
100	CHRIS DECLINED TO OS VISIT ..THEREFORE DIDN'T CONTINUE SURVEY.**SGW

OBS	COMMENT2
76	December, and turned down an On-Site visit...
77	us she wants us to take her of the list and do not call back**JMT
78	more can be learned, declined On-Site. - T&T'd.
79	TAKE HIS NAME OFF THE LIST**JMT
80	ES NOT HAVE THE TIME.**ALS
81	
82	***>> CANCELLED Denis' On-Site appt. for 6/14 @ 1:00 p.m.**SGW
83	DID NOT HAVE TIME.HE WAS ALSO CONCERNED FOR LIABILITY REASONS.
84	
85	HIS SITE**JMT
86	KIM SAID THEY ARE NOT INTERESTED IN SURVEY OR ON SITE *CG**CG
87	decision-maker for the program but would never have time for survey
88	
89	
90	**SGW
91	
92	survey in sections on different days.**BB
93	
94	
95	BOUT NOTHING PLEASE DO NOT CALL HIM BACK**JMT
96	**JMT
97	D IN PARTICIPATING IN THE ON-SITE VISIT.**RRF
98	**SGW
99	
100	

OBS	COMMENT1
101	MR.BARRY INFORMED ME THAT"HE HAS NO TIME TO WASTE ON THIS TYPE
102	HE SAID THAT IF HE CAN NOT HAVE IT SENT IN THE MAIL THEN HE IS NOT
103	Abe Tarecpecan says can only answer questions on paper sent by PG&E
104	Bill Chiala ("key-ala") declined On-Site. Refusal.
105	He does not wish to spend 25 minutes doing the survey. They did the
106	mike said that he would prefer not to do the survey**KAY
107	Jim DECLINED the On-Site, as they DO see their PG&E account rep.
108	HE SAID HE HAS ALREADY HAD PGE COME IN SEVERAL TIME AND LOOK AT TH
109	BOB WAS NOT INTERESTED IN HAVING AN ONSITE.**ALS
110	LEFT 800 NUMBER**CG
111	No one called him at the time that was set up so won't do survey.**
112	Max Zinsman says he is decision contact. He's going on vacation.**B
113	Name pronounced "Ceasar".**BB
114	Part of the facility is a secure facility. It would be too difficul
115	MR. MILLER DID NOT HAVE 20-25 MINUTES TO SPEND ON A SURVEY.**DET
116	this survey was coded as a refusal on inda23 (cati 18) so i coded
117	SHE SAID THAT SHE DOES NOT NEED ANYONE TELLING WHAT SHE IS SAVING
118	He felt that 25 minutes was too much time to spend on the survey.**
119	GAVE OUR 800 NUM.
120	SEE QC. 274**
121	he said that he does not have time to do a survey on the phone, or*

OBS	COMMENT2
101	OF THING".**CG
102	INTERESTED AND ended the call BEFORE I HAD A CHANCE TO SAY ANYMORE**JMT
103	and then cleared by their legal dept. Lots of sensitive info there.
104	
105	program more than once. He already did a survey a year or more ago.
106	
107	quite frequently, already...
108	E LIGHTING HE DOES NOT NEED US TO COME IN TO**JMT
109	CO. CHANGED OWNERS NEW NAME IS CANANDAIGUA WINES.**ALS
110	**CG
111	
112	CB 7/26+.**BB
113	
114	t to allow the auditor access. Did not wish to allow on-site survey
115	**DET
116	it as a refusal here too.
117	BECAUSE SHE USED TO WORK FOR PGE SO SHE CAN DO IT HER SELF**JMT
118	
119	
120	
121	have some one come to the facility**JMT

Appendix J

SAMPLE WEIGHTING FOR NET-TO-GROSS RESULTS

Appendix J

SAMPLE WEIGHTING FOR NET-TO-GROSS RESULTS

Telephone survey data were weighted using population distributions based upon business type and electricity usage. This was done so that reported results obtained from surveyed program participants would reflect program population estimates more accurately. Business type was chosen to ensure firmographic representativeness of survey results. Usage was chosen so that sample results would adequately reflect participant and nonparticipant account size.

To develop the sample weights, population distributions were developed from the MDSS and CIS for each of the following three populations: industrial customers, commercial customers, and nonparticipants. This was done by cross-tabulating business type and a three-level usage stratification variable derived from 1992 annual billing records.

Population distributions were then used in combination with sample distributions developed for each specific analysis. That is, since not all survey respondents provide data for each question, the effective sample size (and therefore the distribution of division and usage segment) varies for each question. The sample weights for each cell were calculated as p_{jk}/s_{jk}, where j is the jth usage segment, k is the kth division, p_{jk} is the percentage of the population represented by the cell p_{jk} and s_{jk} is the percentage of the survey sample represented by cell s_{jk}.

Once sample weights were constructed, they were applied in the calculation of statistics (frequencies, means, and probabilities based upon logistic regression models) from surveyed participants and nonparticipants. This method of sample weighting compensates for differences between the survey samples and their respective populations, by assigning more importance to observations from usage categories and business types that are under-represented in the survey sample, and less importance to observations that are over-represented. All NTG results presented in this report were sample weighted.

PG&E'S 1994 NONRESIDENTIAL RETROFIT PROGRAM
INDUSTRIAL LIGHTING TECHNOLOGIES EVALUATION

QUANTUM CONSULTING

PROTOCOL TABLES 6 AND 7
PG&E STUDY ID #: 311

Submitted to

Elsia Galawish
Market Planning & Research
Pacific Gas & Electric Company
123 Mission Street, Room 2437
San Francisco, CA 94177

Prepared by

QUANTUM CONSULTING INC.
2030 Addison Street
Berkeley, CA 94704

P696.321

February 1996

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INDUSTRIAL LIGHTING TECHNOLOGIES EVALUATION

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Protocol Tables 6 and 7

1994 INDUSTRIAL RETROFIT PROGRAM EVALUATION OF LIGHTING TECHNOLOGIES

PG&E STUDY ID #311

This report presents Tables 6 and 7 for the above referenced study as required under the "Protocols and Procedures for the Verification of Cost, Benefits, and Shareholder Earnings from Demand Side Management Programs" (the Protocols), as adopted by California Public Utility Commission' (CPUC) Decision 93-05-063, Revised January 1995 Pursuant to Decisions 94-10-063, 94-10-059, and 94-12-021.

Table 6 - In some instances, interpretation of the protocols may allow a variety of results to be used. Examples are:

- Table 6, Item 2.B: The per-unit gross and net impacts required by the protocols specify two terms in the denominator that are defined in Tables C-4 and C-5, square footage estimates of the lighted area and hours of fixture operation. The interpretation of these terms are:

  - Square footage estimates of the lighted area were derived using survey responses for post-retrofit total facility square footage. This is the total area not just the retrofit area.

  - Hours of fixture operation were defined using the ratio of program level technology only gross unadjusted first year impacts to the change in total connected load for those particular measures. These technology only impacts exclude HVAC interaction impacts and SAE realization rates. This yields the average number of hours that fixtures were found to operate in the first year. Annual fixture hours of operation were then divided by 1,000 to yield the term used in the denominator. So, if for instance, fixtures were found to operate 4,000 hours per year on average, then the denominator would be the product of the square footage estimate and 4.

- Table 6, Items 4.A and 4.B: The square footage estimates and annual hours of operation estimates provided in this portion of the table are <u>not</u> identical to those used in Table 6, 2.B. In Table 6, 2.B figures are program level, while Table 6, 4.A and 4.B are restricted to the participant group and comparison group. Annual hours of operation were derived using self-report operating schedules

from the telephone survey -- not back-calculated as described for Table 6, 2.B above.

- Table 6, Items 7-1 and 7-2: 1994 paid-year program participation is based upon item control number, where each control number was allowed to contribute just one observation each to indoor and outdoor lighting participation.

Table 7 - "Table 7" is much more of a text format and is designed to provide a synopsis of the methods used. As such, it is more self explanatory.

Protocol Table 6 (Item 1-5)
PG&E Study ID # 311

Table Item		Indoor Lighting			Outdoor Lighting		
Item Number	Result Description	Estimate	Rel. Precision#		Estimate	Rel. Precision#	
			90%	80%		90%	80%
1.A†	Pre-installation Usage, Base Usage, and Per-Unit Base Usage	N/A	N/A	N/A	N/A	N/A	N/A
1.B†	Impact Year Usage and Per-Unit Usage	N/A	N/A	N/A	N/A	N/A	N/A
2.A	Gross Peak kW Impacts	16,197	N/A	N/A	196	N/A	N/A
	Gross Annual kWh Impacts	96,677	N/A	N/A	1,593	N/A	N/A
	Net Peak kW Impacts	14,887	N/A	N/A	159	N/A	N/A
	Net Annual kWh Impacts	88,816	N/A	N/A	1,290	N/A	N/A
2.B	Per-Unit Gross Demand Impacts* (Watts/sqft-1000 hours of operation)	0.08	N/A	N/A			
	Per-Unit Gross Annual Energy Impacts* (kWh/sqft-1000 hours of operation)	0.46	N/A	N/A			
	Per-Unit Net Demand Impacts* (Watts/sqft-1000 hours of operation)	0.07	N/A	N/A			
	Per-Unit Net Annual Energy Impacts* (kWh/sqft-1000 hours of operation)	0.43	N/A	N/A			
2.C†	Percent change in usage of the participant group and comparison group	N/A	N/A	N/A	N/A	N/A	N/A
2.D	Gross Demand Realization Rate	1.35	N/A	N/A	----	N/A	N/A
	Gross Energy Realization Rate	1.36	N/A	N/A	0.97	N/A	N/A
	Net Demand Realization Rate	1.61	N/A	N/A	----	N/A	N/A
	Net Energy Realization Rate	1.62	N/A	N/A	1.02	N/A	N/A
3.A	NTG Ratio Based on Avg. Load Impacts	0.92	N/A	N/A	0.81	N/A	N/A
3.B	NTG Ratio Based on Per-Unit Avg. Load Impacts	0.92	N/A	N/A			
3.C†	Percent change in usage relative to base usage	N/A	N/A	N/A	N/A	N/A	N/A
4.A	Pre Avg. Square Footage (Part)	61,842	23%	18%			
	Pre Avg. Square Footage (Comp. Group)	N/A	23%	18%			
	Pre Avg. Hour of Operation¥ (Part)	4,495	6%	5%	3,995	13%	10%
	Pre Avg. Hour of Operation¥ (Comp. Group)	N/A	N/A	N/A	N/A	N/A	N/A
4.B	Post Avg. Square Footage (Part)	62,241	6%	5%			
	Post Avg. Square Footage (Comp. Group)	N/A	N/A	N/A			
	Post Avg. Hour of Operation¥ (Part)	4,495	6%	5%	3,995	13%	10%
	Post Avg. Hour of Operation¥ (Comp. Group)	N/A	N/A	N/A	N/A	N/A	N/A

† The change model estimates of impact did not require an evaluation of base usage.

Patterned cells in the table are not applicable for exterior lights.

¥ Hours of operation reported are based purely upon survey self-report. It is assumed that pre- and post-retrofit operating schedules are fixed for most impact estimates.

Since statistical adjustments were not applied to the Industrial Sector impact results, relative precision was not estimated.

Protocol Table 6
Item 6: Measure Count Data
PG&E Study ID # 311

Program and Technology Group Description	Number of Measures Paid in 1994		
	All Participants (Item 6.B)	Participant Sample (Item 6.A)	Comparison Group¥ (Item 6.C)
Indoor Lighting			
Retrofit Express Program			
Compact Fluorescent	4,627	1,421	NA
Incandescent to Fluorescent	193	18	NA
Efficient Ballast	11,812	4,224	NA
T8 Lamps and Electronic Ballasts	315,117	46,030	NA
Optical Reflectors w/ Fluor. Delamp	103,738	17,451	NA
High Intensity Discharge	11,532	2,931	NA
Halogen	743	107	NA
Exit Signs	888	220	NA
Controls	8,942	212	NA
Other	0	0	NA
Retrofit Express Indoor Total	457,592	72,614	NA
Customized Incentives Program†			
Compact Fluorescent	0	0	NA
Standard Fluorescent	7	2	NA
High Intensity Discharge	1	1	NA
Exit Signs	0	0	NA
Controls	1	0	NA
Other	0	0	NA
Customized Incentives Indoor Total†	9	3	NA
Indoor Total	457,601	72,617	NA
Exterior Lighting			
Retrofit Express Exterior HID	1,071	286	NA
Customized Incentives Exterior HID†	0	0	NA
Customized Incentives Traffic Lights†	0	0	NA
Outdoor Total	1,071	286	NA
Indoor and Outdoor Total	458,672	72,903	NA

† Measures in the Customized Incentive Program are defined by the number of technology group observations per application in the MDSS

¥ No comparison group data were collected in the industrial sector.

Protocol Table 6

Item 7.A: Market Segment Data (Bldg Type)

Study ID # 311

Business Type	Indoor Lighting		Outdoor Lighting	
	# of Part	% of Part	# of Part	% of Part
Process	87	13%	23	26%
Assembly	607	87%	67	74%
Total	694	100%	90	100%

Protocol Table 6

Item 7.B: Market Segment Data (3-digit SIC)

PG&E Study ID # 311

Industry (3 Digit SIC)	Indoor Lighting		Outdoor Lighting	
	# of Part	% of Part	# of Part	% of Part
367	54	8%	5	6%
357	46	7%	1	1%
208	33	5%	6	7%
359	28	4%	2	2%
275	27	4%	2	2%
308	22	3%	4	4%
382	22	3%	2	2%
344	21	3%	3	3%
242	17	2%	6	7%
203	16	2%	3	3%
384	15	2%	1	1%
271	13	2%	0	0%
366	13	2%	0	0%
265	12	2%	1	1%
327	12	2%	7	8%
209	11	2%	4	4%
249	11	2%	2	2%
652	11	2%	0	0%
349	10	1%	1	1%
201	9	1%	0	0%
371	9	1%	2	2%
399	9	1%	1	1%
154	8	1%	1	1%
243	8	1%	2	2%
347	8	1%	0	0%
354	8	1%	0	0%
355	8	1%	2	2%
171	7	1%	1	1%
233	7	1%	0	0%
352	7	1%	2	2%
153	6	1%	0	0%
173	6	1%	0	0%

Protocol Table 6

Item 7.B: Market Segment Data (3-digit SIC)

PG&E Study ID # 311

Industry (3 Digit SIC)	Indoor Lighting		Outdoor Lighting	
	# of Part	% of Part	# of Part	% of Part
204	6	1%	2	2%
205	6	1%	1	1%
244	6	1%	0	0%
285	6	1%	1	1%
289	6	1%	3	3%
179	5	1%	0	0%
206	5	1%	1	1%
262	5	1%	0	0%
267	5	1%	0	0%
283	5	1%	2	2%
356	5	1%	0	0%
381	5	1%	0	0%
152	4	1%	1	1%
176	4	1%	2	2%
281	4	1%	1	1%
287	4	1%	2	2%
329	4	1%	0	0%
331	4	1%	1	1%
341	4	1%	0	0%
342	4	1%	0	0%
229	3	0%	0	0%
284	3	0%	1	1%
291	3	0%	2	2%
323	3	0%	0	0%
335	3	0%	0	0%
346	3	0%	1	1%
361	3	0%	0	0%
364	3	0%	0	0%
369	3	0%	0	0%
104	2	0%	1	1%
131	2	0%	1	1%
144	2	0%	2	2%

Protocol Table 6

Item 7.B: Market Segment Data (3-digit SIC)

PG&E Study ID # 311

Industry (3 Digit SIC)	Indoor Lighting		Outdoor Lighting	
	# of Part	% of Part	# of Part	% of Part
161	2	0%	1	1%
174	2	0%	0	0%
175	2	0%	0	0%
202	2	0%	0	0%
245	2	0%	1	1%
252	2	0%	0	0%
259	2	0%	0	0%
311	2	0%	0	0%
317	2	0%	0	0%
326	2	0%	0	0%
328	2	0%	0	0%
336	2	0%	0	0%
343	2	0%	0	0%
351	2	0%	0	0%
358	2	0%	0	0%
373	2	0%	0	0%
375	2	0%	0	0%
376	2	0%	0	0%
394	2	0%	0	0%
138	1	0%	1	1%
177	1	0%	0	0%
178	1	0%	0	0%
207	1	0%	0	0%
223	1	0%	0	0%
226	1	0%	0	0%
227	1	0%	0	0%
230	1	0%	0	0%
231	1	0%	0	0%
234	1	0%	0	0%
239	1	0%	0	0%
251	1	0%	0	0%
254	1	0%	0	0%

Protocol Table 6

Item 7.B: Market Segment Data (3-digit SIC)

PG&E Study ID # 311

Industry (3 Digit SIC)	Indoor Lighting		Outdoor Lighting	
	# of Part	% of Part	# of Part	% of Part
263	1	0%	1	1%
273	1	0%	0	0%
278	1	0%	0	0%
282	1	0%	0	0%
295	1	0%	0	0%
301	1	0%	0	0%
302	1	0%	0	0%
306	1	0%	0	0%
321	1	0%	0	0%
322	1	0%	0	0%
345	1	0%	0	0%
353	1	0%	0	0%
365	1	0%	0	0%
372	1	0%	0	0%
379	1	0%	0	0%
386	1	0%	0	0%
391	1	0%	0	0%
543	1	0%	0	0%
650	1	0%	0	0%
Total	694	100%	90	100%

Protocol Table 7

RESULTS OF PG&E'S NONRESIDENTIAL RETROFIT LIGHTING STUDY: INDUSTRIAL SECTOR PG&E STUDY ID # 311

The purpose of this section is to provide documentation for data quality and processing as required in Table 7 of the protocol. Although other important considerations are addressed throughout this section, major topics are organized and presented in the same order as they are listed in Table 7 of the protocols (for ease of reference and review). When responses to the items are discussed in detail elsewhere in the report, only a brief summary will be given in this section to avoid redundancy.

A. Overview Information

1. Study Title and Study ID Number

Study Title: 1994 Industrial Retrofit Program Evaluation of Lighting Technologies

Study ID Number: 311

2. Program, Program Year and Program Description

Program: PG&E Nonresidential Retrofit Program, Industrial Sector.

Program Year: Rebates Received in the 1994 Calendar Year.

Program Description:

The Nonresidential Retrofit Program offered by PG&E has two components: the Retrofit Express (RE) Program and the Customized Incentive (Customized) Program.

The RE Program offers fixed rebates to PG&E's customers that install specific gas or electric energy-efficient equipment in their facilities. The RE Program covers most common energy-saving measures: lighting, air conditioning, refrigeration/food service, and motors. To receive a rebate, the customer is required to submit proof purchase along with the application, no later that December 15, 1994. This Program is primarily marketed to small and medium commercial, industrial, and agricultural customers. The maximum total rebate amount of the RE Program is $300,000 per account. This includes

participation in any combination of the lighting, air conditioning, refrigeration/food service, and motor program options.

The Customized Program offers financial incentives to customers who undertake large or complex projects that save gas or electricity. These customers must submit calculations for the projected first year energy savings, along with an application, prior to the start of the customers' installation of high-efficiency equipment. The maximum total incentive amount for the Customized Program is $500,000 per account. The minimum qualifying incentive amount is $2,500 per project.

3. End Uses and/or Measures Covered

End Use Covered: Indoor and Outdoor Lighting Technologies.

Measures Covered: For the list of measures covered in this evaluation, see *Appendix B*, Exhibit B-2.

4. Methods and Models Used

The PG&E Industrial Lighting Technologies consisted of two key analysis components: Calibrated Engineering (CE)analysis and net-to-gross analysis. This approach describes per-unit net impacts as follows:

The CE models were constructed for each technology and building type, using information gathered from the telephone surveys and on-site audits. This data included the type and number of units installed, the change in connected load, operating hours by time of day, burned out lamp counts, and the percentage of lamps operating, among other things. (See *Appendices C* and *D* for the information collected on site.) All of this data was combined in engineering models that meet the following general format.

$$\text{Net Impact} = (\text{Operating Impact}) * (\text{Operating Factor}) * (\text{Net-to-Gross Ratio})$$

- Operating impact is defined as the load impact coincident with a specific hour, given that the equipment is operating. Our approach relied on the engineering analysis to simulate equipment performance independent of premise size and customer behavioral factors. This term captures the difference of connected loads between program installed high efficiency lighting measures and the existing equipment as well as the lighting/HVAC interactive effects. A detailed discussion of the operating impact calculation can be found in *Section 3.2* and *Appendix B, Section B.5.*

- Operating factor is defined as the fraction of premises with operating equipment during the analysis period. This term reflects the equipment's operating schedule, and were estimated at a high level of precision using lighting logger data in conjunction with on-site audits and telephone surveys. In this analysis, 8,760 operating factor profiles were generated by business type and technology and the operating hours were estimated based on the profiles in the engineering energy impact analysis. A detailed discussion of the operating factor approach can be found in *Section 3.2* and *Appendix B, Section B.5.1.*

- Net effects are estimated through market analysis which involves the development of a model analyzing customer decisions in the lighting market. The market analysis models how participants first decided to purchase lighting equipment, and then, how they decided to purchase measures that correspond to those promoted by PG&E's program. The approach used to calculate program net effects uses self-reported responses from telephone survey data to estimate free ridership and spillover for lighting program participants. A logistic regression model predicting free ridership was developed using self-report data in a pooled model incorporating data from all surveyed lighting program participants. The multivariate purchase decision model attempts to estimate the probability that a customers' revealed choices are consistent with those of a free rider or net participant. Participant spillover effects were measured through simple self-report questions. Responses were tallied, and the rates of the actions in the participant population were calculated and multiplied by ex post estimates of measure savings. Results from each separate subanalysis are combined to generate NTG ratios. The NTG analysis approach is presented in detail in *Section 3.3*.

5. Participant and Comparison Group Definition

Participant

Participants are defined as those PG&E Industrial customers who received PG&E rebates in the 1994 calendar year for installing at least one lighting measure under the Nonresidential Retrofit Program.

Comparison Group

Nonparticipant comparison group sample was not collected in this evaluation.

6. Analysis Sample Size

The final analysis dataset consists of 190 participants with 170 telephone surveys and 154 on-site audits. Among these two samples, a total of 134 participants completed both a telephone survey and on-site audit. In addition, a total of 252 loggers were installed within the sample of 154 on-site audits.

B. Database Management

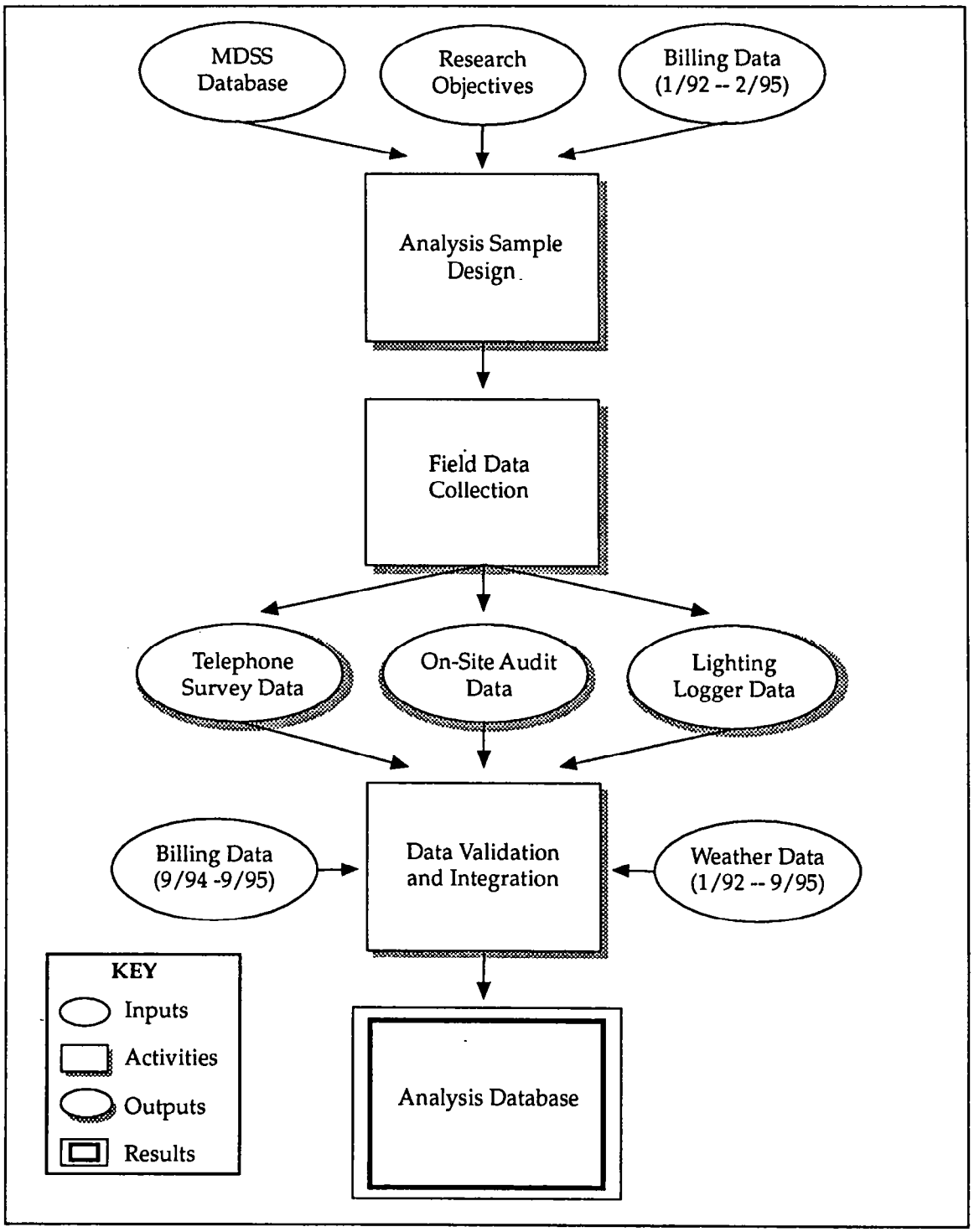
1. Data Description and Flow Chart

The evaluation of PG&E Industrial Lighting Technologies was based on a nested sample design approach (see *Section 3.1.2*). The main feature of this approach is that it consists of four groups of customers according to the evaluation data collected. The largest customer group included all of the Industrial customers who were rebated for eligible lighting technologies in 1994 (the "participant population") with monthly PG&E billing data and participant tracking data. The smallest group included the loggered

participants with the most comprehensive information available -- lighting logger data, on-site audit data, telephone survey, participant tracking data, and billing data. The advantage of a nested sample design was that it yielded overlapping samples which were used to leverage key items from the on-site audit sample to the telephone survey sample. The final samples, however, were not perfectly nested as a result of the small participant population and the desire of maximizing the sample size in each data categories.

All data elements mentioned above were linked to the final analysis database through the unique customer identifier -- PG&E's customer control number. For this Evaluation, the analysis database served as a centralized tracking system for customers' billing history, program participation, and sampling status and helped to reduce data problems such as account mismatch, double counting, or repeated customer contacts. Exhibit A illustrates how each key data element was used to create the final analysis database for the Evaluation.

Exhibit A
Analysis Database Development



2. Key Data Elements and Sources

The Evaluation takes into account all the existing data and the data collected specifically for the Evaluation. The key analysis data elements and their sources are listed below:

- **Program Participant Tracking System.** The participant tracking system for the RE and Customized programs was maintained as part of the PG&E MDSS. It contains program application, rebate, and technical information about installed measures, including measure description, quantity, rebate amount, and ex ante demand, energy, and therm saving estimates. The MDSS database is linked to the billing database and other program databases through PG&E's customer control numbers.

- **PG&E Billing Data.** For this evaluation, the PG&E billing data were obtained from two PG&E data sources. The original nonresidential billing dataset contains monthly energy usage for all nonresidential accounts in PG&E's service territory, and was used in the sample design as described in *Appendix A.*, pages A-1 and A-2.

- **Telephone Survey Data.** A telephone survey sample of 170 participants (166 indoor lighting participants and 4 outdoor lighting only participants) were collected as part of this Evaluation. The telephone survey supplies information on participant decision-making, customer equipment operating schedule, equipment stock, attitude towards the program, etc.

- **On-Site Audit Data.** The participant on-site audit data was collected as part of this Evaluation. This sample contributes site-specific equipment details, and better estimates of operating hours and operating factors. There are a total of 154 on-site audit conducted for this Evaluation, representing 150 indoor lighting participants and 4 outdoor lighting participants.

- **Lighting Logger Data.** The lighting logger data collected for the Evaluation provides operating factor profiles which were used to minimize modeling error in the engineering algorithms. The lighting logger sample was designed to best support the estimate of lighting technology and customer sectors with the highest projected impact. A total of 252 lighting loggers were installed during the period between June 1994 and September 1994 within the sample of the 154 on-site audited participant sites.

Other data elements that are not listed above include PG&E program marketing data, PG&E internal SIC code mapping/segmentation scheme, program procedural manuals and other industry standard data sources.

3. Data Attrition Process

All data elements mentioned above were first validated and then merged together to form the final analysis dataset. Records with out-of-range or questionable data were either deleted or flagged to ensure that only those records with sufficient data, both in

terms of data quality and representativeness, were used in the analysis. The key data attrition decisions are summarized in *Appendix A*.

4. Internal Data Quality Procedures

The evaluation contractor of this project, Quantum Consulting Inc. (QC), has performed extensive data quality control on all categories of program data, including utility billing data, program tracking data, telephone survey data, on-site audit data, and lighting logger data. QC's data quality procedures are consistent with PG&E's internal database guidelines and the guidelines established in the Protocol. The key features of QC's data quality procedures are summarized below:

- **QC Internal Data Quality Assurance.** Throughout the course of sample design and creation, survey data collection, and data analysis, several data quality assurance procedures were in place to insure that all energy usage data used in analysis and all telephone survey data collected was of high quality and would prove useful in later analysis. The stages of data validation undertaken and the methods employed are detailed below.

- **Pre-Survey Account Characteristic Data Validation.** The goal of this stage of data validation was to screen out customers had changes in key elements of their billing data over the 1992 to 1995 period. Accounts for which changes were observed in account numbers, service addresses, SIC codes, electric rate schedules, electric meter numbers, or corporation and premise identification variables, were excluded from sample eligibility. Usage data reliability screening first eliminated from sample eligibility accounts which experienced service interruptions, exhibited inconsistent read dates, or for which bills were estimated. Additionally, based on comparisons of account usage between years, and between different months in the same year, customers with unusual usage patterns such as unusually high variation in monthly or yearly usage were given special attention and, in some cases, excluded from the sample frame. A more detailed discussion of the steps undertaken in the pre-survey usage and account characteristics data validation, is provided in the discussion of survey sample creation in *Appendix A*, page A-2.

- **Real Time Survey Data Validation.** Survey data collection was performed using Quantum Consulting's 24 station Computer Aided Telephone Interviewing (CATI) center. Data entry applications, programmed using SAS/AF software, employed logical branching routines and real-time data validation procedures to insure that survey questions were appropriate for each customer's situation and that recorded responses were reasonable and logical. Data entry applications also performed real time range checks and field protection for out of range values during the data collection process thereby affording an additional means of ongoing data validation. Finally, because SAS/AF was used to program the data collection software, the survey data was on-line in the form of a SAS dataset continuously throughout the course of data collection. This allowed for the generation of frequency distributions

and cross-tabs on data at regular stages throughout the survey fielding to facilitate QC's internal early detection and correction of data entry errors.

- **Final Survey Data Validation.** Following the completion of survey data collection, all data was subjected to a final stage of validation and cleaning during which illogical responses were identified and corrected or flagged, and corrections were made to any miscoding of data not detected in earlier stages of cleaning and validation. All activities undertaken in the course of survey were documented in accordance with QC's Enumerated Quality Assurance Logs and Standards (EQUALS) survey data collection documentation protocols.

5. Unused Data Elements

Without exception, all data collected specifically for the Evaluation was utilized in the analysis.

C. Sampling

1. Sampling Procedures and Protocols

A sample design was applied to each of the primary data collection elements -- telephone survey and on-site audit, consisting of target completion rates by business type and technology group. An attempt was made to nest the on-site audit sample within the telephone survey sample to provide a means by which detailed on-site audit data could be transferred to the telephone survey sample and to allow the combined results from those samples to be used in the general participant population. By concentrating these resources within the business types and selected technology groups with the greatest participation, resource productivity was maximized.

For more detail regarding the sampling methods used or the samples generated for evaluation purposes, sampling procedures and protocol requirements are presented in *Appendix A: Sample Design*, which includes a detailed discussion on sampling frame, sampling strategy, sampling unit definition, data preparation for sample selection, sample target and final achieved sample. It also presents the procedures and results of sample relative precision calculation based on the total energy usage and demonstrates how the evaluation sample design meets the Protocols' requirement in terms of sample size and relative precision.

2. Survey Information

Telephone data collection instruments are presented in *Appendix C*. Participant survey response frequencies are presented in *Appendix F*. Finally, reasons for refusals are presented in *Appendix ???*

The NTG analysis used weighting techniques described in *Appendix J, Net-To-Gross Analysis,* to account for bias in terms of survey response.

3. Statistical Descriptions

As mentioned above, a complete set of participant and comparison group customer's responses frequencies are presented in *Appendix F.*

D. Data Screening and Analysis

This impact evaluation was based on a Calibrated Engineering (CE) model instead of a billing regression model, and as a result, many of the requirements of Table 7, part D are not applicable. However, some general rules implemented during the engineering analyses to account for missing data have been interpreted as applicable under these requirements. An attempt has been made to isolate this discussion to those procedures that had a significant effect upon the final impact results.

11. Treatment of Missing Data

In all significant cases where missing data points were needed to complete an analysis step, segment mean values were substituted. Segments were always defined by business type and technology group, and in some instances according to geographic climate constraints. Missing data were applied in this fashion both within the telephone and on-site samples, and even outside of those samples when estimating impacts for all other participants.

Segment mean values were estimated using weights which were typically based upon the retrofit system connected load, thus placing greater importance on those data elements that were associated with a large proportion of the program impacts.

E. Data Interpretation and Application

2. The Process

Free Ridership. A logistic regression model predicting free ridership was developed using self-report data in a pooled model incorporating data from all surveyed lighting program participants. The multivariate purchase decision model attempts to estimate the probability that a customers' revealed choices are consistent with those of a free rider or net participant.

Spillover. Participant spillover effects were measured through simple self-report questions such as, "Since participating in the program, have you adopted any additional energy-efficiency recommendations?" Customers were asked about specific program-qualifying technologies such as T-8 lamps with electronic ballasts. Responses were tallied, and the rates of the actions in the participant population were calculated and multiplied by ex post estimates of measure savings (average percentage reductions in usage per account). These were then credited to the RE program as additional program kWh savings. This was done for each lighting technology group and the program as a whole.

For a detailed NTG analysis discussion, see *Section 3.4.*