Customer Energy Efficiency Program
Measurement and Evaluation Program

IMPACT EVALUATION OF PACIFIC GAS & ELECTRIC COMPANY'S 1996 INDUSTRIAL SECTOR ENERGY MANAGEMENT SERVICES PROGRAM

PG&E Study ID number: 359

March 1, 1998

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EVALUATION OF
PACIFIC GAS & ELECTRIC COMPANY'S
1996 INDUSTRIAL ENERGY MANAGEMENT SERVICES PROGRAM

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Purpose of Study

This study was conducted in compliance with the requirements specified in "Protocols and Procedures for the Verification of Costs, Benefits, and Shareholders Earnings from Demand-Side Management Programs", as adopted by California Public Utilities Commission Decision 93-05-063, revised January, 1997, pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, 95-12-054, and 96-12-079.

This study evaluated the gross and net energy savings from non-rebated energy saving equipment measures and operations and maintenance practices implemented in response to recommendations from Pacific Gas & Electric Company's 1996 Industrial Energy Management Services Program.

Methodology

A census was attempted of the customers who received an EMS survey in 1996, yielding 349 completed telephone surveys. These survey results were used to identify 161 recommendations implemented without a rebate. For the simplest measures, primarily interior lighting and HVAC, an additional telephone survey provided information needed to create engineering estimates of gross savings. On-site surveys were completed for the more complex measures and sites to provide the engineering data needed for the gross savings calculation. Interviews with decision-makers provided the self-report data needed to compute a net-to-gross ratio (NTGR).

Study Results

Results of the analysis for the 1996 Industrial Energy Management Services Program follow:

IEMS Program	Gross		Ratios			Net		
	Savings	Realization Rate	1-Freeridership (NTG)	Spillover- to-Gross	NTG w/ spillover	Savings	Realization Rate	Spillover Savings
Ex Ante								
kW	250	-	1.00	-	-	250	-	-
kWh	1,900,651	-	1.00	-	-	1,900,651	-	-
Therms	112,999	-	1.00	-	-	112,999	-	-
Ex Post								
kW	267	1.066	0.535	-	-	143	0.570	-
kWh	890,315	0.468	0.664	-	-	591,265	0.311	-
Therms	229,648	2.032	0.493	-	-	113,214	1.002	-

Regulatory Waivers and Filing Variances

There were no waivers or filing variances.

FINAL REPORT

SBW Report No. 9802

Submitted to

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Table of Contents

Executive Summary

This study evaluated the gross and net energy savings from efficiency measures recommended in 1996 by Pacific Gas and Electric Company's (PG&E) Industrial Energy Management Services (IEMS) program. This research was designed to satisfy PG&E's regulatory requirement to provide *ex post* measurements of program impact and to provide information that could be used to improve the design and operation of future programs. The products of this research include:

- *Ex post* savings estimates for gross electric consumption, electric peak demand, and gas consumption by end use (indoor lighting, HVAC and process) and by recommendation type (measures and practices).

- Net-to-gross ratios (NTGR) at both the program and end-use levels.

We developed savings estimates and NTGRs for the overall program as well as for three end uses: indoor lighting, HVAC, and process. Estimates of program impact were based upon data collected from program participants via on-site and telephone surveys.

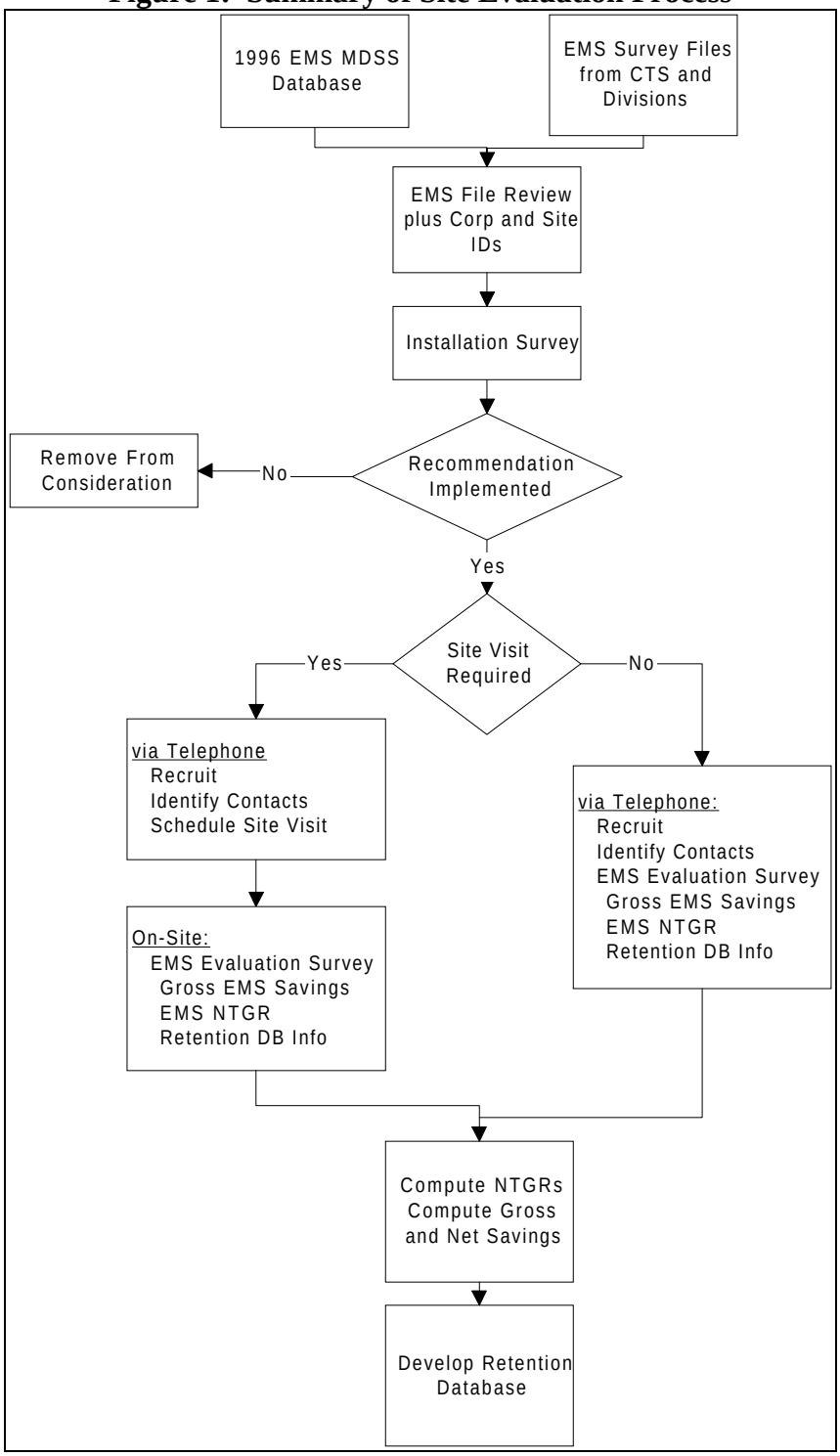
Background

PG&E offers the Energy Management Services (EMS) Program to its industrial customers. During 1996, 416 on-site EMS surveys were completed and 1,482 recommendations for energy efficiency improvements were made to customers by this program. The goal of this research was to determine the load impacts associated with the portion of these recommendations that were implemented without a rebate.

Methodology

A census was attempted of the customers who received an EMS survey in 1996, yielding 349 completed telephone surveys. These survey results were used to identify 161 recommendations implemented by these customers without a rebate. For the simplest measures, primarily interior lighting and HVAC, an additional telephone survey provided information needed to create engineering estimates of gross savings. On-site surveys were completed for the more complex measures and sites to provide the engineering data needed for the gross savings calculation. Interviews with decision-makers provided the self-report data needed to compute a net-to-gross ratio (NTGR). Figure 1 illustrates the major steps in this evaluation methodology.

Figure 1: Summary of Site Evaluation Process



Results

The methods described above were used to estimate *ex post* gross and net savings for the implemented recommendations. The disposition of the analysis sample frame, along with the results of the analyses, is summarized below.

Sample Disposition

An attempted census of 409 EMS surveys yielded 161 recommendations from the 349 completed Installation Surveys. The final program sample frame consists of these 161 recommendations implemented without a rebate at 113 sites. Evaluations were not performed for 17 of these because their savings were expected to be trivial based on the EMS survey files. 10 others were not completed due to participant refusal or a lack of knowledge of the EMS survey on the part of the participant. As shown in Table 1, evaluations were completed for 131 recommendations.

Table 1: PG&E 1996 Industrial Energy Management Services - Summary of Sample

End Use	Population (Number of Recommendations)	Evaluation Survey Sample Frame	Final Analysis Sample			Not Analyzed	
			Telephone	Onsite	Total	Trivial	Missing
HVAC	66	66	36	21	57	4	5
Lighting	61	61	29	15	44	12	5
Process	34	34	9	21	30	1	3
ALL	**161**	**161**	**74**	**57**	**131**	**17**	**13**

Note: The 161 recommendations were obtained from Installation Surveys performed on a census of 351 EMS Survey files from the 1996 EMS Program.

Evaluation Load Impacts

Table 2 provides results of the gross evaluation savings and realization rate calculations. Realization rates could only be determined for the overall program because no end-use or recommendation-type breakdowns of program savings were included in the E-Table filing for the EMS program. For the participants in the study, the natural gas evaluated savings were just over twice the program-estimated savings. On the other hand, electric energy savings were less than half the program estimate. Evaluated demand savings were 7% greater than the program estimate.

The process end-use provided the greatest energy savings for both electric and gas fuels; however, the HVAC end-use provided the greatest reduction in demand. Gas savings for the lighting end-use were negative due to "therm takeback" experienced when reduced internal loads have to be at least partially made up by the HVAC system.

Table 2 also shows estimates of net savings. Lighting has the greatest net kW savings, while process has the greatest therm and kWh savings. The overall NTGRs are 0.535 (kW), 0.664 (kWh), and 0.493 (therms). By end use, lighting had the highest kW and therm NTGRs, while process had the highest kWh NTGR.

Table 2: PG&E 1996 Industrial Energy Management Services - Summary of Evaluation Gross and Net Load Impacts

IEMS Program	Gross		Ratios			Net		
	Savings	Realization Rate	1-Freeridership (NTG)	Spillover- to-Gross	NTG w/ spillover	Savings	Realization Rate	Spillover Savings
Ex Ante								
kW	250	-	1.00	-	-	250	-	-
kWh	1,900,651	-	1.00	-	-	1,900,651	-	-
Therms	112,999	-	1.00	-	-	112,999	-	-
Ex Post								
kW	267	1.066	0.535	-	-	143	0.570	-
kWh	890,315	0.468	0.664	-	-	591,265	0.311	-
Therms	229,648	2.032	0.493	-	-	113,214	1.002	-

1. Introduction

Pacific Gas and Electric offers the Energy Management Services (EMS) Program to its industrial customers. The Industrial EMS Program staff conducts on-site surveys to identify the potential for energy efficiency improvements within each customer's facility and recommends adoption of these improvements where appropriate. The EMS staff examines the customer's total energy consumption before making recommendations. Staff members are encouraged to provide recommendations beyond those covered under PG&E's rebate programs, including low-cost or no-cost energy management practices. The EMS program provides customers with a written evaluation, including calculations, summary of findings, and energy savings potential for at least two end uses or one end use and an energy balance.

During 1996, 409[1] on-site EMS surveys were completed and 1,464 recommendations for energy efficiency improvements were made to customers. EMS surveys were also administered by telephone, but the telephone portion of the program is not covered by this evaluation, as the telephone EMS surveys were more applicable to the commercial sector. Although any business customer may complete a telephone survey, these surveys are targeted to small and medium-sized commercial customers. It was believed that a more accurate assessment of the EMS telephone surveys would be made through their evaluation in the commercial sector EMS Program, and the results transferred to the IEMS Program.

1.1 Evaluation Research Goals and Objectives

The goal of this research was to perform an impact evaluation of all efficiency improvement recommendations (efficiency measures and O&M practices) that were made under PG&E's 1996 Industrial EMS program. This evaluation has been conducted in strict accord with the CPUC-adopted statewide Measurement and Evaluation Protocols (M&E Protocols) for *ex post* measurement of program savings.

Specifically, the EMS program evaluation accomplished the following objectives:

1. Estimated the first year gross and net savings (kW, kWh, and Therms) associated with 1996 EMS recommendations implemented without a rebate. Net savings account for free-ridership, but not spillover.

2. Determined the distribution of 1996 EMS savings by major end-use (HVAC, lighting, and process) and again by efficiency measures and O&M practices.

3. Established a panel that can be used to estimate the retention of measures and practices adopted as a result of EMS recommendations.

4. Identified recommendations based on the study results that pertain to strengthening the Industrial EMS program and increasing customer value.

[1] MDSS contains records for 416 EMS surveys. However, review of the EMS survey files lead to the identification of 7 redundant entries in the database. This left 409 unique surveys completed by the program.

1.2 Units of Analysis

A wide variety of data were collected to support the estimates of gross and net savings. These data provided information for a number of different units of analysis. These units of analysis are defined as follows:

- **Survey**. PG&E's EMS program is based upon a customer survey. PG&E's Marketing Decision Support System (MDSS) database maintains information from these surveys in electronic form. One or more surveys may be processed for the same customer at a single location if multiple control numbers are present.

- **Recommendation**. Each survey describes recommendations for actions to improve energy efficiency. These actions may involve the installation of equipment (an efficiency measure) that may or may not qualify for a rebate under another PG&E program. O&M-related actions (O&M practices) may also be recommended, but generally do not qualify for rebates. Each action related to a specific piece of equipment or process is referred to as a "recommendation." Each recommendation is assigned to a control number, indicating the PG&E meter that will be affected by the recommendation's implementation. However, more than one recommendation may be assigned to the same control number. A recommendation may also affect more than one control number, although the program database allowed for only one.

- **End-Use**. Each recommendation (measure or practice) has been assigned a code and a description. The code and description place each recommendation in one of three end use categories: HVAC, light (interior only), and process.

- **Corporation**. The MDSS application database contains the name of the organization that was surveyed. These names were matched to identify each unique corporation involved in the 1996 program.

- **Site**. A site is defined as one or more contiguous structures that are operated by the same corporation. Sites have been identified by comparing the name of the organization surveyed and the service address associated with the control number or found in the survey file. Multiple sites may be associated with the same corporation.

- **Participant**. A participant is considered to be a survey for which one or more recommendations were installed in 1996 without the benefit of a rebate. Participants exist at both the recommendation and the survey levels. A participant survey is the Designated Unit of Measure (DUM) as required by the protocols for this research.

2. Overview of Research Design

2.1 Sample Selection and Site Recruitment

Following are the sources of information used to select and recruit the sample for this study:

1. **MDSS Database**. MDSS provided information for each EMS survey completed in 1996 and a portion of the associated recommendations, including the kWh, kW and therms savings.

2. **EMS Survey Files**. Review of the EMS Survey files allowed completion of the EMS recommendations database and compilation of customer contact information.

3. **Installation Survey**. The Installation Survey provided the data needed to identify recommendations that had been implemented without a rebate (See Appendix A).

The sample frame for this study was developed from PG&E's MDSS database and available project files for the 1996 EMS Program. Surveys for which project files were provided (351 surveys) were reviewed to fill missing data in the MDSS database. A file review database was created from the MDSS data and the reviewed project files.

An Installation Survey was then performed for each of the 409 EMS Surveys, yielding 349 completes. This process identified 161 recommendations that had been installed without the benefit of a rebate. The Installation Survey served to obtain clarification of recommendation status, to update the file review database, and as a recruitment tool, allowing surveyors to identify 99 participants willing and able to take part in the evaluation of gross and net savings.

Recommendations were aggregated at the site level to form a participant sample frame (a list from which to draw the sample) consisting of 117 surveys, each associated with a single control number (a unique identifier which PG&E assigns to each billing meter location). A census of all sites where at least one recommendation was implemented without a rebate was identified as the participant sample.

2.2 Site Evaluation Process

Figure 2-1 provides an overview of the site evaluation process. As shown in the figure, once the sample frame was identified and participants were assigned to evaluation engineers, the evaluation process began with a review by the assigned engineer of the installation survey and the EMS survey. Review of the installation survey also identified information already obtained from the customer and deemed to be useful in completing the EMS Evaluation Survey. The Installation Survey is presented in Appendix A.

For the purpose of applying the Evaluation Survey, the participant sample was divided into two groups based on whether an on-site inspection was required to obtain data needed to estimate gross savings:

1. **Participants Requiring On-Site Surveys**. Sites with complex measures or practices received an on-site inspection to evaluate 1996 EMS savings and O&M potential.

2. **Participants Requiring Telephone Surveys**. Sites with simple measures or practices, received a telephone survey to evaluate 1996 EMS savings.

Data obtained for similar recommendations in these two groups were identical in all aspects except in the manner data were collected.

The next step was to complete the EMS Evaluation Survey. For the Telephone group, the evaluation survey was completed entirely by telephone. For the On-Site group, telephone contact was used to recruit the site contact's cooperation, to identify key personnel to be interviewed for each portion of the Evaluation Survey, and to schedule the site visit. Data specific to the evaluation of the installed measure or practice were obtained at the facility.

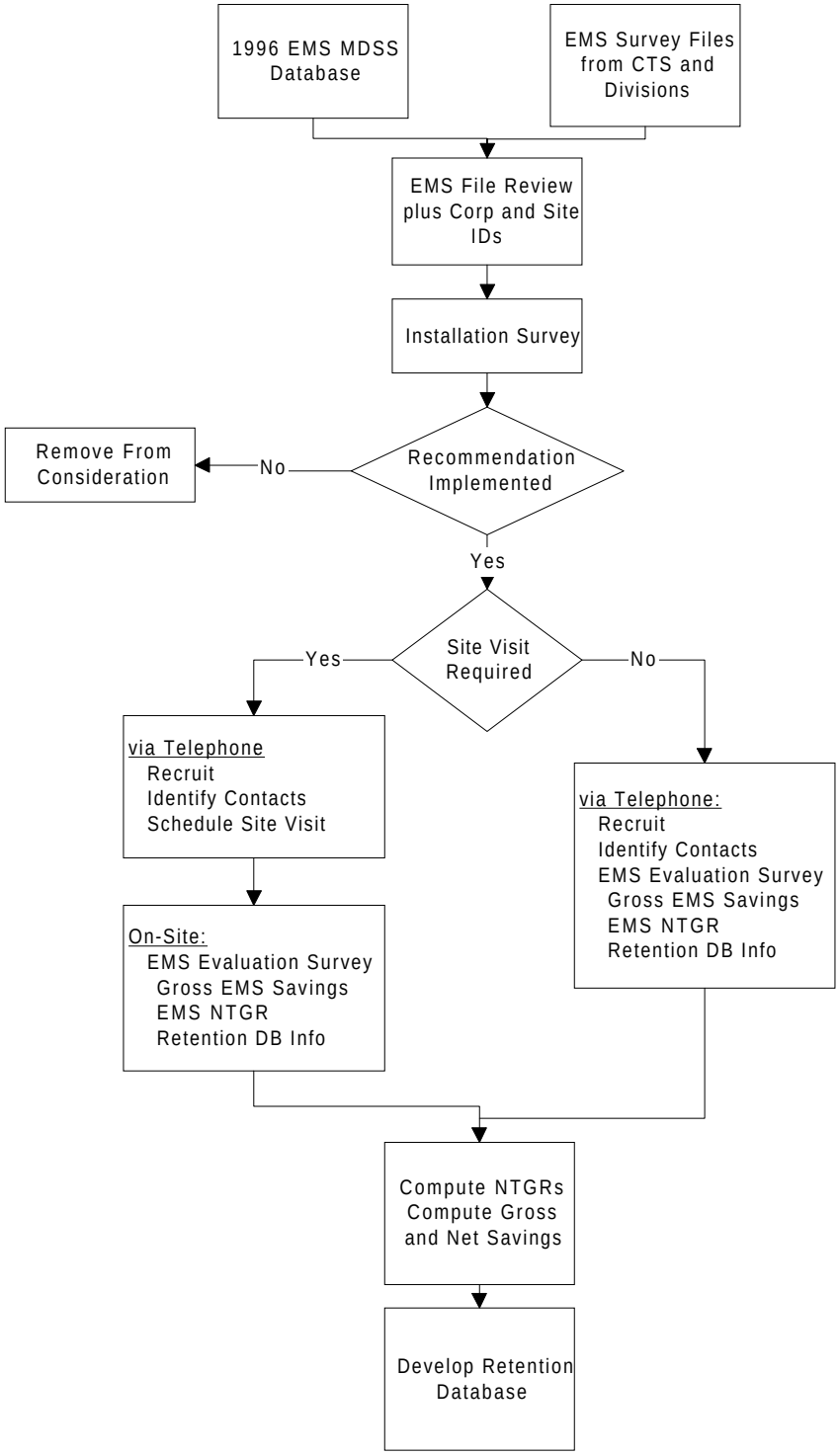


Figure 2-1 Summary of Site Evaluation Process

Evaluation Survey objectives common to both types of sites were:

1. Identification of the persons best able to provide information on the as-built characteristics of implemented recommendations and free-ridership.

2. Collection of the data needed to calculate gross savings for implemented recommendations.

3. Collection of data from the EMS Decision-Maker needed to compute a Net-To-Gross Ratio that accounted for free-ridership.

4. Collect data needed to complete the retention database for each recommendation (location of measure or practice and, as needed, make and model for measures).

As shown in Figure 2-1 the site evaluation process concluded with the analysis of data obtained from the Evaluation Survey. Gross and net savings (kWh, kW and Therms) were estimated for the implemented EMS recommendations at all sites for which analysis was performed. The results of the analyses and data from the Evaluation Survey were added to the evaluation database that was used in the program-level analysis of the EMS program. Finally, data from the EMS Surveys were used to create the retention database for 1996 EMS recommendations.

2.3 Program-Level Impact Analysis

Gross savings were estimated for all recommendations in the participant sample frame, except for cases where customers refused to participate or savings were identified as trivial. For 11 recommendations, gross savings could not be calculated because the Evaluation Survey was not completed. In these cases, gross savings were extrapolated from the analyzed participants. Specifically, average gross savings for all analyzed recommendations of the same type were used in the extrapolation. In two other cases, the recommendations for which analysis was missing were unique in the sample and no extrapolation was performed. These two recommendations were excluded from the program-level analysis.

2.4 Compliance with M&E Protocols

The evaluation of the 1996 Industrial EMS program must comply with Tables 5, 6, 7, and C-11 of the Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management (DSM) Programs (Protocols), as revised in January 1997. This evaluation is in strict compliance with the requirements contained in the relevant Protocol tables presented in Table 2-1 below. Appendix E presents the results of this evaluation as required by Tables 6 and 7 of the Protocols.

Table 2-1: Relevant Protocol Tables for the Evaluation of Industrial Incentive Programs

Table	Pertaining To:
5	Protocols for the general approach to load impact measurement
6	Protocols for reporting of results of impact measurement studies used to support an earnings claim
7	Documentation protocols for data quality & processing
C-11	Impact measurement protocols for the Energy Management Services programs

The methods, described in this report for estimating NTGRs, are in full compliance with the 1997 AEAP-adopted Appendix J of the Protocols, the *Quality Assurance Guidelines for Statistical, Engineering, and Self-Report Methods for Estimating DSM Program Impacts* (QAG). More specifically, this evaluation is in full compliance with Chapter 4 of the QAG that concerns the self-report method. Note also that the 1997 AEAP-adopted language in Table 7 refers to Appendix J for those utilities that are relying on participant self report in estimating net-to-gross ratios.

This evaluation is also in full compliance with recent unanimous agreements made by the CADMAC Modeling and Base Efficiency Subcommittees regarding certain unresolved issues in Chapter 4 of the QAG. These agreements concern the proper handling of:

- accelerated installations (deferred free-ridership)
- unresolved inconsistencies
- third-party influence
- the use of qualitative information

Engineering models were used to estimate gross impacts. However, Table C-11 indicates that: "The end use consumption and load impact model will be either a load impact regression model, CE, or regression model supplemented by engineering models." This requirement is inconsistent with Table C-5 of the Protocols which allows for the use (not just the *supplemental* use) of engineering models in estimating program impacts. We believe that this inconsistency is an oversight. If engineering models can be used in the industrial rebate program, then it would follow that they can be used in a program with smaller impacts and earnings.

3. Sample Design

3.1 Sample Frame and Study Domain

The development of a sample frame began with an analysis of the MDSS database records for EMS surveys completed in 1996. The database provided by PG&E contained records for 1,157 recommendations associated with 416 on-site EMS surveys. PG&E informed the study team that there were two significant flaws in this database:

1. For an unknown number of surveys, not all of the recommendations submitted to the customers were recorded in MDSS.

2. The status of all recommendations (*i.e.*, how many had been implemented with or without a rebate) was unknown.

Given these two limitations on the MDSS database, additional data were needed to develop a sample frame for this evaluation. The following two data collection efforts were completed:

1. EMS Survey files were acquired from each of PG&E's 18 divisions. Survey files contained analyses from both division staff and from PG&E's Customer Technical Services (CTS). Division staffs were able to locate files for 351 of the 416 surveys. These files were reviewed to verify and correct entries for recommendations, which were found in MDSS. We also added records for 325 recommendations, which had not previously been entered in MDSS.

2. Installation Surveys were completed for 1,271 recommendations from 349 surveys using the customer contacts listed in MDSS or on the EMS survey files (88.8% of the 1,482 recommendations

following the EMS file review process) to determine the status of the EMS recommendations. Prior to conducting the Installation Surveys, unique Site Ids and Corporate Ids were assigned to each survey based on customer name and address information obtained from MDSS and the EMS survey file reviews. 387 unique EMS sites were associated with the 409 surveys found in MDSS. EMS Site Ids were cross-referenced with the Site and Corporate Ids established for the 1996 rebate evaluation. This allowed us to group the EMS surveys by corporation in order minimize the number of customer contacts. It also allowed us to coordinate these contacts with the rebate evaluation as 61 of the 1996 EMS sites were also 1996 rebate evaluation sites.

After completion of the Installation Surveys, 16 recommendations identified as duplicates and 159 recommendations not belonging to the HVAC, lighting or process end uses were removed from further consideration. This yielded a total of 1,307 recommendations across 408 EMS surveys.

There were 188 recommendations in the sample for which the Installation Survey was not conducted. EMS survey files were not available for 26 of these recommendations and these were dropped from further consideration due to a lack of documentation to support analysis. The remaining 162 consisted of 47 HVAC, 91 lighting and 24 process recommendations. Gross savings values were assigned to these recommendations based on average savings determined from the analyzed sample for comparable recommendations within the same end use. End-use-average realization rates were applied and the results were summed within each end use. This yielded savings that were approximately 7%, 15% and 3% of the total gross evaluation savings for the HVAC, lighting and process end uses, respectively. Since these extrapolated estimates were a sufficiently small fraction of the evaluation savings estimates, it was concluded that they should be excluded from the evaluation estimate of gross savings. This reduced the sample size to 1,119 recommendations among 348 surveys.

The Installation Survey data were used to determine the status of 1,119 recommendations. Of these, 744 measures had not been implemented. It was determined that 214 had been implemented but either PG&E had already paid the customer a rebate or the customer was expecting to receive a rebate. 144 recommendations (78 of which are O&M practices) were found that had been implemented, where savings were not trivial, no rebate had been paid and none was expected. In addition, 17 had been implemented but were found to have trivial savings, based on a preliminary engineering review. Recommendations identified as having trivial savings were assigned gross savings values of zero and added back into the sample, yielding a total sample size of 161 recommendations. These recommendations are associated with 117 1996 EMS surveys (113 unique sites), which constitute the participant sample frame for this evaluation. However, respondents for five of these sites refused to participate in the Evaluation, for one of the surveys the site contact was never reached and for another site no one knowledgeable about the survey could be found.

The participant sample frame was used for the purpose of estimating the 1996 EMS program gross and net savings and for establishing the retention panel. A census of the participant frame was attempted.

3.2 Recruitment

The sample frame for this study was limited to those sites for which it was possible to complete the Installation Survey. Through this survey, a good contact was identified for further data collection. In addition, each respondent was asked if they would allow an on-site visit if needed to collect data on the systems affected by the EMS recommendations. For the On-Site participants, this established a precedent for requesting permission for an on-site visit at the time of the Evaluation Survey.

3.3 Sample Disposition

As shown in Table 3-1, a total of 409 unique surveys were performed in the 1996 IEMS Program. No survey file was provided for 58 of those surveys, and only two of the remaining 351 had Installation Surveys that could not be completed. Successful Evaluation Surveys (*i.e.*, Evaluation Surveys for which at least one recommendation was successfully analyzed) were performed for 99 of the original EMS Surveys.

Also shown in Table 3-1 is that the final program sample frame consists of 161 recommendations at 113 sites. The table shows their disposition, both by end use and overall, itemized by the reasons for Evaluation Surveys not being performed. The predominant reason (17 participants or 10.6% of the sample frame) for not performing an Evaluation Survey was that the savings were expected to be trivial, followed by customer refusal to participate (8 participants, or 5.0% of the sample frame). Overall, evaluations were performed for 134 recommendations, comprising 83.2% of the total number.

Table 3-1: Final Sample Disposition

	HVAC	Lighting	Process	Total
Surveys[1]				
1996 EMS Surveys (no duplicates)	--	--	--	409
File Reviews Performed	--	--	--	351
Successful Installation Surveys	--	--	--	349
Successful Evaluation Surveys	--	--	--	99
Recommendations				
Evaluation Completed[2]	57	44	30	131
Trivial Savings (Assumed = 0)	4	12	1	17
Customer Refused On-Site Survey	2	2	2	6
Customer Refused Phone Survey	1	1	0	2
Customer Refused to Answer	1	0	0	1
Lack of Knowledge	0	2	0	2
Insufficient Information for Analysis	1	0	1	2
Sample Frame	66	61	34	161

Note: 1 - No end-use breakdown is provided because Surveys may have multiple end-uses.
2 - Evaluation Survey completed for at least one recommendation.

4. Data Collection and Application

A site-specific, engineering-based methodology was used to estimate gross savings for the 1996 EMS program. A self-report methodology was used to estimate the effects of free-ridership and thus net savings. The following describes the data collected to support the gross and net savings methodologies and how these data were applied.

4.1 PG&E's Program Database

To obtain credit for an EMS survey, PG&E's division staff must enter energy savings potential for at least two end uses or one end use and an energy balance. Entries are made in the MDSS program database for each survey performed and for some or all of the recommendations provided in each survey. These data were used to create a list of surveys completed in 1996.

4.2 PG&E's EMS Survey Files

Project files from PG&E's divisions were reviewed both to ensure accuracy of existing MDSS information and to obtain data missing from MDSS. Site information regarding corporate name, site address, contact name and telephone number was reviewed for accuracy. Recommendations were also reviewed to make sure descriptions, end uses and energy savings had been correctly entered into the MDSS.

Files were also reviewed for recommendations not entered in the MDSS database. A file review database was created from the MDSS database, updated to reflect changes and additions resulting from the file review.

The project files were found to vary widely in content. In some cases, the file consisted of a single page briefly summarizing the recommendations. In more complex cases, detailed technical reports prepared by consultants and complete records of communications were available for review. In all cases, a complete review of the file was performed.

4.3 EMS Installation Survey

Because neither the MDSS database nor the project files could provide information regarding the status of the recommendations, it was necessary to conduct a telephone survey of all customers that received on-site EMS surveys in 1996. This survey was designed primarily to identify, on a site-by-site basis, which EMS recommendations customers had installed without the benefit of a PG&E rebate. Installed recommendations for which the customer had already received a rebate, applied for a rebate, or intended to apply for a rebate were excluded from the Evaluation sample. This survey also served as a recruiting tool to identify the person who could authorize site visits by the Evaluation team and to obtain a preliminary commitment to participate in the Evaluation process. 349 Installation Surveys were successfully completed.

Data obtained from the Installation Survey were used to update and expand the file review database.

4.4 EMS Evaluation Survey

For each sampled participant, data collection for the Evaluation Survey began with a telephone contact to obtain the customer's agreement to participate in the survey and to identify the contacts best able to provide information for each portion of the survey. For Telephone Evaluation Surveys, the survey engineer attempted to complete the survey in this first telephone contact.

For On-Site Evaluation Surveys, a site visit was also scheduled during the initial telephone contact. The only difference between the On-Site and Telephone Surveys was that the former provided an opportunity for the survey engineer to obtain data from direct observation or measurement at the site, while the latter relied on the site contact(s) to provide the required information via the telephone.

For both site types, data required to estimate gross annual savings for each installed, non-rebated recommendation were obtained. This information was entered on data collection forms designed to ensure all necessary data were obtained for each recommendation.

For each recommendation, a Decision-Maker Survey was performed with the appropriate site contact. This survey (included as Section 3 of Appendix B) gathered information regarding the influence of the EMS Survey on the recommendation's installation. This information was then used to calculate a net-to-gross-ratio (NTGR) which was subsequently used to convert the gross savings for each recommendation to a net savings.

During the Evaluation Survey, information was also gathered for development of the retention panel. This information included the location of the installed equipment; the number of items installed; the number of items operating; and, as appropriate, the make and model number of the equipment.

5. Methodology for Engineering Estimates of Gross Impact

5.1 Recommendation-Specific Analysis

Our preliminary engineering review of the EMS recommendations indicated that each division was allowed the latitude of defining its own methods for estimating gross savings. It was also discovered that savings had not been estimated for nearly a quarter of the recommendations.

Algorithms were developed for each unique type of recommendation in the sample frame. They were based on engineering principles and were designed to yield electric demand (kW), electric energy (kWh) and natural gas (therm) savings, as appropriate. Data collected in the Evaluation Survey were implemented in the algorithms to determine gross savings for each recommendation. The algorithms were developed in three groups corresponding to the HVAC, lighting and process end uses. For data that could reasonably be estimated (*e.g.*, heating value of natural gas) and for which it was unlikely the information would be readily available, default values were provided. Both primary and, when applicable, alternative (simplified) methods for calculating gross savings were defined to increase the likelihood of obtaining appropriate data for all recommendations. A list of algorithms used is provided in Table 5.1. Each of the algorithms used for this study appears in Appendix C.

General approaches to algorithms used for each end-use follow.

5.1.1 HVAC Algorithms

HVAC recommendations were predominantly related to O&M practices (89% of the sample frame recommendations), all of which affected only cooling energy consumption. The algorithms addressing these practices followed a general approach of determining energy consumption and demand for a baseline condition and assuming a percentage of that baseline as the energy savings. The percentages used were obtained from a search of relevant literature.

Each of the HVAC O&M algorithms provided a preferred method and an alternate method to estimate gross savings. Both methods used DOE2 prototype models employing climate zone weather data specific to the site to identify baseline energy performance. The preferred method estimated baseline demand from survey data of cooling equipment capacity and efficiency, then applied an equivalent full-load cooling hours (EFLCH) factor based on the prototype to determine energy consumption. The alternate method used a cooling-specific energy-use index (EUI) from the prototype model. The EUI is an annual energy consumption value normalized to the area of the affected space. Baseline energy consumption

was adjusted to the site by a ratio of the site area to the prototype area. Baseline demand was determined as the baseline energy consumption divided by EFLCH.

The only measure-related HVAC recommendation was to adjust thermostat settings and/or schedules. Gross savings for these recommendations were determined through the use of DOE2 prototype simulations extrapolated on a floor area or equipment capacity basis.

ID	End-Use	Measure or Practice	Frequency	Recommendation
H04	HVAC	P	11	Thermostat Settings
H07	HVAC	P	48	HVAC O&M
* H10	HVAC	M	2	HVAC Other
* H11	HVAC	M	1	Change/Add Evaporative Cooler
H14	HVAC	M	1	Window Awnings
* T03	HVAC	M	2	Building Shell Insulation
L01	Lighting	M	44	Lighting Capacity Measures (Indoor)
L02	Lighting	M	4	Lighting Capacity Measures (Outdoor)
L03	Lighting	P	5	Lighting Control Measures (Indoor)
* L04	Lighting	P	2	Lighting Control Measures (Outdoor)
* L05	Lighting	P	5	Lighting O&M
P02	Process	M	1	Boiler Economizer
* P03	Process	P	1	Adjust Boiler Air/Fuel Ratio
* P04	Process	P	1	Feedwater Treatment
P05	Process	P	1	Condensate Return
P08	Process	P	3	Repair Compressed Air Leaks
* P10	Process	M	2	Reduce Compressed Air Load
* P11	Process	M	1	Convert from Compressed Air to Blowers
P13	Process	M	7	Process Premium Efficiency Motors
P14	Process	P	1	Change Air Compressor Schedule
P16	Process	P	1	Process Pump Operation (Chilled Water)
P20	Process	M	3	Insulate Steam Lines
* P30	Process	P	1	Retube Boiler
P31	Process	P	1	Reset Chilled Water Temperature
P32	Process	M	1	Process Motor/Pump Downsizing
* P34	Process	P	1	Steam Trap O&M
P35	Process	M	1	Combustion Air Preheat for Gas-Fired Boiler
P36	Process	M	1	Air Compressor Change & Storage
P37	Process	M	1	Air Compressor System Modification
* P39	Process	M	1	Combustion Air Preheat for Wood-Fired Boiler
* P40	Process	P	1	Compressor Low Unload Control
* P50	Process	M	1	Air Compressor - Install Low-Pressure System
P52	Process	M	1	Replace Air Compressor w/ More Efficient Compressor
* P53	Process	P	2	Boiler O&M (General)
* P55	Process	M	1	Process Controls

* Algorithms that were never applied because savings were determined to be zero before analysis.

Table 5-1. Descriptive List and Frequency of Algorithm Application

5.1.2 Lighting Algorithms

Interior lighting recommendations involved either a reduction in lighting connected load (capacity measures) or changes in controls. Both used the number of affected fixtures, fixture watts and a utilization factor to determine demand. For the lighting capacity measures, the difference between baseline and as-built fixture watts was used in determining demand savings. Energy savings were then determined from demand savings and annual hours of operation. For control measures, electric energy savings were determined using as-built demand and the difference between the baseline and as-built annual hours of operation.

Gross savings for all lighting measures required adjustment to account for interactions with the HVAC system. Heating and cooling interaction factors were developed as needed for different types of spaces in different climate zones. DOE2 prototype models were used to develop these interaction factors. The result was to increase cooling savings because decreased lighting energy consumption reduces cooling loads, and to increase heating consumption for converse reasons. In the case of gas heat, a "therm takeback" value resulted.

Lighting O&M practices employed the same algorithms. Delamping practices used the lighting capacity algorithm, whereas simply switching off the lights used the control algorithm.

5.1.3 Process Algorithms

Process algorithms followed a general pattern of using either a preferred or an alternate method to determine baseline demand and energy consumption. For the process end use, the preferred method used equipment-specific metered data to establish baseline consumption whenever it was available. If not, baseline performance was determined from parameters appropriate to the system being studied. As-built conditions were then calculated according to measure- or practice-specific algorithms. Boiler, process refrigeration and compressor systems were the only process-related systems in the participant sample.

Savings due to boiler measures were based on data specific to as-built boiler performance. Savings from O&M practices for boilers were determined as a percentage of baseline consumption. The percentages used were based on a review of relevant literature. Methods used for compressed air measures were similar to those used for boilers.

5.2 Program-Level Gross Impacts

Program-level gross impacts were computed by summing recommendation-level gross impacts. Before this could occur it was necessary to estimate gross savings for a small group of recommendations for which it was not possible to complete the engineering estimates. This was accomplished by first aggregating the non-missing savings for groups of similar recommendations. Each of the recommendations with missing savings was assigned to one of these measure groups. The average savings for the group was used as an estimate of what the evaluation savings would have been if we had been able to complete the engineering calculation for the recommendation with missing savings. This approach provided 4.8, 1.8 and 3.1% of the total gross kW, kWh and therm savings, respectively. Two of the recommendations with missing savings did not match any of the groups of similar measures. The savings for these were left missing and thus do not contribute to the sum of gross savings for the program.

Recommendations determined to have trivial savings were excluded from the Evaluation Survey, but were included in the gross savings calculations with assigned savings of zero.

6. Methodology for Estimates of Net Impact

In addition to the gross savings analysis described in the preceding section, we also performed various analyses to estimate the net impact of the program. These analyses examined the effect of free-ridership on the gross kW, kWh, and therm savings for each implemented efficiency recommendation, as well as for each end use.

6.1 Net Impact for Each Implemented Recommendation

6.1.1 Recommendations with Decision-Maker Interview Data

We computed a net-to-gross ratio (NTGR) for each implemented recommendation based on data collected from the decision-maker interview portion of the EMS Evaluation Survey (refer to Section 3 of the Evaluation Survey in Appendix B). The decision-maker portion of the survey contained a series of questions that provided data on the customer's motivations for implementing the EMS recommendations. These questions explored the degree of influence that the PG&E recommendation had on the customer's decision to implement. For each recommendation with a completed decision-maker portion of the EMS Evaluation Survey, question responses were processed with an algorithm to calculate a core NTGR. This NTGR was applicable to the kWh, kW, and therm savings associated with each recommendation. When multiplied by the estimate of gross savings for the recommendation, the NTGR yielded a corresponding net savings estimate.

The decision-maker interview in the EMS Evaluation Survey contained three types of questions relevant to the recommendation-level NTGR. The five core NTGR questions comprise the first type of questions. Each of these questions asks, in a somewhat different way, what the influence of the recommendation was on the implemented action. The five core questions were:

1. How much influence did the PG&E recommendation have on your decision to [describe implemented recommendation]?

2. If the PG&E recommendation for this action had not been made, how likely is it you would have done exactly the same thing [if equipment was installed that has specific efficiency ratings such as SEER, COP, KW/TON add—with the same efficiency rating]?

3. The recommendation was nice but it was unnecessary to cause the [describe recommendation] to be implemented.

4. The recommendation was a critical factor in implementing [describe recommendation].

5. We would not have implemented the [describe recommendation including its efficiency rating if applicable] without the recommendation.

For each question, the decision-maker was asked to provide a rating from 0 to 10 for each recommendation, with 10 meaning a great deal of influence in the first question, very likely for the second, and completely true for the third, fourth, and fifth questions. The core NTGR was estimated by first subtracting the answers for the second and third questions from ten (thereby standardizing the responses, so that a high response indicated large PG&E influence for all questions). We then took the mean of the answers to these five questions.

The second type of question assessed when PG&E made the recommendation to the customer in relation to when the customer actually implemented the action. The decision-maker interview listed a series of three such questions, the last of which was the critical question used in the analysis:

- Did PG&E make the recommendation BEFORE or AFTER you [describe implemented recommendation]?

This question, called the *recommendation-timing question*, checks for consistency against the five core questions. For instance, if the answer to the recommendation-timing question indicates that the customer implemented an action before receiving the recommendation, a NTGR of zero is implied. If the core NTGR is not zero, then an inconsistency exists between the core questions and the recommendation-timing question. Such an inconsistency required a decision on what aspects of the decision-maker's answers to believe or to weight heavily. The inconsistency was usually addressed in the course of the interview. We handled remaining inconsistencies during the analysis, as described at the end of this section.

The third question type was a single question that provided both a consistency check and an explanation for answers to other questions. This question, known as the *role question*, asked directly what the role of the recommendation was in the decision to implement the action. The decision-maker could provide one or more of these responses, saying that the recommendation did the following:

1. Reminded us of something we already knew

2. Speeded up the process of what we would have done anyway

3. Showed us the benefits of this action that we didn't know before

4. Clarified benefits that we were *somewhat* aware of before

5. Recommendation had no role

6. Other

The answer or answers to this question helped us resolve apparent conflicts in answers to other NTGR questions. In addition, they helped us understand how customers viewed the PG&E recommendations.

In most cases, the NTGR was calculated simply by averaging the responses to the five core questions. The result was questioned only when the decision-maker indicated that the recommendation was received only *after* the action was already implemented. When such an answer was given *and* the core NTGR questions resulted in a NTGR of zero, then that core NTGR was allowed to stand. When the NTGR was not zero, we consulted the answers to the core questions and the role question. Such conflicts occurred in six cases. In five of those cases, the information that the recommendation came after the action seems to be in direct contradiction to all of the other answers to the core questions and the role question. Because all six of the other questions indicated that the recommendation had an impact, the recommendation-timing question was judged to have been measured with error. Thus, the NTGR was taken to be the average of the five core NTGR questions. In the sixth case, all but one of the core questions implied a NTGR of zero, as the answer to the recommendation-timing question also implied. In this case, the NTGR was set to zero. In all other cases, there was no apparent conflict among the various questions.

6.1.2 Recommendations without Decision-Maker Interview Data

For implemented recommendations in which we were unable to complete decision-maker interviews, we applied average end-use-level NTGRs. We determined three average NTGRs for each end use, one each for kW, kWh, and therm savings. For each, we used the respective savings as weighting factors in calculating a weighted mean NTGR for each end use and fuel type. The appropriate average end-use-level NTGRs were then assigned to all implemented recommendations with missing NTGRs. Finally, gross kW, kWh, and therm savings for each recommendation were multiplied by the corresponding average NTGR to yield net savings estimates.

6.1.3 End-Use and Program-Level NTGRs

The procedures described above produced adjusted gross and net savings estimates for all implemented recommendations. The end-use and program-level NTGRs were calculated by summing the gross and net kWh, kW, and therm savings for all items within the group. Dividing each net savings sum by the corresponding gross savings sum produced NTGRs for kWh, kW, and therms within each end use and the program overall. This method essentially weights the raw recommendation-level NTGRs by kWh, kW, or therm savings to calculate an aggregate NTGR.

6.1.4 NTGR Confidence Intervals

We calculated a mean and standard error for all NTGRs in the implemented recommendation group. Using these numbers, the 80% and 90% confidence interval were then calculated as follows:

$$\bar{y} \pm t s_{\bar{y}}$$

where t = the critical value from the t distribution
s = the standard error of $\bar{y}$, the net-to-gross ratio.

The critical values of t for the 80% and 90% levels of confidence are 1.28 and 1.64 respectively.

7. Results of the Engineering Analysis of Gross Impact

7.1 Summary of the Gross Impact Evaluation Methodology

Energy savings were estimated for each recommendation in the sample frame, with the exceptions of sites where customers refused the Evaluation Survey and recommendations had obvious trivial or zero savings. For recommendations determined to have trivial or zero savings, savings were set equal to zero and no analysis was performed. Savings for recommendations for which savings could not be calculated were set equal to the average for similar recommendations whose savings were calculated.

All savings estimates were entered into a database where they could be grouped according to recommendation type (*i.e.*, equipment measure or O&M practice) or end-use. Evaluation savings have been reported by both end-use and by recommendation type. Gross realization rates were also calculated for electric demand (kW) and consumption (kWh) and for natural gas (therm) savings. Realization rates could only be reported on an overall program basis because no breakdown of program savings by end-use or recommendation type were included in PG&E's E-Table filing for the EMS program.

7.2 Gross Savings and Realization Rates

Table 7-1 provides results of the gross evaluation savings and realization rate calculations. Realization rates could only be determined for the overall program because no end-use or recommendation-type breakdowns of program savings were included in the E-Table filing for the EMS program. Table 7-1 shows that, for the participants in the study, the natural gas evaluated savings were just over twice the program-estimated savings. On the other hand, electric energy savings were less than half the program estimate. Evaluated demand savings were 7% greater than the program estimate.

The process end-use provided the greatest energy savings for both electric and gas fuels; however, the HVAC end-use provided the greatest reduction in demand. Gas savings for the lighting end-use were negative due to "therm takeback" experienced when reduced internal loads have to be at least partially made up by the HVAC system.

With respect to recommendation types, the evaluation shows equipment measures provided 98% of the therm savings while electric energy savings were nearly evenly split between equipment measures and O&M practices. O&M practices provided 83.5% of the demand savings, mostly in the HVAC end use.

	No. of Recommendations	kW	kWh	Therms
Program Totals	161			
Program Savings		250.2	1,900,651	112,999
Evaluation Savings		266.7	890,315	229,648
Gross Realization Rate		1.07	0.468	2.03
End Use Evaluation Savings				
HVAC	66	171.0	117,416	3,693
Lighting	61	18.93	74,856	-344.3
Process	34	76.72	698,044	226,299
Measure Evaluation Savings				
HVAC	7	0.71	5,581	-45.00
Lighting	55	18.93	74,856	-344.3
Process	21	24.19	372,737	226,299
Measure Total	83	43.83	453,174	225,910
Practice Evaluation Savings				
HVAC	59	170.3	111,835	3,738
Lighting	6	0	0	0
Process	13	52.53	325,307	0
Practice Total	78	222.8	437,142	3,738

Table 7-1. Program Gross Savings and Realization Rates, and Gross Evaluation Savings by End-Use and Recommendation-Type

8. Results of Net Impact Analysis

In this section, the net impacts and NTGRs for kWh, kW, and therms will be presented at both the end-use and program level. Before reporting these NTGRs, a short discussion of the reliability of the core NTGR questions will be presented.

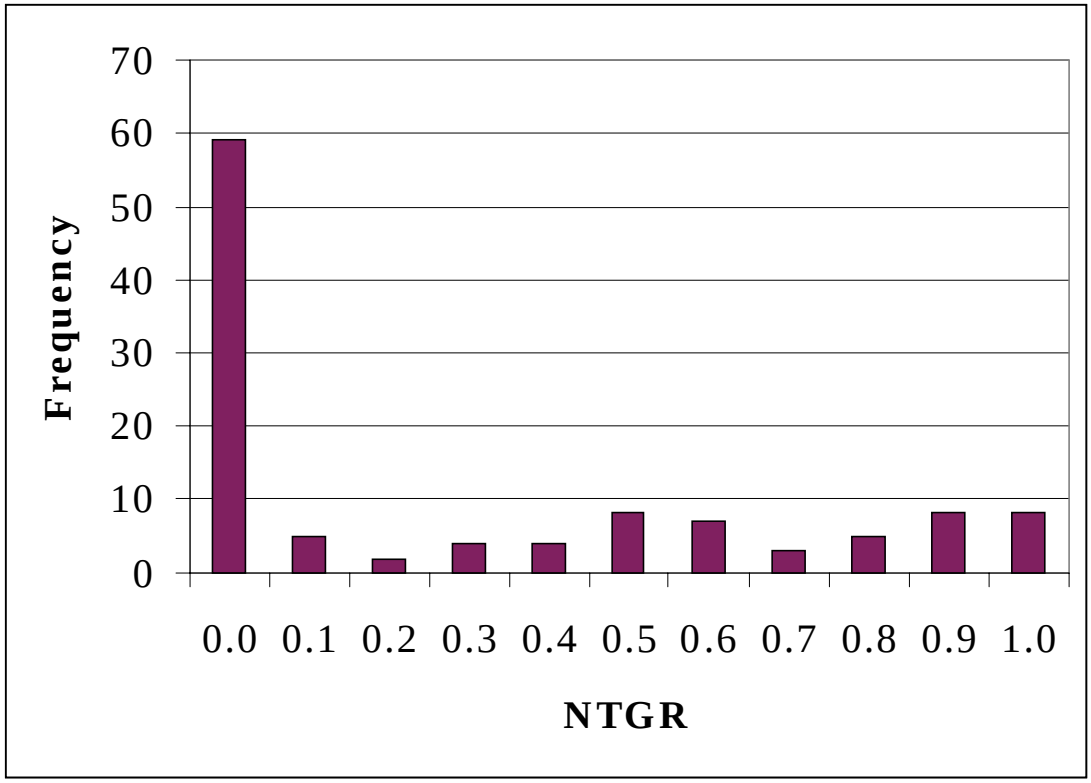
8.1 Reliability of Core NTGR Questions

As indicated in Section 6.1.1, the core NTGR was based on answers to five questions in the decision-maker interview. The Cronbach's alpha for the five questions is 0.98, well above an acceptable level of reliability. Removing any one of the questions from the scale would result in no substantive difference in reliability. This means that one or more questions could be removed with no negative effects on reliability. However, it is also true that there are no negative effects from keeping them all. For the sake of consistency over time and other studies, the decision was made to use all five questions in the core NTGR.

8.2 NTGR Results for Implemented Recommendations

We calculated an NTGR for 113 implemented recommendations with decision-maker survey data. These 113 represent 70% of the 161 evaluated recommendations. Figure 8-1 presents the distribution of the NTGRs. This frequency distribution shows many of the implemented recommendations had no net savings.

Figure 8-1: Distribution of NTGRs for Implemented Recommendations



8.3 Net Savings by End Use and Recommendation Type

Table 8-1 presents the number of recommendations, evaluated gross impacts, evaluated net impacts, and the corresponding NTGR, broken down by the three end uses, HVAC, lighting, and process. Table 8-2 shows the same results for the two recommendation types, measure and practice. Both tables also list 90% confidence intervals for the NTGRs.

As one can see from Table 8-1, lighting has the greatest net kW savings, while process has the greatest therm and kWh savings. The overall NTGRs are 0.535 (kW), 0.664 (kWh), and 0.493 (therms). By end use, lighting had the highest kW and therm NTGRs, while process had the highest kWh NTGR. Note that evaluated lighting gross and net therm savings were negative (as a result of efficient lighting increasing the heating load for buildings).

Table 8-2 shows that practice recommendations had the largest net savings and NTGRs for both kW and kWh. Measure recommendations accounted for the bulk of the net therm savings, and also had a slightly higher therm NTGR.

Table 8-1: Net Impacts by End Use

	kW	kWh	Therms
Total			
No. of Recommendations	161	161	161
Evaluated Gross Savings	267	890,315	229,648
Evaluated Net Savings	143	591,265	113,214
Evaluation Net-to-Gross Ratio	**0.535**	**0.664**	**0.493**
90% Confidence Interval	+/-0.056	+/-0.056	+/-0.056
Program Net Savings	250	1,900,651	112,999
Net Realization Rate	**0.571**	**0.311**	**1.002**
HVAC			
No. of Recommendations	66	66	66
Evaluated Gross Savings	171	117,416	3,693
Evaluated Net Savings	94	61,613	1,971
Evaluation Net-to-Gross Ratio	**0.547**	**0.525**	**0.534**
90% Confidence Interval	+/-0.078	+/-0.078	+/-0.078
Lighting			
No. of Recommendations	61	61	61
Evaluated Gross Savings	19	74,856	-344
Evaluated Net Savings	12	44,817	-254
Evaluation Net-to-Gross Ratio	**0.622**	**0.599**	**0.739**
90% Confidence Interval	+/-0.097	+/-0.097	+/-0.097
Process			
No. of Recommendations	34	34	34
Evaluated Gross Savings	77	698,044	226,299
Evaluated Net Savings	37	484,836	111,498
Evaluation Net-to-Gross Ratio	**0.487**	**0.695**	**0.493**
90% Confidence Interval	+/-0.129	+/-0.129	+/-0.129

Table 8-2: Net Savings by Recommendation Type

	kW	kWh	Therms
Total			
No. of Recommendations	161	161	161
Evaluated Gross Savings	267	890,315	229,648
Evaluated Net Savings	143	591,265	113,214
Evaluation Net-to-Gross Ratio	**0.535**	**0.664**	**0.493**
90% Confidence Interval	+/-0.056	+/-0.056	+/-0.056
Program Net Savings	250	1,900,651	112,999
Net Realization Rate	**0.570**	**0.311**	**1.002**
Measure			
No. of Recommendations	83	83	83
Evaluated Gross Savings	44	453,174	225,910
Evaluated Net Savings	16	280,709	111,202
Evaluation Net-to-Gross Ratio	**0.368**	**0.619**	**0.492**
90% Confidence Interval	+/-0.085	+/-0.085	+/-0.085
Practice			
No. of Recommendations	78	78	78
Evaluated Gross Savings	223	437,142	3,738
Evaluated Net Savings	127	310,556	2,012
Evaluation Net-to-Gross Ratio	**0.568**	**0.710**	**0.538**
90% Confidence Interval	+/-0.071	+/-0.071	+/-0.071

Appendix A

Measure Installation Survey Instructions
1996 Industrial EMS Program Evaluation

1. Interview Instructions for EMS Installation Survey

1.1 Purpose

The primary purpose of this EMS Installation Survey is to determine which of the energy efficiency measures recommended by PG&E in 1996 through its EMS program have been installed or implemented (some measures may not require the installation of equipment, just the implementation of changes in operating procedures) by the customer. The EMS Installation Survey also helps to identify measures for which PG&E has paid a rebate or for which the customer intends to apply for a rebate. Finally, for those sites where measures have been installed or implemented the survey determines whether the customer is willing to allow an on-site inspection.

1.2 Selection of Respondent

The respondent to this survey should be a person who is familiar with actions taken by the company in response to the recommendations made in the 1996 Industrial EMS Survey(s) (PG&E refers to its audits as "surveys"). Start with the contact listed on the Preliminary EMS File Review Report. If more than one recommendation was made, it may be necessary to speak with more than one person to determine what action was taken by the company.

1.3 How these Data are Used

The information from the EMS Installation Survey will be combined with the data obtained from the EMS program files to determine which recommendations resulted in installed or implemented measures for which no rebate was paid by PG&E. All subsequent data collection for the EMS evaluation will focus on these measures.

1.4 Preparing for the Installation Survey

Complete the following steps before administering this survey:

1. Review the Preliminary EMS File Review Report for each 1996 EMS Survey (PG&E's audits) completed for each site. If needed, review the attached survey paperwork provided by PG&E.

2. Some surveys contain clear evidence that a rebate has been paid for one or more recommended measures. **Do not include these recommendations in the installation survey**.

3. For each recommendation, make a copy of page EMSINS-2. Pre-fill the header information on these pages. Site ID, EMS Survey Code and Item Number are mandatory. Pre-fill Recommendation if that makes it easier for you to administer the EMS Installation Survey.

4. For each EMS site, make a copy of EMSINS-3. Pre-fill the header information: Site ID and Surveyor Initials.

1.5 After you Complete a Installation Survey

Complete the following steps after administering this survey:

1. Make sure that a response has been recorded from each question.

2. Staple the pages together and submit to Randy.

1.

Measure Installation Survey
1996 Industrial EMS Program Evaluation

1. If you have a contact name, say:

   My name is [your name] from SBW Consulting calling on behalf of the Pacific Gas and Electric Company. May I please speak to [name of contact person]?

2. If there is no contact name or the contact is no longer with the company, say:

   I am conducting an evaluation of the PG&E Energy Management Services program. Your firm received an energy audit from this program in 1996. I would like to speak with someone who is familiar with that audit.

3. If no one knows anything about the audit, contact the PG&E customer representative. If the customer representative can supply a contact name, restart the survey. If no contact name is available, complete the survey by circling the appropriate response to Question 8.

4. Once you find the correct person to talk with, say:

   I am conducting an evaluation of the PG&E Energy Management Services program. Your firm received an energy audit from this program in [Approximate completion date] 1996. I would like to ask you a few questions about the energy efficiency measures recommended by the audit.

5. Ask the following questions for each recommended efficiency measure. The primary contact may not be able to answer these questions for each of the measure. If not, obtain the name and telephone number for the person who can. Call that person to obtain the needed responses.

5.1 Have you [installed | implemented] the [describe recommendation]?

1 Yes, as recommended. Further description of the measure, e.g., type and size of equipment or number of units installed or affected

_____

_____ (**go to 5.4**)

1 Yes, partially. Describe _____

_____ (**go to 5.4**)

2 Recommendation lead to another action. Describe _____

_____(**go to 5.4**)

4 No action taken yet as a result of this recommendation (**continue**)

98 Don't Know (**go to next rec.**) **99** Refused to Answer (**go to next rec.**)

5.2 Do you intend to [install | implement] this measure sometime in the future?

1 Yes (**continue**) **2** No (**go to next rec.**)
3 Maybe (**continue**)
98 Don't Know (**go to next rec.**) **99** Refused to Answer (**go to next rec.**)

5.3 When will you finish [installing | implementing] this measure? (**all responses continue to 5.5**)

1 Less than 6 months **2** 6 months to 1 year
3 More than 1 year
98 Don't Know **99** Refused to Answer

5.4 Have you received a rebate from PG&E for this measure?

1 Yes (**go to next rec.**) **2** No (**continue**)
98 Don't Know (**continue**) **99** Refused to Answer (**continue**)

5.5 Have you applied for a rebate from PG&E for this measure?

1 Yes (**go to next rec.**) **2** Yes, but PG&E refused (**go to next rec.**)
3 No (**continue**)
98 Don't Know (**go to next rec.**) **99** Refused to Answer (**go to next rec.**)

5.6 Do you plan to apply for a rebate from PG&E for this measure? (**For any response, go to next rec.**)

1 Yes
2 No
98 Don't Know
99 Refused to Answer

1.

Surveyor Initials ___ Site ID_____

6. If there are any installed/implemented measures (or ones that the company plans to install/implement), ask for the name of the person who can authorize a site inspection and contact that person. Explain that we: (a) are conducting an evaluation of the audit program for PG&E, (b) may need to inspect some of the audit sites to evaluate the actual savings from the measures, (c) do not know at this time which sites will be included in the inspections. Then ask the following question.

6.1 Would you allow a brief inspection of the [summarize the installed | implemented measures] by a member of our engineering team?

1 Yes (**continue**)
2 Not the Authorization Contact (**continue**)
3 No (**go to 7**)
98 Don't Know (**go to 7**)
99 Refused to Answer (**go to 7**)

If answer is 1 or 2 ➔

Authorization Contact Name _____ Phone _____

6.2 Who should we contact to schedule this inspection?

Name _____

Title/Position _____

Telephone _____

FAX _____

E-Mail _____

7. Thank you for your assistance with this survey.

8. Survey Disposition

8.1 Indicate the final status of the survey for this site.

1 Survey completed successfully.

2 Unable to find anyone who knew about the audit

3 Never able to reach contact

4 Customer refused to complete this survey

5 Customer claims there was no audit in 1996

6 Survey not completed for other reasons

8.2 Date Complete: / / 97

Appendix B

EMS Evaluation Survey
1996 Industrial EMS Program Evaluation

1. Interview Instructions for EMS Evaluation Survey

1.1 Purpose

The purpose of this interview is to gather data needed to:

1. identify appropriate respondents for different portions of the survey, including an onsite visit
2. estimate the Net-to-Gross Ratio (NTGR),
3. make an engineering estimate of gross savings for implemented recommendations,

1.2 Selection of Respondent

Four types of respondents are necessary for this survey; they may be the same person, or they may be different. One respondent is the **decision-maker**. This is a member of the customer's staff who is familiar with the process by which the customer decided to implement the EMS recommendations, or not, at a sampled site. Another category of respondent is the person who can **authorize a site visit**. Fourth, we need to talk to someone who is familiar with the systems affected by implemented EMS recommendations who will be referred to as the **Measure Information Contact**. Protocols for finding each of these respondents are placed at the beginning of the section of the interview that pertains to each type of respondent.

1.3 Two Types of EMS Sites

This survey will be used for two types of sites:

1. **Participants Requiring On-Site Surveys**. Sites with large annual energy consumption or which implemented complex measures or practices, will receive an on-site inspection to evaluate 1996 EMS O&M savings.

2. **Participants Requiring Telephone Surveys**. Sites with small annual energy consumption or which implemented simple measures or practices, will receive a telephone survey to evaluate 1996 EMS O&M savings.

1.4 How Survey is Organized

This survey is organized into four sections. Each section is defined by the content of the questions and the type of respondent required to seven complete it.

1. Section 1 consists of recruitment for the on-site visit; naturally, this pertains only to sites where an onsite is expected, and it, of course, requires talking to someone who can authorize such a visit.

2. Section 2 gathers information that will form the basis of the engineering evaluation of gross savings.

3. Section 3 covers the NTGR questions and is addressed to the decision-maker. It should be repeated for each implemented recommendation

4. Section 4. In this section you will record the disposition of various section of this survey.

1.5 How to Start an EMS Evaluation Survey

Complete the following steps to start one of these surveys:

1. Review the file for the site. Pay specific attention to the Installation Survey.

2. Review the 1996 EMS Recommendations Summary Form in the Site's file. Make sure you understand each of the implemented recommendations.

3. Complete as much of the survey as possible based on information from the installation survey.

4. Contact the person who was the respondent to the Installation Survey, and explain the purposes of the EMS Evaluation Survey. Tell them that the data provided by their firm will be kept strictly confidential and will not be shared with anyone outside of PG&E.

5. If necessary tell them: If you would like the name and telephone number of a person at PG&E who can give you more information about this study, you may call Mary O'Drain at (415) 973-2317.

Site ID _____ EMS Survey ID _____

Section 1
Recruitment for On-Site Visit
For Sites Requiring an On-Site Visit

Respondent: Person Who Can Authorize Site Visit

In some cases, permission for the on-site visit was obtained in the installation survey. If this was accomplished you can **go immediately to Appendix B of the handbook: Site Scheduling Form and Contact Log**.

If not, contact the person who can authorize the on-site visit (this may be on the installation survey).

Name _____

Title/Position _____

Telephone _____

FAX _____

E-Mail _____

Contact this person and obtain permission to conduct the on-site visit.

When you have obtained permission for the on-site visit, follow the instructions provided in the Site Scheduling Form and Contact Log.

Site ID _____ EMS Survey ID _____

Section 2
Gross Savings Estimates for Implemented EMS Recommendations

Respondent: Measure Information Contact

The purpose of this section of the interview is to collect data needed to calculate gross savings for each of the implemented recommendations.

The first step for all types of sites (On-Site and Telephone-Only) is to make a copy of the applicable Gross Savings Data Collection form for each of the recommendations marked **I** (Implemented) on the 1996 EMS Recommendation Summary Form. These forms specify what information must be obtained.

The next step is to determine who would be the best Measure Information Contact for each recommendation. This would be a person who is well informed about the equipment affected by the recommendation. The form below provides a place to record the Measure Information Contact information for each recommendation.

Name	Firm	Phone	Recommendations to discuss

The final step is to collect the required information. For Telephone-Only sites this will be accomplished via telephone interviews with the Measure Information Contact(s). For sites requiring on-site visits, this will be accomplished by a combination of interviews with various site contacts and inspection of the affected equipment.

Once completed, the Gross Savings Data Collection Forms must be attached to the completed EMS Survey for each site, prior to submitting the EMS Survey form for Quality Control review.

Site ID _____ EMS Survey ID _____

Section 3
Net-To-Gross Ratio Questions for Implemented EMS Recommendations

Respondent: DECISION-MAKER

The purpose of this section is to obtain the information needed to compute a net-to-gross ratio for each implemented recommendation. The implemented recommendations are marked I (Implemented) on the 1996 EMS Recommendations Summary Form for each site. You need to complete this section by interviewing members of the customer's staff who were responsible for the decision to implement each of the recommendations. If this person is not available attempt to locate someone who is at least familiar with how that decision was made. You may have to speak to more than one person if there are different recommendations dealing with different end uses or portions of the customer facility

Contact the person who completed the installation survey and explain the purpose of the entire data collection effort. Then ask who to speak to complete this section of the survey. Record names of the people you need to talk with for this section of the survey in the table below.

Name	Firm	Phone	Recommendations to be discussed

Site ID _____ EMS Survey ID _____ Recommendation Number _____
Recommendation _____

1. When and how did you first learn about PG&E's Energy Management Services Program? (You can explain that it is the PG&E program, which offers surveys of customer facilities and provide recommendations concerning possible energy efficiency measures.) [**Only ask this question <u>once,</u> for the first recommendation for each site.**]

   _____

   1 Didn't know there was a program (**Go to Q.3**)

2. Keeping that in mind, did you learn about the program BEFORE or AFTER you [describe implemented recommendation]? (**Circle One**)

   1 Before **2** After (**Go to Q.4**) **98** Don't Know **99** Refused to Answer

3. Did PG&E make the recommendation BEFORE or AFTER you [describe implemented recommendation]? (**Circle One**)

   1 Before **2** After **98** Don't Know **99** Refused to Answer

4. On a scale from 0 to 10, with 0 being no influence at all and 10 being very influential, how much influence did the PG&E recommendation have on your decision to [describe implemented recommendation]?

   ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

5. If the PG&E recommendation for this action had not been made, how likely is it you would have done exactly the *same* thing [**if equipment was installed that has specific efficiency ratings such as SEER, COP, KW/TON add --** with the same efficiency rating]. Please use a scale from 0 to 10, with 0 being not at all likely and 10 being very likely.

   ___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

   Notes: _____

<u>Special Instruction for Contradictory Responses</u>: If [**<u>Q.4 is 0,1,2</u>** *<u>and</u>* **<u>Q5 is 0,1,2</u>**] *<u>or</u>* [**<u>Q.4 is 8,9,10</u>** *<u>and</u>* **<u>Q.5 is 8,9,10</u>**]. Probe for the reason. However, it is important not to communicate a challenging attitude when posing the question. For example, say,

When you answered "8" for the question about the influence of the recommendation, I would interpret that to mean that the recommendation was quite important to your decision; then, when you answered "8" for how likely you would be to take the same action *without* the recommendation, it sounds like the recommendation was *not* very important in your decision. I want to check to see if I am misunderstanding your answers or if the questions may have been unclear.

If they volunteer a helpful answer at this point, respond by changing the appropriate answer. If not, follow up with something like:

Will you explain in your own words, the role the recommendation played in your decision to take this action?

If possible translate their answer into responses for questions 4 and 5 and check these responses with the respondent for accuracy. If the answer doesn't allow you to decide what answer should be changed, write the answer down and continue the interview.

Answer: _____

_____

6. What would you say the role of the recommendation was in your decision to [**describe implemented recommendation**]? [Prompt by reading list if the respondent has trouble answering.]

1 Reminded us of something we already knew

2 Speeded up the process of what we would have done anyway

3 Showed us the benefits of this action that we didn't know before

4 Clarified benefits that we were *somewhat* aware of before

5 Recommendation had no role

6 Other

_____

98 Don't Know

99 Refused to Answer

Say: Here are some statements that may be more or less true for your company about the PG&E recommendation to [**describe recommendation**]. Please assign a number between 0 and 10 to register how true it is. 10 indicates that it is completely true, and 0 indicates that it is completely untrue.

7. The recommendation was nice but it was unnecessary to cause the [**describe recommendation**] to be implemented.

___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

8. The recommendation was a critical factor in implementing [**describe recommendation**].

___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

9. We would not have implemented the [**describe recommendation, including its efficiency rating if applicable**] without the recommendation.

___ Response (**0-10**) **98** Don't Know **99** Refused to Answer

Site ID _____ EMS Survey ID _____ Recommendation Number _____
Recommendation _____

10. **Do Not Ask This for O&M Recommendations**. If you had not received the recommendation from PG&E, would you have implemented the *same* [**describe recommendation, including its efficiency rating if applicable**] ...

	Count	%	
1	_____	____	..within 6 months?
2	_____	____	..6 months to 1 year?
3	_____	____	..one to two years later?
4	_____	____	..two to three years later?
5	_____	____	..three to four years later?
6	_____	____	..four or more years later?
7	_____	____	..Never
98	_____	____	..Don't Know - **Try for less precise response, if still "don't know" use 98**

	Count	%	
8	_____	____	...less than one year?
9	_____	____	...one year or more?

99	_____	____	...Refused to Answer

<u>Time relative to the installation date</u>. For recommendations that consist of more than one piece of equipment, the Count and % columns allow you to record changes which would have occurred over time. Ultimately, <u>you must indicate the %</u> that would have occurred in each period. 100% will appear in one period for single piece items. The percentages must always sum to 100%.

Repeat questions 2 through 10 for each recommendation marked I (Implemented) on the1996 EMS Recommendation Summary Form for each site.

Appendix C
EMS Algorithms

Algorithm: **L01 – Lighting Capacity Measures (indoor)**

Affected System: **Lighting (Indoor)**

Algorithm

Savings:

$$kW_{svgs} = \#\ fixtures \times (W\ /\ fixt._{base} - W\ /\ fixt._{as-built}) \times UF\ /1000$$

$$kWh_{svgs} = kW_{svgs} \times hours_{as-built} \times HC_{cool}$$

$$therm_{takeback} = kW_{svgs} \times 0.034 \times hours \times HC_{heat}\ /\ heating\ efficiency$$

Variables:

kW_{svgs}	=	Measure electric demand savings in kilowatts
# fixtures	=	Number of lighting fixtures affected by the measure
W / fixt.	=	Lighting fixture electric demand in Watts based on description of fixture type and a look-up table
UF	=	Lighting system utilization factor; the fraction of lights operating during normal operating hours [95%]
kWh_{svgs}	=	Annual measure electric energy savings in kilowatt-hours
hours	=	System annual operating hours
HC_{cool}*	=	Cooling interaction factor from a table developed using DOE-2 prototype models based on cooling system characteristics.
$therm_{takeback}$	=	Annual increase in gas consumption due to the reduced lighting heat load
HC_{heat}*	=	Heating interaction factor from a table developed using DOE-2 prototype models based on heating system characteristics.
heating efficiency	=	Gas space heating system efficiency [80%]

Subscripts:

base	=	Conditions before implementation of the recommendation
as-built	=	Conditions as observed or reported during the time of the survey

*FAX the completed data collection form to SBW for determination of these values

Algorithm: **L02 – Lighting Capacity Measures (outdoor)**
Affected System: **Lighting (Outdoor)**

Algorithm

Savings:

$$kW_{svgs} = \#\ fixtures \times (W\ /\ fixt._{base} - W\ /\ fixt._{as-built}) \times UF\ /1000$$

$$kWh_{svgs} = kW_{svgs} \times hours_{as-built}$$

Variables:

kW_{svgs}	=	Measure electric demand savings in kilowatts
# fixtures	=	Number of lighting fixtures affected by the measure
W / fixt.	=	Lighting fixture electric demand in Watts based on description of fixture type and a look-up table
UF	=	Lighting system utilization factor; the fraction of lights operating during normal operating hours [100%]
kWh_{svgs}	=	Annual electric energy savings in kilowatt-hours
hours	=	System annual operating hours

Subscripts:

base	=	Conditions before implementation of the recommendation
as-built	=	Conditions as observed or reported during the time of the survey

Algorithm: **L03 – Lighting Controls Measures (Indoor)**

Affected System: **Lighting (indoor)**

Algorithm

Savings:

$$kW_{svgs} = \#\ fixtures \times W\ /\ fixt._{as-built} \times UF\ /1000$$

$$kWh_{svgs} = kW_{svgs} \times \left(hours_{base} - hours_{as-built}\right) \times HC_{cool}$$

$$therm_{takeback} = kW_{svgs} \times \left(hours_{base} - hours_{as-built}\right) \times 0.034 \times HC_{heat}\ /\ heating\ efficiency$$

Variables:

	kW_{svgs}	=	Measure electric demand savings in kilowatts
	# fixtures	=	Number of lighting fixtures affected by the measure
	W / fixt.	=	Lighting fixture electric demand in Watts based on description of fixture type and a look-up table
	UF	=	Lighting system utilization factor; the fraction of lights operating during normal operating hours [95%]
	kWh_{svgs}	=	Annual measure electric energy savings in kilowatt-hours
	hours	=	System annual operating hours
	HC_{cool}*	=	Cooling interaction factor from a table developed using DOE-2 prototype models based on cooling system characteristics.
	$therm_{takeback}$	=	Annual increase in gas consumption due to the reduced lighting heat load
	HC_{heat}*	=	Heating interaction factor from a table developed using DOE-2 prototype models based on heating system characteristics.
	heating efficiency	=	Gas space heating system efficiency [80%]
Subscripts:	*base*	=	Conditions before implementation of the recommendation
	as-built	=	Conditions as observed or reported during the time of the survey

*FAX the completed data collection form to SBW for determination of these values

Algorithm: H01 - Clean Condenser Coils

Affected System: Air Conditioning (Compressor)

Preferred Method

Baseline:

$$kW_{Base} = Cool\_Cap \times kWperTon$$
$$kWh_{Base} = kW_{Base} \times EFLCH$$

Savings:

$$kW_{Svgs} = 0$$
$$kWh_{Svgs} = 0.1 \times kWh_{Base}$$

Variables:	*kW*	=	Annual On-Peak electric demand in kW
	kWh	=	Annual electric consumption in kWh
	Cool_Cap	=	Cooling capacity of the cooling equipment in tons.
	kWperTon	=	Rated efficiency of the cooling equipment in kW per ton.
	*EFLCH**	=	Equivalent Full Load Cooling Hours based on a prototype DOE2 model simulation.
	Therms	=	Annual gas consumption in therms.
Subscripts:	*Base*	=	Conditions before implementation of the recommendation
	Svgs	=	Energy savings to be realized by the measure. Assumed at 10% of the cooling end use for this measure. No electric demand or gas savings.

*FAX the completed data collection form to SBW for determination of this value

Algorithm: **H01 - Clean Condenser Coils (cont.)**

Alternate Baseline Method

This method is appropriate if cooling equipment capacity is not available through the use of the telephone survey, but the affected floor area can be estimated by the respondent.

Baseline:

$$kWh_{Base} = Cool\_EUI \times Area$$

$$kW_{Base} = \frac{kWh_{Base}}{EFLCH}$$

Variables:

	*Cool_EUI**	=	Annual cooling end use consumption per square foot of floor area in kWh per square foot per year. This value is based on a DOE2 prototype simulation.
	Area	=	Affected floor area of the measure.
	*EFLCH**	=	Equivalent Full Load Cooling Hours based on a prototype DOE2 model simulation

*FAX the completed data collection form to SBW for determination of these values

Algorithm: **H02 – Check Refrigerant Charge and Correct as Needed**

Affected System: **Air Conditioning (Compressor)**

Preferred Method

Baseline:

$$kW_{Base} = Cool\_Cap \times kWperTon$$

$$kWh_{Base} = kW_{Base} \times EFLCH$$

Savings:

$$kW_{Svgs} = 0$$

$$kWh_{Svgs} = 0.03 \times kWh_{Base}$$

Variables:	*kW*	=	Annual On-Peak electric demand in kW
	kWh	=	Annual electric consumption in kWh
	Cool_Cap	=	Cooling capacity of the cooling equipment in tons.
	kWperTon	=	Rated efficiency of the cooling equipment in kW per ton.
	*EFLCH**	=	Equivalent Full Load Cooling Hours based on a prototype DOE2 model simulation.
	Therms	=	Annual gas consumption in therms.
Subscripts:	*Base*	=	Conditions before implementation of the recommendation
	Svgs	=	Energy savings to be realized by the measure. Assumed at 3% of the cooling end use for this measure. If the percent of over or under charge is known, use figure 9 from E-Source TU-97-2. No electric demand or gas savings.

*FAX the completed data collection form to SBW for determination of this value

Algorithm: **H02 – Check Refrigerant Charge and Correct as Needed (cont.)**

Alternate Baseline Method

This method is appropriate if cooling equipment capacity is not available through the use of the telephone survey, but the affected floor area can be estimated by the respondent.

Baseline:

$$kWh_{Base} = Cool\_EUI \times Area$$

$$kW_{Base} = \frac{kWh_{Base}}{EFLCH}$$

Variables:

	Cool_EUI*	=	Annual cooling end use consumption per square foot of floor area in kWh per square foot per year. This value is based on a DOE2 prototype simulation.
	Area	=	Affected floor area of the measure.
	*EFLCH**	=	Equivalent Full Load Cooling Hours based on a prototype DOE2 model simulation.

*FAX the completed data collection form to SBW for determination of these values

Algorithm: **H03 - Clean Filters**

Affected System: **Air Conditioning**

Preferred Method

Baseline:

$$kW_{Base} = Cool\_Cap \times kWperTon$$

$$kWh_{Base} = kW_{Base} \times EFLCH$$

Savings:

$$kW_{Svgs} = 0.05 \times kW_{Base}$$

$$kWh_{Svgs} = 0.01 \times kWh_{Base}$$

Variables:	*kW*	=	Annual On-Peak electric demand in kW
	kWh	=	Annual electric consumption in kWh
	Cool_Cap	=	Cooling capacity of the cooling equipment in tons.
	kWperTon	=	Rated efficiency of the cooling equipment in kW per ton.
	*EFLCH**	=	Equivalent Full Load Cooling Hours based on a prototype DOE2 model simulation.
	Therms	=	Annual gas consumption in therms.
Subscripts:	*Base*	=	Conditions before implementation of the recommendation
	Svgs	=	Energy savings to be realized by the measure. Assumed at 1% of the cooling end use consumption and 5% of the cooling end use demand for this measure. No gas savings.

*FAX the completed data collection form to SBW for determination of these values

Algorithm: **H03 - Clean Filters (cont.)**

Alternate Baseline Method

This method is appropriate if cooling equipment capacity is not available through the use of the telephone survey, but the affected floor area can be estimated by the respondent.

Baseline:

$$kWh_{Base} = Cool\_EUI \times Area$$

$$kW_{Base} = \frac{kWh_{Base}}{EFLCH}$$

Variables:

	Cool_EUI*	=	Annual cooling end use consumption per square foot of floor area in kWh per square foot per year. This value is based on a DOE2 prototype simulation.
	Area	=	Affected floor area of the measure.
	*EFLCH**	=	Equivalent Full Load Cooling Hours based on a prototype DOE2 model simulation.

*FAX the completed data collection form to SBW for determination of these values

Algorithm: **H04 – Thermostat Settings**

Affected System: **HVAC**

Algorithm

Savings: All savings will be based on DOE2 prototype simulations extrapolated on a floor area or equipment capacity basis.

Algorithm: **H07 – HVAC O & M**

Affected System: **HVAC**

Algorithm

Savings: Use algorithms H01, H02 and H03 as appropriate. If several measures were done, take interactive effects into account by applying the algorithms in sequence (i.e. the as-built kW or kWh from the first algorithm should be used as the base for the second algorithm, and the as-built from the second algorithm becomes the base for the third algorithm)

Algorithm: **H14 – Window Awnings**

Affected System: **HVAC**

Algorithm

Savings: All savings will be based on DOE2 prototype simulations of affected space. Base case is without awnings and as-built is with awnings.

Algorithm: P01 – Boiler Base Consumption
Affected System: Boiler

Preferred Method:

Baseline:

Take the most recent year's metered consumption as the baseline. Assume existing conditions are at the midpoint of the O&M cycle, *i.e.*, halfway between the best and worst case in terms of O&M.

Efficient Case: No efficient case – baseline determination only.

Savings: No savings – baseline determination only

Alternate Method:

Baseline: Assume existing conditions are at the midpoint of the O&M practices cycle, *i.e.*, halfway between the best and worst case in terms of O&M.

Calculate energy consumption as:

$$Therms_{base} = \frac{avg\_lbs\_per\_hr \times (h_{stm} - h_{FW}) \times hrs}{\eta_{current} \times 10^5}$$

Variables:

Therms	=	Annual energy consumption in therms
avg_lbs_per_hr	=	Average steam production rate for current conditions
h	=	Specific enthalpy (BTU/lb – lookup using *P* & *T*)
hrs	=	Annual hours of operation
η	=	Combustion efficiency (from lookup tables)

Subscripts:

base	=	Baseline conditions
current	=	Most recent values at the time of the survey
stm	=	Steam
FW	=	Feedwater

Algorithm: P02 – Boiler Economizer
Affected System: Boiler

Preferred Method:

Baseline: See Algorithm P01 for base consumption. Assume stack temperature upstream of economizer represents the base case.

Efficient Case: Use stack gas temperature downstream from economizer

Savings: Assume 1% savings for each 40°F drop in temperature between the base and efficient cases:

$$Therms_{Svgs} = \frac{T_{Base} - T_{Efficient}}{40 \times 100} \times Therms_{Base}$$

Alternate Method:

Baseline: Feedwater enters boiler without heat recovered from the economizer.

Efficient Case: Heat gain in water flowing through the economizer directly offsets heat required by fuel consumption in the boiler.

Savings:

$$Therms_{Svgs} = \frac{m_{H2O} \times (T_{out} - T_{in}) \times c_p}{\eta_{Base} \times 10^5}$$

Variables:

	Therms	=	Annual energy consumption in therms
	m_{H2O}	=	Economizer water flow rate (lbs/hour or gallons/min)
	T	=	Temperature (°F)
	c_p	=	Specific heat of water (1.0 BTU/lb/°F)
	η	=	Combustion efficiency (from lookup tables)

Subscripts:

	out	=	Economizer outlet
	in	=	Economizer inlet
	Svgs	=	Energy savings from the recommended measure
	Base	=	Base conditions
	Efficient	=	Efficient conditions

Algorithm: **P05 – Condensate Return**

Affected System: **Boiler**

Preferred Method

Baseline: At least some portion of the system condensate is not returned to the boiler.

Efficient Case: Some portion of the condensate that was wasted in the base case is returned to the boiler.

Savings:

$$Therms_{Svgs} = \left(h_{f,cond} - h_{f,mu}\right) \times \Delta makeup \times hrs \times 10^{-5}$$

Alternate Method

Savings:

$$Therms_{Svgs} = \frac{h_{f,stm} - h_{f,cond}}{h_{fg,stm}} \times h_{g,stm} \times avg\_lbs\_per\_hr \times hrs \times 10^{-5}$$

Variables:

	Therms	=	Heat value of fuel that is consumed (therms)
	h	=	Specific enthalpy (BTU/lb - from lookup tables)
	Δmakeup	=	Change in makeup water resulting from installation (lbs/hr)
	avg_lbs_per_hr	=	Average steam production rate for current conditions
	hrs	=	Annual hours of operation
Subscripts:	*Svgs*	=	Energy savings from the recommended measure
	f	=	Saturated liquid
	g	=	Saturated vapor
	fg	=	Vaporization
	stm	=	Steam
	cond	=	Condensate
	mu	=	makeup

Algorithm: P07 – Compressed Air Base Consumption

Affected System: Compressed Air

Preferred Method

Baseline:

$$kW_{Base} = \frac{HP \times 0.746}{\eta_{motor}} \times LF \times SF \times CF$$

$$kWh_{Base} = kW_{Base} \times hrs$$

Efficient Case: No efficient case – baseline determination only.

Savings: No savings – baseline determination only

Variables:

	kW	=	Electric power draw
	kWh	=	Electric energy consumption
	HP	=	Horsepower rating of compressor motors
	LF	=	Load factor
	SF	=	System factor (lookup based on system type & HP)
	CF	=	Controls factor (lookup based on control type)
	η	=	Efficiency (from lookup tables)
	hrs	=	Annual hours of operation

Subscripts:

	Base	=	Baseline conditions
	motor	=	Compressor motor

Algorithm: **P08 – Repair Compressed Air Leaks**

Affected System: **Compressed Air**

Preferred Method

Baseline: See Algorithm P07 for base consumption. Adjust base consumption if customer changed compressed air leak practices as a result of EMS recommendation.

$$Base\_Demand = kW_{base} \times Adjustment\_Factor$$

$$Base\_Consumption = Base\_Demand \times hrs$$

Efficient Case: The efficient case assumes the compressors will run fewer hours, therefore they will consume less energy, but their peak demand will not change. It is assumed that the typical leakage rate in an industrial facility is 20% and half of this can be saved with proper maintenance.

Savings: Assume 10% consumption savings.

$$kW_{Svgs} = 0$$

$$kWh_{Svgs} = 0.10 \times Base\_Consumption$$

Variables:

	kW	=	Electric power draw
	kWh	=	Energy consumption
	Base_Demand	=	Peak electric power draw
	Base_Consumption	=	Annual electric energy consumption, adjusted to account for the impact of PG&E's recommendation on leak repair practices.
	Adjustment_Factor	=	Factor to account for the impact of PG&E's Recommendation on compressed air leak repair practices (1.05 if change was made, 1.0 if no change was made)
	hrs	=	Annual hours of operation
Subscripts:	*Base*	=	Baseline conditions
	Svgs	=	Energy savings from the recommended measure

Algorithm: P13 – Process Premium Efficiency Motor Measures

Affected System: Process Systems

Algorithm

Savings:

$$kW_{svgs} = 0.746 \times Motor\ HP \times LF \times \left(100/\eta_{base} - 100/\eta_{as-built}\right)$$

$$kWh_{svgs} = kW_{svgs} \times hours_{as-built}$$

Variables:

kW_{svgs}	=	Measure electric demand savings in kilowatts
Motor HP	=	Total of motor nameplate horsepower affected by the measure
LF	=	Motor load factor based on either measurement-based information in the file, reported by the customer, or default value [0.85]
η	=	Motor efficiency as reported by the customer or MotorMaster database (Department of Energy) for the reported manufacturer and model number
kWh_{svgs}	=	Annual measure electric energy savings in kilowatt-hours
hours	=	Motor annual operating hours

Subscripts:

base	=	Conditions before implementation of the recommendation
as-built	=	Conditions as observed or reported during the time of the survey

Algorithm: P14 – Compressed Air Shut-off/Reduction in Operating Hours

Affected System: Compressed Air

Algorithm

Savings:

$$kW_{svgs} = \frac{HP \times 0.746}{100 \div \eta_{motor}} \times LF \times SF \times CF$$

$$kWh_{svgs} = kW_{svgs} \times (hours_{base} - hours_{as-built})$$

Variables:

	kW	=	Electric power draw
	kWh	=	Annual electric energy consumption
	HP	=	Horsepower rating of compressor motor(s)
	LF	=	Load factor based on either measurement-based information in the file, reported by the customer, or default value.
	SF	=	System factor (lookup based on system type & HP)
	CF	=	Controls factor (lookup based on control type)
	η	=	Efficiency (from lookup tables, nameplate or manufacturer's data)
	hours	=	Annual hours of operation

Subscripts:

	base	=	Conditions before implementation of recommendation
	as-built	=	Conditions as observed or reported during time of survey
	motor	=	Compressor motor

Algorithm: P16 – Chilled Water Pump Shut-Off/Reduction in Operating Hours

Affected System: Process

Algorithm

Savings:

$$kW_{svgs} = \frac{HP \times 0.746}{100 \div \eta_{pump}} \times LF$$

$$kWh_{svgs} = kW_{svgs} \times (hours_{base} - hours_{as-built})$$

Variables:

	kW	=	Electric power draw
	kWh	=	Annual electric energy consumption
	HP	=	Horsepower rating of pump motor(s)
	LF	=	Load factor based on either measurement-based information in the file, reported by the customer, or default value [0.85]
	η	=	Efficiency (from lookup tables, nameplate or manufacturer's data)
	hours	=	Annual hours of operation
Subscripts:	*base*	=	Conditions before implementation of recommendation
	as-built	=	Conditions as observed or reported during time of survey
	motor	=	Pump motor

Algorithm: P20 – Insulate Steam Lines

Affected System: Gas Process Heating System

Algorithm:

Savings:

$$Therms_{Svgs} = \frac{(length \div 10) \times (heatloss_{base} - heatloss_{eff}) \times hours}{\eta \times 10^3}$$

Variables:

	Therms	=	Annual energy consumption in therms
	length	=	Length of pipe insulated (linear feet)
	heatloss	=	Heat loss for 10 ft of pipe for the particular pipe size, insulation level and steam or hot water temperature (Btu/hr).[Source: nomograph in Architect's & Engineers Guide to Energy Conservation in Existing Buildings, DOE/CS-0132, pg 147, Fig8-48. Heating Heat Loss for Various Pipe Sizes, Insulation Thickness and Water Temperatures from 200°F to 350°F OR IEES Energy Tips, Energy Tip No. 4 from NBS Handbook no.115]
	η	=	Efficiency of heating system
	hours	=	Annual hours of operation of heating system

Subscripts:

	Svgs	=	Energy savings from the recommended measure
	base	=	Base conditions
	eff	=	Efficient conditions (insulated pipe)

Algorithm: P31 – Reset Chilled Water Temp

Affected System: Process

Algorithm

Baseline:

$$kWh_{base} = Cool\_Cap \times kWperton \times EFLCH$$

Savings: Assume 2.1% savings per ^{o}F increase in chilled water temperature

$$kW_{Svgs} = 0$$

$$kWh_{Svgs} = kWh_{base} \times 0.021 \times (chillwtrtemp_{reset} - chillwtrtemp_{base})$$

Variables:

	kW	=	Annual Peak electric demand in kW
	kWh	=	Annual electric consumption in kWh
	Cool_Cap	=	Cooling capacity of the cooling equipment in tons.
	kWperTon	=	Rated efficiency of the cooling equipment in kW per ton.
	EFLCH	=	Equivalent Full Load Cooling Hours (annual)
	chillwtrtemp	=	Chilled water temperature (^{o}F)
Subscripts:	*Base*	=	Conditions before implementation of the recommendation
	Reset	=	Conditions after reset as observed or reported during time of survey
	Svgs	=	Energy savings to be realized by the measure.

Algorithm: P32 – Process Motor/Pump Downsizing

Affected System: Process Systems

Algorithm

Baseline:

$$kW_{base} = 0.746 \times Motor\ HP_{base} \times LF_{base} \times 100 / \eta_{base}$$

Efficient Case:

$$kW_{as-built} = 0.746 \times Motor\ HP_{as-built} \times LF_{as-built} \times 100 / \eta_{as-built}$$

Savings:

$$kW_{Svgs} = kW_{base} - kW_{as-built}$$

$$kWh_{Svgs} = kW_{Svgs} \times hours$$

Variables:

	kW	=	Measure electric demand savings in kilowatts
	kWh	=	Annual electric energy consumption
	Motor HP	=	Total motor/pump nameplate horsepower affected by the measure
	LF	=	Motor/pump load factor based on either measurement-based information in the file, reported by the customer, or default value [0.85]
	η	=	Motor/pump efficiency as reported by the customer, observed on nameplate or from MotorMaster database (Department of Energy) for the manufacturer and model number
	hours	=	Motor/pump annual operating hours
Subscripts:	*Svgs*	=	Energy savings from the recommended measure
	base	=	Conditions before implementation of recommendation
	as-built	=	Conditions as observed or reported during time of survey

Algorithm: P35 – Boiler Combustion Air Preheat

Affected System: Process Boilers

Algorithm

Savings:

$$Therms_{svgs} = 1.08 \times CFM \times (T_o - T_i) \times hours \times 10^{-5}$$

$$CFM = 9.52 \times \left(1 + \%EA/100\right) \times \left(fuel\_rate/60 \right) / heating\_value$$

Variables:

$Therms_{svgs}$	=	Natural gas savings in therms
CFM	=	Combustion air flow rate in cubic feet per minute
T_o	=	Combustion air temperature at the heat exchanger outlet, in °F.
T_i	=	Combustion air temperature at the heat exchanger inlet, in °F.
hours	=	Annual hours of boiler operation.
%EA	=	Percent excess air in the flue gas.
fuel_rate	=	Average fuel flow rate in BTU/hour
heating_value	=	Heating value of the fuel in BTU/cubic foot (default = 1050 BTU/cubic foot)
1.08	=	Conversion factor : cubic feet per minute of airflow and temperature difference to heat transfer rate in BTU/hour.
9.52	=	Stoichiometric volume air to fuel ratio.
60	=	Conversion factor: minutes to hours.

Algorithm: P36 – Adjust Compressor System/Add Storage

Affected System: **Compressed Air**

Algorithm:

Baseline:

$$kWh_{base} = \sum (kWcfm_{base} \times cfmhrs_{base})$$

Efficient Case:

$$kWh_{as-built} = \sum (kWcfm_{as-built} \times cfmhrs_{as-built})$$

Savings:

$$kW_{Svgs} = 0$$

$$kWh_{Svgs} = kWh_{base} - kWh_{as-built}$$

Variables:	*kWcfm*	=	Electric demand of compressor(s) at a particular CFM (based on measured data and manufacturer's curves)
	cfmhrs	=	Annual operating hours of compressor(s) at a particular CFM (based on measured data)
Subscripts:	*Svgs*	=	Energy savings from the recommended measure
	base	=	Conditions before implementation recommendation
	as-built	=	Conditions as observed or reported during time of survey

Algorithm: P37 – Downsize Air Compressor System

Affected System: Compressed Air

Algorithm:

Baseline: See Algorithm P07 for base consumption and demand.

Efficient Case: Use Algorithm P07 with as-built conditions for efficient as-built consumption and demand.

Savings:

$$kW_{Svgs} = kW_{base} - kW_{as-built}$$
$$kWh_{Svgs} = kWh_{base} - kWh_{as-built}$$

Variables:

	kW	=	Electric power draw
	kWh	=	Annual electric energy consumption

Subscripts:

	Svgs	=	Energy savings from the recommended measure
	base	=	Conditions before implementation recommendation
	as-built	=	Conditions as observed or reported during time of survey

Algorithm: P52 – Replace Air Compressor System

Affected System: Compressed Air

Algorithm:

Baseline:

$$kWh_{base} = kWavg_{base} \times hrs$$

Efficient Case:

$$kWh_{base} = kWavg_{base} \times hrs$$

Savings:

$$kW_{Svgs} = kW_{base} - kW_{as-built}$$
$$kWh_{Svgs} = kWh_{base} - kWh_{as-built}$$

Variables:

kWavg	=	Average demand of compressor(s) (use manufacturer's curves and/or measured data)
kW	=	Maximum electric power draw (based on measured or manufacturer's data)
kWh	=	Annual electric energy consumption
hrs	=	Annual operating hours of compressors

Subscripts:

Svgs	=	Energy savings from the recommended measure
base	=	Conditions before implementation recommendation
as-built	=	Conditions as observed or reported during time of survey

Defaults and Assumptions for Compressed Air Systems

Compressor Type	HP Range	System Factor	BHP/100 CFM*
Reciprocating			
Air-Cooled	5 – 30	0.91	29
Water-Cooled	15 – 25	0.78	25
2-Stage/Lubricated	50 – 300	0.61	20
2-Stage/Oil-Free	50 – 300	0.66	21
Screw			
1-Stage/Lubricated	<50	0.84	27
	>50	0.73	24
1-Stage/Oil Free	<50	0.78	25
	>50	0.72	23
Centrifugal	<250	0.77	24
	>250	0.66	21

*For systems at 100 – 125 psi

Compressor Type	Controls Type	LF	CF
Reciprocating	Load/Unload – 2-stage	.75	*
	- 3-stage	.75	*
	- 5-stage	.75	*
Screw	Modulation	.75	0.85
	On-Line/Off-Line	.75	0.63
	Combined	.75	0.50
Centrifugal	Modulation	.75	0.80
	On-Line/Off-Line	.75	0.63

Motor Efficiency Defaults

HP	Open Drip Proof						Totally Enclosed Fan-Cooled					
	1200 RPM		1800 RPM		3600 RPM		1200 RPM		1800 RPM		3600 RPM	
	Base	A-B	Base	A-B	Base	A-B	Base	A-B	Base	A-B	Base	A-B
3	81.3	88.4	81.8	87.0	80.2	84.8	81.4	89.0	85.3	89.0	80.5	87.5
5	83.5	89.4	84.4	88.0	81.8	87.5	82.7	89.0	85.5	89.4	83.8	88.5
7.5	84.9	90.3	84.1	89.1	85.7	88.5	83.5	90.6	87.5	91.3	83.6	90.6
10	85.3	90.6	85.4	90.6	85.7	90.6	84.8	90.6	87.7	91.0	85.5	91.4
15	85.8	91.7	87.3	92.4	87.3	90.3	87.3	91.4	89.5	92.4	87.3	91.0
20	89.0	92.0	87.5	93.0	86.0	91.6	88.3	91.7	90.3	92.7	88.3	91.7
25	88.7	93.3	88.9	93.3	88.0	92.3	89.1	93.0	90.4	93.9	89.3	93.0
30	89.8	93.3	89.7	93.6	87.2	92.7	89.6	92.7	91.6	93.6	89.3	93.0
40	89.9	94.1	90.6	94.1	89.3	93.0	90.3	93.6	92.0	94.1	88.9	93.6
50	89.1	94.1	91.4	94.3	89.4	93.0	90.0	93.6	92.5	94.6	89.8	93.8
60	91.4	95.0	91.4	94.5	89.7	93.6	92.0	93.8	92.8	95.2	90.2	94.6
75	92.0	95.4	91.7	94.8	88.6	94.3	92.3	94.8	93.6	95.2	92.3	94.6
100	89.0	95.4	91.4	95.2	90.1	94.1	92.5	94.0	93.6	95.4	92.2	94.8
125	91.4	95.4	92.5	94.8	90.7	95.0	93.2	94.5	93.9	95.6	92.8	94.8
150	92.6	95.8	92.1	95.2	91.2	94.5	93.0	95.8	94.4	95.6	92.9	94.8
200	92.6	95.6	92.5	95.2	93.3	95.0	94.1	95.4	95.0	94.9	93.0	95.0

Notes: - Base refers to the standard-efficiency motor

- A-B (As-Built) refers to high-efficiency motor
- If motor type is unknown, assume ODP for HVAC and TEFC for process

Appendix D

Program Evaluation and 1996 Retention Panel Data Bases

This appendix documents the final data products from this evaluation. These products consist of the final evaluation and 1996 retention panel databases. In addition, we document the raw data sets we received from PG&E, the intermediate data sets we developed during the evaluation, and the SAS jobs we wrote to analyze and manipulate the data.

All of these data products are loaded on a 100-megabyte Iomega® Zip™ disk, with the following directory structure:

SUBDIRECTORY	CONTENTS
CODE	SAS jobs used to create intermediate data sets.
DATA	Original MDSS data base extracts and intermediate data sets created during the evaluation.
FINDATA	Final program evaluation and retention panel data sets.

A list of the files in each of these subdirectories can be found in Table D-1.

Program Evaluation Data Base and 1996 Retention Panel Data Base

The FINDATA subdirectory contains the final evaluation and retention data bases. These data bases holds information gathered from the PG&E program data base and files, as well as via installation and evaluation surveys. In general, the data fall into the following six categories:

1. PG&E Data Base
2. File Review
3. Installation Survey
4. Evaluation Survey
5. Final Data Processing
6. Retention Panel

Items 1 through 5 are contained in the program evaluation data base, IEMS96DB, and item 6 is contained in the 1996 retention data base, IEMS96RE.

Note that the data bases contain confidential information about customer names, addresses, and phone number.

Table D-2 lists and documents the variables in these categories in more detail. We have supplied both data bases in two formats, with the following file names:

- **IEMS96DB.XPT** (SAS Version 6 transport file containing the data set IEMS96DB)
- **IEMS96DB.XLS** (Microsoft Excel 5.0 workbook)
- **IEMS96RE.XPT** (SAS Version 6 transport file containing the data set IEMS96RE)
- **IEMS96RE.XLS** (Microsoft Excel 5.0 workbook)

The SAS Version 6 transport files can be read by any version of SAS on any currently supported platform, including SAS PC for Windows, and SAS under TSO. The transport files are partially self-documenting, as it contain labels for each variable, along with information on each variable's data type and format. This information can be accessed via the SAS PROC CONTENTS procedure. In addition, a SAS PROC FORMAT job is provided to define value labels for each coded variable in the program evaluation data base.

The two key variables for the 1,482 observations in the program evaluation data base are the survey code (SURVCD) and recommendation number (RECNUM). Information in this data base can be linked to other PG&E data bases via the SURVCD, PREMISE, and CONTROL variables.

The 1996 retention panel data base contains the same two key variables of survey code (SURVCD) and recommendation number (RECNUM) for linkage to the program evaluation data base. In addition, a third key variable for location number (LOCNUM) is provided to define multiple observations of retention information associated with each recommendation number. Retention data is only included for installed recommendations (RECTYPE = I) for which an evaluation was completed (S8_DISP1 = 1).

The zip file also contains DBFORMTS.SAS, which is a SAS PROC FORMAT job. This file defines value labels for each of the coded variables that appear in the data base.

Table D-1: Detailed List of Data Products

Subdirectory	FILE NAME*	TYPE OF FILE(S)	DESCRIPTIONS
\CODE	EMSQC1-3.SAS	SAS 6.12 jobs	Performs QC checks on raw evaluation data
	SUMMARY2.SAS	SAS 6.12 job	Combines sample frame and evaluation data, calculates net savings, NTGRs, and aggregate results.
	FINALRT.SAS	SAS 6.12 job	Generates final retention data set
	FINALDB.SAS	SAS 6.12 job	Generates final evaluation data set
\DATA	**EMS_FIN.ZIP** flocdata.sd2 frecdata.sd2 fsrvdata.sd2* siteassn.sd2* emsqc.sd2* iframe3.sd2* emsqc1.sd2*	SAS 6.12 data sets (zipped)	Raw PG&E program data, site assignment data, sample frame, combined data for QC
	EMSSAVE.SD2	SAS 6.12 data sets	Final recommendation-level evaluation results.
\FINDATA	IEMS96DB.XLS*	Excel 5.0	Final program evaluation
	IEMS96DB.XPT*	SAS Version 6 transport	Final program evaluation
	IEMS96RE.XLS*	Excel 5.0	1996 retention panel data base
	IEMS96RE.XPT*	SAS Version 6 transport	1996 retention panel data base
	DBFORMTS.SAS	SAS code	Formats for IEMS96DB variables

Table D-2: Variable List for Evaluation and Retention Data Bases

DATA BASE	DATA SOURCE	VARIABLE	TYPE	LABEL
IEMS96DB (Evaluation)	**1. PG&E Data Base**	ACCOUNT	Char	account number
		CONTROL	Num	control number
		DIV	Char	division
		EMSKW	Num	data base gross kW savings
		EMSKWH	Num	data base gross kWh savings
		EMSTHM	Num	data base gross therm savings
		EU	Char	end use
		MEASRLBL	Char	measure label
		PREMISE	Num	premise number
		RECNUM	Num	recommendation number (KEY)
		SIC	Num	SIC code
		SICLBL	Char	SIC label
		SURVCD	Num	survey code (KEY)
		CORPID	Num	corporate ID number (SBW-assigned)
	2. File Review	FEU	Char	end use (based on file review)
		FFNAME	Char	contact first name
		FLNAME	Char	contact last name
		FPHONE1	Num	contact phone, part 1
		FPHONE2	Num	contact phone, part 2
		FMEASLBL	Char	adjusted measure label
		SITEID	Num	site ID number (SBW-assigned)
	3. Installation Survey	ICITY	Char	city
		ICOMPANY	Char	company
		ICONTROL	Num	control number
		IEU	Char	end use (based on install. survey)
		IEULBL	Char	end use label
		IFREV	Num	Paper file review code
		IMEASLBL	Char	measure label
		INMDSS	Num	Added recommendation code
		ISQ81	Num	Installation survey completion code
		ISTREET	Char	street
		IZIP	Num	ZIP code
		RECTYPE	Char	Recommendation status code
	4. Evaluation Survey	MEASLBL	Char	Recommendation description code
		S1_KW	Num	evaluation gross kW savings
		S1_KWH	Num	evaluation gross kWh savings
		S1_THM	Num	evaluation gross therm savings
		S4_2	Num	dec-maker survey Q.2 response
		S4_3	Num	dec-maker survey Q.3 response
		S4_4	Num	dec-maker survey Q.4 response
		S4_5	Num	dec-maker survey Q.5 response
		S4_7	Num	dec-maker survey Q.7 response
		S4_8	Num	dec-maker survey Q.8 response
		S4_9	Num	dec-maker survey Q.9 response
		S8_DISP1	Num	section 1 disposition
		SEU	Char	end use (based on eval. survey)
		SFEU	Char	end use (final used)
		SITETYPE	Char	site type description

DATA BASE	DATA SOURCE	VARIABLE	TYPE	LABEL
	5. Final Data Processing	MEASTYPE	Char	recommendation type
		NETKW	Num	evaluation net kW savings
		NETKWH	Num	evaluation net kWh savings
		NETTHM	Num	evaluation net therm savings
		NTGRI	Num	calculated evaluation NTGR
		NTGRKW	Num	final end-use kW NTGR
		NTGRKWH	Num	final end-use kWh NTGR
		NTGRTHM	Num	final end-use therm NTGR
IEMS96RE (Retention)	**1. Retention Study**	SURVCD	Num	survey code (KEY)
		RECNUM	Num	recommendation number (KEY)
		LOCNUM	Num	location number of installed units (KEY)
		DESCRIP	Char	description of installed units
		LOCATION	Char	description of location where installed
		MANUF	Char	equipment manufacturer
		MODEL	Char	equipment model
		NUMINST	Num	number installed
		NUMOP	Num	number operational
		OTHER	Char	other comments

Appendix E

M&E Protocol Information

This appendix provides a consolidated tabulation of results from this evaluation which meet the reporting requirements defined by the California Public Utility Commission's Measurement and Evaluation (M&E) Protocols. The tables and descriptions within provide the information requested in Tables 6 and 7 of the M&E Protocols.

The first part of this appendix contains the information required in Table 6 of the Protocols for the Industrial Energy Management Services program. The designated unit of measurement for this program is Participant, an EMS survey completed in 1996.

Certain items in Table 6 of the protocols address unit energy consumption (UEC). The Protocols deem these items optional in instances where the models employed in the evaluation cannot yield appropriate UECs. These optional items are not included in the tables below. The engineering portion of the evaluation generally yielded energy savings, rather than consumption, estimates for the evaluated items. Because of this, program-wide engineering estimates of gross energy consumption and UEC could not be determined.

The second part of this appendix provides data quality and processing documentation as discussed in Table 7 of the Protocols. The numbering scheme for this portion corresponds to that in Table 7.

Response to Table 6 Requirements

Refer to Page E-2 through E-3.

Response to Table 7 Requirements

Refer to Pages E-4 through E-5.

RESPONSE TO M&E PROTOCOL TABLE 6

Protocols for Reporting of Results of Impact Measurement Studies Used to Support and Earnings Claim **Table 6**

END USE:	**HVAC, Lighting, Process**
DESIGNATED UNIT OF MEASUREMENT:	**Participants (Surveys)**

			5. 90% Confidence Level				5. 80% Confidence Level			
			Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
1.	**Average Participant Group and Average Comparison Group Usage**									
	A. Pre-Installation Usage	kWh								
		kW								
		therms								
	Base Usage	kWh								
		kW								
		therms								
	Base Usage per Designated Unit of Meas.	kWh								
		kW								
		therms								
	B. Impact Year Usage	kWh								
		kW								
		therms								
	Impact Year Usage per Designated Unit of Meas.	kWh								
		kW								
		therms								
2.	**Avg. Net & Gross End Use Load Impacts**									
	A. Load Impacts	kWh								
	(= total impact / total no. of installed measures)	kW								
		therms								
	B. Load Impacts per Designated Unit of Meas.	kWh								
	(= total impact / total no. of installed measures /average no. of DUM per measure)	kW								
		therm								
	C. Participant Group Percent Change in Usage	kWh								
		kW								
		therms								
	Comparison Group Percent Change in Usage	kWh								
		kW								
		therms								
	D. Realization Rates									
		kWh								
		kW								
		therms								
3.	**Net-to-Gross Ratios**									
	A. Average Load Impacts	kWh								
		kW								
		therms								
	B. Avg. Load Impacts per Designated Unit of Meas.	kWh								
		kW								
		therms								
	C. Avg. Load Impacts (as % Change in Usage)	kWh								
		kW								
		therms								
4.	**Designated Unit Intermediate Data**									
	A. Pre-Installation Avg. (Mean) Value for Participant Group									
	Pre-Installation Avg. (Mean) Value for Comparison Group									
	B. Post-Installation Avg. (Mean) Value for Participant Group									
	Post-Installation Avg. (Mean) Value for Comparison Group									
5.	**Precision (see columns at far right)**									
6.	**Measure Count Data**									
	A. No. of Measures Installed by Participants in Part. Group									
	B. No. of Meas. Installed by All Prog. Part. During Prog. Yr.									
	C. No. of Measures Installed by the Comparison Group									

Note: Gray areas indicate category is not applicable.

Gross	Net
5,530	3,672
1.656	0.887
1,426	703
47	31
0.014	0.008
12	6

Ratio	Ratio	Ratio	Ratio	Ratio
0.664	0.608	0.720	0.620	0.708
0.535	0.479	0.592	0.491	0.579
0.493	0.437	0.549	0.449	0.537
0.664	0.608	0.720	0.491	0.579
0.535	0.479	0.592	0.449	0.537
0.493	0.437	0.549	0.491	0.579

DUM
117
117

Count
161
161

END USE: **HVAC, Lighting, Process**

7. Market Segment Data ~~Percent~~

Distribution of Participants by SIC Label

2952	ASPHALT FELTS AND COATINGS	1.2
2086	BOTTLED AND CANNED SOFT DRINKS	0.6
2051	BREAD, CAKE, AND RELATED PRODUCTS	5.6
2064	CANDY AND OTHER CONFECTIONERY PRODUCTS	0.6
2033	CANNED FRUITS AND VEGETABLES	4.3
2066	CHOCOLATE AND COCOA PRODUCTS	0.6
2752	COMMERCIAL PRINTING, LITHOGRAPHIC	8.7
2759	COMMERCIAL PRINTING, NEC	0.6
3575	COMPUTER TERMINALS	1.2
3271	CONCRETE BLOCK AND BRICK	1.2
1411	DIMENSION STONE	1.2
1731	ELECTRICAL WORK	3.1
3845	ELECTROMEDICAL EQUIPMENT	0.6
3679	ELECTRONIC COMPONENTS, NEC	1.9
3571	ELECTRONIC COMPUTERS	0.6
1794	EXCAVATION WORK	1.2
3443	FABRICATED PLATE WORK (BOILER SHOPS)	0.6
3523	FARM MACHINERY AND EQUIPMENT	0.6
2655	FIBER CANS, DRUMS & SIMILAR PRODUCTS	0.6
2026	FLUID MILK	1.2
2038	FROZEN SPECIALTIES	0.6
1793	GLASS AND GLAZING WORK	0.6
2426	HARDWOOD DIMENSION AND FLOORING MILLS	0.6
1629	HEAVY CONSTRUCTION, NEC	0.6
1611	HIGHWAY AND STREET CONSTRUCTION	0.6
3639	HOUSEHOLD APPLIANCES, NEC	1.2
3651	HOUSEHOLD AUDIO & VIDEO EQUIPMENT	1.9
3599	INDUSTRIAL MACHINERY, NEC	4.3
3825	INSTRUMENTS TO MEASURE ELECTRICITY	0.6
3541	MACHINE TOOLS AND CUTTING TYPES	0.6
3695	MAGNETIC & OPTICAL RECORDING MEDIA	1.2
2082	MALT BEVERAGES	1.2
3829	MEASURING & CONTROLLING DEVICES, NEC	0.6
2011	MEAT PACKING PLANTS	1.2
3412	METAL BARRELS, DRUMS, AND PAILS	0.6
3411	METAL CANS	0.6
3479	METAL COATING AND ALLIED SERVICES	0.6
3442	METAL DOORS, SASH, AND TRIM	3.1
2431	MILLWORK	3.1
3496	MISC. FABRICATED WIRE PRODUCTS	0.6
3716	MOTOR HOMES	0.6
3751	MOTORCYCLES, BICYCLES, AND PARTS	0.6
2022	NATURAL, PROCESSED, AND IMITATION CHEESE	1.2
2711	NEWSPAPERS	3.7
3357	NONFERROUS WIRE DRAWING & INSULATING	0.6
3827	OPTICAL INSTRUMENTS AND LENSES	2.5
2834	PHARMACEUTICAL PREPARATIONS	1.2
3085	PLASTICS BOTTLES	0.6
2821	PLASTICS MATERIALS AND RESINS	0.6
3089	PLASTICS PRODUCTS, NEC	0.6
3471	PLATING AND POLISHING	0.6
1711	PLUMBING, HEATING, AIR CONDITIONING	2.5
3672	PRINTED CIRCUIT BOARDS	2.5
3555	PRINTING TRADES MACHINERY	0.6
2013	SAUSAGES AND OTHER PREPARED MEATS	1.2
2421	SAWMILLS AND PLANING MILLS, GENERAL	1.9
3596	SCALES AND BALANCES EXCEPT LABORATORY	0.6
3674	SEMICONDUCTORS AND RELATED DEVICES	0.6
2075	SOYBEAN OIL MILLS	1.2
2429	SPECIAL PRODUCT SAWMILLS, NEC	0.6
1799	SPECIAL TRADE CONTRACTORS, NEC	1.9
3949	SPORTING AND ATHLETIC GOODS, NEC	0.6
3259	STRUCTURAL AND CLAY PRODUCTS, NEC	1.2
3661	TELEPHONE AND TELEGRAPH APPARATUS	1.2
1543	TEMPORARY SERVICES FOR CONSTRUCTION (2)	0.6
3713	TRUCK AND BUS BODIES	1.2
2084	WINES, BRANDY, AND BRANDY SPIRITS	5.0
2339	WOMEN'S AND MISSES' OUTERWEAR, NEC	1.2
2499	WOOD PRODUCTS, NEC	0.6

RESPONSE TO M&E PROTOCOL TABLE 7

A. Overview Information

1. Study Title: Impact Evaluation of Pacific Gas & Electric Company's 1996 Industrial Sector Energy Management Services Program.

   Study ID: 359

2. Energy Management Services. All EMS recommendations were made in 1996.

3. Evaluations covered HVAC, lighting, and process end uses.

4. Gross savings estimated by engineering methods via DOE 2.1E simulations and other engineering models, as described in Section 5. Net-to-gross ratios were estimated through self-reports in interviews. Refer to Section 6 for details.

5. No comparison groups were used.

6. Reports of sample sizes are contained in Section 3.

B. Database Management

1. Tables and flow charts that show all data sources and their interrelations can be found in Section 2 (Figure 2-1).

2. The sources of all data elements are described in Sections 4, 5 and 6.

3. Sample selection processes, recruitment, response rates, and attrition are described in Section 3.

4. Gross savings data quality checks: each evaluation was reviewed by a senior-level engineer who verified the reasonableness of the technical approach, data collected, and evaluation results. Gross savings results were further subjected to data checks which identified items with negative savings, with large discrepancies compared to the program estimates, and other anomalies. Any outliers were further scrutinized to confirm their correctness.

   Net savings data quality checks: internal consistency checks were built into decision-maker interviews, so that interviewers were alerted to internal contradictions.

5. For the most part, all data collected were used. There was one exception. Responses to question 10 on the Decision-Maker Survey were ignored. This decision is consistent with recent agreements by the CADMAC Modeling and Base Efficiency Subcommittees.

C. Sampling

1. A complete description of the sample design and implementation can be found in Section 3.

2. Data collection instruments are provided in Appendices A, B, and C. Sample disposition reports are in Section 3.

3. N/A

D. Data Screening and Analysis

1. Once recruitment was completed, very few data points were missing. The few that were missing, and how they were handled, are discussed in sections 5 and 6.

2. Background variables were not an issue since comparison groups were not used.

3. No screening of cases was done beyond the initial sampling. Since analysis did not depend on billing data, many of the usual reasons for screening did not exist.

4. N/A

5. N/A

6. Potential errors in measuring customers' level of free ridership are dealt with by multiple measures of the same concept, increasing reliability of measures. Also, internal consistency checks are provided to detect contradictions and misunderstandings during the interview so that they can be addressed on the spot with the respondent.

7. N/A

8. N/A

9. N/A

10. N/A

11. Once recruitment was completed, very few data points were missing. The few that were missing, and how they were handled, are discussed in sections 5 and 6.

12. The formulas for calculating standard errors and corresponding confidence intervals are listed in Section 6.

E. Data Interpretation and Application

1. Gross savings were calculated by engineering methods. Net savings were calculated by application of self-report-based NTGRs. Separate estimates of net savings were calculated for each end use. Realization rates based on ratios between engineering estimates and program tracking system estimates, plus NTGRs, both based on sampled and evaluated sites, were applied to excluded site program tracking system savings to produce net savings estimates for all groups. These net savings were summed across end uses to produce program-level net savings.

2. A full description of the aggregation from item-level net savings and NTGRs to program-level net savings, program-level NTGRs, and end-use-level savings and NTGRs is reported in sections 5 and 6.