Customer Energy Efficiency Program
Measurement and Evaluation Program

RETENTION STUDY OF PACIFIC GAS AND ELECTRIC COMPANY'S 1994 AND 1995 RESIDENTIAL APPLIANCE EFFICIENCY INCENTIVES PROGRAM

PG&E Study ID numbers:
1994 Lighting Third-Year Retention: 384bR1
1995 Lighting Third-Year Retention: 401bR1
1994 Space Conditioning Fourth-Year Retention: 384cR1
1994 Refrigeration Fourth-Year Retention: 384aR1

March 1, 1999

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Retention Study of Pacific Gas and Electric Company's
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1995 Residential Lighting Third Year Retention: 401bR1
1994 Residential Space Conditioning Fourth Year Retention: 384cR1
1994 Residential Refrigeration Fourth Year Retention: 384aR1

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 March, 1998, pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, 95-12-054, 96-12-079, and 98-03-063.

This study measures the Effective Useful Life of lighting, space conditioning, and refrigeration measures for which rebates were paid through PG&E's 1994 and 1995 Residential Appliance Efficiency Incentives Program. The Effective Useful Life is the estimated time at which half the units installed through these programs will no longer be in place and operable.

Methodology

The general method of study for each measure is to collect measure retention data from a sample of participants, and fit a parametric survival function to those data. The survival function gives the probability of surviving to any positive time *t*. These parameters of the function are estimated from the retention data. Once the survival function parameters are estimated, median lifetime or EUL is determined as the time t^* such that the survival probability is equal to 50 percent.

For the lighting measures studied, which were rebated through PG&E's Multifamily Rebate Program, retention data were collected via onsite inspections for a sample of 300 participating premises. For the central air conditioners and refrigerators studied, the retention data were gathered via telephone surveys conducted with approximately 400 central air conditioning participants and 400 refrigerator participants. A supplemental sample of 200 new occupants of homes from which a refrigerator participant moved since participating was also conducted. The supplemental new occupant sample provided information on measure loss due to customers' leaving the service territory with their rebated units.

Study Results

The results of this study are summarized in the Table below. For central air conditioning, there were no observed failures. As a result, no model could be estimated and no *ex post* EUL is available. For CFL's and T-8's, the *ex post* estimate is formally significantly different from the *ex ante* EUL. However, these estimates are not considered reliable, and revision of the *ex ante* EUL based on these results is not recommended. For HID lights and for refrigerators, the *ex post* EUL estimates are not significantly different from the *ex ante* values. The *ex ante* EUL's for these measures are therefore not to be revised. In summary, none of the *ex ante* EUL's are to be revised based on the study findings.

Residential Appliance Efficiency Incentives Programs, 1994 and 1995
Summary of Ex Post Effective Useful Life Estimates

Program Year	Studied Measure Description (Measure Group)	End Use	EUL						p-Value for *ex post* EUL	EUL Realizat'n Rate (*ex post*/*ex ante*)
			ex ante	*ex post* from Study	To be used in Claim	*ex post* Standard Error	80% Conf. Interval Lower Bound	Upper Bound		
1994 (3rd year retention)	CFL	Lighting	10	88.5	10.0	13.0	71.9	105.1 *	0.00	1
	HID	Lighting	16	15.4	16.0	1.5	13.5	17.3	0.69	1
	T-8	Lighting	15	135.8	15.0	47.7	74.6	196.9 *	0.01	1
1995 (3rd year retention)	CFL	Lighting	10	88.5	10.0	13.0	71.9	105.1	0.00	1
	HID	Lighting	16	15.4	16.0	1.5	13.5	17.3	0.69	1
	T-8	Lighting	15	135.8	15.0	47.7	74.6	196.9	0.01	1
1994 (4th year retention)	CAC	Space Conditioning	18	--	18.0	--	--	--	--	1
1994 (4th year retention)	Refrigerators	Refrigeration	20	25.8	20.0	9.2	14.0	37.7	0.53	1

* 80 percent confidence interval does not include the *ex ante* EUL. Formally, the *ex ante* would be rejected.

Regulatory Waivers and Filing Variances

This study is conducted according to the terms of Pacific Gas & Electric Company's requested retroactive waiver for a modification to third and fourth earnings claim calculation methodology, approved February 17, 1999.

RETENTION STUDY OF PACIFIC GAS AND ELECTRIC COMPANY'S 1994 and 1995 RESIDENTIAL APPLIANCE EFFICIENCY INCENTIVES PROGRAM

1994 RESIDENTIAL LIGHTING THIRD-YEAR RETENTION

PG&E STUDY ID: 384bR1

1995 RESIDENTIAL LIGHTING THIRD-YEAR RETENTION

PG&E STUDY ID: 401bR1

1994 RESIDENTIAL SPACE CONDITIONING FOURTH-YEAR RETENTION

PG&E STUDY ID: 384cR1

1994 RESIDENTIAL REFRIGERATION FOURTH-YEAR RETENTION

PG&E STUDY ID: 384aR1

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March 1, 1999

SECTION E EXECUTIVE SUMMARY E-1

E.1 Background E-1

E.2 Study Methods E-1

E.2.1 Survival Analysis E-1

E.3 Summary of Results E-2

SECTION 1 INTRODUCTION 1-1

1.1 Background 1-1

1.1.1 Protocol Requirements 1-1

1.2 Study Methods 1-2

1.2.1 Survival Analysis 1-2

1.3 Summary of Results 1-4

1.4 Report Organization 1-5

SECTION 2 LIGHTING RETENTION 2-1

2.1 Introduction 2-1

2.2 Methods 2-1

2.2.1 Overview 2-1

2.2.2 Data Sources 2-1

2.2.3 Estimation 2-4

2.2.4 Weighting 2-4

2.3 Results 2-5

2.3.1 Data Attrition 2-5

2.3.2 Units Still in Place 2-6

2.3.3 Survival Analysis Results 2-6

SECTION 3 SPACE CONDITIONING RETENTION 3-1

3.1 Introduction 3-1

3.2 Methods 3-1

3.2.1 Overview 3-1

3.2.2 Data Sources 3-2

3.2.3 Estimation 3-5

3.3 Results 3-5

3.3.1 Units Still in Place 3-5

3.3.2 Survival Modeling 3-5

SECTION 4 REFRIGERATOR RETENTION 4-1

4.1 Introduction 4-1

4.2 Methods 4-1

4.2.1 Overview 4-1
4.2.2 Data Sources 4-2
4.2.3 Estimation 4-6

4.3 Results 4-9

4.3.1 Separate Analysis for Nonmoving Participants 4-9
4.3.2 Separate Analysis for New Occupants 4-10
4.3.3 Final Results: Combined Modeling of Nonmovers and Movers 4-13

APPENDIX A SURVEY INSTRUMENTS A-1

A.1 Multifamily Lighting Onsite Retention Study A-1

A.2 Refrigerator and Central Air Conditioners Nonmovers Study A-1

A.3 Refrigerator New Occupants Survey A-1

APPENDIX B REPORTING FOR CADMAC PROTOCOLS TABLE 6B B-1

B.1 1994 Lighting B-1

B.2 1995 Lighting B-1

B.3 1994 Space Conditioning B-1

B.4 1994 Refrigeration B-1

APPENDIX C PROTOCOLS TABLE 7B DOCUMENTATION C-1

C.1 1994 Lighting C-2

C.1.1 Overview Information C-2
C.1.2 Database Management C-3
C.1.3 Sampling C-4
C.1.4 Data Screening and Analysis C-7

C.2 1995 Lighting C-10

C.2.1 Overview Information C-10
C.2.2 Database Management C-11
C.2.3 Sampling C-12
C.2.4 Data Screening and Analysis C-15

C.3 Space Conditioning C-18
C.3.1 Overview Information C-18
C.3.2 Database Management C-18
C.3.3 Sampling C-19
C.3.4 Data Screening and Analysis C-21
C.4 1994 Refrigeration C-23
C.4.1 Overview Information C-23
C.4.2 Database Management C-24
C.4.3 Sampling C-25
C.4.4 Data Screening and Analysis C-28

APPENDIX D APPROVED STUDY METHOD WAIVER D-1

LIST OF TABLES

Table E-1 Summary of EUL Findings (years) E-3

Table 1-1 Summary of EUL Findings (years) 1-5

Table 2-1 RAEI Lighting Measures Included in This Study 2-1
Table 2-2 First Wave Sample Allocation Plan 2-3
Table 2-3 Sample Disposition 2-4
Table 2-4 Data Attrition 2-6
Table 2-5 Data Included in Analysis by Technology Group 2-6
Table 2-6 Status of Rebated Lamps 2-6
Table 2-7 Estimated EUL's and Standard Errors for Various Hazard Functions (years) 2-7
Table 2-8 Estimated EUL's and Confidence Intervals for Various Hazard Functions (years) 2-7

Table 3-1 Space Conditioning Measures Studied 3-1
Table 3-2 CAC Sampling Frame 3-3
Table 3-3 CAC Quota Groups and Samples 3-4
Table 3-4 Final Survey Disposition by CAC Quota Group 3-5

Table 4-1 Refrigerator Measures Included in This Study 4-1
Table 4-2 Refrigerator Sampling Frame 4-4
Table 4-3 Refrigerator Quota Groups and Samples 4-5
Table 4-4 Final Survey Disposition by Quota Group 4-6
Table 4-5 Disposition Groups and Weights for Combined Survival Analysis 4-9

Table 4-6	Retention Rates for Nonmoving Participants	4-10
Table 4-7	Data Attrition	4-11
Table 4-8	Status of Rebated Refrigerator New Occupants	4-11
Table 4-9	California Census Data	4-12
Table 4-10	Median Survival Time EUL for New Occupants (years)	4-13
Table 4-11	Disposition Group Weights	4-14
Table 4-12	EUL Estimated from Combined Modeling of Nonmovers and Movers (Years)	4-15
Table 4-13	Estimated EUL's and Confidence Intervals Base Case (years)	4-15
Table C-1	Data Attrition	C-4
Table C-2	Data Included in Analysis by Technology Group	C-4
Table C-3	First Wave Sample Allocation Plan	C-6
Table C-4	Data Attrition	C-12
Table C-5	Data Included in Analysis by Technology Group	C-12
Table C-6	First Wave Sample Allocation Plan	C-14
Table C-7	Refrigerator Sampling Frame	C-27
Table C-8	Data Attrition	C-29

E

EXECUTIVE SUMMARY

E.1 BACKGROUND

This report provides the results of the third- and fourth-year retention study of Pacific Gas and Electric Company's (PG&E's) 1994 and 1995 Residential Appliance Efficiency Incentives Program, as required by the Measurement and Evaluation Protocols of the California DSM Measurement Advisory Committee (CADMAC). The results of the analysis will be used in the third earnings claims filed for each program year.

As given in the Protocols, the goal of the measure retention study is to determine "the length of time the measure(s) installed during the program year are maintained in operable condition." As agreed within the CADMAC Persistence Subcommittee, this question is addressed by estimating each measure's Effective Useful Life (EUL). The EUL is defined as the median survival time, that is, as the time until half the units are no longer in place and operable.

Each measure has an *ex ante* estimate of the EUL, which has been used in the first and second earnings claims. If the *ex post* EUL determined by the retention study for a particular measure is statistically significantly different from the *ex ante* EUL at the 20 percent significance (80 percent confidence) level, the *ex post* EUL will be used for future earnings claims. If there is not such a statistically significant difference, the *ex ante* EUL will be retained. Whether or not the EUL is revised as a result of this study, the EUL may be revised in the future based on subsequent retention studies required by the Protocols.

In this study, lighting, space conditioning, and refrigeration are each addressed in a separate chapter. For each specific measure studied, the resulting EUL estimate will be applied both to it and to a group of like measures. The specific measures studied for each end use and the associated like measures are indicated in each chapter.

E.2 STUDY METHODS

E.2.1 Survival Analysis

The General Survival Function

The general method of study for each measure is to collect measure retention data from a sample of participants, and fit a parametric survival function to those data. The survival function is a function that gives the probability a unit will survive to any positive time *t*. The parameters of the survival function are estimated from the retention data. Once the survival function

parameters are estimated, the median lifetime or EUL is determined as the time *t** when the survival probability is 50 percent. This is the estimated time when half the units will be gone.

Interpretation of Survival Model Results

Estimating a survival function and the corresponding median lifetime from retention data requires an assumed functional form. At this point in the life of the measures addressed in this study, the failure rates are generally low. As a result, there is little solid empirical basis for choosing among possible forms. In some cases, it may be possible to match the empirical data reasonably well over the limited domain of the analysis (three to four years since program participation). However, in most cases the resulting estimated median lifetime will be substantially greater than this elapsed lifetime. That is, the EUL estimate entails extrapolating the data far beyond their original range. Such extrapolation is precarious in any modeling exercise. The exception would be if there were a very strong basis for knowing that the model form had been appropriately specified and that its parameters are consistent across the range from the data to the point of extrapolation.

In the present study, there is no such *a priori* basis for specifying the form. Consequently, in cases where the estimated EULs are substantially greater than the four years of observed lifetimes, these estimates should be regarded as indicative, but not definitive. This issue is discussed further in the context of each measure group's analysis.

Data Required for the Survival Analysis

The retention data required for the survival analysis are data that indicate for each rebated unit at each sampled participant whether the unit was still in place and operable at the time of the survey. A unit not in place and operable is classified as a "failure" for purposes of this analysis. The unit may not have failed physically, but in terms of the program savings objectives has failed. Wherever possible, the retention data for failed units also include the date when the failure occurred.

E.3 SUMMARY OF RESULTS

The results of this study are summarized in Table E-1. The table shows the estimates for the most appropriate distribution for which results were obtained. That distributional form was exponential for the lighting measures, Weibull for refrigeration. For space conditioning, there were no observed failures. As a result, no model could be estimated and no *ex post* EUL is available.

For CFLs and T-8's, the EUL estimated with the exponential form is significantly different from the *ex ante* EUL at the 80 percent confidence level. However, these EUL estimates are extremely large. Moreover, the assumption of a constant failure rate over time, implicit in the exponential form, is not appropriate, and may lead to artificially long estimated EULs. Thus, these *ex post* EULs are not considered reliable. For the other lighting measure studies, HID, the *ex post* EUL

of 15.4 years is very close to the *ex ante* value of 16 years, and is not statistically significantly different. Thus, retaining the *ex ante* EULs is recommended for all three lighting measures.

For refrigerators, the *ex post* EUL estimate of 25.8 years was not statistically significantly different from the *ex ante* EUL at the 20 percent significance (80 percent confidence) level. Moreover, these results are not entirely reliable, because of the limited information available at this date to provide a basis for defining the pattern of failures over the next twenty or more years. Thus, both formally and in consideration of the model robustness, the *ex ante* EUL is not rejected.

Thus, for all the measures studied, retaining the *ex ante* EUL is recommended. No *ex post* EULs have been estimated with sufficient reliability to warrant revising the *ex ante* values.

Table E-1
Summary of EUL Findings
(years)

Program Year	Studied Measure Description (Measure Group)	End Use	EUL						p-Value for *ex post* EUL	EUL Realizat'n Rate (*ex post*/*ex ante*)
			ex ante	*ex post* from Study	To be used in Claim	*ex post* Standard Error	80% Conf. Interval Lower Bound	Upper Bound		
1994	CFL	Lighting	10	88.5	10.0	13.0	71.9	105.1 *	0.00	1
(3rd year	HID	Lighting	16	15.4	16.0	1.5	13.5	17.3	0.69	1
retention)	T-8	Lighting	15	135.8	15.0	47.7	74.6	196.9 *	0.01	1
1995	CFL	Lighting	10	88.5	10.0	13.0	71.9	105.1	0.00	1
(3rd year	HID	Lighting	16	15.4	16.0	1.5	13.5	17.3	0.69	1
retention)	T-8	Lighting	15	135.8	15.0	47.7	74.6	196.9	0.01	1
1994 (4th year retention)	CAC	Space Conditioning	18	--	18.0	--	--	--	--	1
1994 (4th year retention)	Refrigerators	Refrigeration	20	25.8	20.0	9.2	14.0	37.7	0.53	1

1 INTRODUCTION

1.1 BACKGROUND

This report provides the results of the third- and fourth-year retention studies of Pacific Gas and Electric Company's (PG&E's) 1994 and 1995 Residential Appliance Efficiency Incentives Program, as required by the Measurement and Evaluation (M&E) Protocols of the California DSM Measurement Advisory Committee (CADMAC).[1]

1.1.1 Protocol Requirements

The Protocols require that retention studies be performed in the fourth and ninth years for space conditioning and refrigeration, and in the third and sixth years for lighting. The CADMAC Subcommittee on measure retention has directed that the 1994 and 1995 program year retention studies be combined into a single analysis. The results of the combined analysis will be used in the third earnings claims filed for each program year.

Estimating Effective Useful Life (EUL)

The goals of the measure retention study (Protocols, p. A-9) are to determine

> (a) the length of time the measure(s) installed during the program year are maintained in opera[ble] condition; and (b) the extent to which there has been a significant reduction in the effectiveness of the measures.

The CADMAC Persistence Subcommittee has agreed that the Protocols require that the first question (a) should be addressed by estimating each measure's Effective Useful Life (EUL). The EUL is defined as the median survival time, that is, as the time until half the units are no longer in place and operable. Estimating the EUL is the primary focus of this report. The question of reduced measure effectiveness has been addressed in a separate set of studies.

Each measure has an *ex ante* estimate of the EUL, which has been used in the first and second earnings claims. If the *ex post* EUL determined by the retention study for a particular measure is statistically significantly different from the *ex ante* EUL at the 20 percent significance (80 percent confidence) level, the *ex post* EUL will be used for future earnings claims. If there is not such a statistically significant difference, the *ex ante* EUL will be retained. Whether or not the EUL is revised as a result of this study, the EUL may be revised in the future based on subsequent retention studies required by the Protocols.

[1] California Public Utilities Commission, *Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management Programs*, Decision 93-05-063. Revised March, 1998., pursuant to Decisions 94-05-063, 94-10-059, 94-12-021, 95-12-054, 96-12-079, and 98-03-063.

In this study, lighting, space conditioning and refrigeration are each addressed in a separate chapter. For each specific measure studied, the resulting EUL estimate will be applied both to it and to a group of like measures. The specific measures studied for each end use and the associated like measures are indicated in each chapter.

1.2 STUDY METHODS

1.2.1 Survival Analysis

The General Survival Function

The general method of study for each measure is to collect measure retention data from a sample of participants, and fit a parametric survival function to those data. The survival function is a function $S(t;\theta)$ that gives the probability S of surviving to any positive time t, given the parameters θ. These parameters are estimated from the retention data. Once the survival function parameters are estimated, median lifetime or EUL is determined as the time t^* such that the survival probability $S(t;\theta) = 0.5$.

The estimation and application of the survival function requires the specification of the function's parametric form. This form is typically specified in terms of the *hazard function* $h(t;\theta)$. Roughly, the hazard function can be thought of as the instantaneous probability of failing at time t, given that a unit has survived up to that time.

The survival probability $S(t;\theta)$ is one minus the probability $F(t;\theta)$ that a unit will die by time t. Formally, the hazard function is the ratio of the probability density function of the distribution $F(t,\theta)$ to the survival probability $S(t;\theta)$:

$$h(t;\theta) = (dF/dt)/S(t;\theta).$$

Choices of Parametric Forms for the Survival Function

Several parametric forms are in common use as hazard functions. Those explored in this study include the following:

- Gamma
- Weibull
- Exponential
- Log-normal
- Log-logistic.

The Gamma function is the most general of these, and includes the Weibull, Exponential, and Log-normal as special cases. In essence, the Gamma function allows certain parameters to be determined by the data that are constrained by each of the other specifications. As a result, the Gamma function will be able to follow the empirical data most closely. If one of the other forms

is a good description of the data, its results will be similar to those of the less constrained Gamma fit. If the other form is not a good match to the data, its results will be at odds with those of the Gamma fit. This "goodness-of-fit" can be formally tested by the log-likelihood test.

Similarly, the Weibull also includes the Exponential as a special case. The goodness of fit for the exponential form can be tested against the Weibull results, again using the log likelihood test.

The log-normal and log-logistic forms have decreasing hazard functions after an initial peak. That is, failure rates decline over time. This form may be a reasonable fit over a portion of time for certain types of equipment or processes. However, declining failure rates are unlikely to be an accurate representation of the failure pattern several years out.

The exponential form represents a constant hazard function. That is, the chance that a unit will fail in the next time increment, given that it has already survived to the current time, is the same no matter what the current time. This form is often used in survival analysis.

The Weibull form has an increasing hazard function. That is, the failure rate increases as equipment ages. In many respects, this basic assumption is the most reasonable of all the distributions explored.

As noted, the Gamma form is the most general. Depending on the empirical data and the resulting parameters estimated, this form may produce an increasing, decreasing, or essentially constant hazard function.

Interpretation of Survival Model Results

At this point in the life of the measures addressed in this study, the failure rates are generally low. As a result, there is little solid empirical basis for choosing among possible forms of the hazard function. In some cases, it may be possible to match the empirical data reasonably well over the limited domain of the analysis (three to four years since program participation). However, in most cases the resulting estimated median lifetime will be substantially greater than this elapsed lifetime. That is, the EUL estimate entails extrapolating the data far beyond their original range. Such extrapolation is precarious in any modeling exercise. The exception would be if there were a very strong basis for knowing that the model form had been appropriately specified and that its parameters are consistent across the range from the data to the point of extrapolation.

In the present study, there is no such *a priori* basis for specifying the form, and no basis for assuming that the patterns evident so far are retained over extended periods. Consequently, in cases where the estimated EULs are substantially greater than the four years of observed lifetimes, these estimates should be regarded as indicative, but not definitive. This issue is discussed further in the context of each measure group's analysis.

Data Required for the Survival Analysis

The retention data required for the survival analysis are data that indicate for each rebated unit at each sampled participant whether the unit was still in place and operable at the time of the

survey. A unit not in place and operable is classified as a "failure," for purposes of this analysis. The unit may not have failed physically, but in terms of the program savings objectives has failed. Wherever possible, the retention data for failed units also include the date when the failure occurred.

In many cases, the failure is reported but the date when the failure occurred is not known. In this case, the observation is said to be left-censored. That is, the unit is known to have failed by a particular date, but the date of its failure is not known. In other cases, indeed the majority in this study, the unit had still not failed at the time the retention data were collected. In this case, the observation is said to be right-censored. The unit will fail at some future, as yet unknown time. The model forms used in this analysis accept both left- and right-censored data.

1.3 SUMMARY OF RESULTS

The results of this study are summarized in Table 1-1. The table shows the estimates for the most appropriate distribution for which results were obtained. Conceptually, as discussed above, the Weibull distribution is most appropriate. However, this distribution failed to converge for the lighting measures studied. That is, the available data were insufficient to allow an estimate to be developed with this form. For these measures, the results for the exponential distribution are shown.

For central air conditioning, there were no observed failures. As a result, no model could be estimated and no *ex post* EUL is available.

For CFLs and T-8's, the EUL estimated with the exponential form is significantly different from the *ex ante* EUL at the 80 percent confidence level. However, these EUL estimates are extremely large. Moreover, the assumption of a constant failure rate over time, implicit in the exponential form, is not appropriate, and may lead to artificially long estimated EULs. Thus, these *ex post* EULs are not considered reliable. For the other lighting measure studies, HID, the *ex post* EUL of 15.4 years is very close to the *ex ante* value of 16 years, and is not statistically significantly different. Thus, retaining the *ex ante* EULs is recommended for all three lighting measures.

For refrigerators, the *ex post* EUL estimate of 25.8 years was not statistically significantly different from the *ex ante* EUL at the 20 percent significance (80 percent confidence) level. Moreover, these results are not entirely reliable, regardless of the nominal statistical significance, because of the limited information available at this date to provide a basis for defining the pattern of failures over the next twenty or more years. Thus, both formally and in consideration of the model robustness, the *ex ante* EUL is not rejected.

Thus, for all the measures studied, retaining the *ex ante* EUL is recommended. No *ex post* EULs have been estimated with sufficient reliability to warrant revising the *ex ante* values.

Table 1-1
Summary of EUL Findings
(years)

Program Year	Studied Measure Description (Measure Group)	End Use	EUL							EUL Realizat'n Rate (*ex post*/*ex ante*)
			ex ante	*ex post* from Study	To be used in Claim	*ex post* Standard Error	80% Conf. Interval Lower Bound	80% Conf. Interval Upper Bound	p-Value for *ex post* EUL	
1994	CFL	Lighting	10	88.5	10.0	13.0	71.9	105.1 *	0.00	1
(3rd year	HID	Lighting	16	15.4	16.0	1.5	13.5	17.3	0.69	1
retention)	T-8	Lighting	15	135.8	15.0	47.7	74.6	196.9 *	0.01	1
1995	CFL	Lighting	10	88.5	10.0	13.0	71.9	105.1	0.00	1
(3rd year	HID	Lighting	16	15.4	16.0	1.5	13.5	17.3	0.69	1
retention)	T-8	Lighting	15	135.8	15.0	47.7	74.6	196.9	0.01	1
1994 (4th year retention)	CAC	Space Conditioning	18	--	18.0	--	--	--	--	1
1994 (4th year retention)	Refrigerators	Refrigeration	20	25.8	20.0	9.2	14.0	37.7	0.53	1

1.4 REPORT ORGANIZATION

Details on the retention studies for Lighting, Space Conditioning, and Refrigeration are presented in Chapters 2, 3, and 4, respectively. Survey instruments are included in Appendix A. Tables meeting the requirements of Table 6B of the CADMAC Protocols are given in Appendix B. The documentation required by Table 7B of the Protocols is given in Appendix C. A copy of PG&E's approved waiver on study methods is in Appendix D.

2 LIGHTING RETENTION

2.1 INTRODUCTION

This section presents the retention analysis of lighting measures rebated in 1994 and 1995. CFL, HID and T-8 lamps offered through the Multifamily Property Rebate Program account for 89 percent of the total resource value of the RAEI High Efficiency Lighting end-use in the combined 1994 and 1995 program years.

Table 2-1
RAEI Lighting Measures Included in This Study

Measure Group	Percent of Resource Value Covered	*ex ante* EUL (years)
CFL	61	10
HID	9	15
T-8	19	16

2.2 METHODS

2.2.1 Overview

As described in Section 1, the effective useful life of lighting measures was estimated by fitting a set of survival functions to retention data for a sample of customers. The retention data for this program were collected via onsite inspections. The data sources and data collection are described below. The estimation procedures specific to this program are then described.

2.2.2 Data Sources

Data sources used in this study include

- Onsite data collected for this study
- Program tracking data.

The onsite inspection data constitute the primary data collected for the study. For each sampled site, the inspector determined the number of units currently in place and operable for each of the technology types rebated at that site. Wherever possible, the reason for any shortfall from the rebated number was obtained from a customer respondent. Also obtained if possible was the

number of years since any missing equipment was removed or failed. The survey instruments are found in Appendix A.

Program tracking data were used in several ways. First, these data were used to determine the sample allocations. Likewise, these data were used to draw the samples and provide contact information used to recruit sites for the study. For those sites that were visited, the numbers of rebated units of each technology type were provided to the inspectors.

Data Collection

Sample Design

The onsite data were collected in two waves. The first was in January, 1998 and the second was in November, 1998. This methodology allowed for analysis of the preliminary data and improvement of the data collection process prior to the second set of data collection.

The first wave sample design called for a total of 150 completed visits, split evenly between the two program years. This total sample size was chosen to conform with the Protocol requirements for first-year evaluation studies. The Protocols do not include explicit sample size requirements for the retention studies.

The sample was intended to represent customers of various sizes; three broad lighting technology categories; and the entire PG&E region. To allocate the sample effectively, a stratified sample was used. To ensure coverage of the different technology groups, the sample was stratified on what technologies were rebated to each customer: T-8 lights (and possibly others as well) or other technologies only. To allow an oversampling of customers with higher expected savings while ensuring representation of those with lower savings, the "other" sample was also stratified into two size classes, according to the number of rebated units. Finally, to control field costs, it was necessary to limit the geographic dispersion of the sites. This control was accomplished by stratifying the site into regions of varying distances from PG&E's main population center, and assigning a rough relative cost to inspections in each region. The overall sample was then allocated to cells defined by size, technology type, and region.

The allocation for the first wave was proportional to the total cell count divided by the square root of the relative cost. This allocation rule gives an approximately optimal sample design (that is, the best precision for a given total cost) under the assumption that the standard deviation of the variable of interest is the same in each cell. The variable of interest is a proportion (the number failed) and the standard deviation of a proportion depends only on the proportion itself. Lacking any *a priori* reason to believe the failure rates are higher or lower in particular cells, the assumption of uniform proportions, therefore uniform standard deviations, is reasonable. The first wave sample allocation plan is shown in Table 2-2.

Table 2-2
First Wave Sample Allocation Plan

Segment Descriptors			Population	Wave 1 Quota
Year	Tech/size	Area		
1994	Other - Large	1	130	10
1994	Other - Large	2	117	7
1994	Other - Large	3	112	6
1994	Other - Large	4	63	2
1994	Other - Small	1	130	10
1994	Other - Small	2	124	7
1994	Other - Small	3	123	6
1994	Other - Small	4	48	2
1994	T8	1	84	13
1994	T8	2	68	9
1994	T8	3	8	1
1994	T8	4	32	2
1994 Subtotal			**1039**	**75**
1995	Other - Large	1	54	10
1995	Other - Large	2	41	6
1995	Other - Large	3	55	7
1995	Other - Large	4	29	2
1995	Other - Small	1	59	9
1995	Other - Small	2	62	8
1995	Other - Small	3	52	6
1995	Other - Small	4	26	2
1995	T8	1	51	14
1995	T8	2	27	6
1995	T8	3	15	3
1995	T8	4	20	2
1995 Subtotal			**491**	**75**
Overall Total			**1530**	**150**

After preliminary analysis of the data from the first wave, the decision was made to go forward with a second wave of data collection. This additional data would provide a better basis for the analysis, given the low failure rates found in the first wave. In addition, some improvements could be made to the data collection protocols.

For the second wave, the first wave allocation was repeated to the extent possible. Thus, the combined sample was designed to provide a total of 150 sites per program year. However, for some cells the available population was exhausted or nearly exhausted in the recruitment for the first wave. Additional cases were therefore allocated to other cells.

Sample Disposition

The disposition of the sample contacted and successfully recruited for the two waves is shown in Table 2-3.

Table 2-3
Sample Disposition

Disposition	Wave One Frequency	Wave Two Frequency	Total Frequency	Percent of Sample Attempted
Total Sites Attempted	541	568	1109	100.0%
Unable to contact	45	12	57	5.1%
Unable to speak with contact person	168	195	363	32.7%
Could not accomodate in survey schedule	173	209	382	34.4%
Refused	4	1	5	0.5%
Cancelled	1	1	2	0.2%
Completed Surveys	**150**	**150**	**300**	**27.1%**

2.2.3 Estimation

The primary objective of the analysis is the estimation of the EUL or median survival time, by fitting a survival function to the collected retention data. The general methodology is described in Section 1. Details specific to multifamily lighting are provided below.

Survival Modeling

The lighting measures studied were rebated under PG&E's Multifamily Rebate Program. For multifamily properties, it is often difficult to find a respondent knowledgeable about specific equipment. This means that removal dates were not determined with any accuracy. Therefore, all removed units were considered to be left-censored. That is, it was determined whether the unit was still in place and operable at the time of the visit, but the failure time of units that had failed was not known.

A standard survival analysis was conducted on the censored data. This analysis estimated the time when 50 percent of all equipment will fail, with failure defined as final breakdown or disposal, or removal from the PG&E service territory.

2.2.4 Weighting

As described above, the sample was allocated among cells defined by customer size, broad technology type, and location. Weights were applied to account for the disproportionate sampling. An initial cell weight b_c was developed for each cell c, equal to the ratio of the number of customers in the population to the number in the sample for that cell. The number in the sample was the combined number for the two waves.

Accounting for disproportionate sampling rates is one function of the weighting. Another function is to correct the apparent sample size for the true number of independent observations. In the survival analysis, each individual unit at each visited site is effectively treated as a separate observation. As a result, without weighting, the apparent sample size for the survival analysis is several thousand. This inflated apparent sample size distorts the calculated standard errors, making the estimates appear to be much more accurate than they are. In reality, the analysis has

only one observation on each technology for each site. To have this actual sample size reflected in the analysis, the initial weights are adjusted so that the sum of the weights over all observations in the sample is equal to the number of sampled sites. That is, the final weight for each premise *i* is calculated as

$$w_i = A\, b_{c(i)}$$

where

w_i = final weight for premise i
$b_{c(i)}$ = initial cell weight for the cell c containing premise i
$A = n/\Sigma_i N_i b_{c(i)}$
n = total number of premises in the sample
N_i = number of rebated units at premise i.

A separate set of final weights was calculated for each of the three technology types studied.

2.3 RESULTS

2.3.1 Data Attrition

Table 2-4 shows the data collected and used in the analysis, and the reasons for exclusion. Data were originally collected at 300 sites for a total of 495 technology type-premise combinations. Of these collected data, 456 technology type-premise combinations were used in the analysis. Units were excluded from the analysis for three reasons.

1. **Types Not for Retention Analysis.** Rebates were provided for various technology types including several not included in the retention study, such as exit sign kits. If rebated equipment of these additional types was located at the premise, the surveyor noted the number observed. Because survival analysis was only to be performed on CFL, HID, and T-8 lamps, these technology type-premise combinations were excluded from the analysis.
2. **Units Not in Tracking System.** Survival analysis was only to be performed on CFL, HID, and T-8 lamps purchased with assistance from PG&E. While at a premise, the surveyor noted the total number of these lamp types observed. If this total was greater than the tracking system number, the additional lamps were not considered in the analysis.
3. **Indeterminate Disposition.** In a few cases, the surveyor could not determine if the lamps were ever purchased or installed. These cases were excluded from the analysis.

Table 2-4
Data Attrition

	Technology		
	Sites	Type-Premise	Units
Total with Data Collected	300	495	21,653
Types Not for Retention Analysis	0	12	141
Units Not in Tracking System	6	1	60
Total Targeted for Sampled Premises	**300**	**482**	**21,171**
Indeterminate Disposition	7	26	553
Used	**293**	**456**	**20,618**

Table 2-5 shows the numbers included in the analysis by technology group.

Table 2-5
Data Included in Analysis by Technology Group

	Sites	Units
CFL	247	13,249
HID	97	1,548
T-8	112	5,821

2.3.2 Units Still in Place

Table 2-6 shows the status at the time of inspection of the rebated lamps used in the analysis. For HID lamps, a single site where all the lamps were removed due to dissatisfaction accounted for a substantial portion of the failures. However, even with this site removed, the retention rate was lower for HID than for other lamp types, around 90 percent versus 96 percent for CFL and 98 percent for T-8.

Table 2-6
Status of Rebated Lamps

Measure Type	Still in Place	Removed	Percent in Place
CFL	12,771	478	96.4%
HID	1,385	163	89.5%
HID [1]	1,374	130	91.4%
T-8	5,704	117	98.0%
Total	**19,860**	**758**	**96.3%**

[1] Excluding the lamps at the the premise with all lamps removed due to dissatisfaction. This row is not included in the total.

2.3.3 Survival Analysis Results

Table 2-7 presents the estimated median lifetime or EUL, and the corresponding standard error for various distributional assumptions. Missing values indicate that the model did not converge.

Table 2-7
Estimated EUL's and Standard Errors for Various Hazard Functions
(years)

	CFL		HID		T-8	
Hazard Function Distribution	**EUL**	**Standard Error**	**EUL**	**Standard Error**	**EUL**	**Standard Error**
Exponential	88.5	13.0	15.4	1.5	135.8	47.7
Log Normal	519.3	1,005.7	6.2	0.4	4.9	0.1
Log Logistic	346.0	531.5	6.0	0.3	**	**
Weibull	**	**	**	**	**	**
Gamma	**	**	**	**	**	**

** Model did not converge.

Table 2-8 shows the corresponding 80 percent confidence intervals. Also indicated in the table are the estimates that are statistically significantly different from the *ex ante* EUL at this confidence level. Formally, the Protocols indicate that the *ex ante* EUL's should be replaced by the *ex post* results in these cases. However, the range of results across the different hazard function forms, and the conceptual appropriateness of these forms, suggest that such replacement would be premature. This issue is discussed further below.

Table 2-8
Estimated EUL's and Confidence Intervals for Various Hazard Functions
(years)

	CFL		HID		T-8	
***ex ante* EUL:**	**10**		**15**		**16**	
Hazard Function Distribution	**EUL**	**80% Confidence Interval**	**EUL**	**80% Confidence Interval**	**EUL**	**80% Confidence Interval**
Exponential	88.5	(71.9 , 105.1) *	15.4	(13.5 , 17.3)	135.8	(74.6 , 196.9) *
Log Normal	519.3	(0.0 , 1808.6)	6.2	(5.7 , 6.7) *	4.9	(4.8 , 5.0) *
Log Logistic	346.0	(0.0 , 1027.4)	6.0	(5.6 , 6.4) *	**	** **
Weibull	**	** **	**	** **	**	** **
Gamma	**	** **	**	** **	**	** **
EUL for claim	**10**		**15**		**16**	

* 80 percent confidence interval does not include the *ex ante* estimate. Formally, the *ex ante* EUL would be rejected.
** Model did not converge.

Interpretation of the Results

With the Gamma hazard function, the survival model did not converge for any of the three technology types. Failure to converge means that there is not enough information in the available data to determine the parameters of this most general form. As noted in Section 1, the Weibull form is conceptually the most appropriate, as it allows an increasing hazard function—that is, a failure rate increasing with age. This form also did not converge for any of the measure groups.

The log-normal and log-logistic forms converged for the CFL and HID, and the log-normal for T-8 lamps. The two forms gave roughly similar results, given the associated standard errors. As

noted in Section 1, these forms both have decreasing hazard functions after an early peak. While that pattern may fit the data observed in these early years since participation, it is not reasonable to assume that the same pattern would extend over the later life of the measures. Thus, these results must be considered questionable, regardless of the nominal accuracy indicated by the standard errors and confidence intervals.

Likewise, the exponential form, with its assumption of a constant hazard function, is also questionable. In most cases, the constant hazard function would be expected to give longer EUL's than a form that allows for an increasing hazard.

Thus, at this time in the life of the measures, revision of the *ex ante* EUL's based on the retention study results is not recommended. Table 2-8 above indicates that all *ex ante* EUL's are retained at this time.

3 SPACE CONDITIONING RETENTION

3.1 INTRODUCTION

This section presents the retention analysis of central air conditioners (CACs) rebated in 1994 and 1995. Split and packaged air conditioners account for 61 percent of the total resource value of the RAEI Space Conditioning end-use for the combined 1994 and 1995 program years. These measures were rebated through the Residential Central Air Conditioner Rebate Program. The program was discontinued after 1994; units for which rebates were paid in 1995 represent carry-over from the 1994 program.

Table 3-1
Space Conditioning Measures Studied

Group	Percent of Resource Value Covered	*ex ante* EUL (years)
CAC, Split and Package	61	18

Measure retention data were collected via a telephone survey, described further below. The analysis plan called for a survival analysis to estimate the *ex post* EUL, as described in general terms in Section 1. However, because the incidence of failed measures was so low, it was not possible to fit such a model. Therefore, no *ex post* EUL could be developed for these measures. The data collection methods used and the limitations of the collected data for this analysis are discussed below.

3.2 METHODS

3.2.1 Overview

The data collection and analysis plan for CAC followed the general framework outlined in Section 1. That is, retention data were collected for a sample of customers who had participated in the 1994 and 1995 program years. The data collection was designed to provide input to a survival analysis. This analysis would provide an estimate of the Effective Useful Life, defined for purposes of this study as the median lifetime, or equivalently, the estimated time until half the units would no longer be in place and operable.

It was conjectured that failure rates would be very low over the elapsed time period of three to four years. As it turned out, failure rates were so low that no survival analysis could be conducted. As a result, no *ex post* EUL is provided by this study. The *ex ante* EUL's are retained.

3.2.2 Data Sources

Data sources used in this study include

- Telephone survey data collected from participating customers
- Program tracking data
- Customer information from the current billing system.

The telephone survey data constitute the primary data collected for the study. For each sampled participant, the survey asked if the rebated unit was still in place and operable at the home. If the unit was no longer in place or no longer operable, the reasons for this "failure" were asked. In addition, the time when the failure occurred was obtained to the best of the respondent's recollection. Further details on the design of the data collection are given below.

Program tracking data were used as the basis for the sample selection. These data were used to draw the samples and provide contact information for the sample.

Current billing system information was used to identify participants who had moved since the time of participation. These customers were not included in the CAC survey sample, as discussed further below.

Data Collection

Sample Selection

For each of the two program years under study, a target of 200 completed CAC retention surveys was set. These quotas were based on matching the Protocol requirements for a first-year load impact study. The Protocols do not provide explicit sampling requirements for the retention studies. Of the 200 completed surveys, no separate targets were set for split and packaged units. Rather, all participants were selected with equal probability within each year. That is, a simple random sample was taken from each program year's quota group, as defined below.

A small fraction of customers participated in both the central air conditioner and refrigerator rebate programs during 1994 and 1995. To accommodate this overlap, the two surveys were implemented jointly. Customers who had participated in both programs responded to both portions of the survey. The design of the combined sample for the two programs and two years had to recognize that a given customers could have participated in more than one program and year. To avoid giving some customers the chance of being selected for the sample more than once, the combined set of participants for the two programs and years was divided into the following non-overlapping quota groups:

A. 1995 CAC participants
B. 1994 CAC participants excluding A.
C. 1994 refrigerator participants excluding A and B
D. 1995 refrigerator participants excluding A, B, and C.

The quota groups were defined in order of increasing population size, to allow the best chance of achieving the target number of completed surveys for the groups with smaller populations. Survey respondents selected for either CAC quota group (A or B) who were also refrigerator participants were also asked the refrigerator retention questions. Respondents selected for the refrigerator quota groups (C or D) by definition could not have been CAC participants.

CAC participants who had moved since participating were excluded from the CAC quota groups. The rationale was that CAC retention was likely to be the same for movers as for nonmovers, and it would be difficult to collect reliable retention information for the moving participants. Current occupants would not be expected to be able to confirm that a unit at the premise was the rebated unit. Original participants would be difficult to locate at their new addresses, and would not necessarily know the current status of the rebated unit.

To implement this restriction, a nonmover was defined as a customer for whom the date the customer was first served was earlier than the CAC install date recorded in the tracking system. Thus, it was necessary to merge the tracking system data with the current billing system data. Therefore, any customer whose control number (the customer identification number used as the basis for merging) did not appear in both data sets was dropped from the sample frame.

To limit the survey to actual residential customers, any contractors, apartment owners, real estate companies, etc. were also eliminated. To avoid the complication of asking a respondent to distinguish between units purchased in the same year, any participant who purchased more than one unit in a given year was also removed. This left 2,928 premises in the 1994 program and 770 premises in the 1995 program for the sample frame, with some overlap between the two.

The number of units in each program year and the numbers excluded by the nonresidential and multi-unit screens are shown in Table 3-2. The remaining participants were divided into the sampling quota groups described above.

Table 3-2
CAC Sampling Frame

	1994	1995
Tracking System Count	4,698	994
Missing Control Number	1,016	0
Business	8	2
Multiple Units in Year	234	75
Left for Sampling	**3,440**	**917**

To allow for nonresponse and customers unable to be contacted, a total sample of 800—four times as large as the targeted number of completes—was drawn for each CAC program year's quota group. The total number of participants and sample drawn for each quota group is indicated in Table 3-3.

Table 3-3
CAC Quota Groups and Samples

CAC Quota Group	Population	Sample Drawn	Completed Suveys
1994 (B)	2,928	800	208
1995 (A)	770	800	203

Questionnaire Design

A copy of the survey instrument used for CAC and nonmoving refrigerator participants is provided in Appendix A. The CAC question sequence did not require the respondent to recall the PG&E rebate. However, if the respondent did not recall purchasing a new unit in the program year, the survey was terminated. Respondents were asked if the unit had ever been installed at the service address, and if it was still in place and operable. If the unit was not in place and operable, the reasons and date of failure were obtained. If the unit was reported to be installed at another location, information on that location was collected.

Supplemental information was also collected on how the unit was used and maintained, as well as some demographic characteristics of the household. This information was collected as potentially useful explanatory variables to link to the failure data.

The survey was designed to be administered by telephone. This mode of data collection was chosen for several reasons. Compared to a mail survey, for the types of questions to be asked and the somewhat complicated skip patterns, a telephone survey was considered likely to yield more complete and accurate information than a similar mail survey. Compared to an onsite survey, the telephone response rates were likely to be much higher, reducing the potential for bias. In principle, onsite inspection would collect accurate information in instances where the customer might give false information. However, any customer who would be inclined to give deliberately false information would be unlikely to agree to the onsite inspection. In general, customers are expected to be able to report accurately whether their air conditioner is in place and in operating condition, and whether a unit purchased in a recent year was installed at a particular location. Thus, the substantially greater expense of onsite inspections was not considered to be warranted for this measure.

Survey Implementation

The questionnaire was administered by telephone in November and December, 1998. Table 3-4 shows the final dispositions for each CAC quota group. Surveys were completed for 210 CACs that were rebated under the 1994 program, including 2 for respondents selected for the 1995 quota group, and for 203 CACs that were rebated under the 1995 program.

Table 3-4
Final Survey Disposition by CAC Quota Group

Disposition	1994	1995
Completes	208	203
Busy/no Answer	202	172
Callbacks	171	161
Screenouts	16	22
Refusal	96	117
Terminate	26	23
Language	5	3
Wrong Numbers	104	67
Total Sample Used	620	565

3.2.3 Estimation

Based on the survey responses, a unit was classified as failed if it was not in place and operable within PG&E's service territory. A unit that was installed and apparently operable at another location within the territory would have been considered retained.

The analysis plan called for EUL estimation using the retention data from the survey. The analysis was to follow the approach of the survival analysis described in Section 1. However, this analysis was never undertaken, because essentially no failures were reported, as discussed below.

3.3 RESULTS

3.3.1 Units Still in Place

Of the 210 CACs rebated in 1994, all but one unit was reported to be still located and operable at the original premise. The other unit was reported to be still in PG&E's service territory. All 203 CACs rebated under the 1995 program were reported to be still in place at the original premise.

3.3.2 Survival Modeling

Attrition

All completed surveys were used in the analysis.

Survival Analysis Results

As discussed, none of the units for which data were collected are classified as failures based on the survey information. Thus, it is not possible to estimate an *ex post* EUL from these data. Therefore, the *ex ante* effective useful life of 18 years is retained.

4 REFRIGERATOR RETENTION

4.1 INTRODUCTION

This section presents the retention analysis of refrigerators rebated in 1994 and 1995. High efficiency refrigerators account for 100 percent of the total resource value of the RAEI High Efficiency Refrigeration end-use for the 1994 program year. In 1994 these measures were rebated through the Efficient Refrigerator Rebate Program, the Salesperson/Dealer Incentive Program, and the Multiple Refrigerator Rebate Program (for property managers and builders who purchased refrigerators in quantities of two or more). In 1995, the Efficient Refrigerator program was continued, though it was moved out of the Appliance Efficiency category to a non-earnings category due to a low TRC estimate. Some commitments from the 1994 programs were paid as carry-over in 1995.

Table 4-1
Refrigerator Measures Included in This Study

Measure Group	Percent of Resource Value Covered	*ex ante* EUL (years)
Refrigerators	100	20

4.2 METHODS

4.2.1 Overview

The data collection and analysis plan for refrigerators followed the general framework outlined in Section 1. That is, retention data were collected for a sample of customers who had participated in the 1994 and 1995 program years. The data collection was designed to provide input to a survival analysis. This analysis provides an estimate of the Effective Useful Life, defined for purposes of this study as the median lifetime, or equivalently, the estimated time until half the units would no longer be in place and operable. The retention data for this program were collected via telephone surveys conducted in conjunction with the CAC telephone surveys.

For refrigerators, it was anticipated that nonretention rates would be very low over the elapsed time period of three to four years, except in cases where the participant had moved. Taking rebated units out of the territory was considered likely to be a primary reason for nonretention. For this reason, a special effort was made to determine the disposition of rebated units for participating households that moved. This effort entailed both special data collection components and special treatment in the analysis, as described below.

4.2.2 Data Sources

Data sources used in this study include:

- Survey data collected from participating dwelling units
- Program tracking data
- Customer information from the current billing system
- Census data on California households' moving rates.

The telephone survey data constitute the primary data collected for the study. For each sampled participant, the survey asked if the rebated unit was still in place and operable at the home. If the unit was no longer in place or no longer operable, the reasons for this "failure" were asked. In addition, the time when the failure occurred was obtained to the best of the respondent's recollection. Further details on the design of the data collection are given below.

Program tracking data were used as the basis for the sample selection. These data were used to draw the samples and provide contact information for the sample.

Current billing system information was used to identify participants who had moved since the time of participation. A separate survey effort was made for such participants, as discussed further below.

Census data were used to estimate the fraction of customers who moved outside the PG&E service territory, relative to the total number of participants who moved since participating.

The collection of the participant survey data and the associated uses of the other data sources are described below.

Data Collection

Sample Design

For each of the two program years under study, a target of 200 completed refrigerator retention surveys of participating customers was set. These quotas were based on matching the Protocol requirements for a first-year load impact study. The Protocols do not provide explicit sampling requirements for the retention studies.

As noted, moving was considered likely to be a primary reason that rebated refrigerators would no longer be in place at this length of time since participation. Conducting surveys only with participants who have not moved could therefore give an artificially low estimate of the number of units "failed." On the other hand, contacting participants who have moved to determine the disposition of their rebated refrigerator would be very difficult. The possibility of tracking such participants via forwarding addresses or other information retained in PG&E's billing system was investigated, and determined to be impractical.

To address this limitation, a special survey was designed for the new occupants of premises where the previous occupant was a program participant in 1994 or 1995. This new occupant survey is not a "participant survey," since the respondents do not represent the participating household itself. Likewise, the new occupants do not constitute a comparison group, the usual use of a nonparticipant group in evaluation studies. Thus, the new occupant survey is somewhat outside the parameters of a standard retention study as defined by the Protocols. On the other hand, the new occupants are asked to give information about the disposition of the participating unit. In this sense, the new-occupant survey may be regarded as a supplemental participant survey.

To maintain the sample quotas for the basic participant survey, the quotas of 200 per year were assigned entirely to the nonmoving participants. For the new occupant surveys, supplemental quotas of 100 per year were established.

A small fraction of customers participated in both the central air conditioner and refrigerator rebate programs during 1994 and 1995. To accommodate this overlap, the two surveys were implemented jointly. Customers who had participated in both programs responded to both portions of the survey. The design of the combined sample for the two programs and two years had to recognize that a given customers could have participated in more than one program and year. To avoid giving some customers the chance of being selected for the sample more than once, the combined set of participants for the two programs and years was divided into the following non-overlapping quota groups:

A. 1995 nonmoving CAC participants
B. 1994 nonmoving CAC participants excluding A.
C.1 1994 moving refrigerator participants excluding A and B
C.2 1995 nonmoving refrigerator participants excluding A, B,
D.1 1995 moving refrigerator participants excluding A, B, and C1
D.2 1995 moving refrigerator participants excluding A, B, and C2.

The quota groups were defined in order of increasing population size, to allow the best chance of achieving the target number of completed surveys for the groups with smaller populations. Survey respondents selected for either CAC quota group (A or B) who were also refrigerator participants were also asked the refrigerator retention questions. Respondents selected for the refrigerator quota groups (C through F) by definition could not have been CAC participants.

CAC participants who had moved since participating were excluded from the CAC quota groups, as discussed in Section 3, but not from the refrigerator quota groups. Refrigerator participants who had moved since participating were treated as separate quota groups (C2 and D2).

To identify refrigerator participants who had moved, a nonmover was defined as a customer for whom the date the customer was first served was earlier than the refrigerator purchase date recorded in the tracking system. This date was used instead of the date the rebate check was sent,

because the latter date was missing for some participants. This issue is discussed further in the context of the analysis conducted.

To screen for movers as just described, it was necessary to merge the tracking system data with the current billing system data. Therefore, any customer whose control number (the customer identification number used as the basis for merging) did not appear in both data sets was dropped from the sample frame.

Refrigerators were rebated under three programs:

- Efficient Refrigerator Rebate Program, oriented to residential customers who own their own refrigerators;
- Refrigerator Salesperson/Dealer Incentive Program, oriented to refrigerator sales people;
- Multiple Refrigerator Rebate Program, oriented to owners and managers of residential rental property.

Retention data for this study were collected from participants in the Efficient Refrigerator Rebate Program only. Salespeople were not expected to be able to provide information on the current use of appliances they had sold. Similarly, finding informed respondents for leased property is difficult. Accordingly, retention data were collected only for individual households where no more than one unit was rebated in a single program year. Retention for units in the other programs is expected to be similar.

To limit the survey to actual residential customers, any contractors, apartment owners, real estate companies, etc. were also eliminated. To avoid the complication of asking a respondent to distinguish between units purchased in the same year, any participant who purchased more than one unit in a given year was also removed. This screen left 27,104 premises in the 1994 program and 30,562 premises in the 1995 program for the sample frame.

The number of units in each program year and the numbers excluded by the nonresidential and multi-unit screens are shown in Table 4-2. The remaining participants were divided into the sampling quota groups described above.

Table 4-2
Refrigerator Sampling Frame

	1994	1995
Tracking System Count	29,001	34,155
Missing Control Number	278	0
Business	718	2,208
Multiple Units in Year	372	498
Left for Sampling	**27,633**	**31,449**

To allow for nonresponse and customers unable to be contacted, a total sample of 800—four times as large as the targeted number of completes—was drawn for the nonmover quota group for each year. For the refrigerator mover groups, a larger oversample was taken. It was considered likely that the contact information would be less reliable and respondent cooperation with the survey lower for the new occupant survey than for the nonmovers' participant survey. The total number of participants and sample drawn for each quota group is indicated in Table 4-1.

Table 4-3
Refrigerator Quota Groups and Samples

Refrigerator Quota Group	Population	Sample Drawn	Targeted Completed Surveys
1994 nonmovers (C1)	18,077	800	200
1995 nonmovers (D1)	20,765	800	200
1994 movers (C2)	9,027	1200	100
1995 movers (D2)	9,797	1200	100

Questionnaire Design

Copies of the survey instruments used for the nonmoving refrigerator participants and for new occupants are provided in Appendix A. The nonmover's refrigerator question sequence did not require the respondent to recall the PG&E rebate. However, if the respondent did not recall purchasing a new unit in the program year, the survey was terminated. Respondents were asked if the unit was still in the home and operable. If not, the reasons and date of removal or breakdown were obtained. If the unit was reported to be installed at another location, information on that location was collected.

Supplemental information was also collected on how the unit was used and maintained, as well as some demographic characteristics of the household. This information was collected as potentially useful explanatory variables to link to the failure data.

The new occupant survey asked whether a refrigerator matching the description of the rebated unit had been left in the home when the new occupant moved in. If it had been, questions similar to those in the nonmover survey were asked to determine what had happened to the unit since that date, and the time of failure if any. If the unit was not in the home when the new occupant moved in, it was assumed to have been taken from the home on the date of the new account.

Conceptually, units taken away by moving participants were to be treated as failed only if they were taken outside the PG&E service territory. However, it was not known where the participant had moved. This lack of information was handled in the analysis probabilistically, as described below, rather than by attempting to gather explicit information on participant migration.

The survey was designed to be administered by telephone. This mode of data collection was chosen for several reasons. Compared to a mail survey, for the types of questions to be asked and the somewhat complicated skip patterns, a telephone survey was considered likely to yield more complete and accurate information than a similar mail survey. Compared to an onsite survey, the telephone response rates were likely to be much higher, reducing the potential for bias. In principle, onsite inspection would collect accurate information in instances where the customer might give false information. However, any customer who would be inclined to give deliberately false information would be unlikely to agree to the onsite inspection. In general, customers are expected to be able to report accurately whether their refrigerator purchased in a recent year is in place and in operating condition at a particular location. Thus, the substantially greater expense of onsite inspections was not considered to be warranted for this measure.

Survey Implementation

The questionnaire was administered by telephone in November and December, 1998. Table 4-4 shows the final dispositions for each quota group. For nonmovers, surveys were completed for 221 refrigerators that were rebated under the 1994 program, and 208 refrigerators that were rebated under the 1995 program, including those rebated to participants from other quota groups. For households where the participant has subsequently moved, data were obtained from current occupants for 105 refrigerators rebated in 1994, and for 103 refrigerators rebated in 1995.

Table 4-4
Final Survey Disposition by Quota Group

	1994	1995
Tracking System Count	29,001	34,155
Missing Control Number	278	0
Business	718	2,208
Multiple Units in Year	372	498
Left for Sampling	**27,633**	**31,449**

4.2.3 Estimation

The primary objective of the analysis is the estimation of the EUL or median survival time, by fitting a survival function to the collected retention data. The general methodology is described in Section 1. For refrigerators, special treatment was required to incorporate the information from the supplemental new occupant survey.

Retention data from the nonmovers and new occupants surveys were first analyzed separately. A combined analysis was then conducted. In the combined analysis, the responses were weighted to reflect the proportion of participants represented by each sample component. The remainder of this section describes the estimation procedure for the survival analysis.

Overview of the Separate Survival Analysis

As a first attempt at survival modeling, current occupants and nonmovers were modeled separately. The nonmover analysis by itself provides the estimated EUL that would be obtained

if only the formal participant sample is used, without the supplemental new occupant survey. The new occupant analysis alone indicates the rate of loss of rebated units among those participants who move after participating.

Migration from the PG&E Territory

A key factor in both the separate new occupant analysis and the combined analysis is the fraction of movers who go outside the PG&E service territory. This fraction is estimated based on Census data on migrations in California. However, the Census data do not provide information specific to the service territory. A set of three scenarios are therefore provided. The best and worst cases, respectively, correspond to low and high estimates of the fraction who leave the territory. The base case, is midway between these. The development of these estimates is described in the Results section.

For the separate analysis of new occupant data, households from which the unit had been taken by the moving participant were randomly assigned as moving "in-territory" or "out-of-territory". The random proportion assigned to moving out of territory was set equal to the estimated fraction who leave, under each of the three scenarios. Those assigned as having moved outside the territory were coded as failures. For new occupants where the rebated unit had been left behind by the moving participant, the unit was coded as failed only if it was no longer in place and operable at the original premise.

Overview of the Combined Survival Analysis

The retention information collected from the nonmovers and new occupants combines information from three different situations:

1. Nonmovers. The rebated refrigerator stayed with its original owner in its original location. It may have failed or may still be in use. These units are represented by the responses to the nonmover survey.
2. New occupant, unit left behind: the rebated refrigerator stayed in its original location but its original owner moved. The unit may have failed or may still be in use. These units are represented by responses to the new occupant survey for respondents who report that a unit matching the description of the rebated unit had been left in the home when the new occupant moved in.
3. New occupant, unit taken: the rebated refrigerator was removed from its original location when its original owner moved. Whether the unit was taken or left is determined from the new occupant survey.

The overall survival curve and resulting median lifetime (EUL) must combine information on nonretention from all these situations. To develop an EUL estimate that appropriately accounts for the different nonretention scenarios, the retention data from all three types of respondents are combined into a single estimation. However, in this analysis the different categories must be weighted in proportion to their presence in the population.

Within the third category (new occupant, unit taken) the unit is treated as "failed" for purposes of the program if it was taken outside PG&E service territory. Since only the new occupant and not

the participant who moved was interviewed, it is not known whether a unit that was moved was moved within or outside PG&E's territory. For purposes of the analysis, all units that were moved are assigned a status of "failed." However, these units are weighted in the analysis only in proportion to the fraction of moves estimated to be outside the PG&E territory.

For units that were moved within the PG&E territory, no data were collected on whether the units are still in operation. Retention of these units is assumed to be the same as for nonmovers—that is, units that stayed with the original participant and did not move. Thus, the nonmovers are weighted in the analysis to represent both the fraction of the population that did not move and the fraction that moved within PG&E territory.

Table 4-5 summarizes the disposition categories for movers and nonmovers. For each category, the "sample fraction" indicates what fraction of the cases included in the analysis are in this category. Similarly, "population fraction" indicates what fraction of the population falls into this category. The initial weight assigned each sample case in the analysis is the ratio of the population fraction represented by the group to the sample fraction. In the table

q_{non} = proportion of the combined sample who were nonmovers

q_{left} = proportion of the combined sample who were new occupants with a rebated unit left behind.

q_{took} = proportion of the combined sample who were new occupants with a rebated unit not left behind.

r_{left} = fraction of new occupant respondents who had a rebated unit left behind

p_{non} = proportion of the participant population who were nonmovers

p_{left} = estimated proportion of the participant population who were new occupants with a rebated unit left behind.

p_{in} = estimated proportion of the participant population who moved within the PG&E service territory over the study period, and took their rebated unit

p_{out} = estimated proportion of the participant population who moved outside the PG&E service territory over the study period, and took their rebated unit

f = the fraction of those who moved who moved outside the PG&E territory.

Table 4-5
Disposition Groups and Weights for Combined Survival Analysis

Group	Represented by	Sample Fraction	Population Fraction	Initial Weight
Nonmovers	Nonmovers	q_{non}	p_{non}	$(p_{non}+p_{in})/q_{non}$
New Occupant				
--rebated unit left	New occupants with unit left	$q_{left} = r_{left}(1-q_{non})$	$p_{left} = r_{left}(1-p_{non})$	p_{left}/q_{left}
--rebated unit taken				
---- within PG&E	Nonmovers		$p_{in} = (1- f)(1-p_{non}-p_{left})$	
---- outside PG&E	New occupants with unit taken	$q_{took} = (1-r_{left})(1-q_{non})$	$p_{out} = f(1- p_{non}-p_{left})$	p_{out}/q_{took}

Final weights are obtained by scaling all the initial weights so that their sum, over all the respondents in the sample, is equal to the actual number of respondents. This rescaling retains the relative weights indicated by the initial weights, but provides standard errors that are approximately correct. Without this rescaling, the total apparent sample size would be distorted, resulting in distorted standard errors.

4.3 RESULTS

4.3.1 Separate Analysis for Nonmoving Participants

The nonmover participant survey and analysis conforms strictly with the Protocol requirements. Nonmovers alone also represent retention related to factors other than leaving the service territory. This retention rate is important if migrations of rebated units are not a concern.

Attrition

One nonmover who completed the survey refused to answer whether or not the unit was still at the premise and was dropped from the analysis All other respondents to the nonmovers participant survey were used in the analysis.

Units Still in Place

Table 4-6 shows the retention rates for the nonmoving participants. For the 1994 nonmoving participants, 213 of the 220 rebated refrigerators were still in place at the original premise at the time of the survey. For the 1995 nonmoving participants, 204 of the 208 rebated refrigerators are still in place at the participating premise. Of the eleven units not in place at the participants' home, four were reported by the participants to be at other premises in PG&E territory. Thus, the total fraction failed (no longer operating in PG&E territory) is 1.6 percent over the two program years.

Table 4-6
Retention Rates for Nonmoving Participants

	1994	1995
Tracking System Count	29,001	34,155
Missing Control Number	278	0
Business	718	2,208
Multiple Units in Year	372	498
Left for Sampling	**27,633**	**31,449**

Survival Modeling

For nonmovers alone, the survival models did not converge. The number of units that failed was so small that no meaningful estimate of the median time to failure could be obtained. Thus, no *ex post* EUL is provided by the nonmover participant study.

4.3.2 Separate Analysis for New Occupants

The separate analysis of data from new occupants describes nonretention related to participants' moving. Understanding this level of nonretention by itself is important since, as the survey results indicate, most nonretention at this point in time is associated with moving.

Attrition

For purposes of the survey sampling, participants were classified as movers or nonmovers based on the relationship between the refrigerator purchase date and the date the customer was first served. However, during the course of the analysis, a problem with the classification was discovered. For several of the customers administered the "new occupant" survey based on this classification, the elapsed time from program participation to change of occupant (i.e., the time to "failure" if the participant had not left the unit behind) was found to be zero. As it turned out, a relatively large number of participants participated at the time of moving into a new home. In many cases, the purchase was made just before the new account was initiated, and the rebate check was sent just after.

Thus, the screen that flagged customers as movers if the account start-up date was later than the purchase date incorrectly classified these customers. Participants were re-classified as movers or nonmovers according to whether the date the check was sent was later than the date of account start-up. Respondents to the new occupant survey who were classified as nonmovers according to this rule were dropped from the analysis. These respondents could not be included in the nonmovers sample, because the sequence of questions asked was not appropriate to nonmovers for purposes of this study. The proportions of movers and nonmovers in the participant population were also re-calculated, using the revised definition of mover.

One current occupant was also dropped from the analysis because the respondent didn't know if a unit was at the premise when the household moved in. All other correctly completed surveys were used in the analysis. The complete data attrition is shown in Table 4-7.

Table 4-7
Data Attrition

	1994 Nonmovers	1995 Nonmovers	1994 Current Occupants	1995 Current Occupants
Total Surveyed	221	208	105	103
Misclassified as movers	0	0	74	84
Refused/Don't Know Unit Status	1	0	1	0
Used in Analysis	**220**	**208**	**30**	**19**

Units Still in Place

When the current occupants took up residency at the participating premise, 38 of the 49 rebated units in the sample were no longer at the premise. That is, over three-quarters of the participants who moved within a few years of participating took the rebated unit with them. Since the current occupant moved into the premise, one of the 1994 rebated refrigerators sampled was removed from the premise.

Table 4-8
Status of Rebated Refrigerator
New Occupants

Disposition	1994	Percent	1995	Percent	Total Number	Total Percent
Not There When the Current Occupant Moved in	23	18%	15	13%	38	78%
Failed Since Current Occupant Moved in	1	1%	0	0%	1	2%
Still There	6	5%	4	3%	10	20%
Total Responses	**30**	**23%**	**19**	**16%**	**49**	**100%**

Proportion of Customers Moving within and outside PG&E

Fraction of Participants Who Moved over the Study Period

The fraction of participants who moved over the study period was found to be 24.9 percent for 1994 participants and 22.7 percent for 1995 participants.

Customers Moving Out of PG&E Territory

As noted, the analysis of new occupant data requires an estimate of the fraction of movers who leave the PG&E service territory. This fraction was estimated from 1990 Census data on changes of geographic region over a five-year period. Data specific to the PG&E territory were not available, but rough estimates were developed from movements between states and between counties.

As shown in Table 4-9, 55.6 percent of California's (1990) population moved between 1985 and 1990. This compares with 77 percent of the 1995 participants and 75 percent of the 1994 participants that did not move between their participation date and the end of 1998.

Table 4-9
California Census Data

California-1990 Census Data		Totals	Percents
Total Population		27,383,547	
Same house in 1985	12,146,574		44.4%
Different House in US in 1985		13,738,365	50.2%
Same County	8,525,870		31.1%
Different County			
Same State	3,237,662		11.8%
Different State		1,974,833	7.2%
Northwest	308,829		
Midwest	423,473		
South	589,651		
West	652,880		
Abroad in 1985		1,498,608	5.5%
Puerto Rico	6,589		
US outlying area	11,743		
Foreugn County	1,480,276		

Source: http://www.venus.census.gov/cdrom/lookup/901281594. July 24, 1998.

Of those who did move, 12.7/55.6 or 22.8 percent moved from another state or country, and 24.5/55.6 or 44.1 percent moved from another county, state, or country. While these rates do not show the migration rate out of California, they do give some indication of local and remote migration rates. On the basis of these results, this analysis assumes that one-quarter (based on the immigration from out of state) to one-half (based on immigration from out of the county) of those PG&E customers who move go out of the territory. The base case assumption for the analysis is midway between these points: 33.5 percent of the movers are assumed to move away from the service territory.

Survival Analysis for Movers

For the premises where the participant has since moved, results were obtained with three different assumptions for the fraction of movers who leave the PG&E service territory:

- Base case: 33.5 percent of movers leave the territory.
- Best case: 22.8 percent of movers leave the territory.
- Worst case: 44.1 percent of movers leave the territory.

As described above, the best case assumes that the fraction who leave the territory is the same as the fraction who move out of the state. The worst case assumes the fraction who leave the

territory is the same as the fraction who move out of the county. The base case is midway between these two. To the extent that program participants tend to be more stable than the general population, the base case assumption may be conservative--i.e., may overstate the proportion of movers who leave the territory.

Table 4-10 presents the base, best, and worst case predicted lifetime in months, and the standard error associated with the predicted lifetime. All parametric results are presented here, although some models can be rejected based on the shape of the hazard function.

Table 4-10
Median Survival Time EUL for New Occupants
(years)

Case:	Base		Best		Worst	
Percent of Movers Who Leave PG&E Territory	34%		23%		44%	
Distribution	EUL	SE	EUL	SE	EUL	SE
Weibull	7.5	2.2	13.1	6.8	5.6	1.1
Gamma	11.0	5.2	95.2	117.6	-	-
Exponential	8.9	2.5	13.2	4.4	6.5	1.6
Log Logistic	8.2	2.7	15.3	8.9	5.8	1.4
Log Normal	9.3	3.6	19.7	13.3	6.3	1.7

For measure loss due to customers' moving out of the territory, a constant hazard function, which corresponds to the exponential distribution, is reasonable. This assumed distribution yields a median life of 8.9 years in the base case, with a standard error of 2.5 years.

The results are fairly consistent across most of the different distributions for each assumption regarding the fraction of movers who leave the territory. The exception is the gamma distribution, which gives a higher EUL in the base case, an extremely high EUL in the best case, and, and fails to converge in the worst case. As noted in Section 1, the gamma distribution, because it is so general and depends so much on the data to indicate its shape, tends to be unstable when the data are limited.

The exponential result indicates that if all participants moved within four years of participating, half the units will no longer be in operation within PG&E's service territory within approximately nine years. This result by itself does not provide the necessary information about the overall program measure life. To incorporate the effects of movers in the overall population, a combined analysis is required, as described below.

4.3.3 Final Results: Combined Modeling of Nonmovers and Movers

The combined analysis fit the survival function across movers and nonmovers, with weights assigned to reflect the population groups represented by each sample component. The calculated

weights corresponding to Table 4-5 above are shown in Table 4-12. As discussed earlier, the initial weight for each case is the ratio of the population percent represented by the sample percent. The final weights are re-scaled so that the sum of the weights matches the total sample size.

Table 4-11
Disposition Group Weights

	Sample		Percent of Population Represented by Group			Initial Weight		
	Count	Percent	Base Case	Best Case	Worst Case	Base Case	Best Case	Worst Case
Nonmovers	428	89.7%	88.5%	90.5%	86.6%	0.99	1.01	0.97
New occupant								
- with unit left behind	11	2.3%	5.3%	5.3%	5.3%	2.31	2.32	2.31
- with unit taken *	38	8.0%	6.2%	4.2%	8.1%	0.78	0.53	1.02
Total Responses	**477**	**100.0%**	**100.0%**	**100.0%**	**100.0%**			

* Population percents estimated based on the sample fractions of new occupants who had units taken or left.

Table 4-12 shows the estimated EUL's for the combined modeling of nonmovers and movers. As for the new-occupant results alone, results are shown under the different assumptions for the proportion of movers who leave the territory, and using different distributions. Table 4-13 shows the 80 percent confidence intervals for each, and indicates whether the *ex ante* EUL would be rejected.

The EUL estimated with the gamma distribution in the base case not only is unreasonably high, but also has an enormous standard error. The gamma distribution also gives dramatically different results under the three scenarios on the fraction of movers who leave the service territory. These results indicate that the instances of failure are too few for the gamma form to be estimated reliably.

The Weibull distribution, as noted in Section 1, allows an increasing failure rate over time. This assumption makes sense for most types of equipment, including refrigerators. Thus, the Weibull is conceptually the most appropriate distribution. The Weibull estimate is 25.8 years in the base case. As indicated in Table 4-13, the 80 percent confidence interval includes the *ex ante* EUL of 20 years. That is, the *ex ante* would not be rejected by this estimate.

The Weibull result is somewhat suspect in any case, because at this point in time the substantial majority of failures are those due to moving. That is, the increasing rate of equipment breakdown over time is not yet apparent in the data. The projection of the observed failures to 26 years represented by the base case EUL estimate cannot be considered reliable.

The effect on the overall participant population of movers alone is seen in the exponential results. These results have the smallest standard error of any of the distributions estimated, in part because the exponential form is more constrained. The log likelihood test of the exponential distribution against the Weibull shows that the exponential cannot be rejected. That is, the

exponential form is acceptably consistent with the data, as reflected in the fitted model when the less constrained Weibull form is used. The exponential form gives an EUL of 32.9 years in the base case, significantly different from the *ex ante* EUL of 20 years, at the 80 percent confidence level.

However, as noted, the estimated EUL from the exponential form is based on an assumption that the loss rate will remain constant over time. This assumption may reasonably characterize losses due to moving, but does not reflect overall program losses including breakdowns. While the fitted exponential form is an adequate description of the pattern of losses to date, its projection to 20 years or to 32.9 years is not meaningful as a description of the overall program losses.

Accordingly, rejecting the *ex ante* EUL on the basis of this result is not recommended. The log normal and log logistic results are similarly based on distributions that do not make sense for the long run. Thus, none of the results obtained provide a secure basis for rejecting the *ex ante* EUL. The recommendation is to retain the *ex ante* value.

Table 4-12
EUL Estimated from Combined Modeling of Nonmovers and Movers
(Years)

Case:	Base		Best		Worst	
Percent of Movers Who Leave PG&E Territory	34%		23%		44%	
Distribution	EUL	SE	EUL	SE	EUL	SE
Weibull	25.8	9.3	33.7	16.0	20.9	6.0
Gamma	963.2	1195.8			127.9	66.1
Exponential	32.9	5.4	44.7	8.5	26.0	3.8
Log Logistic	32.8	13.0	43.6	22.8	26.0	8.3
Log Normal	61.5	29.7	96.6	62.4	43.5	16.7

Table 4-13
Estimated EUL's and Confidence Intervals
Base Case (years)

ex ante EUL	20			
Distribution	*ex post* EUL	80% Confidence Interval		
Weibull	25.8	(14.0 ,	37.7)	
Gamma	963.2	(0.0 ,	2496.1)	
Exponential	32.9	(26.0 ,	39.9)	*
Log Logistic	32.8	(16.1 ,	49.5)	
Log Normal	61.5	(23.5 ,	99.5)	*

* 80 percent confidence interval does not include the *ex ante* estimate of 20 years. Formally the *ex ante* EUL would be rejected.

A

SURVEY INSTRUMENTS

A.1 MULTIFAMILY LIGHTING ONSITE RETENTION STUDY

A.2 REFRIGERATOR AND CENTRAL AIR CONDITIONERS NONMOVERS STUDY

A.3 REFRIGERATOR NEW OCCUPANTS SURVEY

PG&E Residential Appliance Efficiency Incentive Lighting Program
Multifamily Measure Retention

PG&E Account Number	Name of Owner (as on PG&E bill)
Name of Contact Person	Contact Phone
	(_____) _____ - _____ x(_____)

Name of Complex		
Address where Lighting items installed		
City	State	Zip

Area Code	Measure Code	Fixture Code	Num Obsrvd	Num Expctd	Control Code	Operating Schedule			Discrepancy Code	Removal Code
							Summer	Winter		
						Wkday				
						Wkend				
						Wkday				
						Wkend				
						Wkday				
						Wkend				
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						Wkday				
						Wkend				
						Wkday				
						Wkend				

Table 1-Item Codes for Lighting and Controls

Group	Code	Description
CFL	L87	Compact Fluorescent: Hardwire Fixture, 14-26 Watts (Res. Lighting)
CFL	L88	Compact Fluorescent: Hardwire Fixture, 27-50 Watts (Res. Lighting)
CFL	L86	Compact Fluorescent: Hardwire Fixture, 5-13 Watts (Res. Lighting)
HID	L89	Hid Fixture: 0-70 Watts
HID	L90	Hid Fixture: >= 71 Watts
T8	L93	Fixture: Replace Lamp & Blst, 2 Ft, T-8 & Elec Blst
T8	L94	Fixture: Replace Lamp & Blst, 3 Ft, T-8 & Elec Blst
T8	L95	Fixture: Replace Lamp & Blst, 4 Ft, T-8 & Elec Blst
T8	L96	Fixture: Replace Lamp & Blst, 8 Ft, T-8 & Elec Blst
T8	L97	Fixture: T-8 Fixture & Ballast, 2 Ft, 2-Lamp
T8	L98	Fixture: T-8 Fixture & Ballast, 2 Ft, 4-Lamp
T8	L100	Fixture: T-8 Fixture & Ballast, 4 Ft, 1-Lamp
T8	L101	Fixture: T-8 Fixture & Ballast, 4 Ft, 2-Lamp
T8	L103	Fixture: T-8 Fixture & Ballast, 8 Ft, 2-Lamp
OTHER	L53	Bypass/Delay Timer (Res. Lighting)
OTHER	L85	Exit Sign: Led Or Electroluminescent (Res. Lighting)
OTHER	L40	Exit Sign: Retrofit Kit (Res. Lighting)
OTHER	L92	Fixture: Incand To Fluor Conversion W/Elec Blst (Res. Lighting)
OTHER	L54	Photocell (Res. Lighting)
OTHER	L52	Time Clock (Res. Lighting)

Table 2-Observed/Expected Discrepancy Codes

Code		Description
		Removal
D	1	Removed, not replaced
	2	Removed, replaced with higher energy use (describe)
	3	Removed, replaced with lower energy use (describe)
	4	Removed, stockpiled
	5	Never installed, stockpiled
		Non-operational
	6	Temporarily taken out of operation
	7	Not operating due to failure/maintenance (estimate date of return to operation)
	8	Not being used to full capacity
		Not Identifiable
	9	Could not locate
	10	Could not assess
	11	Could not confirm wattage
	12	Never installed, not stockpiled
		Supplemental
	13	Installed measures exceed tracking system count
	14	Other (describe)

Table 3-Control Codes

Code		Description
C	1	Manual switch
	2	Photosensor
	3	Occupancy sensor
	4	Timer

Table 4-Area Codes

Code		Description
A	1	Hallway
	2	Storage/utility
	3	Office
	4	Recreation area
	5	Parking lot
	6	Laundry room
	7	Exterior walkway
	8	Exit
	9	Kitchen
	10	Other

Table 5-Removal Codes

Code		Description
		Equipment Failure/Maintenance
R	1	Equip failed
	2	Performance unsatisfactory/did not like it
	3	Maintenance issues
	4	Remodeling
	5	Remodeled/new purpose
		Standby/Backup Equipment
	6	Standby unit
	7	Installed. not used
	8	Comfort/Human Aspects
	9	Unable to locate equivalent replacement
	10	Relocated; in use
	11	Did not think it saved energy
		Equipment Use Redesigned
	12	No longer needed for intended purpose
	13	Reduced operations
	14	Increased operations
	15	Reduced space
	16	Increased space
	17	Change of tenancy/use
		Supplemental
	18	Increased number of measures
		Other
	19	Missing/stolen
	20	Don't know
	21	Other (describe)

FINAL
Telephone Survey

Prepared by
XENERGY Inc.

I. INTRODUCTION SECTION

Hello, this is _____, calling from Atlantic Marketing Research. May I speak with (CONTACT NAME)? (IF THIS PERSON IS AVAILABLE, PROCEED. IF NOT, READ:) May I speak to someone who was living at (READ ADDRESS) in (PROGRAM YEAR) and would have some knowledge of major purchases. IF THIS PERSON IS NOT AVAILABLE, GET HIS/HER NAME AND MAKE ARRANGEMENTS TO CALL LATER.

IF THERE IS SOMEONE TO TALK TO, READ: PG&E is required by law to follow up on certain (REFRIGERATOR/CENTRAL AIR CONDITIONER) purchases, to see if they are still working properly. This isn't a marketing call and there isn't a problem with your service. According to PG&E's records there was a (REFRIGERATOR/CENTRAL AIR CONDITIONER) purchased for this household in (PROGRAM YEAR).

SC. SCREENER SECTION

SC1. First, I want to make sure that I reached you at (READ ADDRESS) Is this your correct address?

Yes.....1
No (THANK AND TERMINATE).....2
Don't know.....999

SC2. Is (READ ADDRESS) a home, a place of business, or both?

Home (including those that telecommute) (CONTINUE).....1
Place of business (THANK AND TERMINATE).....2
Both (CONTINUE).....3

SC3. (IF CAC PARTICIPANT) Do you recall your household purchasing a central air conditioner in (PROGRAM YEAR)?

Yes.....1
No.....2
Don't know.....999

SC4. (IF REFRIGERATOR PARTICIPANT) Do you recall your household purchasing a refrigerator in (PROGRAM YEAR)?

Yes.....1
No.....2
Don't know.....999

(IF RESPONDENT DID NOT ANSWER YES TO AT LEAST ONE OF SC3 OR SC4 THEN THANK AND TERMINATE)

CAC. CENTRAL AIR CONDITIONER PARTICIPANTS SECTION

[Central Air Conditioner Rebate Participants Only]

IF SC3=YES

(READ) I would like to ask you some questions about the central air conditioner you purchased in (PROGRAM YEAR) for the home at (READ ADDRESS)

CAC1. Was the air conditioner ever installed at (READ ADDRESS)?

Yes [SKIP TO CAC3] 1
No.....2
Don't know IF REFRIGERATOR PARTICIPANT SKIP TO R1 ELSE THANK AND TERMINATE) 999

CAC2. Why wasn't the central air conditioner installed at (READ ADDRESS)?

Never got around to it (SKIP TO CAC4) 1
Didn't need it (SKIP TO CAC4).....2
Didn't know how (SKIP TO CAC4).....3
Didn't think it would do much good (SKIP TO CAC4) 4
Installed it at another address (SKIP TO CAC7).....5
Other (Specify) _____(SKIP TO CAC4).....6
Don't Know (SKIP TO CAC4).....999

CAC3. Is that air conditioner still in place at (READ ADDRESS)?

Yes [SKIP TO CAC12] 1
No.....2
Don't know [SKIP TO CAC12] 999

CAC4. What happened to the air conditioner? (DO NOT READ LIST)

Broke.....1
Damaged in fire, earthquake, flood or other disaster.....2
Sold it or gave it away (SKIP TO CAC7).....4
Moved it to another address(SKIP TO CAC7) 5
Other (Specify) _____ (SKIP TO CAC9) 6
Don't Know (SKIP TO CAC9).....999

CAC5. Was the central air conditioner replaced?

Yes (SKIP TO CAC9).....1
No (SKIP TO CAC9) 2
Don't know (SKIP TO CAC9) 999

CAC6. Was it replaced with an air conditioner of the same efficiency?

Yes (SKIP TO CAC9).....1
No (SKIP TO CAC9) 2
Don't know (SKIP TO CAC9) 999

CAC7. To the best of your knowledge, is the new owner or new location of the air conditioner somewhere in either central and northern California?

Yes.....1
No (SKIP TO CAC9) 2
Don't know 999

CAC8. What city/area is the central air conditioner now in? SPECIFY _____

CAC9. Approximately when did the air conditioner get (broken/damaged/sold/given away/moved/ installed at a different address/other)

Month_____ Year_____

IF CAC4=1 or 2 SKIP TO CAC14

CAC10. Was the air conditioner still in good working condition when you last had it?

Yes [SKIP TO CAC14] 1
No.....2
Don't know 999

CAC11. What problems did you have with it?

Specify_____

[GO TO CAC14]

CAC12. Is the air conditioner still in good working condition?

Yes [SKIP TO CAC14] 1
No.....2
Don't know 999

CAC13. What problems have you had with the air conditioner?

Specify_____

CAC14. How often do/did you use your central air conditioner? Would you say it was on ...

Almost every day during the summer 1
Most days during the summer.....2
Only on the very hottest days.....3
Other (SPECIFY_____) 4
Don't know 999

CAC15. At what temperature do/did you keep your thermostat during the summer-

During summer days while your home is occupied? _____

During summer nights while your home is occupied? _____

During the summertime while your home is not occupied? _____

CAC16. Do/did you change the air conditioner filters during the summer when you operate your central air conditioner?

Once a summer 1

Monthly in the summer.....2

Other (SPECIFY_____) 3

CAC17. (IF CAC16=YES) How often do/did you change your filters? (DO NOT READ LIST)

Once a summer 1

Monthly in the summer.....2

Other (SPECIFY_____) 3

CAC18. Do/did you have a technician come out and check your central air conditioner?

Yes.....1

No.....2

Don't Know.....3

CAC19. (IF CAC18=YES) How often do/did you have a technician come out and check your central air conditioner? (DO NOT READ LIST)

Once a year.....1

Every other year.....2

When we have a problem 3

Other (SPECIFY _____) 4

CAC20. Do/did you check to make sure that there are no leaves or plants touching your outside unit?

Yes.....1

No.....2

Don't Know.....3

CAC21. (IF CAC20=YES) How often do/did you clean around your outside unit? (DO NOT READ LIST)

Once a year.....1

Twice a year.....2

Monthly.....3

Other (SPECIFY _____) 4

(END OF SECTION)

R. REFRIGERATOR REBATE PARTICIPANTS SECTION

[Questions for Refrigerator Rebate Participants Only]

IF SC4=YES

READ: I would now like to ask you some questions about the refrigerator purchased in (PROGRAM YEAR)

R1. Is the refrigerator still at (READ ADDRESS)?

Yes [SKIP TO R10].....1
No 2
Don't Know 999

R2. What happened to the refrigerator? (DO NOT READ LIST)

Broke 1
Damaged in fire, earthquake, flood or other disaster 2
Sold it or gave it away (SKIP TO R5) 3
Put it at another address I'm responsible for (SKIP TO R5).....4
Brought it with me when I moved (SKIP TO R5) 5
Other (Specify)_____(SKIP TO R7).....6
Don't Know (SKIP TO R7) 999

R3. Was the refrigerator replaced?

Yes.....1
No[SKIP TO R7] 2
Don't know (SKIP TO R7).....999

R4. Was the replaced with a refrigerator of the same efficiency?

Yes[SKIP TO R7].....1
No[SKIP TO R7] 2
Don't know (SKIP TO R7).....999

R5. To the best of your knowledge, is the new owner or new location of the refrigerator somewhere in either central and northern California?

Yes.....1
No (SKIP TO R7).....2
Don't know 999

R6. What city/area is the refrigerator now in? SPECIFY _____

R7. Approximately when did the refrigerator get (broken/damaged/sold/given away/ installed at a different address/moved/other)

Month_____ Year_____

(IF R2 = 1 or 2, SKIP TO END OF SECTION)

R8. Was the refrigerator still in good working condition when you last had it?

Yes [SKIP TO R13] 1
No 2
Don't know 999

R9. What problems did you have with the refrigerator?

Specify_____

(SKIP TO R13)

R10. How is the refrigerator currently being used?

As a main refrigerator 1
As a spare or secondary refrigerator 2
Stored unused 2
Don't know 999

R11. Is the refrigerator still in good working condition?

Yes [SKIP TO R13] 1
No 2
Don't know 999

R12. What problems have you had with the refrigerator?

Specify_____

R13. Do/did you clean the coils on your refrigerator?

Yes 1
No 2
Don't Know 3

R14. (IF R13=YES) How often do/did you clean your coils? (DO NOT READ LIST)

Once a year 1
Every six months 2
When they need it 3
Other (SPECIFY_____) 4

R15. Do/did you check the seals on your refrigerator to make sure that they are still sealing properly?

Yes 1
No 2
Don't Know 3

R16. (IF R15=YES) How often do/did you check your seals? (DO NOT READ LIST)

Yearly 1
Monthly 2
Every time I open the refrigerator 3
Other (SPECIFY _____) 4

(END OF SECTION)

HH. HOUSEHOLD CHARACTERISTICS SECTION

HH1. Has there been any major remodeling or renovations performed at (READ ADDRESS) since (PROGRAM YEAR)?

Yes 1
No 2

HH2. (IF HH1=YES) When did that remodeling occur? _____(RECORD ANSWER)

HH3. (IF HH1=YES and PARTICIPANT WAS A REFRIGERATOR PARTICIPANT) Was this a remodeling of the kitchen?

Yes 1
No 2

HH4. (IF HH1=YES and PARTICIPANT WAS A CAC PARTICIPANT) Did this remodeling include adding any space to the residence?

Yes 1
No 2

HH5. (IF HH4=YES) Was a different central air conditioner installed because of the added space?

Yes 1
No 2

HH6. Do you own or rent this residence?

Own/buying (SKIP TO SECTION D) 1
Rent/lease 2
Other (specify) _____ 3
Refused 888

HH7. Who pays the electric bill for this residence?

We do 1
Landlord 2
Other (SPECIFY_____) 3
Don't Know 999
Refused 888

D. DEMOGRAPHICS SECTION

This final question is for comparison purposes only.

D1. On a scale of 0-10 with 0 being very informed and 10 being not very well informed at all, how informed do you feel you are on matters related to energy efficiency?

0 0
1 1
2 2
3 3
4 4
5 5
6 6
7 7
8 8
9 9
10 10

Those are all of my questions. Thank you very much for taking the time to participate in this study.

FINAL
Telephone Survey

Prepared by
XENERGY Inc.

I. INTRODUCTION SECTION

Hello, this is _____, calling from Atlantic Marketing Research. May I speak with (CONTACT NAME)? (IF THIS PERSON IS AVAILABLE, PROCEED. IF NOT, READ:) May I speak to someone who would have some knowledge of major purchases. IF THIS PERSON IS NOT AVAILABLE, GET HIS/HER NAME AND MAKE ARRANGEMENTS TO CALL LATER.

IF THERE IS SOMEONE TO TALK TO, READ: We are doing a survey for PG&E as required by law. PG&E is trying to find out about certain refrigerators purchased in (PROGRAM YEAR), to see if they are still working properly. This isn't a marketing call and there isn't a problem with your service. According to PG&E's records there was a refrigerator purchased for this household in (PROGRAM YEAR).

SC. SCREENER SECTION

SC1. First, I want to make sure that I reached you at (READ ADDRESS) Is this your correct address?

. Yes.....1
. No (THANK AND TERMINATE).....2
. Don't know.....999

SC2. Did you move to this address since (REBATE MONTH AND YEAR)? (NOTE IF PEOPLE HAVE PROBLEMS ANSWERING THIS QUESTION)

. Yes.....1
No ..... (THANK AND TERMINATE)2

SC3. What month and year did you move into this residence? (RECORD MONTH AND YEAR, IF MONTH UNKNOWN RECORD SEASON)

R. HOUSEHOLDS WHERE THERE USED TO BE REFRIGERATOR REBATE PARTICIPANT

READ: I would now like to ask you some questions about your refrigerator

R1. Was there a refrigerator at (READ ADDRESS) when you moved in?

Yes 1
No (SKIP TO END OF SECTION) 2
Don't know 999

R2. Was the unit a (READ BRAND, SIZE, TYPE AND COLOR)

Yes 1
No (SKIP TO END OF SECTION) 2
Don't know 999

R3. What happened to the refrigerator? (DO NOT READ LIST)

Broke (SKIP TO R6) 1
Damaged in fire, earthquake, flood or other disaster (SKIP TO R6) 2
Sold it or gave it away 3
Put it at another address I'm responsible for 4
Other (Specify)_____ (SKIP TO R6) 5
Sill have it (SKIP TO R9) 6
Don't Know (SKIP TO R6) 999

R4. To the best of your knowledge, is the new owner or new location of the refrigerator somewhere in central or northern California?

Yes 1
No (SKIP TO R6) 2
Don't Know 999

R5. What city/area is the refrigerator now in? SPECIFY _____

R6. Approximately when did the refrigerator get (broken/damaged/sold/given away/ installed at a different address/moved/other)

Month_____ Year_____

IF R3=1 or R3=2 THEN SKIP TO R11
IF R3=4 THEN SKIP TO R10

R7. Was the refrigerator still in good working condition when you last had it?

Yes [SKIP TO R11] 1
No 2
Don't know 999

R8. What problems did you have with the refrigerator?

Specify_____

(SKIP TO R11)

R9. Can you go to the refrigerator for me, and read me the model number.

(IF TYPE IS SIDE BY SIDE READ "You will probably find the model number near the top of the refrigerator section, either on the ceiling or high on the right or left side walls. If not, it could be on the back wall or on the inside of the door".
IF TYPE IS REFRIGERATOR ON TOP READ "You will probably find the model number near the top of the refrigerator section. Usually it is high on the left side wall. If not, it could be on the inside of the door".
IF TYPE IS FREEZER ON TOP READ "The manufacturer usually puts the model number somewhere in the upper part of the refrigerator section. When the refrigerator is above the freezer however, they sometimes put the number in the freezer compartment. If not, it could be on the inside of the door."?
What is it please? RECORD MODEL NUMBER_____

R10. How is the refrigerator currently being used?

As a main refrigerator 1
As a spare or secondary refrigerator 2
Stored unused/unplugged.....2
Don't know 999

R11. Do/did you clean the coils on the refrigerator?

Yes..... 1
No 2
Don't Know..... 3

R12. (IF R11=YES) How often do/did you clean the coils? (DO NOT READ LIST)

Once a year 1
Every six months..... 2
When they need it..... 3
Other (SPECIFY_____) 4

R13. Do/did you check the seals on the refrigerator to make sure that they are still sealing properly?

Yes..... 1
No 2
Don't Know..... 3

R14. (IF R13=YES) How often do/did you check the seals? (DO NOT READ LIST)

Yearly..... 1
Monthly..... 2
Every time I open the refrigerator 3
Other (SPECIFY _____) 4

(END OF SECTION)

HH. HOUSEHOLD CHARACTERISTICS SECTION

HH1. To the best of your knowledge has there been any major remodeling or renovation performed at (READ ADDRESS) since (PROGRAM YEAR)?

Yes 1
No 2

HH2. (IF HH1=YES) When did that remodeling occur? _____(RECORD ANSWER)

HH3. (IF HH1=YES)Was this a remodeling of the kitchen?

Yes 1
No 2

HH4. Do you own or rent this residence?

Own/buying (SKIP TO SECTION D) 1
Rent/lease 2
Other (specify) 3
Refused 888

HH5. Who pays the electricity bill for this residence?

We do 1
Landlord 2
Other (SPECIFY_____) 3
Don't Know 999
Refused 888

D. DEMOGRAPHICS SECTION

These final questions are for comparison purposes only.

D1. On a scale of 0-10 with 0 being very informed and 10 being not very well informed at all, how informed do you feel you are on matters related to energy efficiency?

0 0
1 1
2 2
3 3
4 4
5 5
6 6
7 7
8 8
9 9
10 10

Those are all of my questions. Thank you very much for taking the time to participate in this study.

B

REPORTING FOR CADMAC PROTOCOLS TABLE 6B

B.1 1994 LIGHTING

B.2 1995 LIGHTING

B.3 1994 SPACE CONDITIONING

B.4 1994 REFRIGERATION

Protocol Table 6.B
Results of Retention Study
PG&E 1994 Residential Sector
Residential Lighting Third Year Retention
Study ID 384bR1

Item 1		Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
Studied Measure Description	**End Use**	**Ex Ante EUL**	**Source of Ex Ante EUL (ref. Ftnote)**	**Ex post EUL from Study**	**Ex Post EUL to be used in Claim**	**Ex Post EUL Standard Error**	**80% Conf. Interval Lower Bound**	**80% Conf. Interval Upper Bound**	**p-Value for Ex Post EUL**	**EUL Realizat'n Rate (ex post/ex ante)**	**"Like" Measures Associated with Studied Measure**
CFL											
CFL: HARDWIRE (RES. LIGHTING)	Lighting	10	1	88.5	10.0	13.0	71.9	105.1	0.00	1	
CFL: HARDWIRE FIXTURE, 14-26 WATTS	"	10	1	88.5	10.0	13.0	71.9	105.1	0.00	1	
CFL: HARDWIRE FIXTURE, 27-50 WATTS	"	10	1	88.5	10.0	13.0	71.9	105.1	0.00	1	
CFL: HARDWIRE FIXTURE, 5-13 WATTS	"	10	1	88.5	10.0	13.0	71.9	105.1	0.00	1	
HID											
HID FIXTURE: 0-70 WATTS	Lighting	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
HID FIXTURE: 35-100 WATTS	"	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
HID FIXTURE: 35-70 WATTS	"	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
HID FIXTURE: >= 150 WATTS	"	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
HID FIXTURE: >= 71 WATTS	"	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
T-8											
INCAND TO FLUOR CONVERSION	Lighting	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
INCAND TO FLUOR CONV. W/ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
INCAND TO FLUOR CONV. W/ES BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
REP LAMP & BLST, 2 FT, T-8 & ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
REP LAMP & BLST, 3 FT, T-8 & ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
REP LAMP & BLST, 4 FT, T-8 & ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
REP LAMP & BLST, 8 FT, T-8 & ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
T-8 FIXTURE & BALLAST, 2 FT, 2-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
T-8 FIXTURE & BALLAST, 2 FT, 4-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
T-8 FIXTURE & BALLAST, 4 FT, 1-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
T-8 FIXTURE & BALLAST, 4 FT, 2-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
T-8 FIXTURE & BALLAST, 4 FT, 3-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
T-8 FIXTURE & BALLAST, 8 FT, 2-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
T-8 FIXTURE, 1-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
T-8 FIXTURE, 2-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	

Ex Ante Source References: 1 PG&E Advice Letter 1800-G/1446-E. 1994 DSM Program Activity and Expected Earnings. As approved by the California Public Utilities Commission April 19, 1994.

Protocol Table 6.B
Results of Retention Study
PG&E 1995 Residential Sector
Residential Lighting Third Year Retention
Study ID 401bR1

Item 1		Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
Studied Measure Description	**End Use**	**Ex Ante EUL**	**Source of Ex Ante EUL (ref. Ftnote)**	**Ex post EUL from Study**	**Ex Post EUL to be used in Claim**	**Ex Post EUL Standard Error**	**80% Conf. Interval Lower Bound**	**80% Conf. Interval Upper Bound**	**p-Value for Ex Post EUL**	**EUL Realizat'n Rate (ex post/ex ante)**	**"Like" Measures Associated with Studied Measure (by measure code)**
CFL											
COMPACT FLUORESCENT: HARDWIRE (RES. LIGHTING)	Lighting	10	1	88.5	10.0	13.0	71.9	105.1	0.00	1	
COMPACT FLUORESCENT: HARDWIRE FIXTURE, 5-13 WATTS (RES. LIGHTING)	"	10	1	88.5	10.0	13.0	71.9	105.1	0.00	1	
COMPACT FLUORESCENT: HARDWIRE FIXTURE, 14-26 WATTS (RES. LIGHTING	"	10	1	88.5	10.0	13.0	71.9	105.1	0.00	1	
COMPACT FLUORESCENT: HARDWIRE FIXTURE, 27-50 WATTS (RES. LIGHTING	"	10	1	88.5	10.0	13.0	71.9	105.1	0.00	1	
HID											
HID FIXTURE: 35-70 WATTS	Lighting	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
HID FIXTURE: 0-70 WATTS	"	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
HID FIXTURE: >= 71 WATTS	"	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
HID FIXTURE: 35-100 WATTS (RES. LIGHTING)	"	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
HID FIXTURE: >= 150 WATTS (RES. LIGHTING)	"	16	1	15.4	16.0	1.5	13.5	17.3	0.69	1	
T-8											
FIXTURE: T-8 FIXTURE & BALLAST, 4 FT, 1-LAMP	Lighting	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: T-8 FIXTURE & BALLAST, 4 FT, 2-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: T-8 FIXTURE & BALLAST, 4 FT, 3-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: T-8 FIXTURE & BALLAST, 8 FT, 2-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: T-8 FIXTURE, 1-LAMP (RES. LIGHTING)	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: T-8 FIXTURE, 2-LAMP (RES. LIGHTING)	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: INCAND TO FLUOR CONVERSION W/ES BLST (RES. LIGHTING)	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: INCAND TO FLUOR CONVERSION W/ELEC BLST (RES. LIGHTING)	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: REPLACE LAMP & BLST, 2 FT, T-8 & ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: REPLACE LAMP & BLST, 3 FT, T-8 & ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: REPLACE LAMP & BLST, 4 FT, T-8 & ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: REPLACE LAMP & BLST, 8 FT, T-8 & ELEC BLST	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: T-8 FIXTURE & BALLAST, 2 FT, 2-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
FIXTURE: T-8 FIXTURE & BALLAST, 2 FT, 4-LAMP	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	
BALLAST: ELECTRONIC (RES. LIGHTING)	"	15	1	135.8	15.0	47.7	74.6	196.9	0.01	1	

Ex Ante Source References: 1 - PG&E Advice Letter 1867-G/1481-E. 1995 DSM Program Activity and Expected Earnings. As approved by the California Public Utilities Commission May 8, 1995.

Protocol Table 6.B
Results of Retention Study
PG&E 1994 Residential Sector
Residential Space Conditioning Fourth Year Retention
Study ID 384cR1

Protocol Table 6.B - Results of Retention Study - PG&E 1994 Residential Sector - Residential Space Conditioning Fourth Year Retention - Study ID 384cR1

Item 1		Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
Studied Measure Description	End Use	Ex Ante EUL	Source of Ex Ante EUL (ref. Ftnote)	Ex post EUL from Study	Ex Post EUL to be used in Claim	Ex Post EUL Standard Error	80% Conf. Interval Lower Bound	80% Conf. Interval Upper Bound	p-Value for Ex Post EUL	EUL Realizat'n Rate (ex post/ex ante)	"Like" Measures Associated with Studied Measure
Split CAC											
Split CAC SEER: 11-11.9, 4 Ton	Space Conditioning	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 11-11.9, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 11-11.9, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 12-12.9, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 12-12.9, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 12-12.9, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 12-12.9, 3 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 12-12.9, 3.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 12-12.9, 4 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 12-12.9, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 12-12.9, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13-13.4, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13-13.4, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13-13.4, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13-13.4, 3 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13-13.4, 3.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13-13.4, 4 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13-13.4, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13-13.4, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13.5-13.9, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13.5-13.9, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13.5-13.9, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13.5-13.9, 3 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13.5-13.9, 3.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13.5-13.9, 4 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13.5-13.9, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 13.5-13.9, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 14-14.9, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 14-14.9, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 14-14.9, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 14-14.9, 3 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 14-14.9, 3.5 Ton	"	18	1	--	18.0	--	--	--	--	1	

Protocol Table 6.B - Results of Retention Study - PG&E 1994 Residential Sector - Residential Space Conditioning Fourth Year Retention - Study ID 384cR1

Item 1		Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
Studied Measure Description	End Use	Ex Ante EUL	Source of Ex Ante EUL (ref. Ftnote)	Ex post EUL from Study	Ex Post EUL to be used in Claim	Ex Post EUL Standard Error	80% Conf. Interval Lower Bound	80% Conf. Interval Upper Bound	p-Value for Ex Post EUL	EUL Realizat'n Rate (ex post/ex ante)	"Like" Measures Associated with Studied Measure
Split CAC SEER: 14-14.9, 4 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 14-14.9, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 14-14.9, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 15-15.9, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 15-15.9, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 15-15.9, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 15-15.9, 3 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 15-15.9, 3.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 15-15.9, 4 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 15-15.9, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 15-15.9, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 16-16+, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 16-16+, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 16-16+, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 16-16+, 3 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 16-16+, 3.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 16-16+, 4 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 16-16+, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Split CAC SEER: 16-16+, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	

Protocol Table 6.B - Results of Retention Study - PG&E 1994 Residential Sector - Residential Space Conditioning Fourth Year Retention - Study ID 384cR1

Item 1		Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
Studied Measure Description	End Use	Ex Ante EUL	Source of Ex Ante EUL (ref. Ftnote)	Ex post EUL from Study	Ex Post EUL to be used in Claim	Ex Post EUL Standard Error	80% Conf. Interval Lower Bound	80% Conf. Interval Upper Bound	p-Value for Ex Post EUL	EUL Realizat'n Rate (ex post/ex ante)	"Like" Measures Associated with Studied Measure
Packaged CAC											
Package CAC SEER: 11-11.9, 1.5 Ton	Space Conditioning	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 11-11.9, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 11-11.9, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 11-11.9, 3 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 11-11.9, 3.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 11-11.9, 4 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 11-11.9, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 11-11.9, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 12-12.9, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 12-12.9, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 12-12.9, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 12-12.9, 3 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 12-12.9, 3.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 12-12.9, 4 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 12-12.9, 4.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 12-12.9, 5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 13-13.4, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 13-13.4, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 13-13.4, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 13.5-13.9, 1.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 13.5-13.9, 2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Package CAC SEER: 13.5-13.9, 2.5 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing											
Downsizing 11-11.9 SEER 1/2 Ton	Space Conditioning	18	1	--	18.0	--	--	--	--	1	
Downsizing 12-12.9 SEER 1/2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 13-13.9 SEER 1/2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 14-14.9 SEER 1/2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 15-15.9 SEER 1/2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 16-16.9 SEER 1/2 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 11-11.9 SEER 1 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 12-12.9 SEER 1 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 13-13.9 SEER 1 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 14-14.9 SEER 1 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 15-15.9 SEER 1 Ton	"	18	1	--	18.0	--	--	--	--	1	
Downsizing 16-16.9 SEER 1 Ton	"	18	1	--	18.0	--	--	--	--	1	

Ex Ante Source References: 1 - PG&E Advice Letter 1800-G/1446-E. 1994 DSM Program Activity and Expected Earnings. As approved by California Public Utilities Commission April 19, 1994.

Protocol Table 6.B
Results of Retention Study
PG&E 1994 Residential Sector
Residential Refrigeration Fourth Year Retention
Study ID 384aR1

Item 1		Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
Studied Measure Description	**End Use**	**Ex Ante EUL**	**Source of Ex Ante EUL (ref. Ftnote)**	**Ex post EUL from Study**	**Ex Post EUL to be used in Claim**	**Ex Post EUL Standard Error**	**80% Conf. Interval Lower Bound**	**80% Conf. Interval Upper Bound**	**p-Value for Ex Post EUL**	**EUL Realizat'n Rate (ex post/ex ante)**	**"Like" Measures Associated with Studied Measure**
Refrigerator Rebate, Exceeds Stds by 10%	Refrigeration	20	1	25.8	20	9.2	14.0	37.7	0.17	1	Refrig Sales Incentive, Exceeds Stds by 10% Multiple Refrig Rebate, Exceeds Stds by 10%
Refrigerator Rebate, Exceeds Stds by 15%	"	20	1	25.8	20	9.2	14.0	37.7	0.17	1	Refrig Sales Incentive, Exceeds Stds by 15% Multiple Refrig Rebate, Exceeds Stds by 15%
Refrigerator Rebate, Exceeds Stds by 20%	"	20	1	25.8	20	9.2	14.0	37.7	0.17	1	Refrig Sales Incentive, Exceeds Stds by 20% Multiple Refrig Rebate, Exceeds Stds by 20%
Refrigerator Rebate, Exceeds Stds by 25%	"	20	1	25.8	20	9.2	14.0	37.7	0.17	1	none

Ex Ante Source References: 1 PG&E Advice Letter 1800-G/1446-E. 1994 DSM Program Activity and Expected Earnings. As approved by the California Public Utilities Commission April 19, 1994.

C PROTOCOLS TABLE 7B DOCUMENTATION

C.1 1994 LIGHTING

C.2 1995 LIGHTING

C.3 1994 SPACE CONDITIONING

C.4 1994 REFRIGERATION

C.1 1994 LIGHTING

C.1.1 Overview Information

a. Study Title and Study ID Number

Study Title: 1994 Residential Lighting Third Year Retention Study,

Study ID No: PG&E Study ID 384bR1: Multifamily Lighting.

b. Program Years and Program Description

Program years: 1994, 1995

This report presents the retention analysis of lighting measures rebated in 1994 and 1995. CFL, HID and T-8 lamps offered through the Multifamily Property Rebate Program account for 89 percent of the total resource value of the RAEI High Efficiency Lighting end-use in the combined 1994 and 1995 program years.

c. End Uses and Measures Covered

Lighting:

Compact fluorescent bulbs
HID lamps
T-8 lamps and ballasts.

d. Methods and Models Used

Survival analysis was performed using data collected during on-site surveys. The survival analysis utilized the SAS procedure LIFEREG, and considered the following hazard distributions:

- log-normal,
- exponential,
- log-logistic,
- Weibull, and
- Gamma.

A weighted analysis was used. Weights were used to adjust for disproportionate sampling rates across cells defined by type of equipment rebated, magnitude of savings, and geographic region. The weights were scaled so that the total apparent sample size in the analysis was consistent with the number of sampled premises. This scaling ensured approximately correct standard errors.

Final recommendations were based on consideration of the appropriate hazard function form, the consistency of the estimates across alternative specifications, and the formal estimate of standard errors.

e. Analysis Sample Size

Number of customers: 293 sites.
Number of measures: 20,618 units.

C.1.2 Database Management

a. Specific Data Sources

Tracking Data:

MFA9496.SD2	SAS dataset - application-level data
MFI9496.SD2	SAS dataset - item (measure) level data

On-site survey data:

RETENT.SD2	SAS dataset - first wave retention data
RETLIT2.SD2	SAS dataset - second wave retention data

b. Data Attrition

Table C-1 shows the data collected and used in the analysis, and the reasons for exclusion. Data were originally collected at 300 sites for a total of 495 technology type-premise combinations. Of these collected data, 456 technology type-premise combinations were used in the analysis. Units were excluded from the analysis for three reasons.

1. **Types Not for Retention Analysis.** Rebates were provided for various technology types including several not included in the retention study, such as exit sign kits. If rebated equipment of these additional types was located at the premise, the surveyor noted the number observed. Because survival analysis was only to be performed on CFL, HID, and T-8 lamps, these technology type-premise combinations were excluded from the analysis.
2. **Units Not in Tracking System.** Survival analysis was only to be performed on CFL, HID, and T-8 lamps purchased with assistance from PG&E. While at a premise, the surveyor noted the total number of these lamp types observed. If this total was greater than the tracking system number, the additional lamps were not considered in the analysis.
3. **Indeterminate Disposition.** In a few cases, the surveyor could not determine if the lamps were ever purchased or installed. These cases were excluded from the analysis.

Table C-1
Data Attrition

	Technology		
	Sites	Type-Premise	Units
Total with Data Collected	300	495	21,653
Types Not for Retention Analysis	0	12	141
Units Not in Tracking System	6	1	60
Total Targeted for Sampled Premises	**300**	**482**	**21,171**
Indeterminate Disposition	7	26	553
Used	**293**	**456**	**20,618**

Table C-2 shows the numbers included in the analysis by technology group.

Table C-2
Data Included in Analysis by Technology Group

	Sites	Units
CFL	247	13,249
HID	97	1,548
T-8	112	5,821

c. Data Quality

The PG&E control application code number was used to link tracking data and survey data.

d. Data Collected Specifically for the Analysis but not Used

In the first wave of data collection, the years since removal were reported for some measures at some sites. Most respondents were not able to provide this information. Thus, these data were available for a limited number of sites only. Even these sites did not have dates specific enough to be used in the analysis. Thus, the removal date data collected were not used.

C.1.3 Sampling

a. Procedures and Protocols

The onsite data were collected in two waves. The first was in January, 1998 and the second was in November, 1998. This methodology allowed for analysis of the preliminary data and improvement of the data collection process prior to the second set of data collection.

The first wave sample design called for a total of 150 completed visits, split evenly between the two program years. This total sample size was chosen to conform with the Protocol requirements for first-year evaluation studies. The Protocols do not include explicit sample size requirements for the retention studies.

The sample was intended to represent customers of various sizes; three broad lighting technology categories; and the entire PG&E region. To allocate the sample effectively, a stratified sample was used. To ensure coverage of the different technology groups, the sample was stratified on what technologies were rebated to each customer: T-8 lights (and possibly others as well) or other technologies only. To allow an oversampling of customers with higher expected savings while ensuring representation of those with lower savings, the "other" sample was also stratified into two size classes, according to the number of rebated units. Finally, to control field costs, it was necessary to limit the geographic dispersion of the sites. This control was accomplished by stratifying the site into regions of varying distances from PG&E's main population center, and assigning a rough relative cost to inspections in each region. The overall sample was then allocated to cells defined by size, technology type, and region.

The allocation for the first wave was proportional to the total cell count divided by the square root of the relative cost. This allocation rule gives an approximately optimal sample design (that is, the best precision for a given total cost) under the assumption that the standard deviation of the variable of interest is the same in each cell. The variable of interest is a proportion (the number failed) and the standard deviation of a proportion depends only on the proportion itself. Lacking any *a priori* reason to believe the failure rates are higher or lower in particular cells, the assumption of uniform proportions, therefore uniform standard deviations, is reasonable. The first wave sample allocation plan is shown in Table C-3.

Table C-3
First Wave Sample Allocation Plan

Segment Descriptors			Population	Wave 1 Quota
Year	Tech/size	Area		
1994	Other - Large	1	130	10
1994	Other - Large	2	117	7
1994	Other - Large	3	112	6
1994	Other - Large	4	63	2
1994	Other - Small	1	130	10
1994	Other - Small	2	124	7
1994	Other - Small	3	123	6
1994	Other - Small	4	48	2
1994	T8	1	84	13
1994	T8	2	68	9
1994	T8	3	8	1
1994	T8	4	32	2
1994 Subtotal			**1039**	**75**
1995	Other - Large	1	54	10
1995	Other - Large	2	41	6
1995	Other - Large	3	55	7
1995	Other - Large	4	29	2
1995	Other - Small	1	59	9
1995	Other - Small	2	62	8
1995	Other - Small	3	52	6
1995	Other - Small	4	26	2
1995	T8	1	51	14
1995	T8	2	27	6
1995	T8	3	15	3
1995	T8	4	20	2
1995 Subtotal			**491**	**75**
Overall Total			**1530**	**150**

After preliminary analysis of the data from the first wave, the decision was made to go forward with a second wave of data collection. This additional data would provide a better basis for the analysis, given the low failure rates found in the first wave. In addition, some improvements could be made to the data collection protocols.

For the second wave, the first wave allocation was repeated to the extent possible. Thus, the combined sample was designed to provide a total of 150 sites per program year. However, for some cells the available population was exhausted or nearly exhausted in the recruitment for the first wave. Additional cases were therefore allocated to other cells.

b. Survey Information

A copy of the survey is provided in Appendix A. The disposition of the sample contacted and successfully recruited for the two waves is shown in the table below.

Disposition	Wave One Frequency	Wave Two Frequency	Total Frequency	Percent of Sample Attempted
Total Sites Attempted	541	568	1109	100.0%
Unable to contact	45	12	57	5.1%
Unable to speak with contact person	168	195	363	32.7%
Could not accomodate in survey schedule	173	209	382	34.4%
Refused	4	1	5	0.5%
Cancelled	1	1	2	0.2%
Completed Surveys	**150**	**150**	**300**	**27.1%**

The sample was weighted according to the population in each sample call to avoid bias.

c. Statistical Descriptions

Measure Type	Still in Place	Removed	Percent in Place
CFL	12,771	478	96.4%
HID	1,385	163	89.5%
HID [1]	1,374	130	91.4%
T-8	5,704	117	98.0%
Total	**19,860**	**758**	**96.3%**

[1] Excluding the lamps at the premise with all lamps removed due to dissatisfaction. This row is not included in the total.

C.1.4 Data Screening and Analysis

a. Procedures

Potential extremely influential points were examined, but none turned out to be extremely influential. Removal dates could not be determined with any accuracy, therefore any removals were considered censored with the on-site survey date as the left censoring endpoint.

b. Background Variables

n/a

c. Data Screening

Data were originally collected at 300 sites for a total of 495 technology type-premise combinations. Of these collected data, 456 technology type-premise combinations were used in the analysis. Units were excluded from the analysis for three reasons.

1. **Types Not for Retention Analysis.** Rebates were provided for various technology types including several not included in the retention study, such as exit sign kits. If rebated equipment of these additional types was located at the premise, the surveyor noted the number observed. Because survival analysis was only to be performed on CFL, HID, and T-8 lamps, these technology type-premise combinations were excluded from the analysis.
2. **Units Not in Tracking System.** Survival analysis was only to be performed on CFL, HID, and T-8 lamps purchased with assistance from PG&E. While at a premise, the surveyor noted the total number of these lamp types observed. If this total was greater than the tracking system number, the additional lamps were not considered in the analysis.
3. **Indeterminate Disposition.** In a few cases, the surveyor could not determine if the lamps were ever purchased or installed. These cases were excluded from the analysis.

	Technology		
	Sites	Type-Premise	Units
Total with Data Collected	300	495	21,653
Types Not for Retention Analysis	0	12	141
Units Not in Tracking System	6	1	60
Total Targeted for Sampled Premises	**300**	**482**	**21,171**
Indeterminate Disposition	7	26	553
Used	**293**	**456**	**20,618**

d. Model Statistics

Studied Measure Description (Measure Group)	Distribution	Ex post EUL from Study	SE	Lower Confidence Interval	Upper Confidence Interval	Intercept	SE	Number of Units	Number of Premises
CFL	Exponential	88.5	13.0	71.9	105.1	0.8	0.1	13,249	247
HID	Exponential	15.4	1.5	13.5	17.3	9.0	0.1	1,548	97
T-8	Exponential	135.8	47.7	74.6	196.9	11.2	0.4	5,821	112

e. Specification

Several hazard function distributions were explored for the survival analysis: Gamma, Weibull, exponential, log-normal, and log-logistic. Of these, the Weibull was considered the most appropriate, since it allows for an increasing failure rate over time. However, this model form did not converge. That is, the failure incidence at this date is sufficiently low that with the available sample sizes there was not enough information to fit this most general model form. The exponential result was taken as the next most plausible form. However, the assumption of a constant failure rate implicit in this form is questionable.

The log-normal and log-logistic forms both have an initially high failure rate followed by a declining rate. Initially, this pattern makes sense. A certain fraction of customers find out in the early period after measure installation that they are dissatisfied with the measure, and remove it. After that early period, removals are more sporadic. In later years, however, failure rates due to physical measure failure would be expected to increase. Thus, with either of these forms, the

fitted model may be a reasonable description of the loss rates within the period studied, but its projection to a time period twice as long as what was studied is of unknown validity.

Because of these uncertainties in the model specification, none of the results is considered reliable as a basis for rejecting the *ex ante* EUL, regardless of nominal significance level.

1) Heterogeneity

Customer heterogeneity was addressed by developing a sample stratified by types of technologies rebated, magnitude of savings, and customer location. The sampled customers were weighted in the analysis according to their proportions in the population.

2) Omitted Factors

No covariates were included in the model. With the limited instances of measure failure, estimation of effects of covariates was considered impractical.

f. Error in Measuring Variables

Uncertain removal dates were treated as left censored with the onsite survey date as the left censoring endpoint.

g. Influential Data Points

A site where almost all HID lamps were removed was examined as a potentially extremely influential point. It was determined that this was not extremely influential because it did not have a large effect on the resulting EUL. The distribution of installation and removal dates was also examined, as a screen for potential errors.

h. Missing Data Points

All recidivism dates were considered left censored with the onsite survey date as the left censoring endpoint.

i. Precision

Standard errors were produced by the package destination procedure. Weights used in the procedure were adjusted so that their sum matched the number of independent observations (number of premises), to avoid overstating the accuracy of the analysis that counts each unit as an independent observation.

C.2 1995 LIGHTING

C.2.1 Overview Information

a. Study Title and Study ID Number

Study Title: 1995 Residential Lighting Third Year Retention Study,

Study ID No: PG&E Study ID 401bR1: Multifamily Lighting.

b. Program Years and Program Description

Program years: 1994, 1995

This report presents the retention analysis of lighting measures rebated in 1994 and 1995. CFL, HID and T-8 lamps offered through the Multifamily Property Rebate Program account for 89 percent of the total resource value of the RAEI High Efficiency Lighting end-use in the combined 1994 and 1995 program years.

c. End Uses and Measures Covered

Lighting:

Compact fluorescent bulbs
HID lamps
T-8 lamps and ballasts.

d. Methods and Models Used

Survival analysis was performed using data collected during on-site surveys. The survival analysis utilized the SAS procedure LIFEREG, and considered the following hazard distributions:

- log-normal,
- exponential,
- log-logistic,
- Weibull, and
- Gamma.

A weighted analysis was used. Weights were used to adjust for disproportionate sampling rates across cells defined by type of equipment rebated, magnitude of savings, and geographic region. The weights were scaled so that the total apparent sample size in the analysis was consistent with the number of sampled premises. This scaling ensured approximately correct standard errors.

Final recommendations were based on consideration of the appropriate hazard function form, the consistency of the estimates across alternative specifications, and the formal estimate of standard errors.

e. Analysis Sample Size

Number of customers: 293 sites.
Number of measures: 20,618 units.

C.2.2 Database Management

a. Specific Data Sources

Tracking Data:

MFA9496.SD2	SAS dataset - application-level data
MFI9496.SD2	SAS dataset - item (measure) level data

On-site survey data:

RETENT.SD2	SAS dataset - first wave retention data
RETLIT2.SD2	SAS dataset - second wave retention data

b. Data Attrition

Table C-4 shows the data collected and used in the analysis, and the reasons for exclusion. Data were originally collected at 300 sites for a total of 495 technology type-premise combinations. Of these collected data, 456 technology type-premise combinations were used in the analysis. Units were excluded from the analysis for three reasons.

1. **Types Not for Retention Analysis.** Rebates were provided for various technology types including several not included in the retention study, such as exit sign kits. If rebated equipment of these additional types was located at the premise, the surveyor noted the number observed. Because survival analysis was only to be performed on CFL, HID, and T-8 lamps, these technology type-premise combinations were excluded from the analysis.
2. **Units Not in Tracking System.** Survival analysis was only to be performed on CFL, HID, and T-8 lamps purchased with assistance from PG&E. While at a premise, the surveyor noted the total number of these lamp types observed. If this total was greater than the tracking system number, the additional lamps were not considered in the analysis.
3. **Indeterminate Disposition.** In a few cases, the surveyor could not determine if the lamps were ever purchased or installed. These cases were excluded from the analysis.

Table C-4
Data Attrition

	Technology		
	Sites	Type-Premise	Units
Total with Data Collected	300	495	21,653
Types Not for Retention Analysis	0	12	141
Units Not in Tracking System	6	1	60
Total Targeted for Sampled Premises	**300**	**482**	**21,171**
Indeterminate Disposition	7	26	553
Used	**293**	**456**	**20,618**

Table C-5 shows the numbers included in the analysis by technology group.

Table C-5
Data Included in Analysis by Technology Group

	Sites	Units
CFL	247	13,249
HID	97	1,548
T-8	112	5,821

c. Data Quality

The PG&E control application code number was used to link tracking data and survey data.

d. Data Collected Specifically for the Analysis but not Used

In the first wave of data collection, the years since removal were reported for some measures at some sites. Most respondents were not able to provide this information. Thus, these data were available for a limited number of sites only. Even these sites did not have dates specific enough to be used in the analysis. Thus, the removal date data collected were not used.

C.2.3 Sampling

a. Procedures and Protocols

The onsite data were collected in two waves. The first was in January, 1998 and the second was in November, 1998. This methodology allowed for analysis of the preliminary data and improvement of the data collection process prior to the second set of data collection.

The first wave sample design called for a total of 150 completed visits, split evenly between the two program years. This total sample size was chosen to conform with the Protocol requirements for first-year evaluation studies. The Protocols do not include explicit sample size requirements for the retention studies.

The sample was intended to represent customers of various sizes; three broad lighting technology categories; and the entire PG&E region. To allocate the sample effectively, a stratified sample was used. To ensure coverage of the different technology groups, the sample was stratified on what technologies were rebated to each customer: T-8 lights (and possibly others as well) or other technologies only. To allow an oversampling of customers with higher expected savings while ensuring representation of those with lower savings, the "other" sample was also stratified into two size classes, according to the number of rebated units. Finally, to control field costs, it was necessary to limit the geographic dispersion of the sites. This control was accomplished by stratifying the site into regions of varying distances from PG&E's main population center, and assigning a rough relative cost to inspections in each region. The overall sample was then allocated to cells defined by size, technology type, and region.

The allocation for the first wave was proportional to the total cell count divided by the square root of the relative cost. This allocation rule gives an approximately optimal sample design (that is, the best precision for a given total cost) under the assumption that the standard deviation of the variable of interest is the same in each cell. The variable of interest is a proportion (the number failed) and the standard deviation of a proportion depends only on the proportion itself. Lacking any *a priori* reason to believe the failure rates are higher or lower in particular cells, the assumption of uniform proportions, therefore uniform standard deviations, is reasonable. The first wave sample allocation plan is shown in Table C-6.

Table C-6
First Wave Sample Allocation Plan

Segment Descriptors			Population	Wave 1 Quota
Year	Tech/size	Area		
1994	Other - Large	1	130	10
1994	Other - Large	2	117	7
1994	Other - Large	3	112	6
1994	Other - Large	4	63	2
1994	Other - Small	1	130	10
1994	Other - Small	2	124	7
1994	Other - Small	3	123	6
1994	Other - Small	4	48	2
1994	T8	1	84	13
1994	T8	2	68	9
1994	T8	3	8	1
1994	T8	4	32	2
1994 Subtotal			**1039**	**75**
1995	Other - Large	1	54	10
1995	Other - Large	2	41	6
1995	Other - Large	3	55	7
1995	Other - Large	4	29	2
1995	Other - Small	1	59	9
1995	Other - Small	2	62	8
1995	Other - Small	3	52	6
1995	Other - Small	4	26	2
1995	T8	1	51	14
1995	T8	2	27	6
1995	T8	3	15	3
1995	T8	4	20	2
1995 Subtotal			**491**	**75**
Overall Total			**1530**	**150**

After preliminary analysis of the data from the first wave, the decision was made to go forward with a second wave of data collection. This additional data would provide a better basis for the analysis, given the low failure rates found in the first wave. In addition, some improvements could be made to the data collection protocols.

For the second wave, the first wave allocation was repeated to the extent possible. Thus, the combined sample was designed to provide a total of 150 sites per program year. However, for some cells the available population was exhausted or nearly exhausted in the recruitment for the first wave. Additional cases were therefore allocated to other cells.

b. Survey Information

A copy of the survey is provided in Appendix A. The disposition of the sample contacted and successfully recruited for the two waves is shown in the table below.

Disposition	Wave One Frequency	Wave Two Frequency	Total Frequency	Percent of Sample Attempted
Total Sites Attempted	541	568	1109	100.0%
Unable to contact	45	12	57	5.1%
Unable to speak with contact person	168	195	363	32.7%
Could not accomodate in survey schedule	173	209	382	34.4%
Refused	4	1	5	0.5%
Cancelled	1	1	2	0.2%
Completed Surveys	**150**	**150**	**300**	**27.1%**

The sample was weighted according to the population in each sample call to avoid bias.

c. Statistical Descriptions

Measure Type	Still in Place	Removed	Percent in Place
CFL	12,771	478	96.4%
HID	1,385	163	89.5%
HID [1]	1,374	130	91.4%
T-8	5,704	117	98.0%
Total	**19,860**	**758**	**96.3%**

[1] Excluding the lamps at the premise with all lamps removed due to dissatisfaction. This row is not included in the total.

C.2.4 Data Screening and Analysis

a. Procedures

Potential extremely influential points were examined, but none turned out to be extremely influential. Removal dates could not be determined with any accuracy, therefore any removals were considered censored with the on-site survey date as the left censoring endpoint.

b. Background Variables

n/a

c. Data Screening

Data were originally collected at 300 sites for a total of 495 technology type-premise combinations. Of these collected data, 456 technology type-premise combinations were used in the analysis. Units were excluded from the analysis for three reasons.

1. **Types Not for Retention Analysis.** Rebates were provided for various technology types including several not included in the retention study, such as exit sign kits. If rebated equipment of these additional types was located at the premise, the surveyor noted the number observed. Because survival analysis was only to be performed on CFL, HID, and T-8 lamps, these technology type-premise combinations were excluded from the analysis.
2. **Units Not in Tracking System.** Survival analysis was only to be performed on CFL, HID, and T-8 lamps purchased with assistance from PG&E. While at a premise, the surveyor noted the total number of these lamp types observed. If this total was greater than the tracking system number, the additional lamps were not considered in the analysis.
3. **Indeterminate Disposition.** In a few cases, the surveyor could not determine if the lamps were ever purchased or installed. These cases were excluded from the analysis.

	Technology		
	Sites	Type-Premise	Units
Total with Data Collected	300	495	21,653
Types Not for Retention Analysis	0	12	141
Units Not in Tracking System	6	1	60
Total Targeted for Sampled Premises	**300**	**482**	**21,171**
Indeterminate Disposition	7	26	553
Used	**293**	**456**	**20,618**

d. Model Statistics

Studied Measure Description (Measure Group)	Distribution	Ex post EUL from Study	SE	Lower Confidence Interval	Upper Confidence Interval	Intercept	SE	Number of Units	Number of Premises
CFL	Exponential	88.5	13.0	71.9	105.1	0.8	0.1	13,249	247
HID	Exponential	15.4	1.5	13.5	17.3	9.0	0.1	1,548	97
T-8	Exponential	135.8	47.7	74.6	196.9	11.2	0.4	5,821	112

e. Specification

Several hazard function distributions were explored for the survival analysis: Gamma, Weibull, exponential, log-normal, and log-logistic. Of these, the Weibull was considered the most appropriate, since it allows for an increasing failure rate over time. However, this model form did not converge. That is, the failure incidence at this date is sufficiently low that with the available sample sizes there was not enough information to fit this most general model form. The exponential result was taken as the next most plausible form. However, the assumption of a constant failure rate implicit in this form is questionable.

The log-normal and log-logistic forms both have an initially high failure rate followed by a declining rate. Initially, this pattern makes sense. A certain fraction of customers find out in the early period after measure installation that they are dissatisfied with the measure, and remove it. After that early period, removals are more sporadic. In later years, however, failure rates due to physical measure failure would be expected to increase. Thus, with either of these forms, the

fitted model may be a reasonable description of the loss rates within the period studied, but its projection to a time period twice as long as what was studied is of unknown validity.

Because of these uncertainties in the model specification, none of the results is considered reliable as a basis for rejecting the *ex ante* EUL, regardless of nominal significance level.

1) Heterogeneity

Customer heterogeneity was addressed by developing a sample stratified by types of technologies rebated, magnitude of savings, and customer location. The sampled customers were weighted in the analysis according to their proportions in the population.

2) Omitted Factors

No covariates were included in the model. With the limited instances of measure failure, estimation of effects of covariates was considered impractical.

f. Error in Measuring Variables

Uncertain removal dates were treated as left censored with the onsite survey date as the left censoring endpoint.

g. Influential Data Points

A site where almost all HID lamps were removed was examined as a potentially extremely influential point. It was determined that this was not extremely influential because it did not have a large effect on the resulting EUL. The distribution of installation and removal dates was also examined, as a screen for potential errors.

h. Missing Data Points

All recidivism dates were considered left censored with the onsite survey date as the left censoring endpoint.

i. Precision

Standard errors were produced by the package destination procedure. Weights used in the procedure were adjusted so that their sum matched the number of independent observations (number of premises), to avoid overstating the accuracy of the analysis that counts each unit as an independent observation.

C.3 SPACE CONDITIONING

C.3.1 Overview Information

a. Study Title and Study ID Number

Study Title: 1994 Residential Space Conditioning Fourth Year Retention Study

Study ID No: PG&E Study ID 384cR1: Residential Central Air Conditioners.

b. Program Years and Program Description

Program year: 1994, 1995

This report presents the retention analysis of central air conditioners (CACs) rebated in 1994 and 1995. Split and packaged air conditioners account for 61 percent of the total resource value of the RAEI Space Conditioning end-use for the combined 1994 and 1995 program years. These measures were rebated through the Residential Central Air Conditioner Rebate Program. The program was discontinued after 1994; units for which rebates were paid in 1995 represent carry-over from the 1994 program.

c. End Uses and Measures Covered

Space Conditioning: Central Air Conditioners, split and packaged units

d. Methods and Models Used

Telephone surveys were designed and fielded to support survival analysis. Because no instances of measure failure were found among the surveyed participants, no survival analysis was actually performed, and no *ex post* EUL was developed.

e. Analysis Sample Size

Number of customers surveyed: 413 premises
Number of measures used in the analysis: 413 units

C.3.2 Database Management

a. Specific Data Sources

Billing System Data:

DMPG.Sd2	SAS dataset - tracking system data, including date the household was first served by PG&E

Tracking System Data:

CAC94.sd2	1994 CAC RAEI tracking system.
CAC95.sd2	1995 CAC RAEI tracking system.

Survey data:

PARTS.SD2	SAS dataset - program participant survey data

b. Data Attrition

Total surveyed premises:	413
Total premises used in the analysis:	413

c. Data Quality

It was not necessary to link the survey data with the tracking system because all those surveyed reported that the CAC was still in PG&E territory.

d. Data Collected Specifically for the Analysis but Not Used

Survey data on the use and maintenance of the CACs (questions CAC14-CAC21)were collected to explore the relationship of such factors to measure failure or removal. Because all units were reported to still be in PG&E territory, no analysis of these data was conducted. In addition, household characteristics and demographics were also collected (HH1-HH7 and D1) as a basis for exploring factors related to nonretention. Because there was no instance of measures not being retained, these data were not used.

C.3.3 Sampling

a. Procedures and Protocols

For each of the two program years under study, a target of 200 completed CAC retention surveys was set. These quotas were based on matching the Protocol requirements for a first-year load impact study. The Protocols do not provide explicit sampling requirements for the retention studies. Of the 200 completed surveys, no separate targets were set for split and packaged units. Rather, all participants were selected with equal probability within each year. That is, a simple random sample was taken from each program year's quota group, as defined below.

A small fraction of customers participated in both the central air conditioner and refrigerator rebate programs during 1994 and 1995. To accommodate this overlap, the two surveys were implemented jointly. Customers who had participated in both programs responded to both portions of the survey. The design of the combined sample for the two programs and two years had to recognize that a given customers could have participated in more than one program and year. To avoid giving some customers the chance of being selected for the sample more than once, the combined set of participants for the two programs and years was divided into the following non-overlapping quota groups:

A. 1995 CAC participants
B. 1994 CAC participants excluding A.
C. 1994 refrigerator participants excluding A and B
D. 1995 refrigerator participants excluding A, B, and C.

The quota groups were defined in order of increasing population size, to allow the best chance of achieving the target number of completed surveys for the groups with smaller populations. Survey respondents selected for either CAC quota group (A or B) who were also refrigerator participants were also asked the refrigerator retention questions. Respondents selected for the refrigerator quota groups (C or D) by definition could not have been CAC participants.

CAC participants who had moved since participating were excluded from the CAC quota groups. The rationale was that CAC retention was likely to be the same for movers as for nonmovers, and it would be difficult to collect reliable retention information for the moving participants. Current occupants would not be expected to be able to confirm that a unit at the premise was the rebated unit. Original participants would be difficult to locate at their new addresses, and would not necessarily know the current status of the rebated unit.

To implement this restriction, a nonmover was defined as a customer for whom the date the customer was first served was earlier than the CAC install date recorded in the tracking system. Thus, it was necessary to merge the tracking system data with the current billing system data. Therefore, any customer whose control number (the customer identification number used as the basis for merging) did not appear in both data sets was dropped from the sample frame.

To limit the survey to actual residential customers, any contractors, apartment owners, real estate companies, etc. were also eliminated. To avoid the complication of asking a respondent to distinguish between units purchased in the same year, any participant who purchased more than one unit in a given year was also removed. This left 2,928 premises in the 1994 program and 770 premises in the 1995 program for the sample frame, with some overlap between the two.

The number of units in each program year and the numbers excluded by the nonresidential and multi-unit screens are shown in the table. The remaining participants were divided into the sampling quota groups described above.

	1994	1995
Tracking System Count	4,698	994
Missing Control Number	1,016	0
Business	8	2
Multiple Units in Year	234	75
Left for Sampling	**3,440**	**917**

b. Survey Information

A copy of the survey is provided in Appendix A. The disposition of the is shown in the table below.

Disposition	1994	1995
Completes	208	203
Busy/no Answer	202	172
Callbacks	171	161
Screenouts	16	22
Refusal	96	117
Terminate	26	23
Language	5	3
Wrong Numbers	104	67
Total Sample Used	620	565

c. Statistical Descriptions

Zero failures were found.

C.3.4 Data Screening and Analysis

a. Procedures

No failures occurred so no outliers or missing data existed.

b. Background Variables

n/a

c. Data Screening

No failures occurred so no data screening was necessary.

d. Model Statistics

n/a

e. Specification

Not applicable.

f. Error in Measuring Variables

No removals occurred so this was not an issue.

g. Influential Data Points

No extremely influential data points were located.

h. Missing Data Points

No removals occurred so no missing data existed.

i. Precision

No removals occurred so no statistics were generated.

C.4 1994 REFRIGERATION

C.4.1 Overview Information

a. Study Title and Study ID Number

Study Title: 1994 Residential Refrigeration Fourth Year Retention Study,

Study ID No: PG&E Study ID 384aR1. Residential Refrigerators.

b. Program Years and Program Description

Program year: 1994, 1995

This report presents the retention analysis of refrigerators rebated in 1994 and 1995. High efficiency refrigerators account for 100 percent of the total resource value of the RAEI High Efficiency Refrigeration end-use for the 1994 program year. In 1994 these measures were rebated through the Efficient Refrigerator Rebate Program, the Salesperson/Dealer Incentive Program, and the Multiple Refrigerator Rebate Program (for property managers and builders who purchased refrigerators in quantities of two or more). In 1995, the Efficient Refrigerator program was continued, though it was moved out of the Appliance Efficiency category to a non-earnings category due to a low TRC estimate. Some commitments from the 1994 programs were paid as carry-over in 1995.

c. End Uses and Measures Covered

Refrigerators.

d. Methods and Models Used

Survival analysis was performed using data collected during two telephone surveys, one of program participants and one of current occupants who live at the premise where a program participant used to live. It was conjectured that nonretention rates would be very low over the elapsed time period of three to four years, except in cases where the participant moved. Taking rebated units out of the territory was considered likely to be a primary reason for nonretention. The supplemental survey of new occupants was designed to address this source of nonretention.

The survival analysis utilized the SAS procedure LIFEREG, and considered the following hazard distributions:

- log-normal,
- exponential,
- log-logistic,
- Weibull, and
- gamma.

The Weibull distribution was considered the most appropriate, as it allows for an increasing failure rate over time.

A combined analysis of nonmoving participants and new occupants of premises from which a participant had moved reflected measure failure or removal due to both customer migration and equipment failure. Respondents to the two surveys were weighted in proportion to the fractions of the population represented by each responding component:

1. nonmovers
2. new occupants of premises where the participant who moved took the rebated unit
3. new occupants of premises where the participant who moved left the rebated unit behind.

The weights were scaled so that the standard errors provided by the packaged analysis would be approximately correct.

Data from the U.S. Census specific to California were used as a basis for estimating the fractions of movers who leave the PG&E service territory. Units that were moved to another premise within PG&E's territory were classified as retained.

e. Analysis Sample Size

Number of participating customers surveyed: 428 premises
Number of current occupants surveyed: 208 premises

C.4.2 Database Management

a. Specific Data Sources

Billing System Data:

DMPG.Sd2 SAS dataset - tracking system data, including date the household was first served by PG&E

Tracking System Data:

REF94.sd2 1994 Refrigerator RAEI tracking system.
REF95.sd2 1995 Refrigerator RAEI tracking system.

Survey data:

PARTS.SD2 SAS dataset - participant survey data
MOVERS.SD2 SAS dataset - current occupant survey data

b. Data Attrition

	Participant (nonmovers)	Current Occupants
Total Surveyed	428	208
Number removed because wouldn't (or couldn't) say if was still at site	1	2
Total Used	**427**	**206**

c. Data Quality

The PG&E control application code number was used to link tracking data and survey data.

d. Data Collected Specifically for the Analysis but not Used

All survey data on the maintenance of the refrigerators were not used (questions R13-R16 in the participant survey and R11-R14 in the current occupant survey). In addition, household characteristics and demographics were also collected but not used (HH1-HH7 in the participant survey and HH1-HH5 in the current occupant survey and D1). It was determined that this type of information could not be extrapolated to the population and therefore was not utilized.

C.4.3 Sampling

a. Procedures and Protocols

For each of the two program years under study, a target of 200 completed refrigerator retention surveys of participating customers was set. These quotas were based on matching the Protocol requirements for a first-year load impact study. The Protocols do not provide explicit sampling requirements for the retention studies.

As noted, moving was considered likely to be a primary reason that rebated refrigerators would no longer be in place at this length of time since participation. Conducting surveys only with participants who have not moved could therefore give an artificially low estimate of the number of units "failed." On the other hand, contacting participants who have moved to determine the disposition of their rebated refrigerator would be very difficult. The possibility of tracking such participants via forwarding addresses or other information retained in PG&E's billing system was investigated, and determined to be impractical.

To address this limitation, a special survey was designed for the new occupants of premises where the previous occupant was a program participant in 1994 or 1995. This new occupant survey is not a "participant survey," since the respondents do not represent the participating household itself. Likewise, the new occupants do not constitute a comparison group, the usual use of a nonparticipant group in evaluation studies. Thus, the new occupant survey is somewhat outside the parameters of a standard retention study as defined by the Protocols. On the other hand, the new occupants are asked to give information about the disposition of the participating unit. In this sense, the new-occupant survey may be regarded as a supplemental participant survey.

To maintain the sample quotas for the basic participant survey, the quotas of 200 per year were assigned entirely to the nonmoving participants. For the new occupant surveys, supplemental quotas of 100 per year were established.

A small fraction of customers participated in both the central air conditioner and refrigerator rebate programs during 1994 and 1995. To accommodate this overlap, the two surveys were implemented jointly. Customers who had participated in both programs responded to both

portions of the survey. The design of the combined sample for the two programs and two years had to recognize that a given customers could have participated in more than one program and year. To avoid giving some customers the chance of being selected for the sample more than once, the combined set of participants for the two programs and years was divided into the following non-overlapping quota groups:

A. 1995 nonmoving CAC participants
B. 1994 nonmoving CAC participants excluding A.
C.1 1994 moving refrigerator participants excluding A and B
C.2 1995 nonmoving refrigerator participants excluding A, B,
D.1 1995 moving refrigerator participants excluding A, B, and C1
D.2 1995 moving refrigerator participants excluding A, B, and C2.

The quota groups were defined in order of increasing population size, to allow the best chance of achieving the target number of completed surveys for the groups with smaller populations. Survey respondents selected for either CAC quota group (A or B) who were also refrigerator participants were also asked the refrigerator retention questions. Respondents selected for the refrigerator quota groups (C or D) by definition could not have been CAC participants.

CAC participants who had moved since participating were excluded from the CAC quota groups, as discussed in Section 3, but not from the refrigerator quota groups. Refrigerator participants who had moved since participating were treated as separate quota groups (C2 and D2).

To identify refrigerator participants who had moved, a nonmover was defined as a customer for whom the date the customer was first served was earlier than the refrigerator purchase date recorded in the tracking system. This date was used instead of the date the rebate check was sent, because the latter date was missing for some participants. This issue is discussed further in the context of the analysis conducted.

To screen for movers as just described, it was necessary to merge the tracking system data with the current billing system data. Therefore, any customer whose control number (the customer identification number used as the basis for merging) did not appear in both data sets was dropped from the sample frame.

Refrigerators were rebated under three programs:

- Efficient Refrigerator Rebate Program, oriented to residential customers who own their own refrigerators;
- Refrigerator Salesperson/Dealer Incentive Program, oriented to refrigerator sales people;
- Multiple Refrigerator Rebate Program, oriented to owners and managers of residential rental property.

Retention data for this study were collected from participants in the Efficient Refrigerator Rebate Program only. Salespeople were not expected to be able to provide information on the current use of appliances they had sold. Similarly, finding informed respondents for leased property is

difficult. Accordingly, retention data were collected only for individual households where no more than one unit was rebated in a single program year. Retention for units in the other programs is expected to be similar.

To limit the survey to actual residential customers, any contractors, apartment owners, real estate companies, etc. were also eliminated. To avoid the complication of asking a respondent to distinguish between units purchased in the same year, any participant who purchased more than one unit in a given year was also removed. This screen left 27,633 premises in the 1994 program and 31,449 premises in the 1995 program for the sample frame.

The number of units in each program year and the numbers excluded by the nonresidential and multi-unit screens are shown in the following table. The remaining participants were divided into the sampling quota groups described above.

Table C-7
Refrigerator Sampling Frame

	1994	1995
Tracking System Count	29,001	34,155
Missing Control Number	278	0
Business	718	2,208
Multiple Units in Year	372	498
Left for Sampling	**27,633**	**31,449**

To allow for nonresponse and customers unable to be contacted, a total sample of 800—four times as large as the targeted number of completes—was drawn for the nonmover quota group for each year. For the refrigerator mover groups, a larger oversample was taken. It was considered likely that the contact information would be less reliable and respondent cooperation with the survey lower for the new occupant survey than for the nonmovers' participant survey. The total number of participants and sample drawn for each quota group is indicated in the table above.

b. Survey Information

A copy of the survey is provided in Appendix A. The disposition of the is shown in the table below.

Disposition	Nonmovers 1994	Nonmovers 1995	New Occupant 1994	New Occupant 1995	Total 1994	Total 1995
Completes	216	204	105	103	321	307
Busy/no Answer	178	255	23	87	201	342
Callbacks	184	235	230	218	414	453
Screenouts	37	21	72	56	109	77
Refusal	126	72	83	67	209	139
Terminate	38	25	65	43	103	68
Language	10	12	19	25	29	37
Wrong Numbers	104	107	149	209	253	316
Total Sample Used	893	931	746	808	1639	1739

c. Statistical Descriptions

Nonmovers Survey

	1994		1995		Total	
	Number	Percent	Number	Percent	Number	Percent
In place at original premise	213	96.8%	204	98.1%	417	97.4%
At other PG&E premise	2	0.9%	2	1.0%	4	0.9%
Not in place in PG&E	5	2.3%	2	1.0%	7	1.6%
Total Surveyed	**220**	**100.0%**	**208**	**100.0%**	**428**	**100.0%**

Supplemental Current Occupant Survey

Disposition	1994	Percent	1995	Percent	Total Number	Total Percent
Not There When the Current Occupant Moved in	23	18%	15	13%	38	78%
Failed Since Current Occupant Moved in	1	1%	0	0%	1	2%
Still There	6	5%	4	3%	10	20%
Total Responses	**30**	**23%**	**19**	**16%**	**49**	**100%**

C.4.4 Data Screening and Analysis

a. Procedures

Unknown removal dates were considered censored with the on-site survey date as the left censoring endpoint.

b. Background Variables

n/a

c. Data Screening

For purposes of the survey sampling, participants were classified as movers or nonmovers based on the relationship between the refrigerator purchase date and the date the customer was first

served. However, during the course of the analysis, a problem with the classification was discovered. For several of the customers administered the "new occupant" survey based on this classification, the elapsed time from program participation to change of occupant (i.e., the time to "failure" if the participant had not left the unit behind) was found to be zero. As it turned out, a relatively large number of participants participated at the time of moving into a new home. In many cases, the purchase was made just before the new account was initiated, and the rebate check was sent just after.

Thus, the screen that flagged customers as movers if the account start-up date was later than the purchase date incorrectly classified these customers. Participants were re-classified as movers or nonmovers according to whether the date the check was sent was later than the date of account start-up. Respondents to the new occupant survey who were classified as nonmovers according to this rule were dropped from the analysis. These respondents could not be included in the nonmovers sample, because the sequence of questions asked was not appropriate to nonmovers for purposes of this study. The proportions of movers and nonmovers in the participant population were also re-calculated, using the revised definition of mover.

One current occupant was also dropped from the analysis because the respondent didn't know if a unit was at the premise when the household moved in. All other correctly completed surveys were used in the analysis. The complete data attrition is shown in Table C-8.

Table C-8
Data Attrition

	1994 Nonmovers	1995 Nonmovers	1994 Current Occupants	1995 Current Occupants
Total Surveyed	221	208	105	103
Misclassified as movers	0	0	74	84
Refused/Don't Know Unit Status	1	0	1	0
Used in Analysis	**220**	**208**	**30**	**19**

d. Model Statistics

Studied Measure Description (Measure Group)	Distribution	Ex post EUL from Study	SE	Lower Confidence Interval	Upper Confidence Interval	Intercept	SE	Number of Units	Number of Premises
Refrigerators	Weibull	25.8	9.2	14.0	37.7	9.5	0.4	477	477

e. Specification

Several hazard function distributions were explored for the survival analysis: Gamma, Weibull, exponential, log-normal, and log-logistic. Of these, the Weibull was considered the most appropriate, since it allows for an increasing failure rate over time.

The gamma function, which is more general, gave very different results for modest changes in one of the weighting factors, and did not converge at all for one scenario. Results from this form were therefore not considered reliable.

The exponential form assumes a constant failure rate. This assumption is reasonable for the component of failures due to customer migration, but not for the combined effect of migrations and measure breakdown or disposal.

The log-normal and log-logistic forms both have an initially high failure rate followed by a declining rate. This pattern makes little sense for a major appliance such as a refrigerator; retrofit measures may be removed in the early period after installation due to dissatisfaction, but such behavior is less likely for a major appliance.

The Weibull result, though conceptually most appropriate is still somewhat suspect, because at this point in time the substantial majority of failures are those due to moving. That is, the increasing rate of equipment breakdown over time is not yet apparent in the data. The projection of the observed failures to 26 years represented by the base case EUL estimate cannot be considered reliable. Because of these uncertainties in the model specification, none of the results is considered reliable as a basis for rejecting the *ex ante* EUL, regardless of nominal significance level.

1) Heterogeneity

Customer heterogeneity was addressed by collecting data both on units for which the participant had not moved and on those for which the participant had moved. The sampled customers were weighted in the analysis according to their proportions in the population.

2) Omitted Factors

No covariates were included in the model. With the limited instances of measure failure, estimation of effects of covariates was considered impractical.

f. Error in Measuring Variables

Uncertain removal dates were treated as left censored with the survey date as the left censoring endpoint.

g. Influential Data Points

The distribution of removal dates was examined as a screen for data entry errors.

h. Missing Data Points

All unknown removal dates were considered left censored with the survey date as the censoring endpoint.

i. Precision

Standard errors were produced by the packaged procedure. The weight used in the analysis were scaled so that the total matched the number of units in the sample, ensuring approximately correct standard errors.

D

APPROVED STUDY METHOD WAIVER

DRAFT

PACIFIC GAS & ELECTRIC COMPANY
REQUEST FOR RETROACTIVE WAIVER FOR
COMPANY WIDE MODIFICATION TO THIRD AND FOURTH EARNINGS
CLAIM CALCULATION METHODOLOGY

Study ID: All study IDs for all PG&E programs.
Date Approved: February 17, 1999

Summary of PG&E Request

This waiver requests deviations from, or clarifications of, the Protocols[1] by PG&E for the third earnings claim methodology for PG&E's 1994 programs and for all future third and fourth earnings claims. The Protocols, as written, require that all third and fourth earnings claim impacts be calculated as the sum of the measure level AEAP values as adjusted by appropriate ex post Technical Degradation Factors (TDF) and Effective Useful Life (EUL) values. Since all PG&E second earnings claim AEAP amounts are agreed at the end use level, PG&E does not have the measure level AEAP values. PG&E seeks approval to use the first year ex post evaluation measure level findings to allocate the AEAP end use values into estimates of individual measure savings. These measure level estimates will then be combined, as specified in the Protocols, with the measure level ex post EUL and TDF values to calculate the third and fourth earnings claims.

Proposed Waiver (see Table A for Summary)

PG&E seeks CADMAC approval to:

Use the first year ex post evaluation measure level findings to allocate the AEAP end use values into estimates of individual measure savings. These measure level estimates will then be combined, as specified in the Protocols, with the measure level ex post EUL and TDF values to calculate the Resource Benefit, Net for the third and fourth earnings claims.

Parameters and Protocol Requirements

Table 10, item A.3.b.1 and 2, and A.4.a. and b., require the Resource Benefits, Net to be calculated at the measure level, then summed, using the net load impacts as "determined in the second earnings claim AEAP."

Rationale

The Protocols, as written, require that all third and fourth earnings claim impacts are calculated as the sum of the measure level second earnings claims AEAP values as adjusted by appropriate ex post TDFs and EULs. Since all PG&E second earnings claim AEAP amounts are agreed at the end use level, PG&E does not have the measure level second earnings claim AEAP values required by the methodology. PG&E cannot "back calculate" measure specific level AEAP values since there is no clear information on how to "allocate" the end use level AEAP values to the individual measures. PG&E can, however, use the measure level information from the first year evaluations to proportionally allocate or prorate the end use level AEAP values into estimates of the measure level AEAP values. These measure level estimates will then be combined, as specified in the Protocols, with the measure level ex post EUL and TDF values to calculate the Resource Benefit, Net, for the third and fourth earnings claims.

Conclusion

PG&E is seeking a retroactive waiver to clearly define, in advance, acceptable methods for calculating third and fourth earnings claims. The AEAP process results in AEAP values which cannot be used to

[1] Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings for Demand-Side Management Programs.

estimate the third and fourth earnings claims as required by the Protocols. PG&E's waiver proposes a straightforward alternative that fulfills the spirit of the Protocols.

TABLE A

TABLE 10, EARNINGS DISTRIBUTION SCHEDULE			
Parameters	**Protocol Requirements**	**Waiver Alternative**	**Rationale**
Calculation Methodology for Third and Fourth Earnings Claim.	Sum the product of measure level second earnings claim AEAP, ex post TDF, and ex post EULs.	Allow the use of the first year ex post evaluation measure level findings to allocate the AEAP end use values into estimates of individual measure savings. These measure level estimates will then be multiplied by the measure level ex post EUL and TDF values to calculate the Resource Benefit, Net for the third and fourth earnings claims.	The AEAP results in end use level AEAP values. The proposed method makes maximum use of evaluation findings to allocate the end use level AEAP values to the measure level. Allocation to the measure level allows both third and fourth earnings claims to be calculated as specified in the Protocols.