Customer Energy Efficiency Program
Measurement and Evaluation Program

PACIFIC GAS & ELECTRIC COMPANY
PY94 RESIDENTIAL NEW CONSTRUCTION
RETENTION STUDY

PG&E Study ID number: 322 R1

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Prepared for:
Measurement and Evaluation
Customer Energy Efficiency Policy & Evaluation Section
Pacific Gas and Electric Company
San Francisco, California

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As part of its Customer Energy Efficiency Programs, Pacific Gas and Electric Company (PG&E) has engaged consultants to conduct a series of studies designed to increase the certainty of and confidence in the energy savings delivered by the programs. This report describes one of those studies. It represents the findings and views of the consultant employed to conduct the study and not of PG&E itself.

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PACIFIC GAS & ELECTRIC COMPANY
PY94 RESIDENTIAL NEW CONSTRUCTION "COMFORT HOME" MEASURE RETENTION STUDY

PG&E Study ID Number _322 R1_

A. Purpose of Study

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

The purpose of the 1994 Residential New Construction (RNC) retention study is to collect data on the fraction of installed measures that are still in place and operating in order to produce a revised estimate of PY94 effective useful lifetimes (EULs) of the measures.

B. Methodology

Effective Useful Life Analysis: For each sampled site with one of the four end-uses of interest (high efficiency ducts, air conditioners, gas cooktops, or gas dryer stubs), either a phone or on-site interview (or both) were used to determine whether the measures noted as installed in project documentsare in place and operational. For sites with changes, surveyors called back to ascertain the exact status of the equipment and reason for removal. A subsample of the homes were surveyed by phone and on-site to confirm the validity of the telephone self-report method.

Insufficient failures were found to support estimation of revised survival functions, or other methods that might be attempted. Consequently, the ex ante EUL estimates were judged to provide the best available figure.

Technical Degradation Factor (TDF): Only one technology (air conditioners) in the Comfort Home Program was affected by a change in the TDF. This technology has TDFs that are greater than one resulting in a negative decrease to kWh and kW savings versus standard units.

C. Study Results

Of the four measure types examined, we found that only between zero and three-quarters of one percent had been removed or replaced since installation. All dryer stubs and air conditioning equipment were still in place and operable. A total of six removals and/or replacements occurred, three in ducts and three in gas cooktops. Given the small number of failures among surveyed sites, estimation of any statistical models is not impossible. As a result, the ex ante EUL estimates were retained as the ex post estimates.

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D. Regulatory Waivers and Filing Variances

There are no waivers for RNC.

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I. EXECUTIVE SUMMARY

This study evaluated the retention of measures installed under the 1994 Residential New Construction (RNC) programs. Estimates of retention were based upon data collected from program participants via telephone and on-site surveys. The principal objectives of this evaluation were to:

- provide statistically-based estimates of the fraction of measures that remain and are operable from the PY94 Comfort Home Program,
- estimate the Effective Useful Life (EUL) for each of the four measures included in the study, and
- use statistical methods to test the null hypothesis that the revised estimates of the EULs for each of the four measures are not significantly different (at the 80% confidence level) from the assumed ex ante estimates for EULs.

These results will allow Pacific Gas and Electric (PG&E) to calculate net resource benefits to support their third earnings claim, as specified by the California Public Utilities Commission Protocols.[1]

A. Background

PG&E's Residential New Construction Program, the "Comfort Home" program offered financial incentives to builders and developers who installed qualified measures in new homes. The measures evaluated in this study were installed under the program in PY93, PY94, and PY95, and reimbursed in PY94 and PY95. However, the results reported here represent those for PY94 only. The program was offered to homes constructed in CEC climate zones 11, 12, and 13. The major Program measures included:

- high efficiency air conditioners that exceeded Title 24 specifications for Seasonal Energy Efficiency Rating ("SEER") by 1.5;
- high efficiency duct standards;
- natural gas cooking appliances; and
- the presence of gas stubs in laundry rooms.

[1] California Public Utilities Commission, *"Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand Side Management Programs"*, Revised January 1997. This study represents the 4th year retention study.

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B. Results

Table 1 summarizes the results of the study. Of the four measure types examined, we found that all dryer stubs and air conditioners were in place and operable. Removal of ducts occurred in three installations, and that cooktops were removed in three homes. Given the small number of failures, development of statistical models was not possible, so the *ex ante* EUL estimates were retained as the *ex post* estimates.

Table 1: Study Results

Measure Types	*Ex Ante EUL Estimate*	*Failures Found*	*TDF for PY 94*
Air Conditioners	18 years	0	1.01
Gas Dryer Stubs	18 years	0	1
High Efficiency Ducts	25 years	3	1
Gas Cooktops	20 years	3	1

C. Study Methodology

Since no other studies similar to this had been completed, and the CPUC Protocols did not specify a required sample size, PG&E initially specified a minimum sample size of 150 per program year. In order to provide additional reliability to the study, the final sample totaled 511 (approximately 250 per program year). The sample was selected so that only those households with 3 or 4 of the measures of interest were contacted. This approach allowed the survey to maximize the number of measures that were followed-up on given a specified number of calls or contacts.

A total of 64 follow-up on-site surveys were conducted to verify telephone self-reports on failures or lack thereof. Given the high correlation (100%) of the on-sites verification to the telephone self-report data, the remainder of the 500 surveys were conducted by phone.

D. Effective Useful Life

The 511 telephone and on-site surveys revealed possible changes to 21 installed measures. Each was re-contacted to confirm that the majority of the changes were, as noted, not replacements or removals. In fact, only three ducts and three cooktops were replaced or removed. The reasons are listed below.

Ducts replaced because:
- faulty insulation installation led them to replace return air duct with fixed metal duct
- house suffered flood damage
- duct were corroded

Cooktops replaced because:
- homeowner worked for an appliance manufacturer and replaced cooktop with own model prior to move-in
- homeowner displeased with quality of cooktop and replaced before they moved in
- all appliances were removed (and sold) by previous homeowner in association with

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repossession of the home prior to the new owner taking possession.

The original research plan called for using the failures to fit a statistical model of measure survival, and determine the EUL by identifying the estimated point at which "only 50% of the measures installed under the program are still in place and in use." The absence of sufficient failures made the estimation of statistical models impossible, and the *ex ante* lifetimes cannot be rejected.

E. Technical Degradation

For this program, TDFs were only relevant to Air Conditioning, a measure that had no identified failures / removals / replacements. The Air Conditioning TDFs were also negative, indicating a degradation rate less that the standard Air Conditioner unit. The TDF for Air Conditioners in 1994 is 1.01.

F. Conclusions

The very small number of removals and replacements identified in the study sample leads to the following conclusions.

- The ex ante estimates of the EULs provide the best available estimate.
- The small number of failures indicates that the survival function is unlikely to be linear, but rather, is more likely to be S-shaped, with low failures in early years, increasing in the middle and later years. One functional form of this type is the logistic survival curve.
- Given the long EULs for these measures, it may be that a 3-4 year retention study is too soon after installation to detect failures. Instead, it may be more appropriate to conduct periodic (and cost-effective) phone surveys to monitor failures in this sector. The measures installed under this study are large and obvious. The study also determined that there was an exact correlation between phone and on-site reports of failures / removals, arguing for reliable use of phone surveys and self-reports. This approach would provide stronger data on the precise dates of failure – an important component of good survival analysis. More frequent calls avoid requiring homeowners to remember, too far back, and may help alleviate the problem that homeowner turnover may "lose" information on failure dates. Phone calls every two or three years with a panel sample may provide the best data for evaluating EULs in this sector.

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II. INTRODUCTION

A. Background

Pacific Gas and Electric (PG&E) offered the RNC program to builders and developers to provide financial incentives, in the form of rebates, for adopting efficiency measures and design features that reduce electric consumption and demand in new construction projects. PG&E paid out incentives to approximately 20,000 homes for the two program years (PY) under study – PY94 and PY95. The program year was determined based on the payment year, rather than the installation year – a few measures may have been installed in 1993.

The vast majority of the savings from the program were computed to come from four major end uses:

- air conditioning,
- high efficiency ducts,
- gas cooktops, and
- gas dryer stubs.

In conjunction with the protocols, PG&E determined that these measures represent the top 50% of savings from the program. The measures not falling into the four key categories above were treated as "miscellaneous", and although the survey asked the status of the measures, these results are not relevant to the EUL study.

B. Evaluation Research Objectives

The principal objectives of this evaluation were to:

- estimate the fraction of measures that were installed through the RNC Program during the 1994 and 1995 program years that remain operable.

- provide PG&E with statistically-based estimates of the EUL for each of the four measures included in the study.

- determine whether a phone sampling approach can achieve accurate data.

- determine whether analytic work can help narrow the functional forms to few in order to identify which year a follow-up study is needed to best "anchor" the function and develop a reliable estimate of median useful life.

The study's analytical objective was to use statistical methods to test the following hypothesis:

> ***Null Hypothesis****: The revised estimates of the EULs for each of the four measures are not significantly different (at the 80% confidence level) from the assumed ex ante estimates for EULs.*

The results obtained from this study were designed to be used to support PG&E'S 1999 Annual

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Earnings Assessment Proceedings (AEAP). Therefore, this assessment was undertaken in a manner that is consistent with the Monitoring and Evaluation Protocols (M&E Protocols) as adopted by the California Public Utilities Commission. The revised EULs, if found to be statistically different from the *ex ante* estimates, would be utilized in further proceedings to estimate program savings and calculate shareholder incentives.

C. M&E Protocol Compliance

Accomplishing the objectives listed above allows PG&E to calculate net resource benefits for the PY94 RNC program, according to the following formula:

Net resource benefit = (First-year net impact) ´ (Program-level EUL) ´ (Program-level TDF)

Effective useful life (EUL) is defined by the Protocol (Table 10) as "the moment when only 50% of the measures installed under the Program are still in place and in use".

Technical Degradation Factor (TDF): A scalar to account for the time- and use-related change in the energy savings of a high efficiency measure relative to a standard efficiency measure.

D. Overview of Study Approach

Meeting the study's objectives involved several key steps. Each step is described in more detail in the following sections. The major evaluation steps included:

- ***Review Existing Data***: During this step, we reviewed PG&E databases, identifying the key variables and databases needed for the study. We gathered program databases from PG&E, merged data from PG&E customer data, and reviewed background data and materials on the Comfort Home program. These PG&E data were assembled into SAS® and EXCEL databases for use for succeeding steps in the project.

- ***Data Collection Strategy***: Phone and on-site survey instruments were created to collect key data about the households and the status and disposition of the measures under study. First, a random set of 64 households were administered both phone and on-site surveys. This allowed us to both pretest the survey approach and to gather information on the relative accuracy of self-report phone techniques. The households were called and asked about the presence / removal of measures; then they were scheduled for an on-site visit, which confirmed the responses about measures. The results from the 64 on-site pre-tests were checked and no discrepancy was found between the phone and on-site data – none had failures of any measures. Upon approval, the remainder of the surveys were conducted by phone. After completion of the 511 phone surveys, all households reporting changes were re-contacted to clarify the status of the measure and the reasons for removal or replacement, if it had occurred.

- ***Sampling Strategy***: Sampling alternatives were reviewed and stratified random sampling was selected for the study. To maximize the number of measures included in the study (given a specified number of surveys), the sample was limited to those homes with three or more of the key measures installed under the program. The population was sorted by program year,

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the three climate zones, and "city or supercity". Half the sample was assigned to each of the two program years. Because the sampling plan called for geographic clustering for the survey (to facilitate the on-site work), information from the CEC was used to assign climate zones, and the sample was pulled proportionally from the three zones of interest – 11, 12, and 13. The sampling unit was geographic "city" or "supercity" groups. Each group consisted of approximately twenty households. This was meant to allow for a 50% response rate for the 8-10 households that would equate to one day of on-site field visits. The cities/supercities were pulled randomly for the sample, and the households assigned to the selected cities were sorted randomly and called in that order.

- ***Proposed Analysis Approach***: The planned analysis approach included several steps. First, the percent of failures for the sample and the full population would be computed, and compared to the *ex ante* EULs. Next statistical techniques would be used to estimate the "survival" function for the measures, using the dates of failures found in the sample. The models allow calculation of EULs for each measure type, and the estimated EULs could be compared with the *ex ante* estimates. The results, if different from *ex ante* EULs, would be used to recalculate the benefits from the program.

- The phone and on-site surveys found no failures at all for two of the four measures – air conditioners and gas dryer stubs. All measures investigated were in place and operable, so failure percentages were zero, and no revised EUL estimates could be estimated. For the two other measures – gas cooktops and high efficiency ducts - we found three failures each. These results led to estimates of less than three quarters of one percent failures over three to four years of operation. The low number of failures were not sufficient to allow us to use the proposed estimation procedures to conduct more detailed estimates of survival functions or revised EULs, so in the case of all four measure types, the *ex ante* estimates of EUL were retained.

- ***Database Construction***: SAS® and EXCEL databases were created for the input and survey databases. A directory of key programs was also created. The results of the phone and on-site survey contacts for the two program years was created and tabulated.

E. Organization of the Report

This report consists of seven sections, which are briefly described below.

I -- Executive Summary: Summarizes key findings of the evaluation, as well as the evaluation methodology.

II – Introduction: Includes a brief discussion of the project's research objectives and description of the program.

III -- Analysis Approach: Describes the overall approach used for the study.

IV -- Data Collection: Describing the data used in the study.

V – Results of the Study: including a discussion of the measure retention estimates, and the pre-and post- EUL estimates.

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VI – Recommendations of the Study: including possible recommendations to the EUL approach, or to the protocols.

VII – Appendices: incorporating survey protocols, call disposition reports, and documentation of datasets.

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III. ANALYSIS APPROACH

A. Introduction

Under the Protocols, the purpose of a retention study is to collect data on the fraction of installed measures in place and operable in order to produce a revised estimate of its EUL.
The ultimate goal, the estimation of the EUL (the median number of years that the measures is still in place and operable), can be estimated by identifying the measure's survival function. A survival function describes the percentage of measures installed that are still in place at a given time. The hazard rate is the rate at which measures fail or are removed.

This 4th year analysis is focused on providing the first estimate of the EUL of the measures installed under the new construction program; the 9th year retention study is important to identifying the final "shape" of the survival function and revised estimates of the EUL. Providing estimates for two program years separately (PY94 and PY95) provides information for two points in time and may help define the survival curve "shape". Combining the two program years can result in improved estimates versus what is obtained from analyses of only one program year.

The overall approach was to apply survival analysis to our collected retention data in order to develop survival functions and estimate EULs for each of the studied measures. Two major types of computations formed the core of the planned analysis:

- Estimate fraction of measures still in place and operable: As a first step, the percent of failures for the sample, and the corresponding percent estimated for the full population needs to be computed, with its associated 80% confidence interval. This provides the estimated fraction of measures still in place in the homes.

- Estimate "survival curve" and develop EUL estimates: This step involves using several alternative SAS® procedures -- specifically procedures called "Lifetest", "Lifereg", and "Phreg" -- to estimate the best fit for the "survival" function for the measures, using the dates of failures found in the sample. The best fitting models can be calculated for each of the measure types, for combined and separate program years. The implications of important explanatory factors on the EUL estimates can also be examined.

The 80% confidence intervals around the estimated EULs can be calculated and compared with the *ex ante* estimates, by measure. Specifically, the estimates need to be compared against the *ex ante* estimates of 18 years for dryer stubs, 20 years for gas cooktop/range, 25 years for ducts, and 18 years for central AC. The EUL results for the four measures, if different from *ex ante* EULs, can be used to recalculate the benefits from the program.

The data needed to support these revised estimates include:

- the measures installed in the house
- the status of the measures –
- date of failure of any measures no longer in place or operable
- date the measures were installed, and

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- the program year and climate zone for the house.

To gather the data for the analysis, an appropriate survey and sampling plan needed to be developed and carried out. The steps that were involved in the survey design and data collection are described in Section IV. The results of the analysis are presented in Section V. The paragraphs below go into greater detail on considerations related to the analysis approach.

B. Analysis Challenges

The challenges associated with the analysis for this project are derived from the difficulty in confidently "specifying" the survival function under complicated circumstances.

- There are relatively long expected lifetimes of the measures installed. In this program, we are addressing measures with 18-25 year lifetimes.
- The elapsed time since installation is short relative to the long measure lifetime. In this case, the measures have been in place less than 5 years.
- Relatively few failure points might be available to allow selection between "similar" distribution functions. Relatively few failures complicate fitting a curve through the data points.
- With measures with long lifetimes, estimated survival curves may not fall below .5, making it impossible to estimate the median survival time.

Forseeing these challenges up front, we included several strategies in the initial analysis plan to try to address these issues to the extent possible:

- augmenting sample sizes to try to maximize the chances of finding failures, and
- using multiple statistical techniques to estimate EULs.

1. Increased Sample Size:

The measures studied under this project were in place less than five years (generally installed not earlier than 1994). For measures with lifetimes of almost 20 years, like the ones under study, few failures based solely on technical failures might be expected after such a short time. Another source of failures might be removals by homeowners, perhaps related to dissatisfaction with the measures or a variety of other possible reasons. Either reason for removal affects the effective useful life (EUL) of the measure. However, few removals would still be expected in such a short time.

Few failures reduce the chances to disprove the null hypothesize that the *ex ante* estimate of EUL is incorrect. With few failures, the confidence interval around the estimated hazard function will be fairly wide, and has a higher chance of including the *ex ante* estimate. To improve our chances of finding failures and improving the "fit", the samples size was increased from 300 to 500. Phone surveys were proposed for this increased sample.

Phone surveys were used to provide raw data on the fraction and locations of measures installed in the program years that are still in place and operating. It was also anticipated that the necessary data – presence of equipment and date of removal – could be collected reliably by phone because:

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- Gas stubs, gas cooking appliances, and ductwork are large and relatively easy for homeowners to identify. Unlike lighting or other measures, there are not usually multiple measures of these types in the home, making identification of the measures clear.
- These four measures are only likely to be removed along with a fairly memorable remodeling effort, and the specific dates of these are usually easily remembered. In the case of air conditioners, failure months may be recalled relatively easily because of the tendency for operation to be concentrated in summer months. Failure months might also be verified from records from the purchase of replacement equipment.
- The elapsed time since occupancy of the house is not very long, so resident memories will not be very taxed, even for dates of removal.

2. Using Multiple Estimation Techniques

Survival functions can be based on a variety of functional forms, implying different assumptions about the underlying hazard rate and the EUL. Three different SAS procedures were available to be used to develop an estimate of the survival function. This flexibility would allow the results to be examined to determine the best "fit" (and resulting EUL) for each measure, based on the failure data for that measure. Each of the modeling procedures – SAS procedures "lifetest", "lifereg", and "phreg" – has advantages and disadvantages. Several provide flexibility in the estimation of the distribution function, while others allow us to examine the "fit" of distributions we may believe, *a priori,* are most appropriate. Distributions that can be accommodated include exponential, gamma, loglogistic, lognormal, logistic, normal, and Weibull. Other estimation procedures have underlying functions built in. Several procedures allow time dependent covariates (or explanatory factors), which can recognize and properly incorporate factors such as heating degree days. Using multiple estimation techniques allows us to determine the best fit and EUL estimate based on the failure data for each of the four types of measures.

C. Results

During data collection, no failures were identified for two of the measures, and only three failures were found for each of the remaining two measures. There was an insufficient number of failures to support estimating statistical survival function models for any of the measures. For the four measures under study, the ex ante estimates are recommended.

The analysis was designed to test the null hypothesis, provide credible research to support financial implications, and set the stage for the retention study in the 9th year. Given that the measures will be in place longer, the 9th year study should expect to find greater failure rates, and will be able to provide greater confidence (narrower confidence intervals) around the EUL estimate.

The next section provides a detailed description of the data collection plan.

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IV. DATA COLLECTION

A. Introduction:

A number of steps were taken to assemble program records, assemble the sampling frame, and conduct the steps necessary to conduct the phone and on-site surveys of participating households. These efforts are described in this section.

B. Sampling Frame:

The program records from PG&E contain about 20,000 homes that were approved for and received reimbursement in PY94 and PY95 payment years. Eligible households were in three climate zones covering the central part of the state south from Tehama County to Kern County. The program had a number of eligible measures, covering a variety of air conditioning, cooking, duct, gas furnace upgrades, wall and ceiling insulation, and other measures. Four types of measures were of interest to the study – specifically, air conditioners, gas cooktops/ranges, high efficiency ducts, and gas dryer stubs. The list of all measures that were installed under the program is provided in Table 2.

The information needed to construct the sample frame include:

- measures installed
- the address the measures were installed in, and
- the date they were installed.

A "population" database was constructed from PG&E customer databases.

C. Stratification and Sampling Plan

The most efficient, appropriate sampling strategy is simple random or stratified random. This provides high reliability and well-known properties associated with the final estimates. The types of a priori information needed to support the design can be fairly minimal, but the use of key strata can significantly improve the sample characteristics and resulting analyses.

Dividing the customer population into strata and sampling from within the strata is an appropriate design when the customers are non-homogeneous, or if reliable information is needed for subsets of the population that can be identified with *a priori* data (e.g., in this case, program year). Stratification leads to lower overall variance, and allows more efficient use of sample size.

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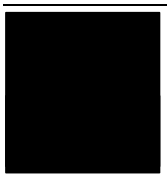
Table 2:
List of All Measures Installed under the Comfort Home New Construction Program

Measure Identification Number	End Use / Measure
1	LOW COST COOLING
2	DOWNSIZING
3	SUPEREFFICIENT AC
4	LOW COST COOLING
5	GAS FURNACE UPGRADE
6	HIGH EFFICIENCY DUCTS
7	LIGHTING
8	1992 COOLING
9	HIGH PERFORMANCE WINDOWS
11	HIGH EFFICIENCY A/C - SINGLE FAMILY DETACHED
12	HIGH EFFICIENCY A/C - MULTI-FAMILY
13	DOWNSIZE A/C BY 1/2 TON
14	DOWNSIZE A/C BY 1 TON
15	SUPER EFFICIENT A/C - 15+ SEER
16	SUPER EFFICIENT A/C - 16+ SEER
17	HIGH EFFICIENCY DUCT
19	GAS FURNACE UPGRADE
20	GAS WATER HEATER UPGRADE
21	GAS COOKTOP/RANGE
22	GAS COOKTOP/RANGE STUB
23	DRYER STUB
24	INCREASED WALL INSULATION
25	INCREASED CEILING INSULATION
26	INCREASED FLOOR INSULATION
27	INCREASED DUCT INSULATION
28	THERMALLY EFFICIENT WINDOWS
29	LIGHTING: INDOOR (CUSTOMIZED)
30	AC 1 UNIT - 10.2 TO 12.2 M/F
36	AC 1 UNIT - 10.2 TO 12.2 S/F
37	AC 1 UNIT - 10.2 TO 13.5 S/F
38	AC 1 UNIT - 10.7 TO 12.2 S/F
41	AC 1 UNIT - 11.2 TO 13.5 S/F
42	AC 2 UNIT - 10.2 TO 12.2 S/F
43	AC 2 UNIT - 10.2 TO 13.5 S/F
44	AC 2 UNIT - 10.7 TO 12.2 S/F
45	AC 2 UNIT - 10.7 TO 13.5 S/F
48	DUCTS-AC - 12.2 M/F
50	DUCTS-AC - 1 UNIT - 12.2 S/F
51	DUCTS-AC - 1 UNIT - 13.5 S/F
52	DUCTS-AC - 2 UNIT - 12.2 S/F
53	DUCTS-AC - 2 UNIT - 13.5 S/F
54	COOKTOP
55	DRYER STUB
56	RANGE
57	LPW40
58	LPW60
59	LPW80
60	ENHANCED ENFORCEMENT - COMPUTER
61	ENHANCED ENFORCEMENT - POINT 1 AC
62	ENHANCED ENFORCEMENT - POINT 2 AC
65	AC 1 UNIT - 10.2 W/1.5 SEER INCREASE
66	AC 1 UNIT - 10.2 W/2.0 SEER INCREASE
67	AC 1 UNIT - 10.2 W/3.0 SEER INCREASE
83	DUCTS 1 UNIT - 10.2 W/1.5 SEER INCREASE
84	DUCTS 1 UNIT - 10.2 W/2.0 SEER INCREASE



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eMI

85	DUCTS 1 UNIT - 10.2 W/3.0 SEER INCREASE
102	COOKTOP
104	DRYER STUB
105	ENHANCED ENFORCEMENT - COMPUTER

The key strata used for this evaluation included:

- program year (2 strata),
- climate zone (3),
- number of measures installed, and
- geographic clustering of the sample.

The rationale for each of these strata is discussed below.

- ***Program year***: This study included sample points from two program years (per the Protocols). This can help support analysis jointly or on a PY basis.

- ***Climate zone***: Newly constructed houses/developments in three climate zones were eligible for the program. There are two reasons that stratification by this variable may be useful:

    - Results by climate zone may be useful.
    - Climate zone may have an effect on measure lifetimes. Air conditioners are included in the study and since some of the climate zones have higher heating degree days than others, it may be that operating characteristics are different between the climate zones.

- ***Number of Measures***: Number of measures installed was selected as a stratification variable because of sample size issues. We determined to draw our sample points entirely from the subset of "treated" households that contained three or four of the measures of interest, omitting those houses with fewer measures per household. This increased the number of observations in the sample of measures checked given a maximum number of on-site surveys. Generally, the larger the number of completed surveys, the more accurate an estimate of the EUL that will be developed. Maximizing the number of observations of measures maximizes the likelihood of finding measure failures. The sample size determines the overall confidence intervals and the reliability of the results. Picking sites with more measures increases the sample size of each of the measures.

  An assumption must be made to justify this approach. It must be assumed that there would be no relationship between measure lifetimes and the number of measures installed – that households with only one measure installed would be expected to have the same lifetime as that measure installed in a house that had multiple eligible measures installed. It was determined that there was no reason to believe, *a priori*, that there would be behavioral, measure, or other differences between houses with one vs. more measures, or varying combinations of measures installed *that would affect the estimated useful life of the measures*.

- ***Geographic clustering***: We used geographic clustering for the study. We chose "city" as the geographic indicator. However, since the participants in the program are not evenly distributed by cities, we found it necessary to create multiple clusters or "subcities" for cities with many participants. We also created "supercities" for areas that were smaller than our

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designated clusters of 20. We assumed a 50% success rate in scheduling appointments or obtaining surveys, resulting in 8-10 on-site appointments per day (later we determined that this was optimistic, and more clusters were ultimately randomly pulled for surveys). This approach retained randomness and sampling properties of the survey, and had the advantage of lowering the travel costs for on-sites. This clustering was superimposed on the stratified/random design based on climate zone and program year discussed above.

The number of participants to be surveyed within each sample cell could be determined using any of several strategies:

- allocate an equal sample size to each cell (an approach often used for load research sampling)
- determine cell sample sizes based on the number of customers within each cell
- determine cell sample sizes based on an indicator in the cell (number of measures, etc.), or a variety of other methods.

Ultimately, the second approach was used, eliminating the need for weighting the data within a program year.

D. Sampling Plan for Phone Sample

We considered several options for the phone sample. However, for consistency, it was determined to use the same sampling strategy for both the on-site and the phone sample. The benefits remain the same:

- sampling from households with many measures increases the sample size for all measures increases the chance of confirming retention or failure, and
- using the same geographic plan will make the samples most easily compatible for combining the samples.

Therefore, 250 sample points were assigned to each program year, and the points were assigned proportionally within the cells.

E. Creating the Population and Reviewing PG&E Databases

The databases received from PG&E contained information on measures installed, builder name and address, date of payment, and address of the home. Data from PG&E customer billing records, (i.e., names and phone numbers) were merged into the database to allow residents to be contacted for the survey and on-site.

1. Climate Zone Sampling

Up front, the databases provided by PG&E did not have information noting the climate zone location of each of the participants. The first step in sampling required merging climate zone data onto each of the records. The only variable available for linking was city. Information matching cities to climate zones was obtained from the State of California Energy Commission (CEC). This table listed climate zones for over 600 cities and areas across the State. The vast majority of the participants were linked using this information. However, for cities in the participant files that were

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not listed in the table, the CEC map of climate zones was used, or the assignment for neighboring communities was used to allocate individual communities/ participants to the specific climate zones. This was a fairly labor intensive exercise.

Information on the number of households in each climate zone and program year, along with the number of measures that were installed in the households is listed in Table 3 below. Note that the sum of zones 11, 12, and 13 do not equal the program year total. Review of program year files showed that approximately 10% of households rebated under the program were located in other climate zones.

Table 3:
Number of Measures "of interest" for Comfort Home Participants
by Program Year and Climate Zone

	Total	***PY94***	***PY95***	***94-11***	***94-12***	***94-13***	***95-11***	***95-12***	***95-13***
Number of Key Measures per Household									
None	1,947	1,946	1	403	463	969	1	0	0
One Measure	3,577	2,568	1,009	543	961	730	80	112	651
Two Measures	3,357	1,100	2,257	126	532	430	275	629	1,254
Three Measures	5,773	2,146	3,627	525	992	60	967	1,870	75
Four Measures	3,982	1,195	2,787	164	979	52	504	1,947	271
Total Number of Each Measure in Participating Households									
A/C	9,400	3,101	6,299	381	1,530	1,032	978	2,841	2,250
Ducts	14,435	6,192	8,243	1,270	3,453	695	1,662	4,414	1,378
Cooktop	9,888	3,353	6,535	689	1,973	112	1,485	3,832	347
Stubs	9,815	3,340	6,475	686	1,961	139	1,422	3,681	493
Total Program Households	19,477	9,100	10,377	1,796	4,008	2,270	1,848	4,807	2,603

The summary of counts of houses for the three climate zones and the program years for households with 3 or 4 measures are listed in the Table 4 below. Once we had specific data on climate zones, we realized that there was a very uneven distribution between climate zones. Residents in some climate zones were almost 20 times more likely to be selected for the sample than those in other zones (e.g., compare 1994 zone 12 to zone 13). This is illustrated in Table 4. We determined that, although we would classify participating households by climate zone, we would sample proportionally, and not oversample from climate zones with low participation. Instead, climate zone would be available for use as an explanatory factor.

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Table 4:
Percent of Sample Distribution
by Climate/Year Stratification Cell

	PY94 Zone 11	***PY94 Zone 12***	***PY 94 Zone 13***	***PY95 Zone 11***	***PY95 Zone 12***	***PY95 Zone 13***
Number with 3 or 4 measures	689	1,971	112	1,471	3,817	346
Percent of PY households	25%	71%	4%	26%	68%	6%

2. Geographic Clustering

The households then needed to be sorted into subcities and supercities – the clusters of approximately 20 households per "city cluster" that would be selected randomly and from which appointments and phone surveys would be conducted. For larger cities, subcities were created using the total number of households divided by 20, rounded to relatively even groups. For smaller areas, individual inspection of locations of the cities on a map was necessary, and the groups were created using adjacent cities and areas. This, again, was fairly labor intensive.

To implement the final sampling, each of these city groups was assigned a random number, and the city groups were then sorted by this number. The database of all participating houses with 3 or 4 measures were also grouped by these same city and sorted randomly. When larger cities were broken into smaller subcities, the first 20 of each randomly-sorted participating households could be assigned to the first sub-city; the second 20 to the next time the city name was mentioned, and so on.

F. Recruitment / Phone Survey and On-site Protocols

The field research for this study included up to two potential points of contact with each customer:

- initial telephone recruitment and survey
- on-site survey.

1. Initial Telephone Recruitment and Survey Protocol

Telephone contact was attempted for each home in the pretest sample, in accordance with the specifications of the sample design. Upon initial contact, customers / occupants were screened and asked to schedule an on-site field inspection. All customers who agreed to participate in a site visit were then scheduled. All occupants who were contacted, regardless of whether or not they agree to a site visit, were then requested to answer a series of questions to ascertain:

- status of the measures installed,
- reasons for removal,
- date of removal, and
- occupancy characteristics.

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Multiple contacts with each customer in the sample were attempted at different times of day. Customers were given a range of times and dates, including early evening and weekend appointments. Contact attempts and results were logged and tracked for each sample point. Reasons that customers give for declining to participate in either the on-site or the telephone survey were recorded.

Customers scheduled for an on-site visit were provided with a number that could be called collect if they needed to reschedule a meeting time. Additionally, the name and telephone number of the PG&E study director was provided if desired in the event that they wish to verify the legitimacy of the study.

Phone surveys were completed with over 500 participants in two stages – 78 in a pretest (resulting in 64 follow-up on-sites), and 436 through phone surveys conducted by a survey firm.

2. On-site Survey Protocol

During the site visit, the inspector explained to the customer the purpose of the project and reviewed the measures that were recorded as being installed in the house. A check was made to ensure that all customer information was complete and accurate.

Occupants were asked to direct the inspector to the appropriate measure locations, where the inspector completed a visual inspection and recorded the status of each measure. For any measures that were found to be missing or failed, additional information was gathered to identify, as possible, (1) the reason a measure was removed or failed; and (2) the date of measure removal or failure. For all measures, general physical condition was noted, based solely on visual inspection. For air conditioning measures, appropriate nameplate data was also be noted.

3. Telephone and On-site Survey Research Components

A summary of the questions included in the telephone and on-site components is provided below in Table 5. The survey instruments are provided in the Appendix.

Table 5:
Telephone and On-site Survey Research Components

Survey Component	Telephone Survey	On-site
Measure Status - Verbal	X	
Measure Status - Visual		X
Reason for removal	X	X
Date of failure / removal	X	X
Follow-up if gas cooktop missing	X	X
Occupant Questions	X	

G. Complexities in the Implementation of the Survey

PG&E program databases were used to develop the sampling frame. To facilitate use as a sampling frame, the database(s) needed to contain at least the following information:

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- address of the specific homes the builder received reimbursement for
- measure(s) installed
- program year
- date of installation or approval or payment (some date adequate to be used for "installed" date)
- name and phone, if available
- climate zone
- data from first follow-up inspection, if any.

No direct information on cities for the specific homes was provided, but a check determined that the city associated with the builder's development was an appropriate assignment. As mentioned before, data on climate zone (obtained from CEC information) had to be attached, as well as name and phone numbers (attached from PG&E billing records) Date of installation was not available, but "date paid" was used as a proxy.

The most complicated development was in determining the exact measures that were installed under the program. Incentive payments were made to developers / builders, and the measures installed and paid are included in the database, and are associated with each house. However, for program years 1994 and 1995, builders could receive the incentive for gas cooktops if the measure was installed in 75% or more of the houses in the development. This means that if a gas cooktop is missing from a specific Comfort Home participant that was in a *development* that received incentives, it is possible that there was never a gas cooktop at that particular home. The survey included the following questions to address this issue:

- if there was no cooktop, and one was noted as installed in the development, we asked if they were the original resident of the home
    - if yes, we asked if there was ever a cooktop
    - if no, we asked if they know who the original owner was, and tried to get a name, moved-to location, and potentially a phone number (or use reverse directories)
    - if no, and other information was not available, we would try to call the builder and ask them to inspect their records to see if this house was one that had a gas cooktop installed (builder names are included on the database).

This was determined to be a manageable approach to this problem because (1) not all installations had gas cooktops; (2) it would be expected in 75% of the buildings in the development; and (3) we were not expecting many failures after only 4 years.

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V. EVALUATION RESULTS

A. Introduction

Through a combination of phone and on-site surveys, data were collected from more than 500 households to try to determine the number of key measures associated with the program that were still in place and operating. The following sections report the results of the surveys and provide conclusions about the EUL estimates for the four measures.

B. On-site and Phone Survey Results

For the most part, PG&E's records regarding installed measures were accurate. The phone interviews and on-sites showed that there were no measure database discrepancies. The phone list and address list, however, had some problems. The data from the survey and on-site inspections showed that:

- the equipment installed under the Comfort Home program 3-4 years ago was still installed,
- the households questioned knew that the equipment was still installed,
- the PG&E measure database was accurate, and
- phone number and address databases could be improved.

The number and distribution of the pre-test phone and on-site surveys are summarized in Table 6 below.

Table 6:
Pre-Test Phone and On-site Disposition

City	*On-site Inspection with Phone Survey*	*Phone Survey Only*	*Total Surveys Completed*
Total	64	14	74
By Pre-test City			
El Dorado Hills	8	10	18
Roseville	11	3	14
Oakley	11	1	12
Sacramento	11	0	11
Folsom	5	0	5
Fresno	10	0	10
Winters	8	0	8

In the pre-test, phone surveys were accomplished with 78 households (the sum of phone survey with onsite inspection and those without on-site inspection), and on-sites inspections were accomplished with 64 Comfort Home participants. During the initial recruitment phases, it was found that customers were reluctant to accommodate on-site visits. In consultation with PG&E, the consultants added a monetary incentive to improve acceptance and to reduce recruitment labor costs. A figure of $20 was used to increase the percentage of customers agreeing to an on-site visit.

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Of the households that were called or inspected, no measures had been removed or changed in any way. There were only one or two instances in which a household indicated problems with the installed measure. All others seemed very pleased with the equipment installed. Most customers were aware that their house was a "Comfort Home".

The inspections were brief, lasting no more than 10 minutes. In fact, most people remarked how "easy" the actual inspection was. A common phrase was "this was the easiest $20 I've ever made." Letters introducing the project (on PG&E letterhead) were helpful to have to show customers. In two cases, customers who had scheduled interviews had to cancel them due to illness or other problems.

The field work found that the designation of "supercities" was, for the most part, adequate. However, one (Elk Grove and Antelope Park) was more than 30 miles in distance, complicating the scheduling of on-sites.

A comparison of the results from 64 telephone and on-site surveys found identical results regarding measure retention and operability. As a result, the remaining contacts were converted to phone survey approaches. Contributing factors to the high degree of match likely include:

- these measures are very easily viewed, and are simple measures to identify, so residents can report the results with good accuracy,
- the measures have not been in place for long, and the majority of the residents are likely the initial occupants, increasing their knowledge of whether the equipment is still in place, and
- not many failures in such long-lived equipment will be expected after only 4-5 years.

Switching to only phone surveys also helped address one other issue. During the recruitment, some customers were a little confused about why they were being asked about the measures via phone, but we still wanted to schedule an on-site. They may have been wondering if their answers were not trusted, or wondering why the money was going to be spent conducting an on-site inspection. During the pre-test, when this issue arose, customers were told about the project's objectives, including the comparison of phone vs. on-site approaches, which addressed the issue for the customers.

C. Phone Survey Results and Confirmation of Removals

In December, 1998 and January 1999, over 400 surveys were completed by phone by First Northwest Group of Bellevue, Washington. These surveys asked in detail about the status of measures indicated as installed, and about basic household characteristics. These results were combined with the data collected during the pre-test and are summarized in tabulations included in the Appendices. A SAS® database of these results was also created.

After the large-scale phone surveys were completed, we determined that a total of 21 possible measures of interest were changed. Each household with a possible change was called and interviewed in some detail to determine whether the change was a removal or replacement. This survey determined that three homes had ducts replaced, and three had gas cooktops removed. In both cases, this represents fewer than ¾ of one percent failures for the measures over a four year period (roughly 0.006 share of failures for two measures, and 0 failures for the other measures). If, using the ex ante lifetimes of 18-25 years, we assumed the same number of failures occurred

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each year over the measure's life, we would translate this to a 2% to 2.7% per year (assuming 25 year lifetimes would mean half had failed by year 25, so it would take 50 years for all to fail, or a 2% failure rate). Using our 0.006 figure for 4 years of failures (.00015), we would expect it to take over 600 years for the last measure to fail, or EULs over 1,000 years. Clearly the failures are not constant every year, and we have gathered data too soon to revise the *ex ante* estimates of EULs.

The disposition of the analysis sample frame, along with the results of the analyses, is summarized below in Table 7. PY represents the program year; the codes 9411 represents program year 1994, climate zone 11. The computed failure rates from the survey are also shown in the Table. All failures were found in Climate Zone 12, the zone with by far the largest number of participating homes. Two ducts failures were from PY 1994; and one cooktop failure was from PY 1994. The remainder of the failures were from PY1995.

Table 7: Combined Phone and On-site Survey Results on Measures and Failures (Program Year, Climate Zone)

	Total	***PY94***	***PY95***	***94-11***	***94-12***	***94-13***	***95-11***	***95-12***	***95-13***
Measures Surveyed									
A/C	277	112	165	14	86	12	14	114	37
Dryer Stubs	495	241	254	62	167	12	53	164	37
Ducts	496	235	261	62	168	5	55	174	32
Cooktops	472	235	237	62	162	11	53	166	12
Total Surveys	511	242	269	62	168	12	55	177	37
Number of Failures Found in Sample									
A/C	0	0	0	0	0	0	0	0	0
Dryer Stubs	0	0	0	0	0	0	0	0	0
Ducts	3	2	1	0	2	0	0	1	0
Cooktops	3	1	2	0	1	0	0	2	0
Proportion of Failures (0 for A/C and Dryer Stubs)									
Ducts									
Cooktops	.0064	.0084	.0038	0	0.12	0	0	.006	0
	.0061	.0043	.0084	0	.006	0	0	.012	0

D. Confidence Intervals

Table 8 summarizes failure rates, *ex ante* EULs, and, based on the failures found in the survey, the 80% confidence intervals for failure rates are also provided.

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Table 8: Failure Rates

Measure Type	*Ex Ante Estimate*	*Failures*	*80% Confidence Interval for Failure Rates*
Air Conditioners	18 years	0 of 280 / 0%	n.a.
Gas Dryer Stubs	18 years	0 of 495 / 0%	n.a.
High Efficiency Ducts	25 years	3 of 499 / 0.64%	0.23% - 1.4%
Gas Cooktops	20 years	3 of 475 / 0.61%	0.22% - 1.4%

Too few failures have been found for reasonable estimates of new EULs to be derived. The study recommends retaining the *ex ante* EULs for these measures.

E. Creation of Databases

A number of databases were created, some in EXCEL (for example, those provided to the phone survey firm) and others in SAS. These databases and programs are listed in the Appendix.

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VI. RECOMMENDATIONS

The surveys showed between zero and three failures for the measures under study, even with more than 500 surveys completed, and between 239 and 434 observations per measure type in the survey. The measures under study have long lifetimes, and are fairly obvious measures for homeowners to "self-report". A strong correlation was found between phone and on-site surveys, indicating on-sites may not be needed to support the research objectives.

The main recommendation from the study is to use the 511 completed contacts as a panel survey, and to re-survey by telephone every 2-3 years. Replacements can be pulled from the same city/supercity groups.

Using phone approaches from the panel allows more accurate information on removal dates because customers will not have to remember as long about when equipment was removed, and accurate removal dates are important to estimating survival functions. It also provides a better chance of narrowing removal dates when homeowners may have changed. This approach provides better data with which to estimate survival functions and estimate appropriate EULs for the measures of interest.

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VII. REFERENCES

The following references were sources of information, techniques, and guidelines for this evaluation:

California Public Utilities Commission, *Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management Programs*, March 1998.

Cochran, William G. *Sampling Techniques*. New York: John Wiley & Sons, 1977.

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APPENDIX A

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Telephone Survey and Recruitment Screener

PG&E Comfort Home Measure Retention Study

Study ID Code	
PG&E Facility ID	
Contact Date / Time:	
Attempt #1 (date / time):	
Attempt #2 (date / time):	
Attempt #3 (date / time):	

1. INTRODUCTION

Hello, my name is _____ and I'm calling on behalf of Pacific Gas & Electric Company (PG&E). Our records indicate that the home at this address was built under PG&E's energy efficient "Comfort Home Program." Under this program, the builder of the house made several energy efficiency improvements, including potentially the installation of high efficiency air conditioning and ducting, gas kitchen appliances, and a gas dryer outlet stub.

1.1 Our company, SERA, is conducting a survey for PG&E to see if any of this original equipment has failed, been replaced, or removed. Are you familiar with these systems, or is there someone else home that I can speak with?

1. Yes, I am the right person (continue…)

   Name: _____

2. No, I am not the right person, but I will get the right person for you

   Name: _____

   (repeat introduction when speaking with correct person)

3. No, I am not the right person, and the right person is not available

   Name: _____

   Suggested call-back time: _____

3 You have made a mistake, this is not a Comfort Home
(Confirm, then terminate)

3 Not Interested
(Try again, then terminate)

II. SCHEDULE SITE VISIT

2.1 We are interested in inspecting these energy efficiency measures to confirm their condition and the accuracy of our installation records. The visit will be very brief, lasting approximately 10 minutes. Our inspector is going to be in your neighborhood over the next week…is there a good time that our inspector could stop by your house?

If YES, record data and time:

1. Yes: Date: _____ Time: _____

Continue with III. Measure and Occupant Questions, below

If NO, record reason:

2. We are not interested in participating in Study

3. No one will be home / available to meet with the inspector

4. Other _____

Continue with III. Measure and Occupant Questions, below

III. MEASURE AND OCCUPANT QUESTIONS

3.1 While we are talking with you, I have a few more questions I'd like to ask in preparation for our visit. May I have 3-5 minutes of your time?

0. No

Try again, then Thank and terminate

1. Yes

Continue…

3.2 Our records indicate that the following systems were installed at your home (**read list from database screen and fill in form, below).** Can you please tell me if the following items are still in place, and whether or not they are the original systems:

	Installed Measure Code	Status Codes 1=yes, original installation 2=yes, replacement installation 3=No, measure removed	Date replaced or removed (mm/yr)	Removal Reason Code (see below)
1				
2				
3				
4				
5				
6				
7				

Removal Reason Codes

1. To the best of occupant's knowledge, the equipment was never installed.
2. Equipment failed and was replaced with similar equipment.
2. Equipment failed and was replaced with a different type of equipment.
3. Equipment has failed and has not been replaced
4. The house was remodeled and the measure was removed
5. The house suffered flood damage
6. The house suffered fire damage

3.2 If database records indicate that a gas dryer stub should have been present, but customer indicates that it was never present, ask:

Are you sure there was not a gas dryer stub present when the house was originally built?

0. No, a stub was not present
1. Yes, sure that stub was not present
2. Unsure

Do you by chance know the name and tel. # for the builder of your home?

Name / tel. _____/_____

3.3 If database records indicate that a gas cook-top or range should have been present, but customer indicates that it was never present, ask:

Are you sure there was not a gas cook-top or range present when the house was originally built?

0. No, a stub was not present
1. Yes, sure that stub was not present
2. Unsure

Do you by chance know the name and tel. # for the builder of your home?

Name / tel. _____/_____

3.4 What year was this home built?

_____ Year

3.5 How long have you lived at this address?

_____ Years

3.6 Do you own or rent this property

0. Rent
1. Own

3.7 IF OWN: Are you the original owner

0. No
1. Yes

3.8 If renting, who pays the electric bill?

0. Not applicable
1. Tenant
2. Landlord

3.9 Are you aware that this home participated in PG&E's Comfort Home Program?

0. No

1. Yes
2. Not sure

3.10 How many full-time occupants live here, (not including military personnel or full-time students living away from home)?

___ occupants

3.11 How many household members are in each of the following age ranges:

___ Under 6 years old
___ From 6 through 22
___ From 23 through 29
___ From 30 through 39
___ From 40 through 49
___ From 50 through 65
___ Over 65 years old

3.12 What is the approximate income level for this household?

0. does not know / refused
1. Less than $10,000
2. $10,000 - 19,999
3. 20,000 - 29,000
4. 30,000 - 39,000
5. 40,000 - 50,000
6. 50,000 - 60,000
7. greater than 60,000

Thank you very much for your cooperation on this survey

FOR CUSTOMERS AGREEING TO AN ON-SITE SURVEY…

[NOT DURING PRETEST: The inspector who comes to your home will have a photo identification badge.]

To confirm your scheduled visit, I have you down for:_____

In case you need to re-schedule this meeting, please call me **collect** at 206/624-8508 (**give name again and be sure that the customer has written down this number**).

Also, in case you are interested in verifying the legitimacy of this study, I can give you the name and telephone number of a contact at PG&E (give Valerie's name and number if they are interested).

On-site Measure Survey

PG&E Comfort Home
Measure Retention Study

SURVEY INFORMATION

1	Survey ID Code:	
2	PG&E Facility ID:	
3	Date of inspection:	
4	Inspector Name:	

OCCUPANT INFORMATION

1	Occupant Name:	
2	Street Address:	
3	Unit Number	
4	City:	
5	State:	
6	Zip:	
7	Tel.	

INSTRUCTIONS:

STEP 1: Explain purposes of the survey and complete the occupant information;

STEP 2: Review measures recorded as originally installed;

STEP 3: Conduct walk-through inspection;

STEP 4: THANK CUSTOMER, and note any questions they may have.

On-Site Measure Survey

PG&E Comfort Home Measure Retention Study (rev 10-13-98)

	Installed Measure Code	Description	Status Codes 1=yes, original installation 2=yes, replacement installation 3=No, measure removed	Date replaced or removed (mm/yr)	Removal Reason Code (see below)	General Condition 1=Excellent 2=Good 3=Fair 4=Poor
1						
2						
3						
4						
5						
6						

Move-in Date: _____

AC Make: _____ AC Model No. _____

Notes: _____

Removal Reason Codes

1. To the best of occupant's knowledge, the equipment was never installed.
2. Equipment failed and was replaced with similar equipment.
3. Equipment failed and was replaced with a different type of equipment.
4. Equipment has failed and has not been replaced
5. The house was remodeled and the measure was removed
6. The house suffered flood damage

7. The house suffered fire damage

APPENDIX B

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P G & E C O M F O R T H O M E

SCREEN1: Hello, this is _____ calling from First Northwest Group, a national research firm.

SCREEN2: I am calling today on behalf PG&E. Our records indicate that the home at this address was built under PG&E's energy efficient "Comfort Home Program."

[IF NEEDED:]"Under this program, the builder of the house made several efficiency improvements, including potentially, the installation of high efficiency air conditioning and ducting, gas kitchen appliances, or a gas dryer outlet stub."

SCREEN3: Our company is conducting a very brief, 3-5 minute, survey for PG&E to see if any of these efficiency improvements such as high efficiency air conditioning, gas appliances, etc. have failed, been replaced, or removed. Are you familiar with these systems?

[RE-INTRODUCE/SCHEDULE CALL-BACK AS NEEDED.]

1. KNOWLEDGEABLE PERSON SPEAKING
2. NOT A "COMFORT HOME" >>> Politely Terminate
3. DON'T KNOW/REFUSED >>> Politely Terminate

VERIFY: Just to confirm, your address is . . . [READ ADDRESS.]

1. YES
2. NO >>> Politely Terminate
3. DON’T KNOW/REFUSED >>> Politely Terminate

NAMERAW: May I please have your name so that my supervisor can verify this interview if needed?

[RECORD FIRST AND LAST NAMES IF OFFERED.]

Q3: We are interested in asking a number of questions about these energy efficiency measures to confirm their condition and the accuracy of our installation records. The interview will be very brief, lasting approximately 5 minutes.

Q3aINTRO: Our records indicate that the following systems were installed at your home - can you please tell me if each is still in place and whether or not it is the original system?

Q: Q3a1a: Thinking of the [READ FIRST ITEM]. Is the original equipment still installed in your home or has it been replaced?

1. ORIGINAL INSTALLATION >>> Skip to next measure
2. EQUIPMENT WAS REPLACED >>> Ask “B” and “C”
3. EQUIPMENT WAS REMOVED >>> Ask “B” and “C”
4. EQUIPMENT WAS NEVER INSTALLED >>> Code “1” on “C”
5. DON'T KNOW/REFUSED >>> Skip to next measure

Q3a1b & Q3a1b2 (MONTH & YEAR)

When was the original equipment replaced or removed?

[IF NEEDED:] 'Just the approximate month and year.’

[9999 = DON'T KNOW/REFUSED]

Q3a1c: Which of the following best describes why the energy efficiency measure was removed or replaced . . .

1. To the best of your knowledge, the equipment was never installed.
2. Equipment failed and was replaced with similar equipment.
3. Equipment failed and was replaced with equipment of lower efficiency.
4. Equipment failed and was replaced with equipment of higher efficiency.
5. Equipment failed/replaced with different equipment of unknown efficiency.
6. Eqipment has failed and has not been replaced.
7. The house was remodeled and the energy efficiency measure removed.
8. The house suffered flood damage.
9. The house suffered fire damage.
10. DON'T KNOW/REFUSED

[REPEAT ABOVE SERIES FOR EACH MEASURE.]

Q3a2a, Q3a2b, Q3a2b2, Q3a2c	=	2ND MEASURE
Q3a3a, Q3a3b, Q3a3b2, Q3a3c	=	3RD MEASURE
Q3a4a, Q3a4b, Q3a4b2, Q3a4c	=	4TH MEASURE
Q3a5a, Q3a5b, Q3a5b2, Q3a5c	=	5TH MEASURE
Q3a6a, Q3a6b, Q3a6b2, Q3a6c	=	6TH MEASURE
Q3a7a, Q3a7b, Q3a7b2, Q3a7c	=	7TH MEASURE
Q3a8a, Q3a8b, Q3a8b2, Q3a8c	=	8TH MEASURE
Q3a9a, Q3a9b, Q3a9b2, Q3a9c	=	9TH MEASURE
Q3a10a, Q3a10b & Q3a10b2, Q3a10c	=	10TH MEASURE

Q3b1: [IF GAS DRYER STUB WAS INDICATED IN SAMPLE BUT DENIED BY RESPONDENT.] Are you sure there was not a gas dryer stub present when the house was originally built?

1. YES, SURE THAT A STUB WAS NOT PRESENT
2. UNSURE
3. REFUSED

Q3b2: Did you do any remodeling that might have affected the system or have been in this area of the home?

1. YES
2. NO >>> Skip to Q3c1
3. UNSURE >>> Skip to Q3c1
4. REFUSED >>> Skip to Q3c1

Q3b3: Do you by chance know the name and telephone number for the builder or remodeler of your home?

1. YES (SPECIFY:)
2. NO
3. DON'T KNOW/REFUSED

Q3c1: [IF GAS COOK TOP OR RANGE WAS INDICATED IN SAMPLE BUT DENIED BY RESPONDENT.]
Are you sure there was not a gas cook top or range present when the house was originally built?

1. YES, SURE THAT GAS RANGE WAS NOT PRESENT
2. UNSURE
3. REFUSED

Q3c2: Did you do any remodeling that might have affected the system or have been in this area of the home?

1. YES
2. NO >>> Skip to Q3d
3. UNSURE >>> Skip to Q3d
4. REFUSED >>> Skip to Q3d

Q3c3: Do you by chance know the name and telephone number for the builder or remodeler of your home?

1. YES (SPECIFY:)
2. NO
3. DON'T KNOW/REFUSED

Q3d: The following demographic information will be used for statistical information only and will be kept strictly confidential. What year was this home built?

[9999 = DON'T KNOW/REFUSED]

Q3e: Do you own or rent this property?

1. OWN
2. RENT >>> Skip to Q3g
3. DON'T KNOW/REFUSED >>> Skip to Q3g

Q3f: Are you the original owner?

1. YES >>> Skip to q3h
2. NO >>> Skip to q3h
3. DON’T KNOW/REFUSED >>> Skip to q3h

Q3g: Who pays the electric bill?

1. Tenant
2. Landlord
3. DON'T KNOW/REFUSED

Q3h: Were you aware that this home participated in PG&E's Comfort Home Program?

1. YES
2. NO
3. DON’T KNOW/REFUSED

Q3i: How many full time occupants live here - not including military personnel or full-time students living away from home?

[99 = DON'T KNOW/REFUSED]

Q3j1: How many household members are in each of the following age ranges . . .Under 6 Years Old

[98 = DON'T KNOW / 99 = REFUSED]

Q3j2 6 to 17
Q3j3 18 to 29
Q3j4 30 to 39
Q3j5 40 to 49
Q3j6 50 to 65
Q3j7 Over 65

Q3K1: And finally, what is the total family income for all members of the household, age 18 and over . . .

Is that above or below $40,000 a year?

1. ABOVE	>>> Skip to Q3k1b
2. BELOW	
3. DON'T KNOW/REFUSED	>>> Skip to INTID

Q3k1a: Is that . . .

1 Under $10,000	>>> Skip to INTID
2 $10,000 to just under $15,000	>>> Skip to INTID
3 $15,000 to just under $20,000	>>> Skip to INTID
4 $20,000 to just under $25,000	>>> Skip to INTID
5 $25,000 to just under $30,000	>>> Skip to INTID
6 $30,000 to just under $40,000	>>> Skip to INTID
7 REFUSED/DON'T KNOW	>>> Skip to INTID

Q3k1b: Is that . . .

1 $150,000 and over
2 $100,000 to just under $150,000
3 $75,000 to just under $100,000
4 $50,000 to just under $75,000
5 $40,000 to just under $50,000
6 REFUSED/DON'T KNOW

[SET VARIABLE "INCOME"]

1 < $10,000
2 $10 - 15,000
3 $15 - 20,000
4 $20 - 25,000
5 $25 - 30,000
6 $30 - 40,000
7 $40 - 50,000
8 $50 - 75,000
9 $75 - 100,000
10 $100 - 150,000
11 > $150,000
12 REFUSED <40
13 REFUSED >40
14 COMPLETE REFUSAL

INTID: This concludes our survey, thank you so much for your cooperation.
In case you are interested in verifying the legitimacy of this study you may call the PG&E Energy Smartline at 1-800-933-9555.

APPENDIX C

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The survey results provided on the disk for this project were in SAS and could not be opened and printed out to create the PDF.

APPENDIX D

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PROTOCOL TABLES 6B AND 7B

FOURTH YEAR RETENTION STUDY FOR THE 1994 RESIDENTIAL NEW CONSTRUCTION PROGRAM

PG&E STUDY 322R1

This appendix presents Tables 6B and 7B for the 1994 Residential New Construction (RNC) study as required under the "Protocols and Procedures for the Verification of Cost, Benefits, and Shareholder Earnings from Demand Side Management Programs" (the Protocols), as adopted by the California Public Utilities Commission (CPUC) 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.

Table 6B Notes

There were insufficient numbers of failures or removals observed in the retention study data to support analysis to revise the EULs for the four measures. For two measures (gas dryer stubs and air conditioners) no failures were found; for gas cooktops and high efficiency ducts, three failures each were found, representing failure rates of less than ¾ of one percent over the four years the measures have been installed.

SERA

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Protocol Table 6.B
Results of Retention Study
PG&E 1994 Residential New Construction "Comfort Home" Program
Study ID 322R1

Item 1			Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
Code	Measure Description	End Use	Ex Ante EUL	Source of Ex Ante EUL	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 Realization Rate (ex post/ex ante)	"Like Measuers Assocated with Studied Measure (by measure code)
	High Efficiency Air Conditioners exceeding Title 24 SEER by 1.5	HVAC	18 years	Advice Filing and MDSS	-	18 years	-	-	-	-	1.0	
	High efficiency duct standards	HVAC	25 years	Advice Filing and MDSS	-	25 years	-	-	-	-	1.0	
	Natural gas cooking appliances / cooktops	Cook	20 years	Advice Filing and MDSS	-	20 years	-	-	-	-	1.0	
	Gas stubs in laundry rooms		18 years	Advice Filing and MDSS	-	18 years	-	-	-	-	1.0	

PROTOCOL TABLE 7B

FOURTH YEAR RETENTION STUDY FOR THE 1994 RESIDENTIAL NEW CONSTRUCTION PROGRAM

PG&E STUDY 322R1

This appendix provides documentation for data quality and processing as required in Table 7B of the CPUC Evaluation and Measurement Protocols. The major headings follow the organization of Table 7B; but for items discussed in detail elsewhere in this report, only an abbreviated summary is included in this Appendix.

1. OVERVIEW INFORMATION

A. Study Title and Study ID Number

Study Title: Fourth Year Retention Study of PG&E's 1994 Residential New Construction Program

Study Number : 322R1

B. Programs, Program Year, and Program Description

Program: Comfort Home Residential New Construction Program

Program Year: Rebates were paid in Program Years 1994 and 1995.

Program Description: PG&E's Residential New Construction Program, the "Comfort Home" program, offered financial incentives to builders and developers who installed qualified measures in new homes.

C. End Uses and/or Measures Covered

End Uses Covered: HVAC, cooking, and dryer measures were the focus of the retention study. Other measures were installed under the program, but did not represent 50% or the top 10 measures. Table 2 lists all measures installed under the program.

Measures Covered: Measures are listed in Table 2 of this retention study report.

D. Methods and Models Used

Our overall approach consisted of:

- Estimate the fraction of measures still in place and operable: We used survey techniques to gather data on the status of installed measure. Reports of failures were confirmed and the fraction of cumulative failures to date were determined.

- Estimate the "survival curve" and develop EUL estimates: Using the information on failures and dates, SAS® procedures could be used to used to determine the best fitting estimated survival function. This curve could then be used to estimate the EUL.

However, insufficient failures were found to support modeling of survival functions. Two measures had no failures during the 4 year period of installation; two measures had only three failures each.

E. Analysis Sample Size

Data were collected from 511 households whose homes received rebates under the program. Table 7 shows the sample disposition.

2. DATABASE MANAGEMENT

A. Key Data Elements and Sources

The original PG&E Comfort Home program records from PY94 and PY95 were used in developing the population. These records were merged with updated customer records from the PG&E billing system to obtain names and phone numbers for the sample. The follow up survey database was the only other data source used for this analysis.

B. Data Attrition Process

All data points that had follow-up survey data were used in the analysis.

C. Internal Data Quality Procedures

The Evaluation Contractor on this project, Skumatz Economic Research Associates, Inc., (SERA) performed extensive data quality control on the retention and follow-up survey data. Throughout the project, data quality assurance procedures were in place to assure that data used was of the highest quality. On questionable responses, and for all reports of measure changes, follow-up phone calls were made to confirm or clarify survey responses and to confirm failures.

D. Unused Data Elements

All data points collected for the Retention Study were used in the analysis.

3. SAMPLING

A. Sampling Procedures and Protocols

Sampling procedures were described in Section IV, A-E. The protocol procedures were described in Section IV.F. The phone survey firm used a CADI system, and made 5 callbacks at varying times of day before a replacement survey point was introduced. The survey instruments (on-site and phone) are included in Appendix A and Appendix B.

B. Survey Information

The data collection instruments are provided in Appendices A and B. The final disposition of the survey is presented in Tables 6 and 7, and tabular results of the survey data are provided in Appendix C. The complete database is included in electronic format on the associated disk.

C. Statistical Descriptions

Participant responses are presented in Appendix C. Reports of the failures found are shown in Table 7, and Section ID summarizes the reasons for failures.

4. DATA SCREENING AND ANALYSIS

A. Procedures for Treating Outliers and Missing Data

All data points that had follow-up survey data were utilized in the analysis. However, insufficient failures were found to support detailed statistical analysis of EULs.

B. Background Variables

No background data were needed for this analysis.

C. Data Screen Process

All data points with survey data were used in the analysis.

D. Regression Statistics

There were insufficient failures to support regression analysis.

E. Model Specification

There were insufficient failures to support estimation of models to revise EUL estimates.

F. Measurement Errors

Three sources were used for data: program records, customer records (for name and phone), and the survey data. The key data needed to support the analysis were clear from the beginning of the work – reports of failure from the survey – and exceptional care was made to confirm all reports of failures/removals and the related circumstances.

Measurement errors might occur from bias introduced by the wording of questions in the survey or from mis-coded study variables. Strategies to minimize these sources of error included: training and inspection of entered data, pretest of survey instruments, cross-validation between phone and on-site data responses for a test group, and confirmation of reports of failures.

Keypunch error, a random source of error, has no impact on estimating mean values because the errors are typically unbiased. All failures were confirmed and keypunch error has no effect on these estimates.

G. Influential Data Points

No diagnostics were used to identify outliers.

H. Missing Data

No statistical work was completed for which missing data procedures might be required. There were no other missing data points.

I. Precision

There were insufficient failures to support estimation of models to revise EUL estimates.