Customer Energy Efficiency Program
Measurement and Evaluation Program

RETENTION STUDY OF PACIFIC GAS & ELECTRIC COMPANY'S 1994 AND 1995 ENERGY EFFICIENCY INCENTIVES PROGRAM, AGRICULTURAL SECTOR MEASURES:

STUDY IDS: 315R1, 321R1, 329R1, & 331R1

March 1, 1999

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Energy Analysis

Project Management

Training

Final Report for

Retention Study of Pacific Gas & Electric's 1994 and 1995 Energy Efficiency Incentives Programs, Agricultural Sector Measures

Submitted by:

Equipoise Consulting Incorporated

in association with

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Ridge & Associates

February 25, 1999

TABLE OF CONTENTS

TABLE OF EXHIBITS

1 OVERVIEW

Energy-efficiency measures installed by Demand-Side Management (DSM) programs all have a predicted time period as to when the measures are expected to provide energy savings. This period of time, called the engineering useful life in the Protocols[1], is the engineering estimate of the number of years that a piece of equipment will operate if maintained properly. However, equipment is removed from operation for a myriad of reasons. When the engineering useful life is adjusted for early removal, the effective useful life (EUL) is determined. The Protocol definition of EUL is "An estimate of the median number of years that the measures installed under the program are still in place and operable." The EUL is, then, the median period of time it takes to go from 100% to 50% of the measures installed. According to the Protocols, a measure retention study assesses two items: (1) the length of time the measure(s) installed during the program year are "in place and operable" (the EUL), and (2) the extent to which there has been a significant reduction in the impact of the measure relative to an equivalent standard-efficiency piece of equipment (technical degradation factor, TDF).

This report of the 1994 and 1995 Agricultural Programs Retention Study covers only the EUL portion of the measure retention study. The TDFs have been determined under other studies.

Within the planned persistence study, there were specific measures from each year for which EULs were, if possible, to be updated. These planned measures are shown in Exhibit 1.1.

Exhibit 1.1
Planned Measures for Persistence Study

PG&E Program Year	PG&E Measure Code	Measure Description	# of Paid Units	Life Cycle Avoided Cost	Project Life	% of Total Avoided Cost
1994	A1	Pump Retrofit	850	11,339,641	9	28%
1994	A10	Greenhouse: Heat Curtain	2,275,350	3,581,667	5	9%
1994	L81	HID Fixture: Interior, 251-400 Watts Lamp	3,619	5,763,910	16	14%
Total % of Avoided Cost for 1994 Program Year						51%
1995	609	Ag Pumps Other	12	6,193,632	20	34%
1995	A1	Pump Retrofit (Repair)	295	3,224,333	9	18%
1995	L81	HID Fixture: Interior, 251-400 Watts Lamp	2,136	3,269,522	16	18%
Total % of Avoided Cost for 1995 Program Year						70%

There were three non-studied, or "like", measures associated with one of these studied measures. These measures are shown in Exhibit 1.2.

[1] Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings for Demand-Side Management Programs, Revised January 1997.

Exhibit 1.2
Non-studied Measures Associated to Studied Measures

Studied Measures		Non-Studied Measures		Rationale
PG&E Measure Code	Measure Description	PG&E Measure Code	Measure Description	Reason Measures are Comparable
L81	HID Fixture: Interior, 251-400 Watts Lamp	L26	HID Fixture: Interior, 101-175 Watts Lamp	All HID interior applications are similar. The participant to participant (or application) variation is accounted for in the range of applications studied in the retention study.
		L27	HID Fixture: Interior, 176-250 Watts Lamp	
		L37	HID Fixture: Interior, >=176 Watts Lamp	

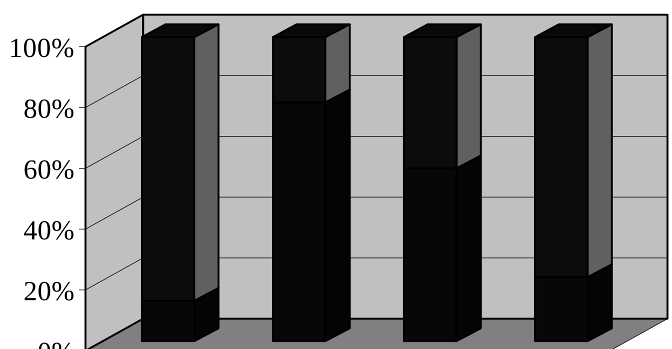
The data collection process, analysis methodology, and analysis results for the 1994 and 1995 Agricultural Program measures are presented next.

2 DATA COLLECTION

The 1994 and 1995 Agricultural Programs Impact Studies created retention databases specific to each year. These databases, assembled in the fall of 1995 and 1996, respectively, collected information on measures so that they could be found later and the extent to which they were operable could be assessed. As required by the Protocols, the retention database measures were selected to represent “the top ten measures, excluding measures that have been identified as miscellaneous (per Table C-9), ranked by net resource value or the number of measures that constitutes the first 50% of the estimated resource value, whichever number of measures is less.” The 1994 retention database covered three measures: pump repairs, low-pressure sprinkler nozzles, and greenhouses. The greenhouse measure included heat curtains, rigid double-walled, and double-walled polyethylene. The 1995 retention database also included pump repairs, but not low-pressure sprinkler nozzle sites or greenhouses. There were two other measures in the 1995 retention database; other pumping (custom sites which included pumping) and high-intensity discharge (HID) fixtures.

As Exhibit 2.1 indicates, there were 993 total measures in the 1994 program for the three measures. Information for 208 measures (21% of the total) was gathered for the 1994 retention database.

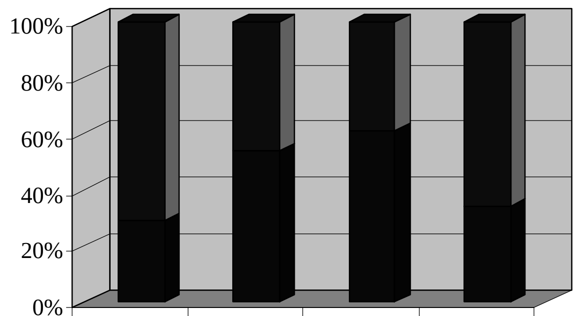
Exhibit 2.1
1994 Retention Panel and Program Population



	Pump Repair	Low-Pressure	Greenhouse	Total
Portion of 1994 Population Not Audited	738	15	32	785
1994 Retention Database	112	54	42	208

Similarly, Exhibit 2.2 shows that there were 365 total measures in the 1995 program for the three measures. Information for 125 measures (34%) was gathered for the 1995 retention database.

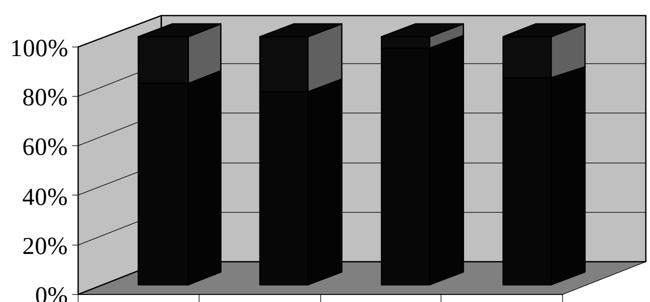
Exhibit 2.2
1995 Retention Panel and Program Population



	Pump Repair	HID	Custom	Total
Portion of 1995 Population Not Audited	209	24	7	240
1995 Retention Database	86	28	11	125

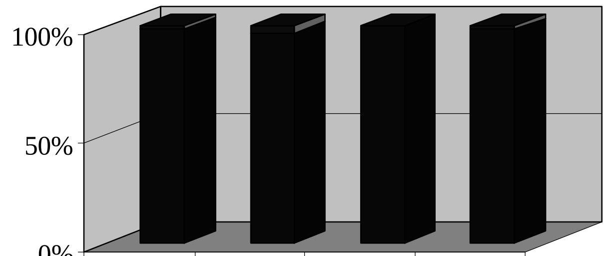
The same firm that gathered data for both the 1994 and 1995 retention panels also collected the information for the retention evaluation. The data was collected in the Fall of 1997 for the 1994 retention database and the Fall of 1998 for the 1995 retention database. A census of those included in the retention panels was conducted. As shown in Exhibit 2.3 and Exhibit 2.4, 173 of the 208 sites (83%) were audited during the 1994 program evaluation, and 123 of the 125 sites (98%) were audited during the 1995 program evaluation.

Exhibit 2.3
1994 Retention Panel Evaluation Audits



	Pump Repair	Low-Pressure	Greenhouse	Total
Portion of 1994 Retention Database Not Audited	21	12	2	35
1996 Program Year Evaluation Audits	91	42	40	173

Exhibit 2.4
1995 Retention Panel Evaluation Audits



	Pump Repair	HID	Custom	Total
Portion of 1995 Retention Database Not Audited	1	1	0	2
1997 Program Year Evaluation Audits	85	27	11	123

Once contacted by telephone or in person, the customer was asked a series of questions to determine if the measure was still in place and operable. If the measure was no longer in place or was not operable, the customers were asked why not and when the measure had been removed from service. Additionally, the customers were asked if the measure had been used during 1997 or 1998, and if not, why not. Also, for greenhouse, low-pressure sprinkler nozzle, and HID measures, the percentage of equipment still in place and operable was determined.

3 METHODOLOGY

3.1 Sample Treatment

There were differences in the 1994/95 retention panels and how the data were used in the analysis. This section outlines, by measure, the data collected and how it was used in the analysis.

3.1.1 1994 Retention Data

The 1994 retention panel covered three measures: pump repairs, low-pressure sprinkler nozzles, and greenhouses. The greenhouse measure included heat curtains, rigid double-walled, and double-walled polyethylene. Persistence data from the retention panel was collected in the fall of 1997. However, as described below, the actual retention analysis did not use all the data.

All data from the pump repair measure was used in the retention analysis. The low-pressure sprinkler nozzle measure, however, was not in the final determination of the top measures in the 1994 program to be analyzed. Therefore, while data was collected on the low-pressure sprinkler nozzle measure, there was no analysis on the measure.

Conversely, it was determined after the 1994 retention panel had been collected, that the HID measure (L81) was among the top measures for inclusion in the retention analysis. This also includes the “like” measures (L26, L27, L37). Since this data had not been collected during the original retention panel, it could not be revisited for the retention analysis. Because the 1995 program year retention panel included the L81 measure, the failure rates from the 1995 retention panel data were applied to the 1994 measure data.

The greenhouse measures collected in the 1994 retention panel included three distinct measures (as stated above). However, only the heat curtain measure was among the top measures to be included for retention analysis. Retention panel data was collected for all three measures (40 sites), but only the heat curtain measure (18 sites) was analyzed for retention.

3.1.2 1995 Retention Data

The 1995 retention database included pump repairs, Ag other pumping (custom sites which included pumping), and HID fixtures. As in the 1994 retention analysis, the HID fixtures (L81) includes the “like” measures (L26, L27, L37). All data from the retention panel collected during the revisits was used in the analysis.

3.2 EUL

Three basic approaches to estimating EULs were explored. The first approach used was standard ordinary least squares (OLS) (Maddala, 1992). This involved regressing the percentage of measures still in place and operable against time (i.e., months for which data are available). The possibility of applying a classic survival analysis to the data collected in this study was also explored as a second approach. This approach involves the analysis of data that correspond to time from a well-defined time origin until the occurrence of some particular event or end-point (Collett, 1994). The third approach is the *assumed functional* *form* (AFF) approach. The AFF assumes a functional form such as the logistic or exponential, involves conducting a survey at a given point in time after the installation, and uses the data in conjunction with the adopted functional form to estimate the EUL. This method has most recently been developed by Wright (1999) and is more fully described in Appendix B.

4 RESULTS

The results are presented in two ways. First, the data are tabulated to see how many measures continued to be in place and operable and what portion of these were used in 1997 and 1998. Second, if there are sites with measures removed, the EUL is determined (when possible) using the three analysis methods described in Section 3.

4.1 Survival of Measures

As shown in Exhibit 4.1, some pumps were operable, but not in use in 1997.

Exhibit 4.1
1994 Program Measures Present and in Use as of 1997

Measure		In Place and Operable	Used in 1997?
Pump Repair	No	4	12
	Yes	87	79
	%	95.6%	86.8%
Low-Pressure Sprinkler Nozzle*	No	1	1
	Yes	41	41
	%	98.8%	98.8%
Greenhouse	No	0	0
	Yes	40	40
	%	100%	100%

* See text for explanation of percentages

For this analysis, if the measure was still in place and operable, but not used in 1997, it was considered to be present. Therefore, for the 1994 retention panel pump repair measure, there were 87 pumps in place and operable. Of the 91 sites audited, 4 had been removed. While there was one low-pressure sprinkler site that indicated it had removed the sprinklers, the percentages presented represent the total number of nozzles found compared to the number initially installed at these sites. No greenhouse measure removals were found among the 40 audited. However, only the 18 sites with heat curtain installations were used in the retention study.

Exhibit 4.2 shows the measures found during the evaluation of the 1995 program. There is a discrepancy in the number of pump repairs between Exhibit 2.4 and Exhibit 4.2. Of the 85 audits, 84 were used in the analysis. One pump was dropped from the sample because it could not be found, the meter to which it should have been connected was off, and there was no customer to contact about this particular pump.

Exhibit 4.2
1995 Program Measures Present and in Use as of 1998

Measure		In Place and Operable	Used in 1998?
Pump Repair	No*	4	20
(One pump per site)	Yes	80	65
	%	94.1%	76.5%
Lighting	No	0	0
	Yes	27	27
	%	100%	100%
Custom	No	0	3
	Yes	11	8
	%	100%	73%

*One pump was unable to be located, meter was off, no customer to be contacted

4.2 Effective Useful Life of Measures

Where possible, an EUL was to be determined for the measures indicated in Exhibit 1.1. This exhibit indicates that 1994 HID measures required analysis. Since the 1994 retention panel did not include HID fixtures[2], the analysis used the failure rates seen in the 1995 retention panel HID measures. Since there were no failures observed in the 1995 data, the ex ante HID measure EUL was retained as the best estimate of effective useful life.

Similarly, the greenhouse heat curtain measure indicated no failures. The ex ante EUL is retained as the best estimate of effective useful life. While the low-pressure sprinkler nozzles showed a small number of removals, they were not within the top measures to be analyzed.

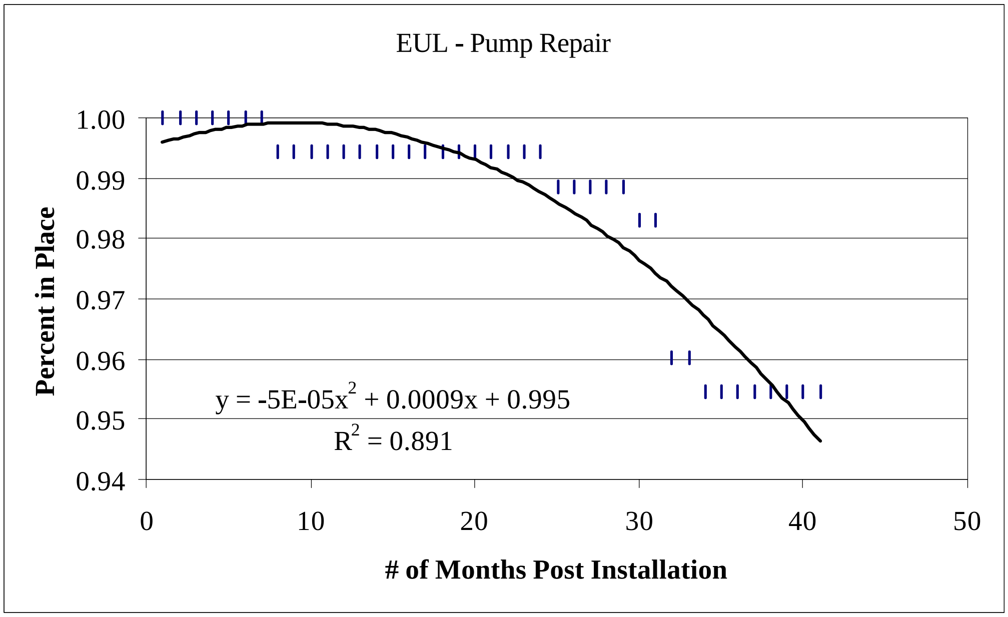
The pump repair measure was the only one to be analyzed that had failures. Data from the two program years were combined and the three different analysis methods were applied to the data gathered on this measure. The results of these analyses are described below.

4.2.1 Ordinary Least Squares

Exhibit 4.3 shows the data for the pump repair removals along with a polynomial trend line calculated in an EXCEL spreadsheet. The polynomial trend line was chosen because it provided the best R^2 value.

[2] Because they were not in the measures that comprised the top 50% of the avoided cost.

Exhibit 4.3
EUL for Pump Repairs



When the algorithm is applied to determine when the trend line would reach 50% of the measures remaining, the EUL determined is 110 months past the installation date, or 9.1 years. The ex ante EUL for this measure is 9 years.

4.2.2 Classic Survival Analysis

Calculations indicated that 113 failures were required for a classic survival analysis of any given measure (See Appendix B). However, for all measures, the required number of failures to estimate these survival models was not found.

4.2.3 Assumed Functional Form

The assumed functional form can only be used for those measures that experienced some decay. Thus, this approach could only be used for pump repairs. The estimated EUL is 34 years for the pump. However, this estimate is implausibly large.

4.3 Implications of Results for Classic Survival Analysis and the AFF Approach

The discovery of no or very few failures affects three key elements of the retention study: 1) the ex ante EUL, 2) the functional form of the survival curve, and 3) the timing of the retention study. Each will be discussed below.

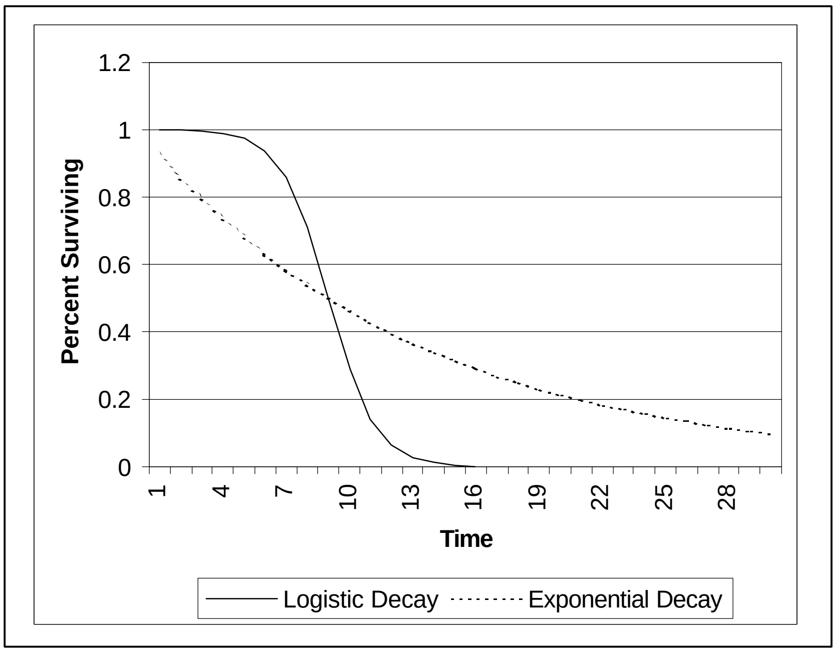
4.3.1 Acceptance of Ex Ante EUL for Pump Repairs

Because the OLS estimate of ex post EUL for pump repairs is not significantly different from the ex ante EUL, the ex ante EUL cannot be rejected. Even if the OLS results were significantly different, we have little confidence that this model has captured the true functional form. That the results are very close to the ex ante EUL are, we believe, serendipitous. For pump repairs, the AFF approach produced an implausibly large estimate. For the classic survival analysis, models could not be estimated due to insufficient failures. For all these reasons, the ex ante EUL should be adopted.

4.3.2 Functional Form of Survival Curve

That the observed data contained either no or very few measure failures is not consistent with the exponential survival function. These data appear to be more consistent with the logistic survival curve. For example, assuming that the ex ante EUL of 9 years for pump repairs was correct, and that the functional form of the decay was exponential, we would have to have found approximately 26% of the sample failed. Instead, only 4.5% were found to have failed. This is graphically illustrated in Exhibit 4.4,which compares the exponential and logistic functional forms.

Exhibit 4.4
Logistic versus Exponential Curves



4.3.3 The Timing of the Retention Study

It seems clear that for the agricultural measures studied, the third-year retention/survival studies were premature.

5 PROTOCOL TABLES

5.1 Protocol Table 6.B – 1994 Agricultural Sector

Refer to Appendix C for the method used to determine the confidence intervals shown in this table.

Protocol Table 6.B
Results of Retention Study
PG&E 1994 Agricultural Sector
Study ID 315R1 and 321R1

Item 1			Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
PG&E Measure Code	**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)**
A1	Pump Retrofit	Pumping and Related	9.0	2	9.1	9.0	0.078	9.0	9.2	0.800	1.0	-
L81	HID Fixture: Interior, Standard, 251-400 Watts Lamp	Ag Other	16.0	1	NA*	16.0	NA	NA	NA	NA	NA	L26, L27, L37
A10	Greenhouse Heat Curtain	Ag Other	5.0	2	NA*	5.0	NA	NA	NA	NA	NA	-

*No failures were found during the retention study - no EUL can be calculated

Ex Ante Source References:
1 PG&E Advice Filing 1867-G-A/1481-E-A January 1995
2 PG&E Advice Filing 1997-G/1608-E October 1, 1996

5.2 Protocol Table 6.B – 1995 Agricultural Sector

Refer to Appendix C for the method used to determine the confidence intervals shown in this table for the pump retrofit measure.

Protocol Table 6.B
Results of Retention Study
PG&E 1995 Agricultural Sector
Study ID 329R1 and 331R1

Item 1			Item 2		Item 3	Item 4	Item 5	Item 6		Item 7	Item 8	Item 9
PG&E Measure Code	**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)**
A1	Pump Retrofit	Pumping and Related	9.0	1	9.1	9.0	0.078	9.0	9.2	0.800	1.0	-
609	Ag Pumps Other	Pumping and Related	20.0	2	NA*	20.0	NA	NA	NA	NA	NA	-
L81	HID Fixture: Interior, Standard, 251-400 Watts Lamp	Indoor Lighting	16.0	3	NA*	16.0	NA	NA	NA	NA	NA	L26, L27, L37

*No failures were found during the retention study - no EUL can be calculated

Ex Ante Source References:
1 PG&E Advice Filing 1997-G/1608-E October 1, 1996
2 Calculated from MDSS Data
3 PG&E Advice Filing 1867-G-A/1481-E-A January 1995

5.3 Protocol Table 7 – 1994 Retention Study (Study # 315R1 and #321R1)

1994 Agricultural EEI Program
Retention Study
PG&E Study ID #315R1 and #321R1

The purpose of this section is to provide the documentation for data quality and processing as required in Table 7 of the California Public Utility Commission (CPUC) Evaluation and Measurement Protocols (the Protocols). Major topics are organized and presented in the same order as they are listed in Table 7 for ease of reference and review. When responses to the items are discussed in detail elsewhere in the report, only a brief summary will be given in this section to avoid redundancy.

5.3.1 Overview Information

5.3.1.1 Study Title and Study ID Number

Study Title: Evaluation of Retention in PG&E's 1994 Agricultural Energy Efficiency Incentives (AEEI) Program

Study ID Number: 315R1 and 321R1

5.3.1.2 Program, Program Year and Program Description

Program: PG&E Agricultural EEI Program, Agricultural Sector

Program Year: Rebates Received in the 1994 Calendar Year.

Program Description: The 1994 Agricultural Program rebated technologies covered by the Retrofit Express (RE) and Customized Incentives (CI) Programs.

5.3.1.3 End Uses and/or Measures Covered

End Uses Covered: Agricultural Pumping Technologies
Agricultural Other Technologies

Measures Covered: Pump Repair
Greenhouse Heat Curtain
HID Interior 251-400 W Lamps

5.3.1.4 Methods and Models Use

The PG&E AEEI Program retention study evaluated three methods: 1) ordinary least squares (OLS), 2) classic survival analysis, and 3) assumed functional form.

5.3.1.5 Analysis Sample Size

The analysis sample size is shown below in Exhibit 5.1.

Exhibit 5.1
Sample Summary – 1994 Agricultural Sector

Measure	1994 Population	1994 Retention Database	1996 Program Year Evaluation Audits
Pump Repair	850	112	91
Greenhouse	74	42	40
HID Interior 251-400 W Lamps	3,619	0	0
Total	4,543	154	131

5.3.2 Database Management

5.3.2.1 Specific Data Sources

On-site survey data were collected for a census of the 1994 retention panel. All data came directly from the retention panel except for the HID measures that were not included in the original 1994 retention panel. The failure rate from the 1995 retention panel HID data was applied to the HID measures from the 1994 MDSS database.

5.3.2.2 Data Attrition

All data elements mentioned above were first validated and then merged together to form the final analysis dataset. All data points collected during the on-site audits were kept.

5.3.2.3 Internal Data Quality Procedures

The data quality procedures are consistent with PG&E's internal guidelines and the guidelines established in the Protocols. The on-site audits were validated by an agricultural engineer prior to data entry.

5.3.2.4 Unused Data Elements

The low-pressure sprinkler nozzle measure was not analyzed. There were 22 greenhouse audited sites that were not used as well in the analysis. All other data collected specifically for the Evaluation were utilized.

5.3.3 Sampling

5.3.3.1 Sampling Procedures and Protocols

The limited participant population necessitated an attempted census of retention panel participants. The number of completed participant surveys as mentioned above in section 5.5.1.5, reflects such an attempted census.

5.3.3.2 Survey Information

On-site audit instruments are presented in Appendix E.

5.3.3.3 Statistical Descriptions

The final model used was an OLS model for the pumping end use with time as the independent variable and percent surviving as the dependent variable. The final model equation was:

$$y = -5E - 05x^2 + 0.0009x - 0.995$$

where:

y = percent surviving
x = months

The equation had an R^2 of 0.891.

5.3.4 Data Screening and Analysis

5.3.4.1 Outliers and Missing Data

When the failure date was unavailable (as was the case for 2 data points for the pumping end use), the date of removal was set as January of 1997. There were no outliers in the analysis.

5.3.4.2 Background Variables

There were no background variables modeled.

5.3.4.3 Data Screening Process

No data was screened from the retention analysis.

5.3.4.4 Model Statistics

For the OLS model, model statistics are shown in Exhibit 5.2

Exhibit 5.2
Model Statistics

End Use	Average Age (Months)	Standard Deviation	Variance	Percent Surviving
Pumping	40.30	3.97	15.92	95.6%
Ag Other	41	0	0	100%

5.3.4.5 Model Specification

Classical Survival Analysis - Calculations indicated that 113 failures were required for a classic survival analysis of any given measure (See Appendix B). However, for all measures, the required number of failures to estimate these survival models was not found.

Assumed Functional Form Analysis - The assumed functional form can only be used for those measures that experienced some decay. Thus, this approach could only be used for pump repairs. The estimated EUL is 34 years for the pump. However, this estimate is implausibly large.

OLS Analysis - Various functional forms were used to determine the best form (i.e., exponential, power, logarithmic). The chosen model had the highest R^2 and, therefore, the best predictive power.

5.3.4.6 Measurement Errors

The main source of measurement errors is the on-site survey. Our approach has been to proactively stop the problem before it happens so that statistical corrections are kept to a minimum.

Measurement errors are a combination of random and non-random error components that plague all survey data. The non-random error frequently takes the form of systematic bias, which includes, but is not limited to, ill-formed or misleading questions and miscoded study variables. In this project, we have implemented controls to reduce the systematic bias in the data. These steps include (1) thorough auditor training, and (2) instrument pre-test.

The random measurement error, such as data entry error, has no impact on estimating mean values because the errors are typically unbiased.

5.3.4.7 Influential Data Points

Since the analysis consisted of a simple regression of the percent surviving pumps by time, there were no influential data points in the OLS analysis. There were no outliers in the analysis.

5.3.4.8 Missing Data

When the failure date was unavailable (as was the case for 2 data points for the pumping end use), the date of removal was set as January of 1997. For the 1994 HID measures that were not included in the original 1994 retention panel, the failure rate from the 1995 retention panel HID data was applied to the HID measures from the 1994 MDSS database.

5.3.4.9 Precision

The precision was determined as specified in Appendix C.

5.4 Protocol Table 7 – 1995 Retention Study (Study # 329R1 and #331R1)

1995 Agricultural EEI Program
Retention Study
PG&E Study ID #329R1 and 331R1

The purpose of this section is to provide the documentation for data quality and processing as required in Table 7 of the California Public Utility Commission (CPUC) Evaluation and Measurement Protocols (the Protocols). Major topics are organized and presented in the same order as they are listed in Table 7 for ease of reference and review. When responses to the items are discussed in detail elsewhere in the report, only a brief summary will be given in this section to avoid redundancy.

5.4.1 Overview Information

5.4.1.1 Study Title and Study ID Number

Study Title: Evaluation of Retention in PG&E's 1995 Agricultural Energy Efficiency Incentives (AEEI) Program

Study ID Number: 329R1 and 331R1

5.4.1.2 Program, Program Year and Program Description

Program: PG&E Agricultural EEI Program, Agricultural Sector

Program Year: Rebates Received in the 1995 Calendar Year.

Program Description: The 1995 Agricultural Program rebated technologies covered by the Retrofit Express (RE), Retrofit Efficiency Options (REO), and Customized Incentives (CI) Programs.

5.4.1.3 End Uses and/or Measures Covered

End Uses Covered: Agricultural Pumping Technologies
Agricultural Indoor Lighting Technologies

Measures Covered: Pump Repair
Ag Pumps Other (Measure 609)
HID Interior 251-400 W Lamps

5.4.1.4 Methods and Models Use

The PG&E AEEI Program retention study evaluated three methods: 1) ordinary least squares (OLS), 2) classic survival analysis, and 3) assumed functional form.

5.4.1.5 Analysis Sample Size

The analysis sample size is shown below in Exhibit 5.1.

Exhibit 5.3
Sample Summary – 1995 Agricultural Sector

Measure	1995 Program Population	1995 Retention Database	1997 Program Year Evaluation Audits
Pump Repair	295	86	85
HID	52	28	27
Ag Pumps Other	18	11	11
Total	365	125	123

*Lighting Sample includes L26, L27, L79, L81

5.4.2 Database Management

5.4.2.1 Specific Data Sources

On-site survey data were collected for a census of the 1995 retention panel. All data came directly from the retention panel.

5.4.2.2 Data Attrition

All data elements mentioned above were first validated and then merged together to form the final analysis dataset. One data point (a pump repair measure) was dropped from the final analysis dataset because it could not be confirmed whether the pump continued to operate or was a failure.

5.4.2.3 Internal Data Quality Procedures

The data quality procedures are consistent with PG&E's internal guidelines and the guidelines established in the Protocols. The on-site audits were validated by an agricultural engineer prior to data entry.

5.4.2.4 Unused Data Elements

All data collected specifically for the Evaluation were utilized.

5.4.3 Sampling

5.4.3.1 Sampling Procedures and Protocols

The limited participant population necessitated an attempted census of retention panel participants. The number of completed participant surveys as mentioned above in section 5.5.1.5, reflects such an attempted census.

5.4.3.2 Survey Information

On-site audit instruments are presented in Appendix E.

5.4.3.3 Statistical Descriptions

The final model used for the pump repair measure only was an OLS model with time as the independent variable and percent surviving as the dependent variable. The final model equation was:

$$y = -5E - 05x^2 + 0.0009x - 0.995$$

where:

y = percent surviving
x = months

The equation had an R^2 of 0.891.

5.4.4 Data Screening and Analysis

5.4.4.1 Outliers and Missing Data

When the failure date was unavailable (as was the case for 2 data points for the pumping end use), the date of removal was set as January of 1998. There were no outliers in the analysis.

5.4.4.2 Background Variables

There were no background variables modeled.

5.4.4.3 Data Screening Process

No data was screened from the retention analysis.

5.4.4.4 Model Statistics

For the OLS model, model statistics are shown in Exhibit 5.2

Exhibit 5.4
Model Statistics

End Use	Average Age (Months)	Standard Deviation	Variance	Percent Surviving
Pumping – Pump Repair	40.30	3.97	15.92	95.6%
Pumping – Ag Pumps Other	41	0	0	100%
Interior Lighting	41	0	0	100%

5.4.4.5 Model Specification

Classical Survival Analysis - Calculations indicated that 113 failures were required for a classic survival analysis of any given measure (See Appendix B). However, for all measures, the required number of failures to estimate these survival models was not found.

Assumed Functional Form Analysis - The assumed functional form can only be used for those measures that experienced some decay. Thus, this approach could only be used for pump repairs. The estimated EUL is 34 years for the pump. However, this estimate is implausibly large.

OLS Analysis - Various functional forms were used to determine the best form (i.e., exponential, power, logarithmic). The chosen model had the highest R^2 and, therefore, the best predictive power.

5.4.4.6 Measurement Errors

The main source of measurement errors is the on-site survey. Our approach has been to proactively stop the problem before it happens so that statistical corrections are kept to a minimum.

Measurement errors are a combination of random and non-random error components that plague all survey data. The non-random error frequently takes the form of systematic bias, which includes, but is not limited to, ill-formed or misleading questions and miscoded study variables. In this project, we have implemented controls to reduce the systematic bias in the data. These steps include (1) thorough auditor training, and (2) instrument pre-test.

The random measurement error, such as data entry error, has no impact on estimating mean values because the errors are typically unbiased.

5.4.4.7 Influential Data Points

Since the analysis consisted of a simple regression of the percent surviving pumps by time, there were no influential data points in the OLS analysis. There were no outliers in the analysis.

5.4.4.8 Missing Data

When data was unavailable, the data points were removed in January of 1998.

5.4.4.9 Precision

The precision was determined as specified in Appendix C.

APPENDIX A

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APPENDIX B

PLANNED SURVIVAL ANALYSIS METHOD

Effective Useful Life Analysis

This appendix provides the analysis originally planned for the effective useful life (EUL) analysis. As presented in the report, what was planned did not actually occur due to lack of failures. However, this appendix is included for completeness. The first part describes the appropriate unit of analysis. The final part describes various issues surrounding survival analysis in the context of this study, including left versus right censoring, the hazard function, precision, covariates, hypothesis testing, data structure, required sample sizes, and alternative approaches.

Units of Analysis

The unit of analysis for the survival estimation is the survival unit being studied, such as patients or light bulbs. The unit of analysis is always a binary outcome - survival versus failure or death. For this study, the units are failed pump repairs, HID fixtures, custom installations, and a collections of greenhouse measures.

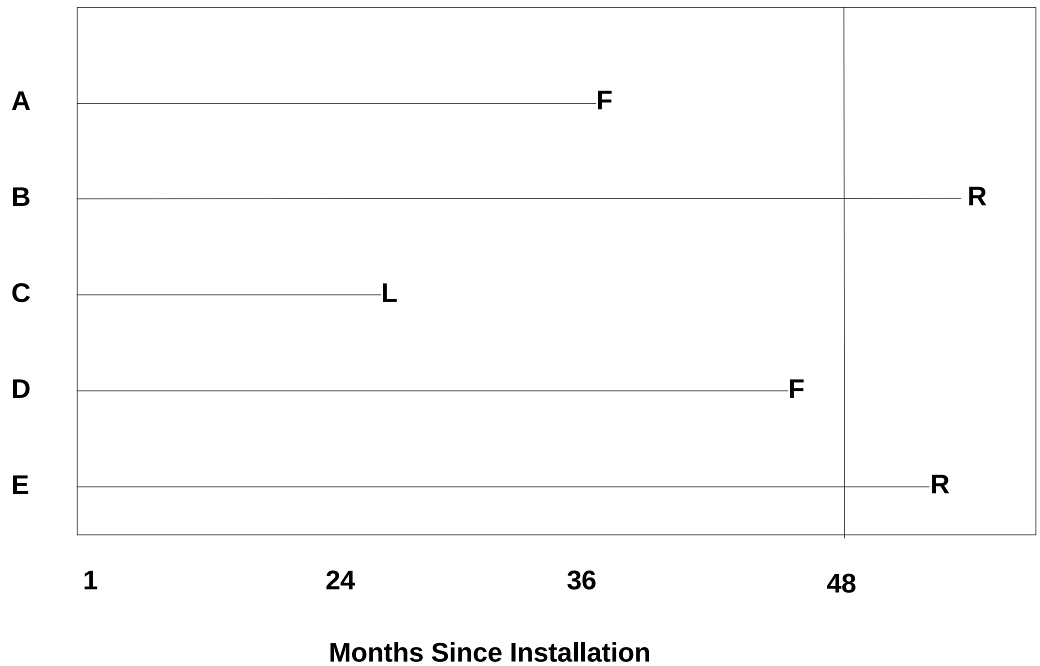
Left Censoring versus Right Censoring

In this survival analysis, an event is defined as a point in time at which a particular measure is no longer "in place and operable", hereafter referred to as a "failure." This implies that we need to know not only that a given measure has failed but also when it failed.

Two concepts critical to our approach are the right censoring and left censoring of the data. Right censoring of the data occurs when a measure is observed before the failure event occurs, i.e., the measure is still "in place and operable". Left censoring occurs when the actual installation or failure date for a measure is unknown. Exhibit 1 illustrates the distinction between right and left censoring. The observation followed by an "L" is a case in which the measure did not survive until the 48th month, the month of observation, but we do not know the time of failure. This is a case of "left" censoring. The observations by an 'F" represent those cases in which the measure did not survive until the 48th month but for which we *do* know the time of failure. These represent cases of "no" censoring. The observations marked by an "R" represent those cases in which the measure survived until the 48th month and will not fail until some time beyond the 48th month. These represent cases of "right" censoring. Both right censoring and left censoring can have significant impacts on the precision of any survival analysis.

Right censoring is inevitable when one conducts a two- or four-year follow-up on kWh savings associated with measures that have expected useful lives of 15 to 18 years. For example, in a four-year retention study, very few chiller or boiler measures (long life measures) in a small sample will have experienced failure. The problem with right censoring is that more measures that have experienced failure must be brought into the sample in order to produce a robust estimate of the EUL. Of course, right censoring is expected to be somewhat less of a problem in the case of measures that have a shorter EUL.

Exhibit 1
Right Versus Left Censoring



The problem of left censoring can be somewhat more easily mitigated by asking participants to report the time of failure. When a sampled site was inspected, we asked the customer when the measure failures occurred. The failures were defined as failures at that date. In using such an approach, we must guard against the threat of measurement error since customers may not be able to remember the true failure date accurately.

Hazard Function

For the time being, we will assume the following general form of the constant hazard function:

$$h(t) = l \tag{1}$$

The corresponding survivor function is:

$$S(t) = e^{-lt} \tag{2}$$

This, in turn, has the following implied probability density function for the well-known exponential distribution with parameter λ:

$$f(t) = \lambda e^{-\lambda t} \tag{3}$$

This constant hazard implies an exponential distribution for the time until an event occurs. Other functional forms, such as the Gompertz and the Weibull, will also be explored during the analysis. However, we also realize that the probability of a measure not surviving increases with time, i.e., the hazard is not constant over time. To handle such a situation, we will also explore non-proportional hazard functions. For this purpose, Cox's (1984) partial likelihood method will be explored.

$$S(t) = [S_o(t)]^{\exp(\beta x)} \quad (4)$$

where:

S(t) = The survival probability at time t with covariate x

So = The survivor function for a building for which the covariate values are all 0.

X = A vector of covariates

t = Time

Of course, it is possible that there are other probability distributions that might be adopted. Such a model is the log-logistic model, which has a rather simple survivor function,

$$S(t) = \frac{1}{1 + (\lambda t)^{\gamma}} \quad (5)$$

where

$\gamma = 1/\sigma$

$\lambda = \exp\{-[\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k]\}$

Such a model is called the *accelerated failure time model*.

Precision

The precision that one can achieve is in large part a function of the number of failures that one can expect to see in a third-year study. The number of failures that one can expect to see is largely a function of the expected EULs. For example, for the hazard function (Equation 1), the median survival time is given by

$$\hat{t}(50) = \hat{\lambda}^{-1} \log 2 \quad (6)$$

with a standard error of

$$\text{s.e.}\{\hat{t}(50)\} = \frac{\hat{t}(50)}{\sqrt{r}} \quad (7)$$

where r is the number of failures within a sample. The more failures there are, the smaller the standard error and the greater the precision of the estimate. That is, the number of failures is directly related to the power of any survival analysis to determine whether any differences between re-estimated EULs and the ex ante EULs are statistically different at some predetermined level of confidence. Of course, in a third-year retention study, the number of failures for longer-EUL measures will be very small while the numbers of failures associated with shorter-EUL measures will be more numerous. While the problem of right censoring may be somewhat serious for all measures, it may be particularly acute for the measures with longer EULs.

Covariates

Other factors that may affect the life distribution should also be investigated. For example, do the pump repair measures savings in the south Central Valley, where wells are deep, experience different rates of failure than pump repair measures near Sacramento, where wells are shallow? Such an analysis will allow us, to some extent, to control for the heterogeneity of the determinants of measure survival. Also, note that the characteristics of each area that do not change over time will be controlled for by including an area-specific intercept in the model, i.e., each measure associated with a given area will have a common intercept.

Software

The Statistical Analysis System (SAS) software will be used to estimate all survival functions. SAS has a wide range of procedures (LIFETEST, LIFEREG, and PHREG) that can handle right censoring and provide standard errors for each point on the survival curve (including the median), as well as the entire survival function itself. LIFETEST and PHREG also allow for the inclusion of covariates. This software also allows for the possibility of weighting each observation to reflect the sample weights when a non-proportional sample is drawn, as is the case in this study.

Hypothesis Testing

First, note that the Protocols consider effective useful life to be that median number of years in which half of the units associated with a given measure (e.g., T-8 lamps) installed in a given program year are still in place and operable. It turns out that in survival analysis, the median value is of greatest importance because the mean value is biased downward when there is right censoring, as is the case in this study. Thus, our hypothesis test will focus on the ex ante and ex post median values.

The null hypothesis established for this phase of the analysis is that the measure-level EUL (a median value) estimated as a part of this research project is not statistically different from the ex ante EUL (a median value) at the 80% percent level of confidence, i.e.,

$$EUL_{ex\ post} = EUL_{ex\ ante}$$

The hypothesis test is perhaps the most difficult task. This is the case since, in order to compare the ex ante median to the ex post median, we must first forecast the ex post median. That is, the model will be extrapolated to times that are far beyond those that are actually observed. The forecast error will be substantial.

Once the median is forecasted, a one-sample sign test will be calculated. This test is a way to compare the EUL based on the sample to a predetermined point estimate, the ex ante EUL (that is, the median of all values, which we will designate M0). First, a count is made of the number of values exceeding M0. We will call this count n1. The count of the number of values less than M0 is designated as n2. If the alternative hypothesis is that the population median $\neq$ M0, then the test statistic is the smaller of n1 and n2. The null hypothesis is rejected if the test statistic is less than the critical value contained in the appropriate statistical tables.

The critical value that will be used for this two-tailed sign test is 1.28 (80%).

Data Structure

Once data are collected, they will be placed into a database with the structure shown in Exhibit 2. Each observation represents a measure, with the duration denoting the number of years after installation that each measure has survived to date. For measures that have not survived, the status flag is equal to one, and the duration is the time from installation to failure. For measures that have survived, the status flag is equal to 0, and the duration is the time from installation to the date of observation. These data can then be read into SAS where the data will be structured in the manner shown in Exhibit 3.

Exhibit 2
Data Structure for EUL Analysis

Measure	Install Date	Failure Date	Observation Date	Duration (Yrs.)	Status
1	6/1/94	3/1/96	4/1/98	1.75	1
2	2/3/94	.	4/2/98	4.16	0
3	12/15/94	.	4/5/98	3.31	0
4	12/25/95	2/14/97	5/12/98	1.14	1
5	4/2/95	4/4/96	5/2/98	1.01	1
6	8/30/95	3/1/97	5/5/98	1.50	0
7	11/1/94	.	4/9/98	3.44	0
n	.	.	.	.	.

Exhibit 3
Data Structure in SAS

OBS	**DURATION**	**STATUS**
1	1.75	1
2	4.16	0
3	3.13	0
4	1.14	1
5	1.01	1
6	1.50	0
7	3.44	0
n		

Required Failures

For a classic survival analysis, one must attempt to estimate the number of failures needed to achieve the required level of precision. To perform this calculation, one must make a number of other assumptions in addition to the confidence level. For example, how big a difference between the ex ante and the ex post EULs (the so-called effect size) should the statistical test be able to detect as significant? This is a particularly critical factor since the sample size is, to a large extent, a function of the effect size. As the expected size of the effect increases, the required size of the sample decreases. Because the Protocols say nothing about effect size, there is a fair amount of latitude regarding the size of their retention samples. Simply setting the desired level of confidence at 80%, as the Protocols do, does not lead one to the desired sample size.

For this calculation, the exponential functional form was assumed to produce a range of required sample sizes. The following assumptions were made:

- a power of 0.8 or 0.7
- an alpha of 0.20 (i.e., 80% confidence level)
- an ex ante EUL of 9 years
- a range of possible effect sizes, Δ

The calculation of the effect size requires some further explanation. If one assumes that the survival curves have an exponential distribution, then we have:

$$p_{\mathrm{T}} = \mathrm{S}(t)\exp(-l_{\mathrm{T}}t) \tag{8}$$

where p_T is the proportion of measures surviving at some fixed time t and l_T is the constant hazard for a given measure. Equation 9 can be rewritten as

$$l_{\mathrm{T}} = \frac{-\log p_{\mathrm{T}}}{t} \tag{9}$$

In a similar way, we can obtain for the ex ante EUL at the same time t

$$l_{\mathrm{C}} = \frac{-\log p_{\mathrm{C}}}{t} \tag{10}$$

Thus, the effect, Δ, is defined as

$$\frac{l_T}{l_C} \tag{11}$$

Specifically for the median, the following equation holds

$$\Delta = \frac{l_{\mathrm{T}}}{l_C} = \frac{\mathrm{M_C}}{\mathrm{M_T}} \tag{12}$$

where MC is the estimated median survival time based on the sample in this study, while MT is the estimated median survival time for the ex ante EUL.

It can be shown that if an equal number of subjects are allocated to each treatment, the total number of events, E, that need to be observed in a study comparing two treatment groups is given approximately by

$$E = [(Z_{1-a} + Z_{1-b})(1+\Delta)/(1-\Delta)]^2 \qquad (13)$$

where $Z_{1-a/2}$ is the upper point of the standard normal distribution and Z_{1-b} is the power of the test. Using this equation and the assumptions listed earlier, the number of required failures was calculated. However, an adjustment must be made to these numbers that accounts for the fact that we have only one group that has a known distribution, the sample of sites and their associated measures in this study. The ex ante EUL has no distribution; it is just an *a priori* engineering assumption. Such an adjustment must be done in order to account for the fact that we have only half of the sampling error. Using an adjustment factor of 0.50 (Cohen, 1988) produces *113 required failures*.

Alternative Approaches

There are three basic approaches to estimating EULs. The approach we proposed was the familiar ordinary least squares (OLS) regression that estimates the relationship between time and the percentage of measures remaining that are still present and operable (Maddala, 1992). Also explored was the classic survival analysis (CSA), which involves the analysis of data that correspond to the time from a well-defined time origin until the occurrence of some particular event or end-point (Collett, 1994). Finally, we entertained the assumed functional form (AFF) approach. The AFF first assumes a functional form, such as the logistic or exponential. Next, a survey is conducted at a given point in time after the installation. The results of the survey are entered into an equation that describes the functional form that has been manipulated algebraically to derive the EUL associated with 50% survival. This method has most recently been developed by Roger L Wright (RLW, 1999). RLW begins with the exponential survival function:

$$S(t) = e^{-lt} \qquad (14)$$

Here the mean survival time is equal to $1/l$. They define the EUL as the value of t that satisfies the equation $S(t) = e^{-lt}$ = 0.5. Solving for t=EUL, they obtain

$$EUL = -\frac{\ln(0.5)}{l} \qquad (15)$$

If they observe $\bar{S}$ in a sample with average measure age t, then they can solve the survival function for

$$\bar{l} = -\frac{\ln(\bar{S})}{t} \qquad (16)$$

If they substitute this equation in the preceding one, they obtain

$$E\bar{U}L = \frac{t\ln(0.5)}{\ln(\bar{S})} \qquad (17)$$

Thus, for example, if one finds that, in a sample of 100, 90% survive and that the average age of the surviving units is three years, then the estimated EUL is 19.7 years.

APPENDIX C

METHOD FOR CALCULATING CONFIDENCE INTERVAL AROUND FORECAST SURVIVAL PERCENTAGE FOR PUMP REPAIRS

The pump repair measure was the only measure found to have failures. The 80% confidence intervals shown in the tables in section 5 were calculated using the approach shown below.

The variance of the model error (the residuals) is first estimated using equation 1 (Pindyck and Rubinfeld, 1981).

$$s^2 = \frac{1}{T-2} \Sigma(Y_t - \hat{Y}_t)^2 \qquad (1)$$

The variance of the forecast error is then estimated using equation 2.

$$s_f^2 = s^2\left[1+\frac{1}{T}+\frac{\left(X_{T+1}-\overline{X}\right)^2}{\sum\left(X_t-\overline{X}\right)^2}\right] \qquad (2)$$

Finally, the calculation of the confidence interval around each forecasted point is then done using equation 3.

$$\hat{Y}_{T+1} \ +/- \ t_{.20}s_f \qquad (3)$$

The 80% confidence interval for the percentage of pump repairs surviving is very small. There are two primary reasons for this. First, the pump forecast is unconditional, since the explanatory variable, time, is known with certainty for the entire forecast period. This absence of error around future explanatory values removes a large source of forecasting error. Second, the model has a very high R2 of 0.891, leading to a very small model error using equation 1.

However, the percentage of pump repairs surviving is not an EUL. The EUL is derived as follows. First the estimated model is evaluated at future values of time to determine when the forecasted percentage reaches 50%. The number of months associated with this 50% value is then divided by 12 to derive the EUL. To calculate the 80% confidence interval around this EUL, the upper and lower bounds surrounding the forecasted value of 50% are first determined. Then, forecasted values that are near to the upper and lower bounds are identified and the number of months associated with each are divided by 12 to derive the upper and lower bounds of the EUL.

APPENDIX D

CADMAC WAIVER

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

<u>Summary of PG&E Request</u>

This waiver requests deviations from, or clarifications of, the Protocols[3] 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 <u>measure level</u> 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 <u>end use level</u>, PG&E does not have the <u>measure level</u> 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."

<u>Rationale</u>

The Protocols, as written, require that all third and fourth earnings claim impacts are calculated as the sum of the <u>measure level</u> 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 <u>end use level</u>, PG&E does not have the <u>measure level</u> 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.

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

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 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.

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APPENDIX E

ON-SITE AUDIT INSTRUMENTS

1995 AG PROGRAM RETENTION QUESTIONAIRE

Customer Name

Business Name

Customer Addres

City

Phone or

New Contact Name ______________________

New Phone Num?: __________ Acct Code

PGE Audit Acct

New PGE Acct __________

Audit Num: 600

Orig CCS Surveyor ________

Division: ________

Assigned To: ________

Old Audit ID ________

Date Customer Talked To: ________

Is a Site Visit Necessary? 0

Date Site Visited ________

Date Completed: ________

1995 Measure:	**Measure Code**	**Measure Description**
0 **Custom Audit**		
0 **Pump Audit**		
0 **Lighting Audit**		

Location Description - Custom, Pump Repair

Location Description - Lighting

Is the 1995 measure still present? **(yes / no)** ________

If not present, explain why not

____

Was this measure used in 1998? **(yes / no)** ________

If no, explain why not?

____

Approximate date removed from service ________

Continue for Lighting Audits ONLY

Num Fixtures	**Group Descriptions**	**Lamp Fixture**	**Watt**

What % of the equipment from this measure is still in use? 0%

When was the unused portion removed from service? (approx): ________

Why was it removed from service?

____

Auditors Comments: ____

____

____

Notes: ____

Data Class: ______ 1= Good

2= Marginal

Customer Name: ______________________________________3= Bail Out

Customer Business Name: ______________________________________4= Refused

Customer Address: ______________________________________5= Can't Contact

______________________________________6= Duplicate

Customer Phone: ______________________________________

PG&E Account Number: ___________________ Verified?___________

New Account Number: ___________________ (1=Yes, 2=No)

PG&E Meter Number: ___________________ Verified?___________

New Meter Number: ___________________ (1=Yes, 2=No)

Location/Directions (include major cross streets):

____

____

____

____

Type of Measure

Y/N	Meas #	Measure Name
______	1	Pump Repair (REO)
______	3	Low Pressure Sprinkler Nozzle Conversion (REO)
______	4	Micro Irrigation System Conversion (REO)
______	5	Heat Curtain (REO)
______	6	Refrigeration (REO)
______	7	1995 Retention Panel Verification

This on-site survey conducted by: ______________________ On: _______________

Note: Verify PG&E Account Number from copy of customer's bill.

Pump Repair Audit *(page 1 of 1)*

1. Normal Pumping Plan Configuration (from pump tester's notes):

2. Was this pump worked on in: 1 = 1996 or 1997, 2 = Not worked on ____________

If Yes:

a) When was this work done (Month/Year)? /______

b) What work was done? ____________

(1=pump rebuilt/replaced, 2=well casing cleaned, 3=pump rebuilt & casing cleaned)

c) Was this pump re-tested after the repairs were made (1=Yes, 2=No)? _________

If Yes

c1) when was it re-tested _____/_____

c2) what was the plant efficiency?

3. Other electrical load on this meter? (1=Yes, 2=No, 3=Unable to determine) _____

If NO, then stop audit here; if Booster, go to #4, if OTHER, go to #5

4. *If Booster Pump*, then complete the following:

a) _____ What is the horsepower of the booster pump?

b) _____ Do the booster and deep well pump always run at the same time? (1=Yes, 2=No)

If yes, then STOP here

If NO, then ? (These last 3 questions should add to 100%)

i) ______ % of the time does the booster run by itself?

ii) ______ % of the time does the booster run with the deep well pump?

iii) ______ % of the time does the deep well pump run by itself

1. *If Other Loads, then what portion of the year do they run and what are their horsepowers?*

Tested Pump ______ % of year run:

Other Load #1______ % of year run and ______ Horsepower

Other Load #2______ % of year run and ______ Horsepower

Other Load #3______ % of year run and ______ Horsepower

Other Load #4______ % of year run and ______ Horsepower

Pump Repair Retention Panel Information

Information for the retention portion of this audit are collected above (location of pump) and during the pump test (horsepower of pump).

Customer Contact By: ______________ On: _______ Forward To Tester On: ________

Pump Test Work Sheet (Page 1 of 2)

Field Pump Test

Location Description (major cross streets and location from intersection; include HP):

____

____

____

Normal Pumping Plant Configuration (How is it usually used):

____ Single deep well pump with open discharge

____ Single deep well pump with pressurized discharge:

____ Low (1-20 psi) or ____ High (20+ psi)

____ Single deep well pump in conjunction with electric booster pump

____ Single deep well pump in conjunction with diesel booster pump

____ Deep well joined with other deep well pumps

____ Axial / Propeller pump (low head)

____ Other: ____

PG&E Meter Number (in program yr) _____________________ Verified? __________

New Meter Number (if changed)__________________________ (1-Yes, 0=No)

Are their other electrical loads on this meter? _____ (1=Yes, 0=No)

If Yes, what is the other load: [ ] Booster, [ ] Other ________________________

Sketch of Pumping Configuration:

Pump Test Work Sheet (Page 2 of 2)

Field Pump Test

Comments (include pumping plant configurations used other than the “normal” one):

____

____

Pump Test Conducted By: _________________________ On: __________________

Pump Test Data Review By: ____________ On: __________ Data Classification: ___

Low Pressure Sprinkler Nozzle ***(page 1 of 3)***

The information here, unless otherwise noted, is specific to the site audited.

1. The low pressure sprinkler nozzles were placed in a system which is a:

   1 = Permanently Installed System 2 = Hand Moved System

   Total number of rebated nozzles *throughout company* - ___________

   Total number of rebated nozzles *at this site* - ___________

2. The nozzles are used across _____ pumping accounts.

3. Is the pumping pressure reduced? (1=Yes, 2=No)

   If yes, how was the pressure reduced:

   ____

   ____

4. What was the approximate psi of the previous high pressure sprinkler system? _______

5. What is the configuration of the pumping system being tested?

   a)_____Deep well pump only.

   b)_____ Deep well pump in conjunction with booster pump that boosts directly from the deep well.

      Booster pump is _______ (1=Electric, 2=Diesel)

   c)_____ Deep well pump in conjunction with booster pump with the booster pump pulling water from a reservoir or canal.

      Booster pump is _______ (1=Electric, 2=Diesel)

   d)_____ No deep well pump. Electric booster used to pull water from canal.

6. *If booster pump used*, what is the current horsepower? _____

7. *If booster pump was changed* with addition of low-pressure sprinkler nozzles, what was the horsepower of the old booster pump? _____

Low Pressure Sprinkler Nozzle *(page 2 of 3)*

8. *If moveable sprinkler system*, complete the following information for the pumps to which the irrigation system is attached. The assumption is that all rebated nozzles are on this system. If not, make a note of where they all are. Circle the pump number of the pump that has been tested.

Pump Number	Account Number	Pump Type (Booster, Deep Well, Combined)	Pump HP	Acres Irrigated with Pump	% of time Pump Used (column adds to 100%)
1					
2					
3					
4					
5					
Total	NA	NA	NA		100

1. *If permanent sprinkler system*, complete the following information for the pumps to which the irrigation system is attached. The assumption is that the grower spread out the rebated number of nozzles across more than one account. Circle the pump number for the pump that has been tested.

Pump Number	Account Number	Pump Type (Booster, Deep Well, Combined)	Pump HP	Number of Nozzles on Pump System	Acres Irrigated with Pump
1					
2					
3					
4					
5					
Total	NA	NA	NA		

Low Pressure Sprinkler Nozzle (page 3 of 3)

Low Pressure Sprinkler Retention Panel Information

Sprinkler Brand: ____

Sprinkler Model: ____

Nozzle Manufacturer: ____

Nozzle Size: ____(Inches or Model Number)

Note: Other retention information is gathered earlier (location of fields, number of nozzles, type of irrigation system).

Micro Irrigation Conversion ***(page 1 of 2)***

1. What was the previous irrigation system?

    ____ Big Gun sprinklers of approximately _____ psi

    ____ High Pressure sprinklers of approximately ___ psi

    ____ Low Pressure sprinklers of approximately ___ psi

    ____ Other ____

2. Current estimated psi ________________
3. Current estimated irrigation efficiency ____________
4. Complete the following information for the pumps to which the irrigation system is attached. Circle the pump number for the pump that has been tested.

Pump Number	Account Number	Pump Type (booster, deep well, both)	Pump HP	Acres Irrigated with Pump
1				
2				
3				
4				
5				
Total	NA	NA	NA	

1. At the time of the conversion to a micro system, was:

    a) _____ the deep well replaced or rebuilt (1=Yes, 2=No)?

    b) _____ the booster replaced or rebuilt (1=Yes, 2=No)?

1. If new pump, what was the old pump:

    a) _____ Type b) _____ horsepower

2. *If retrofit*, what was done to the pump? ________________________________
3. Micro-Irrigation Schedule

    Does the system have a peak-period lock-out on the meter? ________ (1=Yes, 2=No)

Continue if #8 answer is No

When the system is turned on, how many hours per day does it run (on average)? ___________

When are those hours? ____

Micro Irrigation Conversion *(page 2 of 2)*

Micro-Irrigation Retention Panel Information

Type of micro irrigation system (e.g., drip tape, drip tubing, micro sprinklers)

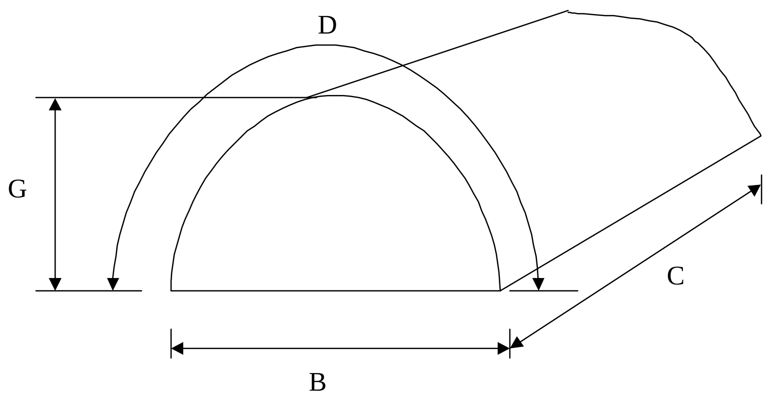
____

____

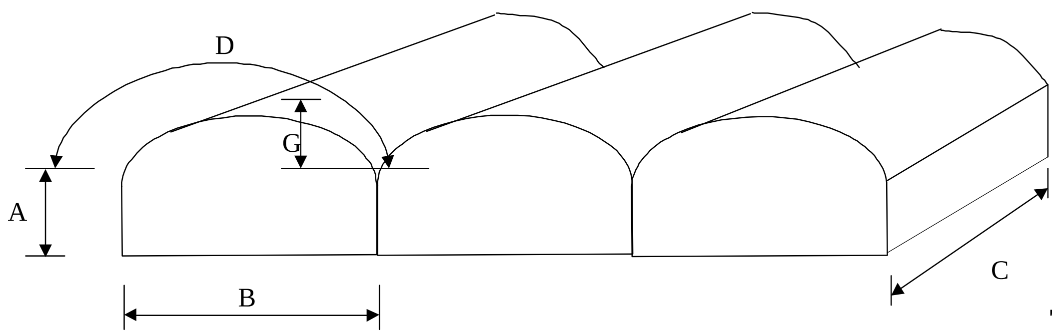
Greenhouse Heat Curtain *(page 1 of 5)*

Greenhouse Volume

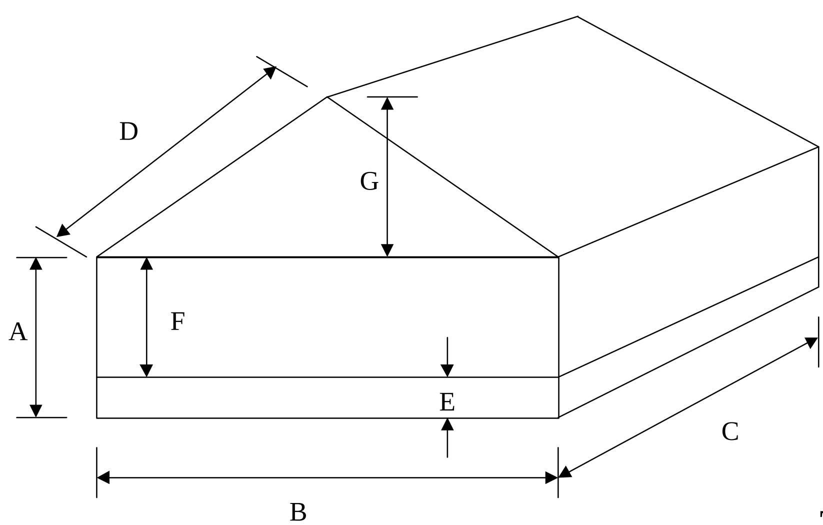
If the greenhouse being audited does not have one of the shapes shown below, draw it on the next page and label the lengths provided. Draw how the heat curtain has been installed. Measure dimensions in feet and include on Page 3.



Type: Quonset (Q)



Type: Multi-Span (M)



Type: Rectangular (R)

Greenhouse Heat Curtain ***(page 2 of 5)***

Greenhouse Volume (cont.)

Sketch of Other Type (if required):

Greenhouse Heat Curtain *(page 3 of 5)*

Greenhouse #___					
Number the Same =					
GreenhouseType (Q,M,R,O) =					
	Meas.	Material	Heat Curtain*		
Location	Feet	Type	Length AND	Width OR	Area
A Wall height					
B House Width					
C House Length					
D Rafter Length					
E Lower Wall Height					
F Upper Wall Height					
G Gable Height					

Greenhouse #___

Heating Thermostat Setpoint: ______

Heating Schedule: (Months heating available and hours used if programmable thermostat)___

____

____

____

____

____

____

Comments: ____________________________

____

____

____

____

____

*If there are more than one greenhouse the same, the heat curtain is assumed to be the same in each greenhouse.

Cloth Type: LS14 LS15 LS15F LS16 PH1 PH98 Other
(Circle One or More)

Other:____

Circle the type of framing materials in the greenhouse:

Wood Aluminum Galvanized Steel

Other: ____

Circle the Construction Age: New Construction (less than 5 years) Old Construction (>=5 years)

Circle the Maintenance: Good Maintenance Poor Maintenance

Greenhouse Heat Curtain *(page 4 of 5)*

Greenhouse Construction

Use the Material Number to indicate Material Type on Page 3.

Material Number	*General Material Type*	*Typical Trade Name*
1	Glass	Double Strength Insulated Units Low Iron
2	Acrylic	Plexiglass Lucite Acrylite Double Wall Exolite Acrylite SDP
3	Polycarbonate	Lexan Tuffak A Tuffack Twinwall Qualex
4	Fiber Reinforced Polyester	Lascolite Filon Glasteel Kalwall
5	Laminated Acrylic/Polyester Film	Flexigard
6	Polyethylene Film	Visqueen Tufflite II Monsanto 602 or 603
7	Weatherable Polyester Film	Llumar Mylar Melinex

If the glazing construction material is not on this list, number it, state below what it is and refer to it as that number on page 3.

____

____

____

____

Greenhouse Heat Curtain *(page 5 of 5)*

Comments on Greenhouse Audit not covered elsewhere.

1995 Ag Program Retention Questionnaire

Customer Name		Audit Num:
Business Name		Orig CCS Surveyor
Customers Address		Division
City		Assigned To:
Phone		Old Audit ID:
New Contact Name		Date Customer Talked To:
New Phone Number	Area Code	Is a Site Visit Necessary?
PG&E Audit Acct.		Date Site Visited
New PGE Acct.		
1995 Measure:	Measure Code	Measure Description
Custom Audit Pump Audit Lighting Audit		

Location Description – Custom, Pump Repair

Location Description – Lighting

Is the 1995 measure still present (yes/no) ____________

If not present, explain why not

____

Was the measure used in 1998?

If no, explain why not

____

Approximate date removed from service ____________________

Continue for Lighting Audits ONLY

Num Fixtures	**Group Descriptions**	**Lamp Fixture**	**Watt**

What % of the equipment from this measure is still in use? ________________

When was the unused portion removed from service? (approx.) ________________

Why was it removed from service?

____

____

Auditors Comments:

____

____

Refrigeration Audit ***(page 1 of 5)***

Measure Rebated (circle one):

1. Oversized Evaporative Condenser – Halocarbon Refrigerant
2. Oversized Evaporative Condenser – Ammonia Refrigerant
3. Non-electric Refrigerant Condensate Evaporator
4. Strip Curtains

If Measure is #1 or #2 – GO TO NEXT PAGE

For Measure #3

Location of Measure: ____

____

____

Manufacturer: ____

Make and Model Number: ____

Number of Measures: ___________________

For Measure #4

Location of Measure: ____

____

____

Square Foot of Measure Installed: _________

Door Measurements: _________Ft. by __________ Ft.

Volume of Walk-In: __________ Ft. by ___________ Ft. by ___________ Ft.

Average Indoor Temperature ______________F

Type of HVAC System: ______________________ EER of HVAC System: ________________

Hours per Year in Use: _______________________

Schedule: ____

____

On-Site Audit Number: _____________
Auditor: ________________________

Refrigerant: Ammonia (R717) Halocarbon (R22)

Refrigeration Line	Compressors*					
	Manuf.	Model	hp	Suction Temp (F)	Pressure	
						psia psig
						psia psig
						psia psig
						psia psig
						psia psig
						psia psig
						psia psig

*Obtain the average compressors and cylinders running during off-peak and on-peak periods

Refrigeration Components

Total Refrigeration ________ Btuh Tons Lbs.
Flow ________ lb/min

	Maximum	Average
Pre-Retrofit Suction Pressure or Temperature		
Pre-Retrofit Condensing Pressure or Temperature		
Post-Retrofit Suction Pressure or Temperature		
Post-Retrofit Condensing Pressure or Temperature		

Refrigeration On-Site Audit

On-Site Audit Number: _____________
Auditor: ________________________

	Condensers								
Number	Manuf.	Model	Condesing Temp (F)	Pressure		Number of Fans	Fan hp	Number of Pumps	Pump hp
1					psia psig				
2					psia psig				
3					psia psig				
4					psia psig				
5					psia psig				
6					psia psig				
7					psia psig				

Location of Condenser ____

____

Fan Control Schedule ____

____

Refrigeration On-Site Audit

On-Site Audit Number: _____________
Auditor: ________________________

Line Drawing of Refrigeration Line Layout

On-Site Audit Number: _____________
Auditor: ________________________

Operating Hour Schedule for Plant

Gather information on seasonal, weekly hours of operation and coincident peak periods - use July and August 3-4PM as CP