SDGE

San Diego Gas & Electric
Marketing Programs & Planning
8306 Century Park Court
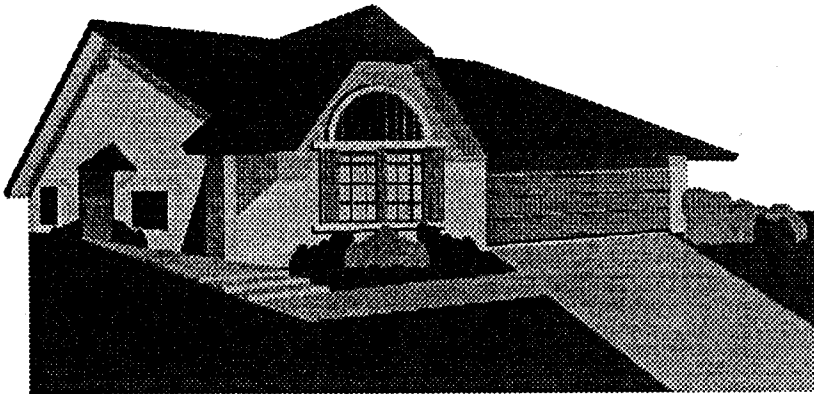**San Diego, California 92123**

1995 Residential Energy Management Services

First Year Load Impact Evaluation

February 1997

SDGE

San Diego Gas & Electric
Marketing Programs & Planning

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Executive Summary

During 1995, 21,009 audits were conducted through SDG&E's Residential Energy Management Services (REMS) Program. This report summarizes net energy impact estimates for participants in the ENERGRAF (onsite) and the Home Energy Profile Service (Mail-In) audits. The analysis includes a survey of the number and types of adoptions by program participants.

Program savings estimates are summarized in Table 1 below:

Table 1 NET ANNUAL ELECTRIC AND GAS LOAD IMPACTS (Program savings are depicted as negative numbers)					
	Whole House	**Miscellaneous**	**Space Heating**	**Space Cooling**	**Water Heating**
ENERGRAF					
Kwh Savings	-629.64	-303.48	-729.60	-144.96	-98.76
Therm Savings	-39.60	-31.92	-7.92	N/A	-2.40
MAIL-IN					
kWh Savings	135.48	-238.80	102.72	257.16	-173.64
Therm Savings	-15.36	-12.24	-3.24	N/A	-6.36
ALL AUDITS					
kWh Savings	15.60	-251.52	-28.08	214.80	-152.28
Therm Savings	-18.96	-15.12	-2.16	N/A	-6.60

Energy Impacts

- ENERGRAF (onsite) audit participants experienced significant savings at the whole house level and at each major end use both in electric and gas consumption. At the whole house level, electric savings were -629.64 kWh per year (t=-17.79), which represents 9.7% of average annual household consumption. Gas savings were -39.60 therms per year (t=-8.29), which is 8.0% of average annual gas consumption. Gas savings were realized for all major end uses.

- Mail-In audit participants experienced an overall increase in electric consumption of 135.48 kWh per year (t=7.01) at the whole house level. These customers also experienced increases in space heating and space cooling consumption. However, savings were experienced in the miscellaneous and water heating electric end uses. The Mail-In participants realized significant savings in gas consumption at the whole house level and at the major end use level. Gas savings were -15.36 therms per year (t=-5.60), which is 3.0% of average annual household gas consumption.

- All audit participants combined experienced an insignificant increase of 15.60 kWh per year (t=0.83) and a significant savings of -18.96 therms per year (t=-7.03) at the whole house level. Overall, those participants who had ENERGRAF (onsite) audits tended to realize greater savings than those who filled out Mail-In audits. Onsite audits are the result of high bill complaints while Mail-In audit customers have a different motivation for participating in the program. Another

reason for the savings differences may be due to an increase in motivation to adopt recommendations when the more personal onsite attention is given. ENERGRAF customers also demonstrated significant space heating and space cooling savings, whereas Mail-In customers showed increased consumption in these end uses.

Adoption Activity

- Adoptions of audit recommendations were split evenly between measures (equipment changes) and practices (behavioral changes). There was no significant difference between adoptions from onsite audits and those from Mail-In audits.

- The majority of electric adoptions were in lighting (36%) and refrigeration (15%). The majority of gas adoptions were in space heating (41%) and water heating (33%).

- Results of the adoption survey suggest that savings under the "miscellaneous" end use category may be capturing some of the water heating savings from clothes washing and dish washing.

- Allocation of savings to specific measures and practices is nearly impossible due to lack of information at this level.

Introduction

Program Overview

The San Diego Gas & Electric (SDG&E) Residential Energy Management Services (REMS) Program offers four types of services to customers:

- The onsite **ENERGRAF Service** provides customers with a computer-prepared graph showing their monthly consumption and the approximate cost of using their major appliances. Customers also receive written recommendations of energy saving practices.

- The **Home Energy Profile Service (Mail-In)** employs a questionnaire mailed to customers about their energy use. After a completed questionnaire is mailed back to SDG&E, a computer-prepared graph that shows monthly consumption, the approximate cost of using major appliances, and recommendations of energy saving practices are returned to the customer.

- The **Low-Cost/No-Cost Service** offers customers a physical inspection of their appliances. Customers receive written recommendations for implementing low-cost or no-cost energy saving practices and measures.

- The **Pool/Spa Audit Service** encourages customers to use off-peak hours of operation for filtration. Free time clock trippers are provided, if needed, to reset pool and/or spa filtration time clocks.

This report summarizes the energy impact analysis of customers who received the ENERGRAF and Mail-In audits during 1995. Low-Cost/No-Cost and Pool/Spa audits, which constitute a minority of services, are not included in this evaluation.

Background

SDG&E's residential audit program was created in response to the U.S. Department of Energy's 1978 mandate that required all large utilities to offer in-home energy audit services. Audits were first offered by SDG&E in 1981 through the Residential Conservation Service (RCS) program, and in 1984 ENERGRAF audits were added to the services. The ENERGRAF service utilizes trained auditors to conduct in-home surveys of appliances. Data are entered into a lap-top computer and the customer is provided with a graph depicting current energy usage and costs for major appliances and a written list of conservation recommendations. Recommendations can take the form of either equipment/insulation suggestions or behavioral changes that affect the way energy is used. Many of the ENERGRAF audits are conducted in response to high-bill inquiries during peak winter months.

Mail-In audits became available in late 1991. Each customer requesting this audit is mailed a Home Energy Profile questionnaire. The questionnaire is returned to SDG&E and the customer is sent a graph showing monthly consumption, energy savings recommendations, and potential annual energy savings.

Availability of the ENERGRAF, Low-Cost/No-Cost, and Home Energy Profile Services were promoted through the Customer Service Telephone Center, the "Energy Notes" newsletter, and direct mail. A total of 21,009 services were completed as of December 31 1995.

A multi-family audit pilot project was undertaken during the third quarter of 1994 and evaluated the first quarter of 1995. Audits were completed at 62 customer sites to test the feasibility of offering a computerized audit service to multi-family "common area" applications. The pilot project was evaluated and found to be non-cost-effective and the recommendation was made to not expand or promote this audit service to multi-family customers.

The ENERGRAF, Low-Cost/No-Cost, and the Home Energy Profile Services provide customers with comprehensive information about energy management measures and practices making the RCS service redundant. As a result, the RCS Service was not offered to customers during 1995.

Sampling & Data Collection

Data for the 1995 REMS analysis were obtained from several major sources:

1. Participant name, address, account number, appliance saturation, demographics, and participation date from the 1995 ENERGRAF (onsite) program tracking database;

2. Participant name, address, account number, appliance saturation, demographics ,and participation date from the 1995 Mail-In program tracking database;

3. Nonparticipant name, address, account number, appliance saturation, demographics, and conservation activity from the Home Energy Survey for 1995 (MIRACLE XII) database;

4. 1994-1996 electric and gas consumption history from SDG&E's Customer Master File;

5. 1994-1996 hourly weather data for three climate zones from the National Oceanic and Atmospheric Administration (NOAA) files; and

6. Participant survey of adoption of audit recommendations by measure and practice.

A data flow diagram is provided below:
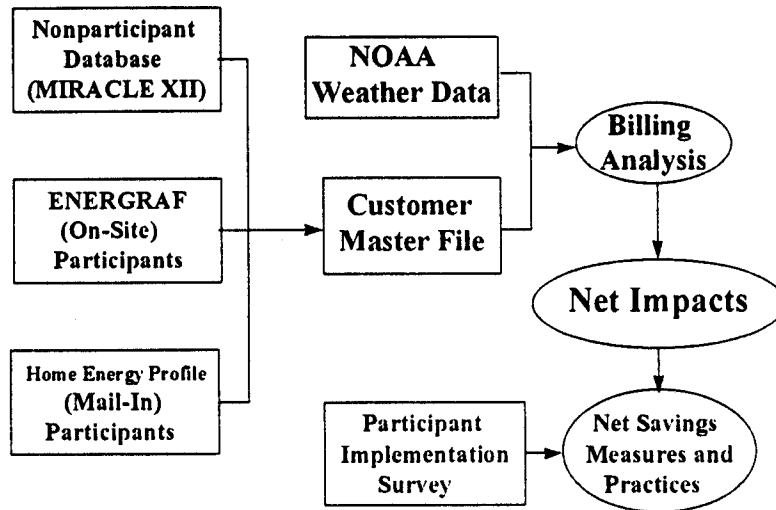
A census of the 5,895 participants in the 1995 ENERGRAF Audit Service database was attempted. Eliminating unreadable records and missing data on square footage or number in household left 5,005 participants. These were matched to 4,701 historical billing records. This number was reduced to 2,029 potential participants due to the M&E Protocols billing history requirement of 12 months of pre-installation data and 9 months of post-installation data. An additional 233 records were eliminated during the regression analysis and outlier[1] screening, leaving a total of 1,796 records for analysis.

A census of the 12,701 participants in the 1995 Mail-In Audit Service database was attempted. Eliminating records with missing square footage or number in household left 12,622 participants. These were matched to 11,476 historical billing records. This number was reduced to 8,330 potential participants due to the M&E Protocols billing history requirements. An additional 1,145 records were eliminated during the regression analysis and outlier screening, leaving a total of 7,185 records for analysis.

A census of the 5,000 nonparticipants in the 1995 MIRACLE XII Home Energy Survey database was attempted. Eliminating records with missing square footage or number in household left 4,642 participants. These were matched to 4,527 historical billing records. This number was reduced to 2,614 potential nonparticipants due to the M&E Protocols billing history requirements and by eliminating nonparticipants who added no conservation

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[1] See M&E Protocols Table 7 for an explanation of outlier screening.

measures during 1995[2]. An additional 451 records were eliminated during the regression analysis and outlier screening, leaving a total of 2,163 records for analysis.

The Econometric Framework

The load impact analysis estimates the monthly savings for space heating, space cooling, and miscellaneous end uses for those customers who adopted energy saving measures or practices that affect those particular end uses. To estimate savings for the entire household, all program participants were evaluated in the regression models described below, regardless of which end uses were affected by program adoption or whether any measures or practices were adopted. Thus, the sample sizes vary across the end uses evaluated, and the sum of the average savings of the individual end uses does not equal the average savings of all the households in the program. However, for each individual program participant, the estimated savings for his household is equal to the sum of his space heating, space cooling, and miscellaneous end uses.

Electricity Model

The electricity consumption model was designed to take advantage of variation in weather over time (with months indexed by t), which allows the regression model to yield estimates of weather-related consumption for individual customers (indexed by i):

The Customer Specific End Use Electricity Consumption Model

$$kWh_{it} = \alpha_i + \theta_i t + \beta_i \left(cdh_{it} \right) + \gamma_i \left(hdh_{it} \right)$$

$$+ \Delta\alpha_i \left(d_{it} \right) + \Delta\beta_i \left(cdh_{it} \right) \left(d_{it} \right) + \Delta\gamma_i \left(hdh_{it} \right) \left(d_{it} \right) + \varepsilon_{it}$$

The term $\alpha_i + \theta_i t$ (t=1,2,3,...) is the non-weather related trended element of the household electricity consumption, such as refrigeration and lighting. The next two terms, $\beta_i \left(cdh_{it} \right)$ and $\gamma_i \left(hdh_{it} \right)$, are the weather related kWh consumption based on cooling degree-hours $\left(cdh_{it} \right)$ and heating degree-hours $\left(hdh_{it} \right)$ respectively. The following three terms make up the estimated monthly savings associated with the audit date term d_{it} (a zero-one indicator variable): the miscellaneous end use is captured in the $\Delta\alpha_i \left(d_{it} \right)$ term, the space cooling end use is estimated as $\Delta\beta_i \left(cdh_{it} \right) \left(d_{it} \right)$, and the space heating end use is defined as $\Delta\gamma_i \left(hdh_{it} \right) \left(d_{it} \right)$. The least-squares regression model also contains the usual random disturbance term ε_{it}. Final weather-normalized estimates are $\Delta\alpha_i$, $\Delta\beta_i \left(\overline{cdh_i} \right)$, and $\Delta\gamma_i \left(\overline{hdh_i} \right)$ based on the 12-year averages of $\overline{cdh_i}$ and $\overline{hdh_i}$.

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[2] A total of 25.5% of the MIRACLE nonparticipants added no conservation measures during 1995. As a result, no delta between pre-installation and post-installation consumption could be calculated. The estimated pre/post consumption and number of participants were recalculated at the end of the analysis by adding 25.5% zeroes to the pre/post calculations. The final nonparticipant sample count is 2,715.

Gas Model

The gas consumption model is identical to the electricity consumption model with the following two exceptions: (1) the left side of the equation is therms, not kWh, and (2) there are no cooling terms since that end use is associated with electricity only.

The Customer Specific End Use Gas Consumption Model

$$\text{Therms}_{it} = \alpha_i + \theta_i t + \gamma_i \left(\text{hdh}_{it}\right)$$
$$+ \Delta\alpha_i \left(d_{it}\right) + \Delta\gamma_i \left(\text{hdh}_{it}\right)\left(d_{it}\right) + \varepsilon_{it}$$

In order to establish an implementation date for nonparticipants who claimed to have implemented one or more conservation measures or practices, a "best fit" approach was used. Regressions were run for each customer and for each month of 1995, changing the installation 0/1 indicator variable (d_{it}) each time to reflect the month being examined. The month with the smallest mean square error was deemed to be the most likely month for implementation.

In addition, to account for differences in demographics between the nonparticipant group and the two participant groups, participant gross impacts and net savings were normalized to the nonparticipant square footage and number in household.

Results

Energy Savings Estimates

The savings estimates for the end uses space heating, space cooling, miscellaneous, and all measures combined are derived directly from the load impact regression analysis. The coefficients from the models represent the estimated monthly load impact (kWh) associated with each end use (a negative coefficient represents a decrease in monthly consumption while a positive coefficient represents an increase in monthly consumption). In Tables 2 and 3, the monthly gross load impacts are converted into estimated annual estimates and normalized to the nonparticipant square footage and number in household. Estimates for nonparticipants are subtracted from those of participants to estimate net program savings as per Table 5 of the California M&E Protocols. Water heating savings are attributed to the difference between impacts for households with gas water heaters and impacts for households with electric water heaters where the households had similar heating and cooling systems.[3]

Capacity Savings Estimates

In order to estimate the capacity (kW) savings, the average annual kWh savings were divided by 8,760 (number of hours in a year) which is then divided by the coincident system peak load factor (ratio of average hourly consumption to demand coincident with system peak). SDG&E's 1995 estimated residential class system peak

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[3] For example, the average miscellaneous impact for households with electric space heat, air conditioning, and gas water heat is subtracted from the average miscellaneous impact for households with electric space heat, air conditioning, and electric water heat to yield the electric water heat savings.

load factor from the 1995 Class Load Studies was 0.5837. The estimated demand savings is .0059 kW per household.

The methodology described above produced the gross energy impacts and estimated net annual savings for the 1995 Residential EMS Program as shown in Tables 2 and 3 below:

Table 2 ANNUAL ELECTRIC IMPACTS AND SAVINGS (Program savings are depicted as negative numbers)					
	Whole House	**Miscellaneous**	**Space Heating**	**Space Cooling**	**Water Heating**
MIRACLE[4]					
Count	2715	2715	276	1010	194
Gross Impact	-103.92	-573.12	365.64	455.52	-165.12
ENERGRAF					
Count	1796	1796	343	608	185
Gross Impact	-733.56	-876.60	-363.96	310.56	-263.88
Net Savings	-629.64	-303.48	-729.60	-144.96	-98.76
MAIL-IN					
Count	7185	7185	1363	3623	1240
Gross Impact	31.56	-811.92	468.36	712.68	-338.76
Net Savings	135.48	-238.80	102.72	257.16	-173.64
ALL AUDITS					
Count	8981	8981	1706	4231	1425
Gross Impact	-88.32	-824.64	337.56	670.32	-317.40
Net Savings	15.60	-251.52	-28.08	214.80	-152.28

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[4] MIRACLE estimates have 25.5% zeroes added in to the mean and a count increased by the same percentage to account for nonparticipants who added no conservation measures during 1995, and hence had a zero impact.

Table 3 ANNUAL GAS IMPACTS AND SAVINGS (Program savings are depicted as negative numbers)				
	Whole House	**Miscellaneous**	**Space Heating**	**Water Heating**
MIRACLE[4]				
Count	2353	2353	2211	2278
Gross Impact	-2.88	10.56	-14.16	10.92
ENERGRAF				
Count	1339	1339	1314	1313
Gross Impact	-42.48	-21.36	-22.08	8.52
Net Savings	-39.60	-31.92	-7.92	-2.40
MAIL-IN				
Count	5941	5941	5598	5744
Gross Impact	-18.24	-1.68	-17.40	4.56
Net Savings	-15.36	-12.24	-3.24	-6.36
ALL AUDITS				
Count	7280	7280	6912	7057
Gross Impact	-21.84	-4.56	-16.32	4.32
Net Savings	-18.96	-15.12	-2.16	-6.60

Participant Adoption of Measures and Practices

A measure involves the installation, replacement, or removal of physical equipment or material (e.g., install timer, add insulation, replace worn-out parts). A practice is a change in behavior toward appliances (e.g., reduce use, change thermostat setting, clean filter, change time of use).

In order to determine the extent to which program participants adopted specific measures and practices, a telephone survey was conducted of customers who had implemented one or more conservation recommendations. A total of 1,077 participants were interviewed representing 4,058 electric and 2,557 gas adoptions of measures and/or practices. A copy of the survey is included in Appendix A. Appendix B contains a detailed summary of the results of the survey by end use and type of adoption activity.

Synopsis of Results

The following are observations made from the results of the participant adoption survey:

- Adoption of electric and gas recommendations were split nearly evenly between measures and practices.
- General space conditioning adoptions (insulation, weather stripping, caulking, etc.) consisted entirely of measures, whereas the majority of adoptions specific to space heating or air conditioning were practices (reduce use, change thermostat).

- On the electric side, measure adoptions were more prevalent than practice adoptions in general space conditioning, water heating, lighting, and refrigeration. On the gas side, measure adoptions were more prevalent than practice adoptions in general space conditioning and water heating.

- The majority of electric adoptions were in lighting (36%) and refrigeration (15%). The majority of gas adoptions were in space heating (41%) and water heating (33%).

- Both practice and measure adoptions as the result of onsite audits were not significantly different from those of Mail-In audits.

One important modeling implication can be made from the survey results. On the gas side, 33% of adoptions were made in water heating while only 11% of the adoptions were made in the "miscellaneous" end use category. Yet the econometric model shows that miscellaneous therm savings far outweigh water heater savings. This suggests that the miscellaneous coefficient is capturing some of the water heating effects, possibly in the clothes washing and dish washing end uses which use a great deal of hot water. If this is true, the same misallocation may exist on the electric side, although it is not as obvious.

Allocation of Savings to Measures and Practices.

Any effort to allocate program savings to measures and practices using information from the type of survey described above runs into major stumbling blocks. To develop allocation percentages from frequencies alone requires the assumption that each practice or measure results in the same amount of savings. An assumption of this nature is incorrect. For example, cleaning an air filter is not comparable to disconnecting a refrigerator. Some practices, such as changing time of use, may produce a cost savings but may result in no decrease of consumption.

What is needed is a reliable estimate of savings for each of the hundreds of possible measures and practices, and this information is not available. *Ex ante* estimates of savings are usually based on analyses done at the end use level, at best.

The real value in surveys such as the one conducted for this study lies in identifying the types of measures and practices that customers are most willing to adopt, and targeting those activities for education and recommendation. As pointed out in the previous section, the survey may also prove useful as a tool to verify or validate modeling results.

Summary

Energy Impacts

- ENERGRAF (onsite) audit participants experienced significant savings at the whole house level and at each major end use both in electric and gas consumption. At the whole house level, electric savings were -629.64 kWh per year (t=-17.79), which represents 9.7% of average annual household

consumption. Gas savings were -39.60 therms per year (t=-8.29), which is 8.0% of average annual gas consumption. Gas savings were realized at all major end uses.

- Mail-In audit participants experienced an overall increase in electric consumption of 135.48 kWh per year (t=7.01) at the whole house level. These customers also experienced increases in space heating and space cooling consumption. However, savings were experienced in the miscellaneous and water heating electric end uses. The Mail-In participants realized significant savings in gas consumption at the whole house level and at each major end use. Gas savings were -15.36 therms per year (t=-5.60), which is 3.0% of average annual household gas consumption.

- All audit participants combined experienced an insignificant increase of 15.60 kWh per year (t=0.83) and a significant savings of -18.96 therms per year (t=-7.03) at the whole house level. Overall, those participants who had ENERGRAF (onsite) audits tended to realize greater savings than those who filled out Mail-In audits. Onsite audits are the result of high bill complaints while Mail-In audit customers have a different motivation for participating in the program. Another reason for the savings differences may also be due to an increase in motivation to adopt recommendations when the more personal onsite attention is given. ENERGRAF customers also demonstrated significant space heating and space cooling savings, whereas Mail-In customers showed increased consumption in these end uses.

Adoption Activity

- Adoptions of audit recommendations were split evenly between measures and practices. There was no significant difference between adoptions from onsite audits and those from Mail-In audits.

- The majority of electric adoptions were in lighting (36%)and refrigeration (15%). The majority of gas adoptions were in space heating (41%) and water heating (33%).

- Results of the adoption survey suggest that savings under the "miscellaneous" end use category may be capturing some of the water heating savings from clothes washing and dish washing.

- Allocation of savings to specific measures and practices is nearly impossible due to lack of information at this level.

M&E PROTOCOLS TABLE 6

RESULTS USED TO SUPPORT PY95 SECOND EARNINGS CLAIM

FOR

RESIDENTIAL ENERGY MANAGEMENT SERVICES
FIRST YEAR LOAD IMPACT EVALUATION

FEBRUARY 1997

STUDY ID NO. 977

SAN DIEGO GAS & ELECTRIC

M&E PROTOCOLS TABLE 6 - RESULTS USED TO SUPPORT PY96 SECOND EARNINGS CLAIM FOR RESIDENTIAL ENERGY MANAGEMENT SERVICES PROGRAM

FIRST YEAR LOAD IMPACT EVALUATION, FEBRUARY 1997, STUDY ID NO. 977

Designated Unit of Measurement: LOAD IMPACTS PER DWELLING UNIT
END USE: ALL END USES COMBINED, ALL AUDITS COMBINED

| | | | 6. A. 90% CONFIDENCE LEVEL | | | | 6. B. 80% CONFIDENCE LEVEL | | | |
			LOWER BOUND		UPPER BOUND		LOWER BOUND		UPPER BOUND	
1. Average Participant Group and Average Comparison Group	PART GRP	COMP GRP	PART GRP	COMP GRP	PART GRP	COMP GRP	PART GRP	COMP GRP	PART GRP	COMP GRP
A. Pre-install usage:										
Pre-Install kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pre-Install kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pre-Install Therms	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Base kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Base kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Base Therms	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Base kW designated unit of measurement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Base kWh designated unit of measurement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Base Therms/ designated unit of measurement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B. Impact year usage:										
Impact Yr kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Impact Yr kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Impact Yr Therms	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Impact Yr kW/designated unit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Impact Yr kWh/designated unit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Impact Yr Therms/designated unit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2. Average Net and Gross End Use Load Impacts	AVG GROSS	AVG NET	AVG GROSS	AVG NET	AVG GROSS	AVG NET	AVG GROSS	AVG NET	AVG GROSS	AVG NET
A. i. Load Impacts - kW	0.0059	-0.0010	0.0046	-0.0031	0.0072	0.0010	0.0049	-0.0026	0.0069	0.0006
A. ii. Load Impacts - kWh	88.32	-15.6	69.2	-46.5	107.5	15.3	73.4	-39.7	103.2	8.5
A. iii. Load Impacts - Therms	21.84	18.96	19.5	14.5	24.2	23.4	20.0	15.5	23.7	22.4
B. i. Load Impacts/designated unit - kW	0.0059	-0.0010	0.0046	-0.0031	0.0072	0.0010	0.0049	-0.0026	0.0069	0.0006
B. ii. Load Impacts/designated unit - kWh	88.32	-15.6	69.2	-46.5	107.5	15.3	73.4	-39.7	103.2	8.5
B. iii. Load Impacts/designated unit - Therms	21.84	18.96	19.5	14.5	24.2	23.4	20.0	15.5	23.7	22.4
C. i. a. % change in usage - Part Grp - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C. i. b. % change in usage - Part Grp - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C. i. c. % change in usage - Part Grp - Therms	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C. ii. a. % change in usage - Comp Grp - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C. ii. b. % change in usage - Comp Grp - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C. ii. c. % change in usage - Comp Grp - Therms	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D. Realization Rate:	AVG GROSS	AVG NET	AVG GROSS	AVG NET	AVG GROSS	AVG NET	AVG GROSS	AVG NET	AVG GROSS	AVG NET
D.A. i. Load Impacts - kW, realization rate	109%	0%	86%	0%	133%	19%	91%	0%	128%	11%
D.A. ii. Load Impacts - kWh, realization rate	472%	0%	370%	0%	574%	82%	392%	0%	552%	45%
D.A. iii. Load Impacts - Therms, realization rate	327%	264%	292%	218%	363%	351%	300%	232%	355%	336%
D.B. i. Load Impacts/designated unit - kW, real rate	109%	0%	86%	0%	133%	19%	91%	0%	128%	11%
D.B. ii. Load Impacts/designated unit - kWh, real rate	472%	0%	370%	0%	574%	82%	392%	0%	552%	45%
D.B. iii. Load Impacts/designated unit - Therms, real rate	327%	264%	292%	218%	363%	351%	300%	232%	355%	336%
3. Net-to-Gross Ratios	RATIO		RATIO		RATIO		RATIO		RATIO	
A. i. Average Load Impacts - kW	0.0	N/A	0.0	N/A	0.1	N/A	0.0	N/A	0.1	N/A
A. ii. Average Load Impacts - kWh	0.0	N/A	0.0	N/A	0.1	N/A	0.0	N/A	0.1	N/A
A. iii. Average Load Impacts - Therms	0.9	N/A	0.7	N/A	1.0	N/A	0.8	N/A	0.9	N/A
B. i. Avg Load Impacts/designated unit of measurement - kW	0.0	N/A	0.0	N/A	0.1	N/A	0.0	N/A	0.1	N/A
B. ii. Avg Load Impacts/designated unit of measurement - kWh	0.0	N/A	0.0	N/A	0.1	N/A	0.0	N/A	0.1	N/A
B. iii. Avg Load Impacts/designated unit of measurement - Therms	0.9	N/A	0.7	N/A	1.0	N/A	0.8	N/A	0.9	N/A
C. i. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C. ii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C. iii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - Therms	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4. Designated Unit Information Data	PART GRP	COMP GRP							COMP GRP	
A. Pre-install average values										
Electric Participant Square Footage	1,787	1,598								N/A
Electric Participant Number in Household	2.93	2.67								N/A
Gas Participant Square Footage	1,828	1,576								N/A
Gas Participant Number in Household	3.00	2.72								N/A
B. Post-install average values										
Electric Participant Square Footage	1,787	1,598								N/A
Electric Participant Number in Household	2.93	2.67								N/A
Gas Participant Square Footage	1,828	1,576								N/A
Gas Participant Number in Household	3.00	2.72								N/A
6. Measure Count Data	NUMBER									
A. Number of measures installed by participants in Part Group	N/A									
B. Number of measures installed by all program participants in the 12 months of the program year	N/A									
C. Number of measures installed by Comp Group	N/A									
7. Market Segment Data	CZone 7	CZone 10								
Number of Participants	4,120	4,861								

Note 1: For purposes of this table, negative load impacts are depicted as positive numbers.
Note 2: kW savings derived from 1995 Class Load Studies residential System peak load factor of 6.5837.
Note 3: Ex-Ante estimated savings and participant count used in realization rates are taken from the DSM Annual Summary and Technical Appendix, May 1996, pp. II-9 and TA 1-28.

M&E PROTOCOLS TABLE 7

DATA QUALITY AND PROCESSING DOCUMENTATION

FOR

RESIDENTIAL ENERGY MANAGEMENT SERVICES
FIRST YEAR LOAD IMPACT EVALUATION

FEBRUARY 1997

STUDY ID NO. 977

M&E PROTOCOLS TABLE 7
DATA QUALITY AND PROCESSING DOCUMENTATION
For Residential Energy Management Services Program
First Year Load Impact Evaluation
February 1997
Study ID No. 977

A.   OVERVIEW INFORMATION

1.   **Study Title and Study ID:**   1995 Residential Energy Management Services (REMS) Program: First Year Load Impact Evaluation, MPAP-95-P03-977-702, Study ID No. 977, February 1997.

2.   **Program, Program Year(s), and Program Description (Design):** Residential Energy Management Services Program for the 1995 program year.   The ENERGRAF (onsite), Low-Cost/No-Cost Pool/Spa, and Home Energy Profile Service (Mail-In) audits provide customers with comprehensive information about energy management measures and practices to reduce electric and gas consumption.   This report covers only the ENERGRAF and Mail-In audits.

3.   **End Uses and/or Measures Covered:** All end uses combined disaggregated by space cooling, space heating, water heating, and miscellaneous.

4.   **Methods and Models Used:** The study uses a regression-based billing analysis to estimate net Program impacts.   See the section of the report entitled "The Econometric Framework" on page 5 for a complete description of the final model specifications.

5.   **Participant and Comparison Group Definition:** For the load impact analysis, the participants are defined as customers having had an ENERGRAF (onsite) or Mail-In audit during 1995.   The comparison group was taken from the 1995 Home Energy Survey (MIRACLE XII) database.

6.   **Analysis Sample Size:**

ELECTRIC PARTICIPANT SAMPLE FOR 1995 RESIDENTIAL EMS				
	# of Customers	# of Installations [*]	# of Measures [*]	Avg. # of Months of Data
Space Heating	1,706	Not Available	Not Available	32.3
Space Cooling	4,231	Not Available	Not Available	32.5
Water Heating	1,425	Not Available	Not Available	32.5
Miscellaneous	8,981	Not Available	Not Available	32.5
Total	8,981	Not Available	Not Available	32.5

GAS PARTICIPANT SAMPLE FOR 1995 RESIDENTIAL EMS				
	# of Customers	# of Installations *	# of Measures *	Avg. # of Months of Data
Space Heating	6,912	Not Available	Not Available	32.6
Water Heating	7,057	Not Available	Not Available	32.5
Miscellaneous	7,280	Not Available	Not Available	32.5
TOTAL	7,280	Not Available	Not Available	32.5

* Only the number of *recommended* installations and measures is available on the audit databases. Actual adoptions of recommendations are not available except in the adoptions survey sample (see Appendix B).

B. DATABASE MANAGEMENT

1. Flow Charts:
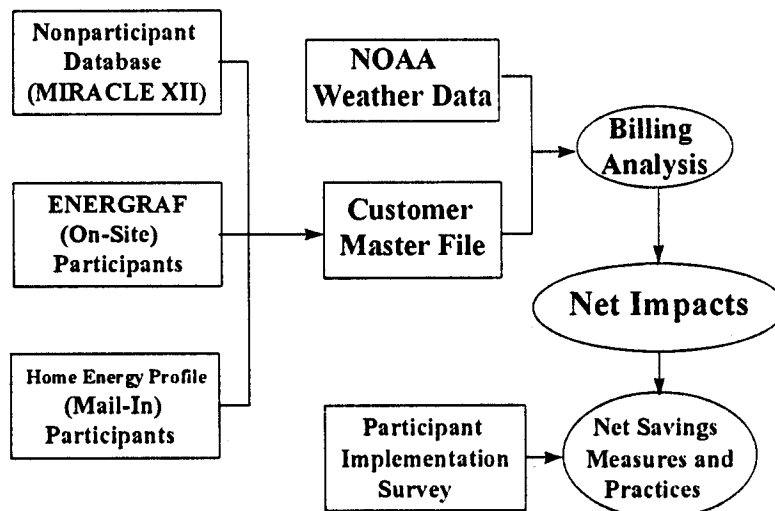
2. Data sources: the data came from the following sources:

a. Participant name, address, account number, appliance saturation, demographics, and participation date from the 1995 ENERGRAF (onsite) program tracking database;

b. Participant name, address, account number, appliance saturation, demographics, and participation date from the 1995 Mail-In program tracking database;

c. Nonparticipant name, address, account number, appliance saturation, demographics, and conservation activity from the Home Energy Survey for 1995 (MIRACLE XII) database;

d. 1994-1996 electric and gas consumption history from the Customer Master File;

e.   1994-1996 hourly weather data for three climate zones from the National Oceanic and Atmospheric Administration (NOAA) files; and

f.   Participant survey of implementation of audit recommendations by measure and practice.

The data were merged together to form the dataset for the regression analysis leading to the estimated energy savings per dwelling unit. The savings were further disaggregated by space cooling, space heating, water heating, and miscellaneous end uses.

3.   Data Attrition:

a.   Participant Sample - Load Impact Analysis

Number of Participants for Load Impact Analysis	
1995 REMS Participants Initial Database	18,596
Eliminate accounts with missing account, appliance, or demographic data	17,627
Successful match with historical billing file	16,177
Participants meeting minimum pre/post data requirements	10,359
Eliminate influential data points and participants with invalid regression output	8,981

b.   Nonparticipant Sample - Load Impact Analysis

Number of Nonparticipants for Load Impact Analysis	
1995 MIRACLE XII nonparticipants	5,000
Eliminate accounts with missing account, appliance, or demographic data	4,642
Successful match with historical billing file	4,527
Participants meeting minimum pre/post data requirements	3,280
Eliminate influential data points and participants with invalid regression output	2,715

4.   **Data Quality Checks:** The data sets for the regression analysis were merged in SAS by the appropriate key variables. Counts of the data sets before and after the merges were verified to ensure accurate merging.

5.   **All data collected** for this analysis were utilized.

C.   SAMPLING

1.   **Sampling procedures and protocols:** A census of participants was attempted. See section B.3.a. of this Table 7 for a detailed description.

2.   **Survey information:** A copy of the Participant Adoption Survey is included in Appendix A of the report.   Participants were sampled until at least 1,000 adopters were contacted.

3. **Statistical Descriptions:**

Electric Participant and Nonparticipant Statistics				
	Count	**Square Footage**	**Number in Household**	**Average kWh/month**
ENERGRAF	1,796	1,429	2.89	629
Mail-In	7,185	1,877	2.94	727
All Audits	8,981	1,787	2.93	707
MIRACLE XII	2,715	1,598	2.67	481

Gas Participant and Nonparticipant Statistics				
	Count	**Square Footage**	**Number in Household**	**Average Therms/month**
ENERGRAF	1,339	1,516	2.92	41.2
Mail-In	5,941	1,899	3.02	42.2
All Audits	7,280	1,828	3.00	42.0
MIRACLE XII	2,353	1,576	2.72	34.6

D.   DATA SCREENING AND ANALYSIS

1.   In determining **outliers** and **influential** data points, the root mean square error in the regression equation was divided by the intercept for each individual household and used as a proxy for volatile data streams.   For electric consumption, the influential point definition was >40% while for gas consumption, (which generally has less volatility than electric consumption), the outlier definition was 70%. Outliers were defined as those estimates which were at least four standard deviations away from the sample mean.   Estimated household savings determined to be influential points were eliminated from the mean household savings and associated statistical calculations.   It was found that elimination of outliers had no significant affect on the results and these points were left in the analysis.

Missing Data Points: Only one variable with missing data was updated, the fuel type for water heating variable. If the residence had gas consumption, and if the fuel type for water heating was missing, it was assumed to be gas. According to SDG&E's MIRACLE (residential saturation survey), this would be correct 98% of the time.

Remaining missing data points were ignored in all calculations.

Weather Adjustments are described in "The Econometric Framework" section of the report on page 5.

2. A trend variable was included in the model to control for the effect of "background" variables.

3. See sections B.3.a. and D.1. of this Table 7 for data screening for inclusion in the final analysis dataset.

4. Regression statistics: see Table 6 of the report for coefficients and confidence intervals.

5. **Specification:**

a. The model is estimated entirely at the customer level (the extreme case of accounting for customer heterogeneity); the sources of variation are variation in weather over time and the date of the audit.

b. The cooling degree-hour and heating degree-hour regressors are based on estimates of hourly temperature (which are, in turn, based on daily high and low temperatures). The base for the cooling degree-hour and heating degree-hour are 65 degrees Fahrenheit. Other time-dependent regressors are a trend variable, an audit date indicator variable, and interactions between degree-hours and the indicator variable.

c. Self-selection was not addressed.

d. No factors were eliminated from the regression model as it was originally specified.

e. The difference between pre-audit consumption and post-audit consumption is calculated directly from the regression equation, yielding gross impacts. Net impacts are defined as the difference in the gross impacts between participants and the comparison group.

6. **Error in Measuring Variables:** A series of reasonability checks were run on survey data to verify fuel types and account for missing answers to the water heater fuel type. Billing data were screened for changes in occupancy.

7.   **Autocorrelation:** Not Addressed.

8.   **Heteroskedasticity:** Not Addressed.

9.   **Collinearity:** With both cooling degree-hours and heating degree-hours in the electric model, it is likely that collinearity exists. However, since the goal is to estimate all end uses combined at the dwelling level, while the savings allocated to the end uses may be biased, the savings in the aggregate are reliable.

10.   **Influential Data Points:** See part D.1. Influential data points were eliminated from all calculations.

11.   **Missing Data:** See part D.1. Remaining missing data points were ignored in all calculations.

12.   **Precision:** The standard errors for the estimates were calculated from the variances of the samples of participants on the variable(s) in question.

E.   DATA INTERPRETATION AND APPLICATION

1.   **Calculation of Net Impacts** is specified by item a: the difference between participant impacts and nonparticipant impacts.

2.   **The process** used in calculation of net impacts is that specified in Table 5 of the M&E Protocols.