APPENDIX C

IMPACT MEASUREMENT PROTOCOLS
FOR DSM PROGRAMS

TABLE C-1: IMPACT MEASUREMENT PROTOCOLS FOR
THE RESIDENTIAL WEATHERIZATION RETROFIT INCENTIVES PROGRAM
(Space Conditioning-Weatherization)

STUDY SCOPE

A. End Use Elements (SFDU): (1) space heating (electric and/or gas); (2) combined electric heating and cooling

A. Measures: attic, wall, and/or duct insulation, weatherstripping and caulking.

DESIGNATED UNIT(S) OF MEASUREMENT

- Load impacts per dwelling unit;

PARTICIPANT GROUP

1. Sample design and billing data requirements , per Table 5, for each end use element; a participant is further defined as a customer who at least installed either attic or wall insulation.

2. The End Use Consumption and Load Impact Model will be either a load impact regression model or CE model; may include the use of a Building Simulation Model to improve the model capability to identify the effects of heating and/or cooling on bills from the weatherization treatment.

3. Hours of operation and related equipment characteristics used in the end use model(s) to produce estimates of pre-installation usage, base usage, and first year load impacts will be based on premise-specific data from a mix of data sources, including mail surveys, on-site data collected by a utility representative, and on-site data produced from end use metering and/or monitoring equipment.

4. Electric capacity load impacts should be based on (a) the results of end use metering activities identified in #3 or, if not available or usable; (b) a documented end use load shape study of the mix of data sources, including mail surveys, on-site data collected by a utility representative, and on-site data produced from end use metering and/or monitoring equipment. end use element, or, if not available or usable; (c) relationships between end use energy and capacity loads used in utility or CEC demand forecasting models.

5. Weather adjustments to usage and load impacts must be based on long-run normal weather conditions, as used in the utility or CEC demand forecasting model.

6. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

7. Usage and load impacts for years beyond the first impact year will be measured, calculated, and reported according to the above protocols for each required year of the measurement period according to the requirements for impact studies identified in Tables 8 and 9.

COMPARISON GROUP

1. Sample design and billing data protocols per Table 5, Comparison Group (B) only; customers who installed weatherization measures prior to the program year should not be excluded from the sample.

2. The comparison group must either be analyzed simultaneously with participants within the chosen end use consumption and load impact model or use the same model if the two groups are analyzed separately in a difference-of-differences approach.

3. Data for hours of operation (and related equipment characteristics) must be used in the same manner as for Participant Group analysis, Protocol #3 , but based on data collected from the Comparison Group sample.

4. Electric capacity and weather adjustment protocols for Participant Group apply to Comparison Group.

5. Measure cost analysis not required; if included in the evaluation design, the collection of measure cost data from the Comparison Group should be done in a manner and form which will facilitate the inclusion of the data in the statewide Measure Cost Study.

6. Usage and load impacts for years beyond the first impact year: Participant Group protocol #7 applies to the Comparison Group analysis.

TABLE C-2: IMPACT MEASUREMENT PROTOCOLS FOR
THE RESIDENTIAL APPLIANCE EFFICIENCY INCENTIVES PROGRAM
(Space Conditioning--High Efficiency Appliances)

STUDY SCOPE

A. End Use Elements (SFDU): (1) space heating (electric or gas); (2) electric space heating and/or cooling; (3) gas space heating and electric cooling; and (4) gas water heating

B. Measures: high efficiency space heating and/or space cooling appliances; high efficiency gas water heaters

DESIGNATED UNIT(S) OF MEASUREMENT

- Load impacts per dwelling unit

PARTICIPANT GROUP

1. Sample design and billing data requirements , per Table 5, for each end use element.

2. The End Use Consumption and Load Impact Model will be either a CDA or CE model; may include the use of a Building Simulation Model to improve the model capability to identify the effects of heating and/or cooling on bills from the high efficiency appliance.

3. Hours of operation and related equipment characteristics used in the end use model(s) to produce estimates of pre-installation usage, base usage, and first year load impacts will be based on premise-specific data from a mix of data sources, including mail surveys, on-site data collected by a utility representative, and on-site data produced from end use metering and/or monitoring equipment.

4. The effects of existing state or federal efficiency standards on base usage and load impact calculations must be explicitly accounted for and be based on the methods prescribed in Appendix G.

5. Electric capacity load impacts must be based on (a) the results of end use metering activities identified in #3 or, if not available or usable; (b) cooling end use load shapes from other sources.

6. Weather adjustments to usage and load impacts must be based on long-run normal weather conditions, as used in the utility or CEC demand forecasting model.

7. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

8. Usage and load impacts for years beyond the first impact year will be measured, calculated, and reported according to the above protocols for each required year of the measurement period according to the impact studies identified in Tables 8 and 9.

COMPARISON GROUP

1. Sample design and billing data protocols per Table 5, Comparison Group (A); customers who installed high efficiency equipment prior to the program year should not be excluded from the sample.

2. The comparison group must either be analyzed simultaneously with participants within the chosen end use consumption and load impact model or use the same model if the two groups are analyzed separately in a difference-of-differences approach.

3. Data for hours of operation (and related equipment characteristics) and accounting for the effects of state and federal efficiency standards must be used in the same manner as for Participant Group analysis Protocols #3, 4, and 5, but based on data collected from the Comparison Group sample.

4. Electric capacity and weather adjustment protocols for Participant Group apply to Comparison Group.

5. Measure cost analysis not required; if included in the evaluation design, the collection of measure cost data from the Comparison Group should be done in a manner and form which will facilitate the inclusion of the data in the statewide Measure Cost Study.

6. Usage and load impacts for years beyond the first impact year: Participant Group protocol #8 applies to the Comparison Group analysis.

TABLE C-3A: IMPACT MEASUREMENT PROTOCOLS FOR THE RESIDENTIAL APPLIANCE EFFICIENCY INCENTIVES PROGRAM
(High Efficiency Lighting)

STUDY SCOPE

A. End Use Elements: Lighting in Single-Family and Multi-Family Dwelling Units

B. Measures: High-Efficiency Lighting

DESIGNATED UNITS OF MEASUREMENT

- Load impacts per lamp

GENERAL REQUIREMENTS

To the extent possible, all parameters specified for the end use consumption and load impact models will be developed from statewide studies recognizing the differences between program types (e.g., direct install, rebate-type, etc.). Statewide results may be modified based on program-specific data. Other utility/program specific parameters will be developed from studies conducted by the individual utilities.

PARTICIPANT GROUP

1. Sample design per Table 5. A participant is defined as a residential customer who has acquired high efficiency lights through a utility -sponsored Residential Appliance Efficiency Incentive Program.

2. The End Use Consumption and Load Impacts will be assessed through a Simplified Engineering Model (SEM) or Calibrated Engineering (CE) Model.

3. Annual hours of operation (adjusted for seasonal variation), installation wattage (including replaced wattage), and other related equipment characteristics needed in the end use model(s) will be based on premise-specific data from (a) mail or telephone surveys, (b) on-site inspections, (c) direct mail response ("bounceback") cards, (d) end-use monitoring, and/or (e) existing data.

4. Electric capacity load impacts will be based on sources identified in #3 above or lighting end-use load shapes from other sources.

5. Weather adjustments to usage and load impacts are not necessary for lighting.

6. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

7. Retention will be estimated based on premise-specific data. Retention includes the estimation of installation and removal rates. Migration of compact fluorescent bulbs outside the service territory and cross-over sales into the nonresidential sector will also be accounted for. Acceptable approaches for data collection on retention are: (a) mail or telephone surveys, (b) on-site visits, (c) bounceback cards, (d) sales and store audit data, and/or (e) product shipment data. Data for retention studies will be collected annually.

8. Usage and load impacts for years beyond the first impact year will be measured, calculated, and reported according to the above protocols for each required year of the measurement period according to the duration and frequency requirements for impact studies identified in Tables 8 and 9.

NET LOAD IMPACTS

1. <u>Acceptable methods to estimate first year net impacts</u> include:

    a. use of Comparison Groups, (refer to Comparison Group Requirements below), or

    b. modeling pre- and post-program sales trends with regression-based time-series methods,

    c. quasi-experimental design control area/program treatment area comparisons, or

    d. discrete choice models.

2. <u>Comparison Group Requirements</u>:

    a. Sample design, per Table 5, Comparison Groups (A) and/or (B); customers who installed high efficiency lights prior to the program year should not be excluded from the sample.

    b. The comparison group must either be analyzed simultaneously with participants within the chosen <u>end use consumption and load impact model</u> or use the same model if the two groups are analyzed separately in a difference-of-differences approach.

    c. Data for hours of operation and related equipment characteristics must be used in the same manner as for the Participant Group.

    d. Electric capacity load impacts and weather adjustments protocols for the Participant Group apply to the Comparison Group.

    e. Measure cost analysis not required.

3. <u>Data for net program impacts</u> for net load impact methods (b), (c), and (d) will be based on product-specific data from a mix of data sources that capture high efficiency lighting measure penetration rates. Sources shall include program records and (a) customer and general consumer surveys of program participants and program nonparticipants, (b) retail sales and store audit data, or (c) product shipment data.

TABLE C-3B: IMPACT MEASUREMENT PROTOCOLS FOR
THE RESIDENTIAL APPLIANCE EFFICIENCY INCENTIVES PROGRAM
(High Efficiency Refrigeration)

STUDY SCOPE

A. End-Use Elements: Refrigeration in Single-Family and Multi-Family Dwelling Units

B. Measures: High-Efficiency Refrigerators and Freezers

DESIGNATED UNITS OF MEASUREMENT

*   Load impacts per cubic foot of adjusted volume[1] or per refrigerator

GENERAL REQUIREMENTS

1. To the extent possible and reasonable, the estimates used for per unit measure costs and load impacts shall be obtained through a single statewide activity.

2. Assumptions for per-unit impacts for refrigerators will account for the effects of changes in Federal and State energy efficiency standards.

METHODS TO ESTIMATE FIRST YEAR IMPACTS

A. Sample design requirements, per Table 5, where survey samples are required to collect premise-specific information. A program participant is defined as a residential customer who acquired a high efficiency refrigerator through a utility-sponsored residential appliance efficiency program.

B. Data collection and analysis methods

    1. Appliance characteristics data required for energy consumption calculations will be based on analysis of brand and model-specific information obtained from (a) utility DSM program tracking records and, where appropriate, (b) consumer product registration records supplied by manufacturers.

    2. Gross energy impacts, adjusted for the effects of refrigerator standards, will be calculated based on estimates of energy consumption from:

        a. Manufacturer test results obtained from DOE testing procedures[2] and the maximum allowable energy consumption permitted by refrigerator standards for comparable sized units. The results of DOE testing procedures used to estimate in-field energy consumption will be verified or adjusted through analyses of metered data for efficient refrigerators.

    3. Demand (kW) impact estimates will be based on:

        a. Metered hourly load data from existing utility refrigerator metering studies, or,

        b. ongoing refrigerator load metering studies.

    4. Data for net program impacts will be based on product-specific data from a mix of data sources that capture refrigerator penetration rates. Sources shall include program records and (a) customer and general consumer surveys of program participants and program non-participants, (b) retail sales and store audit data, or (c) product shipment data.

    5. Acceptable methods to estimate first year net impacts include:

        a. modeling pre and post-program sales trends with regression-based time-series methods,

        b. quasi-experimental design control area/program treatment area comparisons, or

        c. discrete choice models.

C. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

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[1] Adjusted volume is the volume used to rate refrigerators according to federal energy efficiency regulations. It is calculated as 1.63 x (volume of freezer) + (volume of fresh food compartment).

[2] Federally mandated test required to document manufacturer compliance with Federal and California energy efficiency regulations. Results are published by the CEC in Directory of Refrigerators, Refrigerator-Freezers, and Freezers.

TABLE C-4: IMPACT MEASUREMENT PROTOCOLS FOR
THE COMMERCIAL ENERGY EFFICIENCY INCENTIVES PROGRAM

STUDY SCOPE

A. End Use Elements: (1) indoor lighting; (2) HVAC (electric or gas); (3) gas cooking

B. Measures (from customized and standard rebate programs combined): all major lighting related high efficiency measures combined; all major high efficiency HVAC measures combined

DESIGNATED UNIT(S) OF MEASUREMENT

- Lighting: load impacts per affected square foot per 1000 hours of operation
- HVAC: load impacts per affected square foot of conditioned space
- Gas Cooking: load impacts per project

PARTICIPANT GROUP

1. <u>Sample design and billing data requirements</u>, per Table 5, for each end use element; a participant is further defined for each end use element as a customer who installed at least one of the end use measures identified in the forecast filing for the program year.

2. <u>The End Use Consumption and Load Impact Model</u> will be either a load impact regression model (LIRM) or Calibrated Engineering (CE) model, or for the HVAC end use specifically, a Building Simulation Model; the LIRM or CE may include the use of a Building Simulation Model to improve the model capability to identify the effects of heating and/or cooling on bills from high efficiency HVAC or from space conditioning effects of lighting measures.

3. <u>Hours of operation</u> and related equipment characteristics used in the end use model(s) to produce estimates of pre-installation usage, base usage, and first year load impacts will be based on premise-specific data from a mix of data sources, including mail surveys, on-site data collected by a utility representative, and on-site data produced from end use metering and/or monitoring equipment.

4. <u>Square footage estimates</u> (conditioned space and lighted area) used in the end use model(s) to produce estimates of pre-installation usage, base year usage, and first year impacts must be based on (a) premise-specific data collected and used for purposes of establishing the terms and conditions of financial assistance, or, if not available; (b) premise-specific data collected on-site from all remaining customers in the participant group evaluation sample.

5. <u>The effects of existing state or federal efficiency standards</u> on pre-installation usage, base usage, and load impact calculations must be explicitly accounted for and be based on the methods prescribed in Appendix G.

6. <u>Electric capacity load impacts</u> must be based on (a) the results of end use metering activities identified in #3 or, if not available or usable; (b) end use load shapes from other sources, or, if not available or usable; (c) relationships between end use energy and capacity loads used in utility or CEC demand forecasting models, weighted to reflect the average of building types in the participant sample.

7. <u>Weather adjustments</u> to usage and load impacts must be based on long-run normal weather conditions, as used in the utility or CEC demand forecasting model.

8. <u>Measure cost</u> estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

9. <u>Usage and load impacts for years beyond the first impact year</u> will be measured, calculated, and reported according to the above protocols for each required year of the measurement period, according to the duration and frequency requirements for impact studies identified in Tables 8 and 9.

COMPARISON GROUP

1. <u>Sample design and billing data protocols</u>, per Table 5, Comparison Groups (A) and (B); for each end use element; customers who installed high efficiency measures prior to the program year should not be excluded from the sample.

2. The comparison group must either be analyzed simultaneously with participants within the chosen <u>end use consumption and load impact model</u> or use the same model if the two groups are analyzed separately in a difference-of-differences approach.

3. Data for <u>hours of operation </u>(and related equipment characteristics), <u>square footage,</u> and accounting for the <u>effects of state and federal efficiency standards</u> must be used in the same manner as for Participant Group analysis Protocols #3, 4, and 5, but based on data collected from the Comparison Group sample.

4. <u>Electric capacity and weather adjustment</u> protocols for Participant Group apply to Comparison Group.

5. <u>Measure cost</u> analysis not required; if included in the evaluation design, the collection of measure cost data from the Comparison Group should be done in a manner and form which will facilitate the inclusion of the data in the statewide Measure Cost Study.

6. <u>Usage and load impacts for years beyond the first impact year</u>: Participant Group protocol #10 applies to the Comparison Group analysis.

TABLE C-5: IMPACT MEASUREMENT PROTOCOLS FOR
THE INDUSTRIAL ENERGY EFFICIENCY INCENTIVES PROGRAM

STUDY SCOPE

A. End Use Elements: (1) Indoor lighting; (2) motors; (3) industrial process (electric and gas)

B. Measures (from customized and standard rebates combined): all high efficiency lighting measures combined, all motor efficiency improvement measures combined, all types of industrial processes efficiency improvement projects (electric or natural gas)

DESIGNATED UNIT(S) OF MEASUREMENT

- High Efficiency Lighting: load impacts per affected square foot per 1000 hours of operation
- High Efficiency Motors: load impacts per horsepower
- Industrial Process(electric or gas): load impacts per group of related measures or per project

PARTICIPANT GROUP

1. Sample design and billing data requirements, per Table 5, for each end use element; a participant is further defined for each end use element as a customer who installed at least one of the end use measures identified in the forecast filing for the program year.

2. The End Use Consumption and Load Impact Model may be a load impact regression model, CE, or Engineering Model. For end use elements in which end-use consumption and load impacts are based on premises-specific engineering models, engineering analyses must be applied to either: (a) projects representing at least 70 percent of the total kW, kWh, and therm savings for that end use element, or (b) the total evaluation sample for that end use element per Table 5. Verification of installation must be conducted for all projects in the evaluation sample. Thorough and credible premise-specific *ex ante* engineering models may be employed provided that the ex ante model results are adjusted to reflect post-installation premise specific hours of operation and related equipment characteristics (see 3, below).

3. Hours of operation and related equipment characteristics used in the end use model(s) to produce estimates of pre-installation usage, base usage, and first year load impacts will be based on premise-specific data based from a mix of data sources, including: telephone surveys, Mail surveys, on-site discussions with facility personnel, on-site data produced from end-use metering and/or monitoring equipment, facility production records, and facility billing records.

4. Square footage estimates (conditioned space and lighted area) used in the end use model(s) to produce estimates of pre-installation usage, base year usage, and first year impacts must be based on (a) premise-specific data collected and used in performing customer cost-effectiveness analysis for purposes of establishing the terms and conditions of financial assistance, or, if not available; (b) premise-specific data collected on-site from a sub-sample.

5. The effects of existing state or federal efficiency standards on pre-installation usage, base usage, and load impact calculations must be explicitly account for and be based on the methods prescribed in Appendix G.

6. Electric capacity load impacts must be based on (a) the results of end use metering activities identified in #3, or, if not available or usable; (b) end use load shapes from other sources, or, if not available or usable; (c) relationships between end use energy and capacity loads used in utility or CEC demand forecasting models, weighted to reflect the average of similar SIC industries in the participant sample.

7. Weather adjustments (for weather-sensitive end uses, if any) to usage and load impacts must be based on long-run normal weather conditions, as used in the utility or CEC demand forecasting model.

8. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

9. Usage and load impacts for years beyond the first impact year will be measured, calculated, and reported according to the above protocols for each required year of the measurement period, according to the duration and frequency requirements for impact studies identified in Tables **8** and **9**.

10. The analysis of load and cost impacts will be conducted by a registered Professional Engineer, or other professional, with a demonstrated expertise in the affected industry.

COMPARISON GROUP

1. Each utility must conduct an assessment of the extent to which major measures that are being promoted in the Industrial EEI Program may have been installed by some customers in the absence of a program. These studies should estimate the net-to-gross ratios for the measures or end uses that comprise over 50% of the expected savings from this program. These studies do not have to employ comparison group analysis. Other measures can use the following default ratios: 1.0 for projects with a demonstrated payback of two years or more, .75 if the payback period is more than 6 months and less than 2 years, and .4 if the payback period is 6 months or less.

TABLE C-6: IMPACT MEASUREMENT PROTOCOLS FOR THE AGRICULTURAL ENERGY EFFICIENCY INCENTIVES PROGRAM

STUDY SCOPE

A. End Use Element: (1) pumping (electric and/or gas)

B. Measures (customized and standard rebates combined): pump replacement and repairs for electric motors and gas engines

DESIGNATED UNIT(S) OF MEASUREMENT

- Load impacts per acre foot of water pumped

PARTICIPANT GROUP

1. Sample design requirements per Table 5.

2. The End Use Consumption and Load Impact Model will be either a load impact regression model, or CE model or a Simplified Engineering model.

3. If billing data is used, requirements of Table 5 apply.

4. If billing data is not used in the analysis, the analysis will rely on direct end use metering.

5. Hours of operation and related equipment characteristics used in the end use model(s) to produce estimates of pre-installation usage and first year load impacts must be based on premise-specific data from a mix of data sources, including mail surveys, on-site data collected by a utility representative, and on-site data produced from end use metering and/or monitoring equipment.

6. Electric capacity load impacts must be based on (a) the results of end use metering activities identified in #4 or, if not available or usable; (b) end use load shapes from other sources, or, if not available or usable; (c) the relationships between end use energy and capacity loads used in utility or CEC demand forecasting models.

7. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

8. Usage and load impacts for years beyond the first impact year will be measured, calculated, and reported according to the above protocols for each required year of the measurement period according to the duration and frequency requirements for impact studies identified in Tables **8** and **9**.

COMPARISON GROUP

1. Sample design and billing data protocols per Table 5, Comparison Groups (A) and (B); for each end use element; customers who installed high efficiency measures prior to the program year should not be excluded from the sample).

2. The comparison group must either be analyzed simultaneously with participants within the chosen end use consumption and load impact model or use the same model if the two groups are analyzed separately in a difference-of-differences approach.

3. Billing data requirements (if used) and load metering (if used) treated the same as for Participant Group.

4. Electric capacity protocols for Participant Group apply to Comparison Group.

5. Measure cost analysis not required; if included in the analysis design, it must be used in a manner consistent with the Participant Group.

6. Usage and load impacts for years beyond the first impact year: Participant Group protocol #8 applies to the Comparison Group analysis.

TABLE C-7: IMPACT MEASUREMENT PROTOCOLS FOR THE RESIDENTIAL NEW CONSTRUCTION PROGRAM

STUDY SCOPE

A. End Use Elements (SFDU): Whole Building
B. Measures: all combinations of envelope improvements and high efficiency heating/cooling, high efficiency water heating appliances (including solar)

DESIGNATED UNIT(S) OF MEASUREMENT

- Load impacts per dwelling unit and per square foot

PARTICIPANT GROUP

1. <u>Sample design</u>, per Table 5 for each end use element; a participant is further defined as a customer who installed at least one of the end use measures used in forecast filing for the program year

2. <u>Billing data requirements</u>, per Table 5, without pre-installation billing data.

3. <u>The End Use Consumption and Load Impact Model</u> will be (a) a load impact regression model or CE model, supplemented with the use of the Building Simulation Model approved by the CEC to set Title 24 Building standards; or (b) a Building Simulation Model approved by the CEC to set Title 24 Building standards, using billing data as primary determinants of usage. In addition, load impacts must be allocated to water heating, space heating, and space cooling end uses and included in the final evaluation.

4. <u>Hours of operation</u> and related equipment characteristics (i.e., thermostat settings, infiltration rates, solar gain, etc.) used in the end use model(s) to produce estimates of base usage and first year load impacts must be based on premise-specific data from a mix of data sources, including mail surveys, on-site data collected by a utility representative, and on-site data produced from end use metering and/or monitoring equipment.

5. <u>Square footage estimates</u> (conditioned space) used in the end use model(s) to produce estimates of base year usage and first year impacts must be based on the energy compliance forms used to obtain a building permit.

6. <u>The effects of existing state building (Title 24) standards</u> on base usage (efficiency levels planned without utility assistance) and load impact computations (with utility program participant) in the CEC-approved Building Simulation Model must be established from premise-specific data collected for purposes of establishing the terms and conditions of financial assistance.

7. <u>Electric capacity load impacts</u> must be based on (a) the results of end use metering activities identified in #4 or, if not available or usable; (b) end use load shapes from other sources, or, if not available or usable; (c) relationships between end use energy and capacity loads used in utility or CEC demand forecasting models, weighted to reflect the average of building types in the participant sample.

8. <u>Weather adjustments</u> to usage and load impacts must be based on long-run normal weather conditions, as used in the CEC Title 24 standards-setting models.

9. <u>Measure cost</u> estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

10. <u>Usage and load impacts for years beyond the first impact year</u> will be measured, calculated, and reported according to the above protocols for each required year of the measurement period according to the duration and frequency requirements for impact studies identified in Tables 8 and 9.

COMPARISON GROUP

1. <u>Sample design and billing data</u> protocols, per Table 5, Comparison Groups (A) and (B), should be used with the following modifications. The comparison group is composed of similar nonparticipant new homes built during the same time period. If used, a minimum of nine months of billing data are required for both participants and nonparticipants.

2. The comparison group must either be analyzed simultaneously with participants within the chosen <u>end use consumption and load impact model</u> or use the same model if the two groups are analyzed separately in a difference-of-differences approach.

3. Data for <u>hours of operation</u> (and related equipment characteristics), <u>square footage</u>, and accounting for the efficiency requirements of <u>Title 24 standards</u> must be used in the same manner as for Participant Group analysis Protocols #3, 4, and 5, but based on data collected from the Comparison Group sample.

4. <u>Electric capacity and weather adjustment</u> protocols for Participant Group apply to Comparison Group.

5. <u>Measure cost</u> analysis not required; if included in the evaluation design, the collection of measure cost data from the Comparison Group should be done in a manner and form which will facilitate the inclusion of the data in the statewide Measure Cost Study.

6. <u>Usage and load impacts for years beyond the first impact year</u>: Participant Group protocol #10 applies to the Comparison Group analysis.

TABLE C-8: IMPACT MEASUREMENT PROTOCOLS FOR THE NONRESIDENTIAL NEW CONSTRUCTION PROGRAM

STUDY SCOPE

A. End Use Elements: Whole Building

B. Measures: all lighting hardware efficiency improvements combined, all HVAC combined

DESIGNATED UNIT(S) OF MEASUREMENT

- Load impacts per building

PARTICIPANT GROUP

1. <u>Sample design</u> per Table 5; a participant is further defined as a customer who installed at least one of the end use measures used in the forecast filing for the program year.

2. <u>Billing data requirements</u> per Table 5, without pre-installation billing data.

3. <u>The End Use Consumption and Load Impact Model</u> will be (a) a load impact regression model or CE model, supplemented with a Building Simulation Model approved by the CEC to set Title 24 Building standards; or (b) a Building Simulation Model approved by the CEC to set Title 24 Building standards, using billing data as primary determinants of usage. In addition, load impacts must be allocated to the lighting and HVAC end uses and included in the final evaluation.

4. <u>Hours of operation</u> and related equipment characteristics used in the end use model(s) to produce estimates of base usage and first year load impacts will be based on premise-specific data from a mix of data sources, including mail surveys, on-site data collected by a utility representative, and on-site data produced from end use metering and/or monitoring equipment.

5. <u>Square footage estimates</u> (conditioned space and lighted area) used in the end use model(s) to produce estimates of base year usage, and first year impacts must be based on the lighting and HVAC compliance forms used to obtain a building permit.

6. <u>The effects of existing state building (Title 24) standards</u> on base usage (efficiency levels planned without utility assistance) and load impact computations (with utility program participant) in the CEC-approved Building Simulation Model must be established from premise-specific data collected for purposes of establishing the terms and conditions of financial assistance.

7. <u>Electric capacity load impacts</u> should be based on (a) the results of end use metering activities identified in #4 or, if not available or usable; (b) end use load shapes from other sources, or, if not available or usable; (c) relationships between end use energy and capacity loads used in utility or CEC demand forecasting models, weighted to reflect the average of building types in the participant sample.

8. <u>Weather adjustments </u>to usage and load impacts must be based on long-run normal weather conditions, as used in the CEC Title 24 standard-setting models.

9. <u>Measure cost</u> estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

10. <u>Usage and load impacts for years beyond the first impact year</u> will be measured, calculated, and reported according to the above protocols for each required year of the measurement period according to the duration and frequency requirements for impact studies identified in Tables 8 and 9.

COMPARISON GROUP

1. <u>Sample design and billing data</u> protocols, per Table 5, Comparison Groups (A) and (B);should be used with the following modifications. The comparison group is composed of similar nonparticipant new buildings built during the same time period. If used, a minimum of nine months of billing data are required for both participants and nonparticipants.

2. The comparison group must either be analyzed simultaneously with participants within the chosen <u>end use consumption and load impact model</u> or use the same model if the two groups are analyzed separately in a difference-of-differences approach.

3. Data for <u>hours of operation </u>(and related equipment characteristics), <u>square footage</u>, and accounting for the efficiency requirements of <u>Title 24 standards</u> must be used in the same manner as for Participant Group analysis Protocols #3, 4, and 5, but based on data collected from the Comparison Group sample.

4. <u>Electric capacity and weather adjustment</u> protocols for Participant Group apply to Comparison Group.

5. <u>Measure cost</u> analysis not required; if included in the evaluation design, the collection of measure cost data from the Comparison Group should be done in a manner and form which will facilitate the inclusion of the data in the statewide Measure Cost Study.

6. <u>Usage and load impact for years beyond the first impact year</u>: Participant Group protocol #10 applies to the Comparison Group analysis.

TABLE C-9: IMPACT MEASUREMENT PROTOCOLS FOR
MISCELLANEOUS EFFICIENCY PROGRAM ACTIVITIES

STUDY SCOPE

End Use Elements and Measures: Program end uses with measures that are authorized for implementation and earnings recovery and that account for, individually or collectively, no more than 15% of the total resource benefits, net (Line 9 of Table E-2) in any given program. All other Protocol-defined or end use designations in Appendix A of the DSM Reporting Requirements Manual within each program that exceed 15% of the program's total net resource benefits, will require load impact and retention studies for earnings recovery as described in Tables C-1 to C-8.

GENERAL

1. At the time of the Utility Forecast Filing, the utility will identify: (a) all miscellaneous measures it expects to promote during the program year and (b) the methodology for estimating the first year and lifecycle load impacts.

1. Preparation of the method and a specific utility request for approval, will be subject to the DRA verification function identified in Appendix B. The method approved for a measure will be considered the basis for earnings claims in future years unless changed by an AEAP.

1. At the time of the first earnings claim, the utility may reclassify measures and/or end uses as miscellaneous measures per the study scope of the Miscellaneous Efficiency Program Activities measurement protocols. The first earnings claim will be accompanied by documentation and a load impact methodology that conforms with the Participant Group and Comparison Groups protocols defined below.

1. The results of the methodology employed for miscellaneous measures will be included in the first earnings claim. The verification by DRA of earnings for miscellaneous measures will be limited to: (a) verification of recorded participation, (b) verification of the appropriate application of the methodologies for load impacts and, (c) verification of program and measure costs.

1. Earnings from no more than 15% of each program's total resource benefits, net shall be allowed under the miscellaneous end use.

1. Earnings from miscellaneous measures adopted in the AEAP for the first earnings claim for a given program year will not be subject to additional adjustments from any further earnings claims, unless those adjustments are caused by more general features of an earnings mechanism not associated with miscellaneous measures.

PARTICIPANT GROUP

2. The method for Participant Group first year earnings claim load impact estimates may be based on an Engineering model. The method will identify key assumptions, data requirements, engineering principles, and calculation procedures used to calculate first year participant load impacts.

3. Lifecycle load impacts may be based on the simplifying assumption that participant first year load impacts are unchanged through the effective useful life of the measure.

4. The estimate of the effective useful life may be based on the simplifying assumption that the effective useful life is a specified fraction of the product life (manufacturer, retailer) of products likely to be installed. The adopted method will include documentation and evidence of useful life and effective useful life assumptions.

5. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

6. Retention Studies are not required for measures identified under miscellaneous end uses.

COMPARISON GROUP

7. No Comparison Group analysis is required (unless done so as a condition for funding at the time of authorization); collection of data and information for the purposes of creating proxies for measure adoption in the absence of the program is encouraged.

8. The net-to-gross ratio will be based on a default assumption of .75 unless specified otherwise; a ratio other than .75 will be based on a rationale or documented evidence that the alternative ratio is reasonable.

TABLE C-10: IMPACT MEASUREMENT PROTOCOLS FOR
THE RESIDENTIAL DIRECT ASSISTANCE PROGRAM
(weatherization)

STUDY SCOPE

A. End Use Elements: (1) primary analysis at the program level (all end uses combined) for each services program; (2) impacts allocated to space heating, space cooling, and water heating.

B. Measures: all measures included in the utility's program or mandated by the Legislature.

DESIGNATED UNIT(S) OF MEASUREMENT

- Load impacts per dwelling unit
- Load impacts per dwelling end use element

PARTICIPANT GROUP

1. Sample design and billing data requirements, per Table 5.

2. The End Use Consumption and Load Impact Model will be either a load impact regression model, CE, or regression model, supplemented by engineering models; engineering models or the load impact regression models or CE models must be used as the basis for allocating total load impacts to major end uses.

3. Hours of operation and related equipment characteristics used in the end use model(s) to produce estimates of pre-installation usage and first year load impacts will be based on premise-specific data collected from a mix of data sources, including mail surveys, on-site data collected by a utility representative, and on-site data produced from end use metering and/or monitoring equipment.

4. Electric capacity load impacts should be based on (a) a documented end use load shape study of the end use element, or, if not available or usable; (b) relationships between end use energy and capacity loads used in utility or CEC demand forecasting models.

5. Weather adjustments to usage and load impacts must be based on long-run normal weather conditions, as used in the utility or CEC demand forecasting model.

6. Usage and load impacts for years beyond the first impact year will be measured, calculated and reported according to the above protocols for each required year of the measurement period according to the duration and frequency requirement for impact studies identified in Tables **8** and **9**.

COMPARISON GROUP

Not required.

TABLE C-11: IMPACT MEASUREMENT PROTOCOLS FOR
THE ENERGY MANAGEMENT SERVICES PROGRAMS

STUDY SCOPE

A. End Use Elements: (1) Primary analysis at the program level (all end uses combined) for each services program; (2) impacts allocated to major end uses within each program:
- Residential--space heating, space cooling, water heating, and other;
- Commercial--lighting, HVAC and other;
- Industrial--lighting, motors, and other;
- Agricultural--pumping and other.

B. Practices and Measures: Any change in behavior which affects energy use or investment in equipment or measures which affect energy use.

DESIGNATED UNIT(S) OF MEASUREMENT

- Load impacts per participant from all practices and measures combined.
- Load impacts per participant from all practices for each major end use.
- Load impacts per participant from all measures for each major end use.

PARTICIPANT GROUP

1. Sample design and billing data requirements, per Table 5; for each program for each end use element; a participant is further defined as a customer who received an energy audit from the utility. (The same sample used for the corresponding sector Retrofit Energy Efficiency Incentives Programs may be used in part or whole.)

2. The End Use Consumption and Load Impact Model will be either a load impact regression model, CE, or regression model, supplemented by engineering models; engineering models or the load impact regression models or CE models must be used as the basis for allocating total load impacts to major end uses and between practices and measures.

3. For nonresidential programs: Hours of operation and related equipment characteristics of measures used in the model(s) to produce estimates of pre-installation usage, base usage, and first year load impacts will be based on data collected on site.

4. For residential programs: Hours of operation and related equipment characteristics of measures used in the model(s) to produce estimates of pre-installation usage, base usage, and first year load impacts will be based on (a) data collected and reported by utility energy service representatives, or (b) data collected and reported by the customer.

5. For energy efficiency investments in measures, the effects of existing state or federal efficiency standards on pre-installation usage, base usage, and load impact calculations must be explicitly accounted for and be based on the methods prescribed in Appendix G.

6. Electric capacity load impacts must be based on (a) utility end use load shape studies or, if not available or usable; (b) relationships between end use energy and capacity loads used in utility or CEC demand forecasting models.

7. Weather adjustments to usage and load impacts must be based on long-run normal weather conditions, as used in the utility or CEC demand forecasting model.

8. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target earnings forecast.

9. Usage and load impacts for years beyond the first impact year will be measured, calculated, and reported according to the above protocols for each required year of the measurement period, according to the duration and frequency requirement for impact studies identified in Tables 8 and 9.

COMPARISON GROUP

1. <u>Sample design and billing data protocols</u>, per Table 5, Comparison Groups (A) and (B); customers who installed high efficiency measures prior to the program year should not be excluded from the sample. (The same sample used for the corresponding sector retrofit energy efficiency incentives programs may be used in part or whole.)

2. The comparison group must either be analyzed simultaneously with participants within the chosen <u>end use consumption and load impact model</u> or use the same model if the two groups are analyzed separately in a difference-of-differences approach.

3. Data for <u>hours of operation</u> (and related equipment characteristics) and accounting for the <u>effects of state and federal efficiency standards</u> must be used in the same manner as for Participant Group analysis Protocols #3, 4, and 5, but based on data collected from the Comparison Group sample.

4. <u>Electric capacity and weather adjustment</u> protocols for Participant Group apply to Comparison Group.

5. <u>Measure cost</u> analysis not required; if included in the evaluation design, the collection of measure cost data from the Comparison Group should be done in a manner and form which will facilitate the inclusion of the data in the statewide Measure Cost Study.

6. For the Industrial EMS Program, each utility must conduct an assessment of the extent to which major measures that are being promoted in the program may have been installed by some customers in the absence of a program. These studies should estimate the net-to-gross ratios for the measures or end uses that comprise over 50% of the expected savings from this program. These studies do not have to employ comparison group analysis. Other measures can use the following default ratios: 1.0 for projects with a demonstrated payback of two years or more, .75 if the payback period is more than 6 months and less than 2 years, and .4 if the payback period is 6 months or less.

7. <u>Usage and load impacts for years beyond the first impact year</u>: Participant Group protocol #9 applies to the Participant Group analysis.

TABLE C-12: IMPACT MEASUREMENT PROTOCOLS FOR NONRESIDENTIAL FUEL SUBSTITUTION PROGRAM

STUDY SCOPE
A. End Use Elements: Water Heating, HVAC, Process and Water Pumping
B. Measures (from customized and standard rebates combined): all measures implemented under the Fuel Substitution Program

DESIGNATED UNIT(S) OF MEASUREMENT
Load impacts per group of related measures or per project (electric and gas)

METHODS TO ESTIMATE FIRST YEAR LOAD IMPACTS

1. <u>Sample design and billing data requirements</u>, per Table 5, for each end use element. A participant is defined as a customer who installed one of the end use measures identified in the fuel substitution program for the program year.

1. <u>Parameters that require verification</u>
    a. Installation date of equipment.
    a. Hours of operation and related equipment characteristics.
    a. For gas to electric fuel substitution, estimate the increase in electric consumption and demand and the decrease in gas consumption. For electric to gas fuel substitution, estimate the decrease in electric consumption and demand and the increase in gas consumption.

1. <u>Confounding factors</u> that must be included/accounted for in the impact analysis:
    a. the effects of existing state or federal efficiency standards on pre-installation usage, base usage, and load impact calculations must be explicitly accounted for and be based on the methods prescribed in Appendix G.
    a. selection of the appropriate base case to be consistent with the 3-prong test for Fuel Substitution Programs
    a. weather adjustments (for weather-sensitive end uses, if any) to usage and load impacts must be based on long-run normal weather conditions, as used in the utility or CEC demand forecasting model.
    a. for industrial sites, operational changes (e.g., production schedules)

1. <u>Methods of Analysis</u> for gross impacts include the use of engineering models, LIRM, or CE.
    a. For engineering models, verification of installation must be conducted for all projects in the evaluation sample. Thorough and credible premise-specific *ex ante* engineering models may be employed provided that the ex ante model results are adjusted to reflect post-installation premise specific hours of operation and related equipment characteristics (see Data Collection Methods). Engineering models may include the use of building simulation models.
    a. For LIRM or CE models, electric/gas capacity load impacts must be based on (a) the results of end use metering activities as specified in C below, or, if not available or usable; (b) end use load shapes from other sources, or, if not available or usable; (c) relationships between end use energy and capacity loads used in utility or CEC demand forecasting models, weighted to reflect the average of similar SIC industries in the participant sample.
    a. The analysis of load and cost impacts will be conducted by a registered Professional Engineer, or other professional, with a demonstrated expertise in the affected industry.

1. <u>Data Collection Methods</u>
    a. The verification of parameters in 2. above will be based on premise-specific data from a mix of data sources, including: telephone surveys, mail surveys, on-site discussions with facility personnel, on-site data produced from end-use metering and/or monitoring equipment, facility production records, and facility billing records.
    a. Measure cost estimates must be based on (a) costs shown on collected customer invoices adjusted to calculate incremental measure costs, or if not available, (b) incremental costs collected and reported in the biennial Measure Cost Study filed by the California DSM Measurement Advisory Committee (CADMAC), or if not available, (c) incremental measure costs collected and used to conduct customer cost-effective analysis, or if not available, (d) estimates of incremental measure costs filed in the target

earnings forecast.

TABLE C-12: (continued)
IMPACT MEASUREMENT PROTOCOLS FOR
NONRESIDENTIAL FUEL SUBSTITUTION PROGRAM

6. <u>Net-to-Gross Ratio Estimation</u>: Fuel Substitution measures can use the following default net to gross ratios: 1.0 for projects with a demonstrated payback of two years or more, 0.75 if the payback period is more than 6 months and less than 2 years, and 0.4 if the payback period is 6 months or less. Other methods for determining net-to-gross ratios may be discrete choice analysis, the use of a comparison group (per Table 5) or customer survey information regarding their energy efficiency choices.

7. <u>The persistence of load impacts for years beyond the first impact year</u> will be measured, calculated, and reported according to the above protocols for each required year of the measurement period, according to the duration and frequency requirements for impact studies identified in Tables 8 and 9.

TABLE C-13: PROTOCOLS FOR THE TREATMENT OF DATA PERTURBATIONS FROM CHANGES AT THE PREMISE OF CUSTOMERS IN THE MEASUREMENT DATABASE

TYPE OF CHANGE	TREATMENT
1. CHANGE IN LEVEL OF SERVICE FOR THE AFFECTED END USE (as measured by designated unit of measurement)	Retain in database, document, account for changes in impact study
2. BUILDING DEMOLITION OR CHANGE IN BUILDING FUNCTION (if sufficient to cause change in SIC)	Remove from database and reweigh sample.
3. CUSTOMER REMOVAL OF EQUIPMENT INSTALLED DURING THE PROGRAM YEAR	Retain in database, document, account for changes in impact study, and incorporate into retention study
4. FAILURE OF EQUIPMENT INSTALLED DURING THE PROGRAM YEAR	Retain in database, document, account for changes in impact study, and incorporate into retention study
5. INSTALLATION OF ADDITIONAL MEASURE(S) (without participation in utility program)	Retain in database, document, and account for changes in impact study.
6. SAMPLE MEMBER DROP-OUT (within first two years after program year)	Use replacement sample member established at time of original sample
7. SAMPLE MEMBER DROP-OUT (after first two years following program year)	Remove from database, reweigh sample, and document in impact and retention studies

NOTE: "documentation" for impact study according to Table 7 protocols.

TABLE C-14: REFERENCE TABLE FOR BILLING DATA REQUIREMENTS
(for impact studies required per Tables C-1 through C-8, and C-10, C-11)

	PROGRAM YEAR 1994	PROGRAM YEAR 1995	PROGRAM YEAR 1996
BASE USE:			
• Earliest month of billing data	Jan 1993 (Retrofit)	Jan 1994 (Retrofit)	Jan 1995 (Retrofit)
	Jan 1994 (New Con.)	Jan 1995 (New Con.)	Jan 1996 (New Con.)
• Latest month of billing data	Sept. 1994	Sept. 1995	Sept. 1996
• Number of months	12	12	12
• Latest date of participation	Sept. 30, 1994	Sept. 30, 1995	Sept. 30, 1996
1st YEAR IMPACTS:			
• Earliest month of billing data	Jan 1994	Jan 1995	Jan 1996
• Latest month of billing data	July 1995	July 1996	July 1997
• Number of months	9 (min.) to 12	9 (min.) to 12	9 (min.) to 12
2nd YEAR IMPACTS:			
• Earliest month of billing data	Jan 1995	Jan 1996	Jan 1997
• Latest month of billing data	July 1996	July 1997	July 1998
• Number of months	12	12	12
3rd YEAR IMPACTS:			
• Earliest month of billing data	Jan 1996	Jan 1997	Jan 1998
• Latest month of billing data	July 1997	July 1998	July 1999
• Number of months	12	12	12
4th YEAR IMPACTS:			
• Earliest month of billing data	Jan 1997	Jan 1998	Jan 1999
• Latest month of billing data	July 1998	July 1999	July 2000
• Number of months	12	12	12
5th YEAR IMPACTS:			
• Earliest month of billing data	Jan 1998	Jan 1999	Jan 2000
• Latest month of billing data	July 1999	July 2000	July 2001
• Number of months	12	12	12

NOTE: Impacts beyond the 5th year follow same pattern through the last year of the measurement period