Low Income Energy Efficiency Program Standardization Project
Phase II Follow-up Report
to the California Public Utilities Commission
October 26, 2000

1. Introduction

This report responds to an Assigned Commissioner's Ruling (ACR) dated September 11, 2000, which focused on four issues that could not be resolved in the course of Phase II. These issues were ceiling insulation levels, the eligibility of master-metered dwelling units, the eligibility of evaporative coolers for rental units, and gas appliance testing. The ACR instructed the Low Income Energy Efficiency Program Standardization Team to provide pros and cons of different options in its Phase II report, and to file a supplemental report as soon as possible in the event that any recommendations were reached early in Phase III. Our Phase II report provided a partial response to the ACR, in two ways:

- It discussed a series of issues associated with the determination of appropriate levels of ceiling insulation, and
- It examined a variety of pros and cons associated with treating master-metered units.

This supplemental report is designed to complete the Team's response to the ACR. In the remainder of this report, we do the following:

- Reiterate the difficulties in establishing proper assumptions for the analysis of ceiling insulation levels, discuss recent efforts to make such assumptions, and propose a set of recommendations for insulation levels,
- Discuss the advantages and disadvantages of making master-metered units eligible for the program, suggest means of mitigating the disadvantages, and make a recommendation on eligibility,
- Discuss the pros and cons of providing evaporative coolers to rental units, and suggest deferring this issue until measure selection criteria are finalized later in Phase III, and
- Describe current utility practices in the area of gas appliance testing and provide a recommendation for a minimum statewide level of gas appliance testing.

2. Ceiling Insulation Levels

2.1. Introduction

One of the issues left unresolved in the Phase II report was the designation of ceiling insulation levels to be installed in different climate zones. In what follows, we summarize the current policies of the utilities with respect to ceiling insulation levels, explain the issues that had to be addressed in order to develop recommendations for insulation levels, and present the utilities' recommendations.

2.2. Current Policies

The current policies followed by the four utilities with respect to ceiling insulation levels are summarized below:

- In the SCE/SoCalGas overlap area, SoCalGas installs R-19 if the existing level of insulation is R-0 through R-7, installs R-11 if the existing level is R-8 through R-15, and installs nothing if the existing level of insulation is R-16 or greater.
- In its non-overlap area, SCE installs insulation if the existing level is less than R-19, and installs nothing if the existing level is R-19 or above. Amounts of insulation added depend upon the degree-days in the area in question.
- SDG&E installs R-19 if the existing level of insulation is R-0 through R-7, installs R-11 if the existing level is R-8 through R-15, and installs nothing if the existing level of insulation is R-16 or greater.
- PG&E brings the total level of insulation to R-30 if the existing level is R-0 through R-11, and installs nothing if the existing level of insulation is R-12 or greater (unless specifically approved by the Program Manager).

2.3. Problems and Issues

As pointed out in the Phase II report, several issues needed to be resolved before the analysis described above could be finalized and recommendations for ceiling insulation levels could be made. These issues include the following:

- The means of incorporating hardship (comfort) into the analysis,
- The means of valuing savings (avoided costs or retail prices),
- The forecasts of avoided costs or retail prices to be used, and
- Whether to have separate levels for gas and electric space heating.

Some progress has been made on these issues over the past several weeks, primarily because of two statewide efforts: the organization of California Measurement Advisory Committee (CALMAC) workshops to discuss avoided costs, and the development of recommendations on assessing low-income programs by the Reporting Requirements Manual Working Group

(RRMWG). Although some open questions remain, the results of these statewide efforts provided some guidance for the analysis of ceiling insulation levels.

Incorporating Hardship. AB1393 specifies that the analysis of the LIEE Program, the measures it offers, and (presumably) adopted levels of these measures should take into account hardship as well as cost-effectiveness. While the Team is committed in principle to the incorporation of hardship effects into any analysis of measures or measure levels, it had some difficulties in operationalizing the concept of hardship in conducting the analysis of ceiling insulation levels. As noted in Appendix B of the Phase II report (included in this report for reference), hardship issues relating to ceiling insulation take the form of impacts on health and comfort. Insofar as ceiling insulation is not likely to influence safety, this approach is consistent with the RRMWG's Draft definition of hardship as "adverse impacts on the comfort, health and safety of low income customers that can be mitigated by access to low income energy efficiency programs and services."[1] Even though the formal analysis focused on energy savings to determine appropriate ceiling insulation levels, the Team took comfort and health into account in two concrete ways:

- First, for the purposes of simulating the effects of ceiling insulation on energy usage, it was assumed that all participants have air conditioning. Of course, only a small fraction of LIEE participants have air conditioning; however, those who do not have air conditioning will still enjoy increases in comfort and health during hot periods as a result of the installation of ceiling insulation. The value of energy savings that would have occurred if air conditioning had been present was essentially used as a proxy for comfort benefits for participants without air conditioning.
- Second, comfort and health were also taken into account indirectly through the use of engineering calculations of savings. These estimates ignore the well-documented fact that customers receiving conservation measures often take some of the potential savings from these measures in the form of comfort. That is, they choose a higher level of energy service (e.g., warmer homes in the winter) as a result of the increased efficiency of the home. This is sometimes called the "rebound effect." If we were to consider the rebound effect, we would use lower estimates of savings based on the general results of billing analyses of programs like this one. Ignoring the potential for the rebound effect essentially implies that we are treating increases in comfort associated with comfort tradeoffs as part of the benefits of insulation additions.

Valuing Energy Savings. As noted in our Phase I Report, the valuation of energy savings could be conducted from the perspective of participants (using retail rates) or from a resource cost perspective (using avoided costs). Our Phase I report discussed the implications of

[1] *Draft Reporting Requirements Manual (RRM) Working Group Report for Low Income Assistance Programs*, October 1, 2000.

using these alternative approaches in assessing program cost-effectiveness, and recommended that an average of retail rates and avoided costs be used. Our Phase II report further discussed this issue, but refrained from taking a position on it. We were reluctant to take a position because we did not want to preempt the work of the RRMWG, insofar as that group was charged with the development of a cost-effectiveness framework to be used in the assessment of LIEE Programs.

The RRMWG's recent draft report[2] discusses the application of several tests, including the Total Resource Cost Test (TRC), the Utility Cost Test, the Public Purpose Test (PPT) and some form of Participant Test. It recommends against the use of the PPT, and proposes that the TRC and Utility Cost Tests be included in reporting requirements. It further recommends that some type of a Participant Test be added on an interim basis, adding that in such a test "…utility bill savings approximate the net total benefits from this (Participant) test."[3] In spite of the fact that the RRMWG cites the need for a test that uses retail rates to value energy savings, it does not specify whether this test should be used as an alternative to the TRC or as complement to it. As a result, we cannot use the RRMWG's recommendations to determine which type of test should be used to assess various levels of ceiling insulation. While the RRM proposes to further consider the design of a Participant Test in a subsequent phase of its work, it is unclear that the RRM will make a recommendation on the best single test to use in the evaluation of the programs. This is understandable, insofar as this choice requires an explicit value judgment that can not be defended from a technical point of view. Insofar as we are unlikely to have a more definitive recommendation from RRMWG with respect to this issue, we are forced to rely on an arbitrary practice suggested in our Phase I report. That is, we will adopt the average of avoided costs and retail rates to value energy savings.

Forecasting Avoided Costs and Retail Prices. Whether avoided costs or retail rates or some combination of these is used to value energy savings from different ceiling insulation additions, a forecast of the chosen rate is necessary for the analysis. When the utilities submitted their Phase II report, there was considerable uncertainty relating to forecasts of both avoided costs and retail prices. Since that time, statewide CALMAC workshops have been held to discuss forecasts of avoided costs. A recent report by CALMAC[4] presents a set of forecasts designed to incorporate California Energy Commission (CEC) forecasts of market clearing Power Exchange (PX) prices, utility estimates of

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2 Op. cit.

3 Op. cit., p. 17. Note that we assume that the RRMWG intends to design a modified Participant Test that would ignore incentives and focus instead on bill savings and measure costs. The reason for this presumption is that the standard Participant Test would be trivial, since the participant pays nothing for the measures in question.

4 CALMAC, *Avoided Costs Report*, October 2, 2000.

transmission and distribution costs, as well as adjustments of on-peak prices to account for the impact of reductions in peak usage on market prices.[5] We have adopted these forecasts of avoided costs, and have weighted them to reflect the time-of-use distribution of energy savings likely to occur as a result of ceiling insulation.

Unfortunately, the CALMAC workshop participants decided that no retail electric price forecasts will be developed as part of the current effort, as a consequence of "the uncertainty associated with 'rate caps' and energy de-regulation…" (p. 7). As a result, we have been forced to develop our own set of retail price forecasts for the purpose of assessing the cost-effectiveness of various insulation options.

Distinguishing between Gas and Electric Space Heat. An earlier analysis showed clearly that the cost-effectiveness of various levels of attic insulation depends strongly on the heating fuel. However, some Program staff are reluctant to have separate policies on insulation levels for customers with gas and electric space heating. In recognition of this, we developed a single set of recommendations based on the assumption that the space heating fuel mix is 90% gas and 10% electric. While we do not have explicit fuel shares for eligible households, these shares represent the entire population of homes across the state, and are likely to be reasonably representative of the low-income housing stock.

2.4. General Approach to Developing Recommendations for Insulation Levels

After discussion of existing policies, the reasons for those existing policies, and some of the issues surrounding ceiling insulation, it was decided that a cost analysis should be performed to help assess what levels of insulation made sense. The first attempt by the group was to examine cost-effectiveness by comparing the value of customer energy savings versus installed costs. Installed cost estimates were derived from utility costs and an independent source, 1996 Means Residential Cost Data. However, calculation of the value of customer savings was a more involved process.

First, energy savings (in kWh and therms) had to be estimated. Standard ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) procedures were used for calculating U-values.[6] These procedures are also incorporated into the Title 24 Standards. Second, heating/cooling degree day (HDD/CDD) estimates were obtained from CEC Climate Zone weather data, and condensed down to the five climate zones to be used for the weatherization effort (see Appendix C). A map of the climate zones used in the analysis is presented below in Figure 1.

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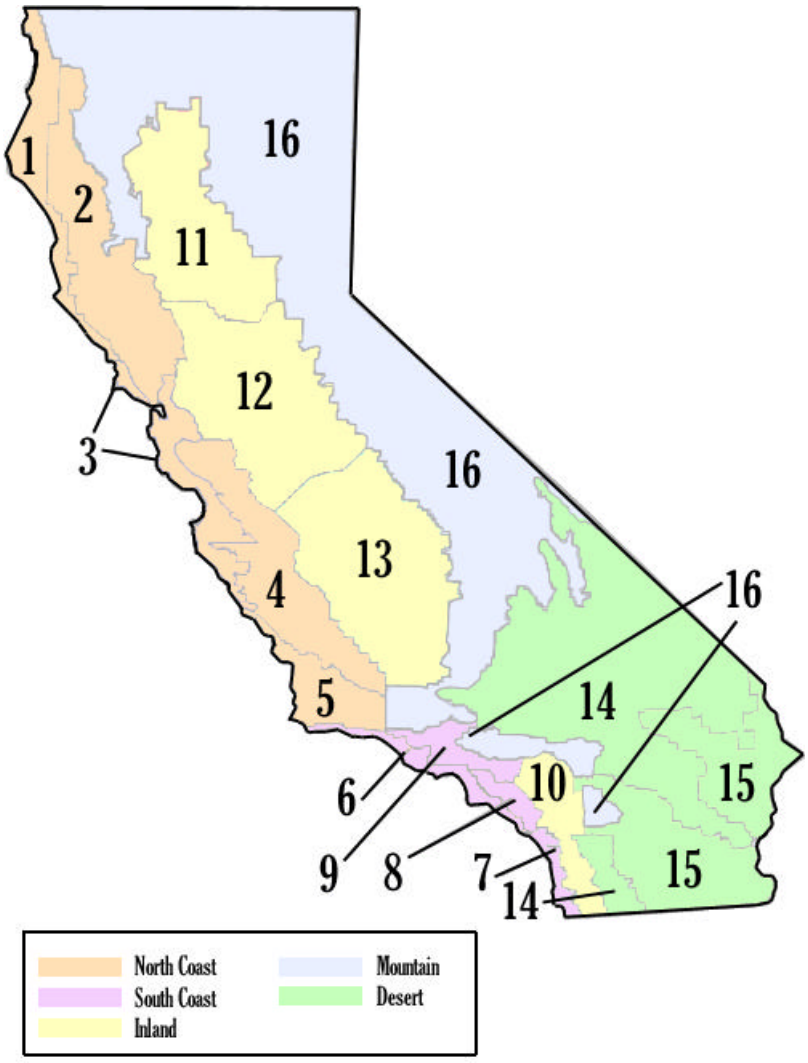
5 These adjustments are loosely based on a study by JBS Energy, Inc. (JBS Energy, Inc., *Analysis of PG&E's Electric Distribution Marginal Cost, Revenue Allocation and Rate Design, Appendix A: Cost Curve Analysis of the California Power Markets*, September 29, 2000.)

6 1997 ASHRAE Handbook of Fundamentals, Chapter 24.

Figure 1: Proposed Climate Zones for Attic/Ceiling Insulation Levels



These two components (U-values and degree-days) were used to estimate heat loss/gain through the roof, which was then converted to source energy (gas/electric) energy use (therms or kWh). Assumed avoided energy costs by time-of-use were then applied to obtain estimated customer savings.

An extensive range of insulation levels was examined for each climate zone. The base analyses were performed for both electric and gas heating systems with air conditioning. Since the team thought fuel-based insulation levels might be difficult to implement, we also looked at an average of these two runs—one that weighted the natural gas/electric results as 90% /10% to reflect current fuel shares for space heating in California.

2.5. Assumptions

In order to conduct the analysis of ceiling insulation savings, several assumptions must be made. These assumptions relate to the installed cost of various levels of ceiling insulation, the lifetime of the insulation, the discount rate used to convert forecasted values to present discounted values, the forecasted avoided costs of electricity and natural gas savings, and current values of and forecasted escalation rates in retail rates. Table 1 contains the assumptions used in the analysis.

Table 1: Assumptions

Concept	Assumed Value
Installed Cost of Ceiling Insulation	
R-11	$0.35 per square foot
R-19	$0.47 per square foot
R-30	$0.63 per square foot
R-38	$0.75 per square foot
Lifetime of Ceiling Insulation	25 years
Discount Rate	8%
Retail Electricity Rate in 2000	$0.125
Escalation Rate for Retail Electricity Rate	3%
Natural Gas Retail Rate in 2000	$1.00
Escalation Rate for Retail Natural Gas Rate	3%
Avoided Electricity Cost (G, T & D)	per CALMAC
Natural Gas Avoided Cost	per CALMAC

2.6. Results and Recommendations

Table 2 provides the results of the analysis of adding various amounts of ceiling insulation to different preexisting levels. For each existing ceiling insulation level, the level of insulation that gave the highest net benefits (present value of savings less the installed cost) was chosen as the amount of installation to add. (Note: This table will be completed later, as soon as avoided cost estimates are finalized.)

Table 2: Implied Ceiling Insulation Policies (Baseline Assumptions)

Climate Zone	*Existing* Ceiling Insulation Level	Insulation to be *Added*
North Coast	R-0 (uninsulated)	
	R-1 to R-11	
	R-12 to R-19	
	Above R-19	
South Coast	R-0 (uninsulated)	
	R-1 to R-11	
	R-12 to R-19	
	Above R-19	
Inland	R-0 (uninsulated)	
	R-1 to R-11	
	R-12 to R-19	
	Above R-19	
Desert	R-0 (uninsulated)	
	R-1 to R-11	
	R-12 to R-19	
	Above R-19	
Mountain	R-0 (uninsulated)	
	R-1 to R-11	
	R-12 to R-19	
	Above R-19	

Given the current level of uncertainty with respect to market prices and avoided costs, the Utility Standardization Team recommends that these ceiling insulation policies be revisited during Phase III of the Standardization Project, as well as periodically in future years.

3. Eligibility of Evaporative Coolers for Rental Units

3.1. Introduction

In our Phase II report, we gave no recommendation on the eligibility of evaporative coolers for rental units. This section summarizes current utility practices in this area and describes some advantages and disadvantages of alternative treatments.

3.2. Current Policies

PG&E, SCE, and SDG&E all provide evaporative coolers to owner-occupied units with functional air conditioning in some weather zones. However, these electric utilities differ with respect to the treatment of rental units. SCE has been given Commission authorization to continue to provide permanently installed evaporative coolers for renter-occupied dwellings. SCE requires a co-payment from the tenant. The other utilities do not offer any type of evaporative coolers to rental units.

3.3. Pros and Cons of Offering Evaporative Coolers to Rental Units

The arguments in favor of making rental units with existing air conditioning eligible for evaporative coolers are:

- The use of evaporative coolers in place of refrigerated air conditioning results in significant energy bill savings to the renter,
- Renters pay Public Goods Charges, directly or indirectly, and deserve benefits of savings, and
- Evaporative coolers are one of the few measures that can significantly affect cooling loads during peak periods.

The primary argument against providing evaporative coolers to rental units is that:

- If the landlord takes ownership of the evaporative cooler, some of the major benefits of the unit accrue to landlord.

While evaporative coolers would not necessarily be offered with copayments, SCE currently requires the tenant to make a small copayment on the unit. According to SCE, this provides a sense of ownership and maximizes the use of Program funds.

3.4. Recommendation

The utilities feel that making a recommendation on the eligibility of evaporative coolers for rental units would be premature at this time, for three reasons:

- First, making a recommendation for a common treatment of evaporative coolers cannot be separated from the selection of specific measures to be offered by the

utilities. Insofar as measure selection is being deferred pending the development of cost-effectiveness criteria by the RRMWG, the resolution of this issue should also be postponed.

- Second, the treatment of evaporative coolers raises a broader issue of the overall eligibility of rental units for Program measures.
- Third, the issue relates indirectly to the type of evaporative cooler installed in rental units, and there are arguments for and against the installation of portable and permanent units.

Therefore, the Team recommends that this issue be deferred until later in Phase III.

4. Eligibility of Master-Metered Units

4.1. Introduction

The Phase II report briefly discussed some advantages and disadvantages of making master-metered[7] dwelling units eligible for the LIEE Program, but did not recommend a common policy with respect to this issue. In this section, we provide the several types of information designed to support a decision on this key policy. Subsection 4.2 summarizes current utility practices with respect to the eligibility of master-metered customers. Subsection 4.3 presents a profile of the master-metered segment. Subsection 4.4 discusses the advantages and disadvantages of making these customers eligible for the Program. Finally, subsection 4.5 presents a set of joint utility recommendations relating to eligibility.

4.2. Current Practices

Current utility practices are as follows:

- For PG&E and SDG&E, master-metered customers are not eligible for the LIEE Program; customers must be individually metered or sub-metered to be eligible.
- For SoCalGas, master-metered customers are eligible, but cannot exceed 15% of any contractor's allocation
- For SCE in the non-overlap area, master-metered customers are eligible as long as they have electric space heat.

4.3. A Profile of Master-Metered Customers

The utilities have relatively little information about master-metered customers. The paucity of information can be traced to two primary factors. First, the utilities have little or no influence on what happens on the other side of the utility meter, and consequently have little

[7] For the purposes of this discussion, we refer to dwelling units that are not individually metered by the utility or submetered by the master-metered customer.

information about the characteristics of end users on master-metered accounts. Second, when designing surveys of residential customers, sample frames are developed from account data and samples are typically restricted to separately metered customers. Nonetheless, rough profiles can be constructed on the basis of impressionistic data. For this purpose, the four utilities provided account data for separately metered and master-metered accounts, and judgmental characterizations of the master-metered populations.

Note: A table summarizing the predominance of master-metered customers in the four service areas will be provided here at a later date.

4.4. Advantages and Disadvantages of Making Master-Metered Units Eligible

There are a variety of advantages and disadvantages associated with making master-metered customers eligible for the LIEE Program. The primary advantages are:

- Tenants in master-metered units indirectly pay the Public Goods Charge through rents,
- Installation of measures could reduce these rents or at least reduce pressures for rent increases over time,
- Tenants receiving measures would enjoy increases in comfort, health and safety, all of which should be considered benefits of the Program as mandated by AB1393, and
- Some of the possibly neediest households in the State, including migrant farm workers, live in master-metered dwellings.

Key disadvantages of making master-metered customers eligible for the Program are:

- There is no guarantee that tenants will receive the benefits of reductions in energy bills associated with the installation of LIEE measures (no feasible way to enforce a landlord pass-through of bill reductions, since the CPUC has no jurisdiction over the landlord-tenant relationship),
- The installation of minor home repairs could even lead to increases in rents under some circumstances if measures increased the attractiveness of dwelling units,
- It is difficult to measure energy savings for a dwelling unit when master metering is present,
- It may be difficult to get owner approval in the event that master-metered housing is substandard, and
- Recruiting participants could cause friction between tenants and landlords if housing is substandard.

4.5. Recommendations

While the utilities understand the arguments against making master-metered customers eligible for the Program, we recommend that they be eligible under the following conditions:

- Deemed savings should be permitted for use in the evaluation of Program savings for master-metered units.
- Utility Program personnel should attempt to explain the Program to the landlord or property manager prior to contacting tenants, in order to minimize the creation of friction between landlords and tenants.
- If the master-metered dwellings are multifamily units, the fractional (80%) qualification used for multifamily dwellings should be used for the purposes of qualifying tenants for the Program. Landlords should be informed that income documentation will be required for the purposes of determining eligibility.
- Utilities may set a maximum on the percentage of participants treated by a contractor in a program year that are master-metered. This percentage should reflect the predominance of master-metered dwellings in the service area, but should be no higher than 15%.

5. CO/CAS/Gas Appliance Testing

5.1. Introduction

CO/CAS/gas appliance testing is one of the most complex issues considered by the Standardization Team. Because of the need to discuss this issue at some length, it was deferred to Phase III of the Project. The utilities have made considerable progress on this topic in the early weeks of Phase III, and are prepared to make a recommendation for a statewide minimum standard for testing. In the remainder of this section, we describe current utility policies and procedures relating to testing and present our recommended minimum standard.

5.2. Current Utility Practices within the LIEE Program

Overview

There are considerable differences in the policies and procedures used by the four utilities in the area of natural gas appliance testing. PG&E and SDG&E offer some sort of testing as explicit components of their LIEE Programs, although the test funding comes from their O&M budget. SoCalGas offers testing as part of its general gas service policy (as do the other gas utilities), but does not offer the service as an explicit component of the LIEE Program. SCE obviously does not have a gas service program, and therefore does not offer gas appliance testing within its LIEE Program.

One of the issues that confuses the comparison of utility programs is the terminology used to describe the testing procedures. PG&E uses the term Combustion Appliance Safety Testing, for instance, while SDG&E refers to gas appliance testing. In what follows, we will use the term natural gas appliance testing to denote the process of testing for gas leaks and CO emissions from natural gas appliances. While the presence of CO may indicate the presence of other gases, we do not consider directly testing for these other gases.

This subsection describes current utility practices in the area of natural gas appliance testing. The primary focus of the section is on general polices with respect to when testing is done and by whom it is done. Because of the connection of natural gas appliance testing with furnace repair and replacement, we also describe the link between the LIEE Program and the furnace repair and replacement program for each utility. Appendix A provides a detailed description of the specific procedures that are followed by each utility in those cases where testing is done.

PG&E Current Policies and Practices

The main features and highlights of PG&E's current approach to natural gas appliance testing are:

- Weatherization and Furnace Repair & Replacement are administered as a single program.
- Once a contractor identifies a home for weatherization, the contractor will notify PG&E and PG&E will perform a Combustion Appliance Safety (CAS) test before the weatherization measures are installed. This is called the pre-CAS test and all homes are subject to this test. If the CAS test fails, or PG&E is unable to complete the test, the installation of infiltration reducing measures is prohibited until that failure is corrected and the home is re-tested and passes a CAS test. Non-infiltration reducing measures may still be installed.
- Twenty percent of the homes that passed the pre-CAS test and received infiltration reduction measures will receive another CAS test. This is called the post-CAS test.
- If a home passes the initial pre-CAS test, but after installation of infiltration reducing measures fails the post-CAS test, PG&E will correct the reason for the fail.
- If a home fails a CAS test and the fail is corrected, another CAS test will be performed by a CIP Inspector to verify corrections.
- The components that make up a CAS test are available on request to all PG&E natural gas customers with natural gas appliances. Any customer in or out of the EP Program can call in a high CO, gas leak, delayed ignition, etc, situation and schedule an appointment with a PG&E Gas Service Representative (GSR) at 1-800-PGE-5000.

- Home owners that qualify may receive a new heating appliance or repairs of the their existing heating appliance if the heating appliance is fueled by PG&E natural gas and the CIP inspector confirms the venting system meets the current code and the unit is deemed not operational or hazardous by a GSR.
- Rental units do not qualify for the R&R program, but are eligible for minor furnace adjustments that are within the scope of a GSR's job description.

The following specific steps make up the process currently used by PG&E in this area:

1) An Energy Specialist (ES) visits the customer, completes the customer information, evaluates the feasibility of weatherization measures for the home, and collects data on the combustion appliances (types, fuel). The ES informs the resident of the Combustion Appliance Safety (CAS) inspection aspect of the LIEE program. Prior to leaving the residence, the ES will call Central Inspection Program (CIP) dispatch w/customer and home information (i.e., site data and feasible weatherization measures), and schedule an EEM approval inspection and a pre-CAS test. If the ES has identified a combustion appliance that is not operational, CIP dispatch will schedule a GSR appointment prior to the CAS appointment.
2) A CIP inspector will identify all feasible weatherization measures. If the customer has gas appliances, then a CAS test will be performed.
3) If a CAS test identifies problems, the inspector will schedule an appointment to have a GSR come out and evaluate/correct the problem. If the CAS test identifies a problem out of the scope of GSR work, the customer is referred to an equipment dealer, or a community based organization. However, CIP will intercept furnaces at this point and place the home into the Furnace Repair and Replacement program, if the customer owns the home. If the fail reason cannot be corrected the home will be rated NIM, and only Non-Infiltration Measures (NIM's) can be installed. In addition, if the CIP inspector Can't Get In (CGI) to perform a CAS test, only Non-Infiltration Measures (NIM's) can be installed.
4) Once in the Furnace R&R program, an HVAC contractor will be sent out to evaluate the furnace. They can repair or replace the furnace if the cost is below $1500. There is $750 dedicated to furnace R&R, if more than this is needed, they can also dip into the $750 set aside for Building Envelope Repair (BER). After the furnace is repaired or replaced, a CIP Inspector will perform a second pre-CAS test. If necessary, the local building department must also sign off on a permit. Other appliances that passed the pre-CAS test are may not be tested a second time unless the GSRs made adjustments to them.
5) After the furnace that failed the initial CAS test has been repaired or replaced and the second pre-CAS test has been performed, the weatherization contractor is notified that they can proceed with feasible weatherization measures. (Note: If there was another inoperable primary appliance (stove and/or water heater), the pre CAS test would still fail, therefore infiltration reducing measures still would not be

installed.) The weatherization contractor is notified of the amount spent on furnace R&R, they will deduct that amount from $1500 to get the remainder or $750, whichever is less, that can be used for BER.

6) Participation in the furnace R&R program will not influence whether or not a home is drawn for a post inspection of any kind. There are two types of post inspections, the post EEM inspection where the Energy Efficient Measures are inspected and the post CAS inspection where the home is given another CAS inspection.

7) Post EEM Inspections
   - All homes that received attic insulation are targeted for inspection.
   - A minimum of 20% of all non-attic insulation homes are inspected.

8) Post CAS Inspections
   - Twenty percent of homes that pass a pre-CAS test and receive infiltration reduction measures also receive a post CAS test.

SDG&E Current Policies and Practices

The main features and highlights of SDG&E's current practices in the area of gas appliance testing are as follows:

- SDG&E conducts natural gas appliance operational checks in support of its LIEE program.
- Weatherization and Furnace Repair and Replacement are administered as a single program.
- Only natural gas furnaces are targeted for operational check inspection/evaluation. Other natural gas combustion appliances are evaluated if ambient CO levels in the living space that are not attributable to the furnace are discovered, or if the customer requests other services.
- Gas appliance operational checks are completed on all homes after the weatherization process occurs, so the mix of infiltration and non-infiltration measures is not limited in any way by the manner in which SDG&E conducts its checks.
- Natural gas appliance operational checks /troubleshooting is available on request to all SDG&E customers with gas appliances. If a customer calls SDG&E with a problem, a gas service representative will do everything they can to locate, and resolve the problem.
- Only eligible homeowners may receive a new furnace or major repairs from the SDG&E Low Income Program.
- Rental units are eligible to receive the Furnace Operation Inspection and minor furnace repairs. The prime contractor will work with the property owner on a case by case basis on minor repairs.

The specific process followed in the SDG&E program is as follows:

1) An Energy Specialist visits the customer, completes intake and evaluates feasibility for weatherization. The Energy Specialist informs the resident of the Furnace Operation Inspection (if furnace is natural gas) aspect of the LIEE program, and stresses the importance of inspection to make sure that the furnace is operating efficiently. There is no direct discussion regarding the effects of carbon monoxide (CO) and how to recognize them. The focus is energy efficiency and ensuring that gas appliances are operating correctly.

2) Energy Team intake forms for homes with natural gas fuel heating are routed to the Furnace Inspection Team. Only natural gas furnaces are targeted for inspection. No other natural gas appliances are inspected unless there is an ambient CO reading in the home, and the furnace is not suspected as the gas appliance causing the ambient CO reading. Other natural gas appliances will be inspected if ambient CO levels are present, a natural gas leak is detected or if the customer requests that a gas appliance be inspected.

3) A Furnace Technician performs the Furnace Operation Inspection and completes the Gas Appliance Inspection Form (noting any minor repairs) after all weatherization work has been completed. If the customer is in immediate danger, the furnace or gas appliance will be shut-off, tagged and SDG&E Gas Service will be notified immediately.

4) Furnaces that are not currently operational and furnaces that have been shut-off and tagged can be repaired or replaced if the customer is a qualified homeowner. The Furnace Inspection Form is completed by the Furnace Technician and will recommend repair or replacement of the furnace (SDG&E is also notified of the recommendation)

5) Customers in rental units are informed of problems that were detected during the inspection in the comments section of the Gas Appliance Inspection form. The Furnace Program Administrator will work with Property Owners to complete minor repairs on a case by case basis. Property Owners are also notified by mail of inspection problems detected at their rental units. SDG&E is notified immediately if the customer in a rental unit is in immediate danger. The furnace or gas appliance will be shut-off and tagged.

6) Furnace Inspection Forms are reviewed by the Furnace Program Supervisor to verify that repair or replacement recommendations are correct. The Furnace Inspection Form is then routed to an HVAC subcontractor for completion of work.

7) The Furnace Program Supervisor verifies that all required permits and city/state inspections[8] are completed and conducts a final check of all subcontracted furnace repair and replacement work to ensure all invoiced work has been completed.

[8] Local building officials have jurisdiction and final authority over furnace installations to ensure the installations comply with local building code(s). SDG&E's post installation check is merely to verify all

SoCalGas Current Policies and Practices

The main features of the SoCalGas policy with respect to gas appliance testing are summarized below:

- Weatherization and Furnace Repair and Replacement are administered as completely separate programs.
- All furnace activity is completely separate from the weatherization process, so infiltration measures are not impacted in any way by the furnace activity.
- Natural gas appliance testing/troubleshooting is available on request to all SoCalGas customers with gas appliances, but is not conducted for LIEE participants in the absence of a specific request from the customer or someone acting on behalf of the customer. If a customer calls up with a problem, a Gas Service Representative will do everything they can to reproduce, locate, and resolve the reported problem.
- Only eligible homeowners may receive a new furnace or repairs from the SoCalGas Low Income Program.
- Rental units are eligible to receive the Furnace Operation Inspection and minor furnace repairs under SoCalGas' regular service policy applicable to all customers.

The specific steps taken under the SoCalGas Program are:

1) An Energy Education Specialist visits the customer, determines eligibility, and evaluates feasibility for weatherization. No information on the types of combustion appliances present in the residence is collected at that time. In the process of evaluating measures, if the customer indicates they have a problem with a gas appliance, they will refer to a SoCalGas gas service representative. There is no discussion regarding the effects of CO poisoning and how to recognize them.
2) Customers are referred to the Furnace Repair and Replacement in a variety of ways:
   - From weatherization contractors (when a customer indicates their furnace is inoperative, they would like to have the furnace checked for proper operation or a gas odor or dangerous situation noticed by the contractor). They will refer customer to SoCalGas to have problem checked.
   - From SoCalGas service technicians performing "standard service" evaluation of furnaces.
   - From outreach effort by HVAC contractors who "knock on doors"

invoiced furnace components have been installed. SDG&E does not assume responsibility to ensure furnace installations compliance with building code(s).

- From coordination of weatherization and furnace repair replacement program customer databases.

3) When an Energy Technician is sent out, he will identify the discrepant appliance. If the customer is in immediate danger, the furnace or gas appliance will be repaired to the extent of possible by regular service or if it cannot be repaired, it will be shut-off and tagged (1813 "Notice of Unsatisfactory Condition"). If repair or replacement is needed for a furnace, the customer will be advised of the Furnace R&R program. If repair or replacement of combustion equipment other than furnaces is needed, the customer is told to find a commercial HVAC dealer/repair company (no specific recommendations or referrals are made).

4) Once referred into the furnace program, a DAP Furnace Inspector evaluates the furnace for repair or replacement, income qualifies the customer, and issues a work order for an HVAC Contractor to either repair or replace the furnace as appropriate. Customers in rental units are not eligible for the program.

SCE Current Policies and Practices

SCE does not have a Furnace Repair and Replacement program, and does not do any testing/evaluation of combustion appliances.

Summary

Table 3 compares current utility policies and procedures using a series of key attributes.

Table 3: Summary of Current LIEE Program Natural Gas Appliance Testing Practices

Policy/Practice Description	PG&E	SDG&E	SCG	SCE (non-overlap)
1.0 GENERAL POLICY VERSUS LIEE POLICY				
1.1 Is the basic approach to dealing with gas appliances under a utility's *General Policy* that is applicable to *all* utility customers: Proactive (done as part of a systematic effort to contact ALL customers and evaluate their CO problems) or Reactive (done only in response to customer complaints, problem reports from Gas Service Representatives or HVAC contractors, etc.)?	REACTIVE	REACTIVE	REACTIVE	N/A
1.2 Is the basic approach to dealing with gas appliances under the LIEE program different than that for the *General Policy* applicable to *all* utility customers?	YES	YES	NO	N/A
1.3 Is the basic approach to dealing with gas appliances under the LIEE program: Proactive (done as part of normal LIEE Furnace R&R process) or Reactive (done only in response to customer complaints, gas leaks, visual inspections, etc)?	PROACTIVE	PROACTIVE	REACTIVE	N/A
2.0 LIEE-SPECIFIC POLICY				
2.1 Are the Weatherization & Furnace Repair & Replacement programs administered as a SINGLE program or SEPARATE programs?	SINGLE	SINGLE	SEPARATE. but still under LIEE	FR&R is N/A
2.2 Are all combustion appliances in the residence identified (type and fuel) at first contact with the customer under either the single or separate program approach?	YES	YES	Only appliances affected by measures	NO
2.3 Is CO education provided to the customer during Energy Education?	NO[9]	NO	NO	NO
2.4 If the primary space heating unit is a combustion appliance other than a device designed for that purpose and/or the primary space heating device is non-operational, infiltration measures will/will not be installed.	WILL NOT BE INSTALLED	WILL BE INSTALLED	WILL BE INSTALLED	WILL BE INSTALLED
2.5 Is the type of testing contained in the proposed Minimum Standard performed as part of the current LIEE Program or Furnace Repair and Replacement Program?				
-- Natural gas furnaces?	BOTH	BOTH	NO	N/A
-- Natural gas water heaters?	BOTH	BOTH	NO	N/A
-- Other natural gas appliances?	BOTH	NO	NO	N/A
-- Non-natural gas combustion appliances?	BOTH	NO	NO	N/A

[9] However, each customer is advised via a letter that the home will undergo a CAS test and the test must pass before infiltration measures are installed.

Table 3 (cont'd.): Summary of Current LIEE Program Natural Gas Appliance Testing Practices

Policy/Practice Description	PG&E	SDG&E	SCG	SCE (non-overlap)
2.6 Is an ambient CO test[10] part of the normal evaluation/testing procedure?	YES	YES	NO	N/A
2.7 Is an appliance CO test part of the normal testing procedure under the LIEE or FRR Program?				
-- Natural gas furnaces?	YES	YES	NO	N/A
-- Natural gas water heaters?	YES	If ambient test fails	NO	N/A
-- Other natural gas appliances?	YES	If ambient test fails	NO	N/A
-- Non-natural gas combustion appliances?	YES	NO	NO	N/A
2.8 Who does the initial combustion appliance evaluation under the LIEE program? (NOTE: CIP = Central Inspection Representative)	CIP	Third party	N/A	N/A
2.9 Is installation of infiltration measures based on combustion appliance evaluation/test results?	YES	NO	NO	NO
2.10 Is blower door and duct blaster equipment used to weatherize the home against infiltration (as in the CSD program)?	NO	NO	NO	NO
2.11 When is combustion appliance evaluation/testing under the normal LIEE process performed? a) Prior to installation of any measures (PRE) b) After installation of any measures (POST) c) Both PRE and POST (PRE/POST)	PRE/POST[11]	POST	N/A	N/A

5.3. Standardization Team Recommendation for Minimum Standard

The Team feels that greater consistency in natural gas appliance testing policies and procedures can best be achieved through *an agreement to a minimum set of procedures to be implemented across programs.* These minimum standards would have two general provisions:

- First, the minimum standards would be implemented whenever natural gas appliances are present in the dwelling and natural gas is served by the utility providing the LIEE Program to the household.
- Second, the procedures comprising the minimum standard would be implemented either prior to the installation of measures (pre test), after the installation of measures (post test), or both before and after installation, at the utility's option.

[10] An ambient CO test is a test for CO at various points in the living space.

[11] Pre-installation CAS testing is done on all homes, and all appliances that fail are retested after repairs; post-installation testing is done on a 20% sample.

The specific procedures listed in Table 5 summarize the recommended minimum standards. It should be noted that the agreement to this set of minimum standards was possible only under the understanding that individual utilities can continue to provide additional procedures if they consider these additional steps warranted. For instance, PG&E does not object to the minimum natural gas appliance testing standards reached by the Utility Standardization Team, as long as it is authorized to follow its combustion appliance safety procedures, which include more tests and activities than covered by the recommended minimum standards.

Table 4: Recommended Minimum Standard for Gas Appliance Testing

General Procedure	Specific Procedures
Olfactory Test	■ Smell for natural gas leaks
Visual Examinations	■ Flue and Vent System—Check for: ■ Draft hood defects: Multiple, missing or improperly installed. ■ Holes in pipe or other hazardous conditions. ■ Connection with a solid fuel appliance chimney. ■ Flue/vent cap missing or damaged. ■ Inadequate distance from an evaporative cooler inlet.
	■ Appliance Components—Check for: ■ Furnace combustion chamber door(s) not present. ■ Water Heater combustion chamber cover (rollout shield or access door) not present. ■ Excessive amounts of carbon or rust in/around heat exchanger, draft hood or flue/vent pipe.
Combustion Air Evaluation	■ Combustion Air Vents—Check for: ■ Vents are present and adequate (size and location) ■ Source of combustion air is adequate and unobstructed.
Ambient CO Tests	■ CO tester zeroed outdoors. ■ First CO sample taken indoors with all combustion appliances turned off. ■ Second CO sample taken in same indoor location after all combustion appliances have been operating at least five minutes. ■ Third CO sample: - Forced-air units—inside the register nearest the supply plenum. - Non-ducted units—in the atmosphere just above the heat exchanger.
Draft Tests	■ Visual (non-instrument) test ■ Tactile test

Appendix A

Comparison of LIEE Program Practices for Natural Gas Appliance Safety and Operational Checks

COMPARISON OF LIEE PROGRAM PRACTICES FOR NATURAL GAS APPLIANCE SAFETY AND OPERATIONAL CHECKS (REV. 10/19/00)

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COMPARISON OF LIEE PROGRAM PRACTICES FOR NATURAL GAS APPLIANCE SAFETY AND OPERATIONAL CHECKS (REV. 10/19/00)

Summary

A comparison of utility combustion appliance safety and operational practices as they are implemented within or outside of the LIEE program is identified in Table 1-1 as:

IN = Indicates the practice is performed inside the LIEE program and is automatically offered to all LIEE participants.

IN- = Is the same as above, except that it is only offered if a CO problem is identified by Ambient CO test, customer complaint, or other means.

OUT = Indicates the practice is performed outside of the Low-Income Energy Efficiency program and/or is not offered to all LIEE participants.

Table 1-1 Combustion Appliance Testing Matrix

	PG&E	SCG	SDG&E
1.0 Check for Natural Gas Leaks & Defects			
1.1 Types of Tests for Gas Leaks			
1. Olfactory (Smell) Test	IN	IN	IN
2. Leak Detection Spray	IN	OUT	IN
3. Electronic Detection Instrument	IN[1]	OUT	IN
4. Clock the Meter	IN	OUT	IN-
5. Pressure Drop Test	NO	OUT	IN-
1.2 Locations Checked for Gas Leaks			
1. Valves	IN[2]	OUT	IN
2. Fittings	IN	OUT	IN
3. Flexible Gas Connectors	IN	OUT	IN
1.3 Appliances Checked for Gas Leaks and Defects			
1. All gas appliances affecting the living space:			
• Inside the home	IN	OUT	IN
• In attic, basement, crawlspace, closet or other space adjacent to the living space	IN	OUT	IN
• Within 10' of an opening into the living space	IN	OUT	IN
2. Gas appliances more than 10' from an opening into the living space	IN	OUT	IN
1.4 Examination for Gas Line Defects			
1. Butt soldered or copper connector present	IN[3]	OUT	IN
2. Any natural gas connectors[4]	IN	OUT	IN

[1] PG&E: Instruments used by Gas Service Representatives (GSRs) during gas leak check if called by CAS Inspector

[2] PG&E: This service is performed by GSRs and is not part of the weatherization program, only done if requested by customer.

[3] PG&E: "Yes – GSR"

	PG&E	SCG	SDG&E
2.0 All Other CAS Tests			
2.1 Appliances Checked			
1. All combustion appliances inside, adjacent to, and within 10' of the living space, including:[5]			
• Furnace	IN	OUT	IN
• Water Heater	IN	OUT	IN-
• Cook Top	IN	OUT	IN-
• Oven/Broiler	IN	OUT	IN-
• Clothes Dryer	IN	OUT	IN-
• Gas Log or Log Lighter	IN	OUT	IN-
• Gas Fireplace	IN	OUT[6]	IN-[6]
• Roof-Top Units	IN	OUT[7]	IN-[7]
2. Unvented Combustion Heaters NOT ALLOWED	IN[8]	IN[9]	IN[10]
3. Combustion Appliance not fueled by utility commodity.	IN[11]	NO	NO

[4] SDG&E added this item.

[5] SoCalGas: 10' criteria not applicable; if unit is outside it is not serviced.

[6] SDG&E/SoCalGas: gas fireplace is checked with "damper locked open."

[7] SDG&E/SoCalGas: roof units are checked only "if accessible."

[8] PG&E: Unit must be disconnected from the gas line in order for the home to be eligible for infiltration reducing measures. GSRs performing routine service calls available to all customers would not disconnect this appliance unless it was located in a sleeping area.

[9] SoCalGas: Unit is capped and red-tagged; 1813ed which is a "Notice of Unsatisfactory Condition"

[10] SDG&E: Unit is disconnected, capped, and red-tagged.

[11] PG&E: Will check appliances not fueled by a PG&E commodity, but only under WIS program, not under general service program that is available to all customers upon request.

	PG&E	SCG	SDG&E
3.0 Visual Examinations			
3.1 Heat Exchanger—Check for:			
1. Cracks—visual evaluation	IN[12]	OUT	IN
2. Cracks—chemical (smoke) test	NO	NO	NO
3. Proper sealing to air side of furnace	IN	OUT	IN
3.2 Flue and Vent System—Check for:			
1. Multiple draft hoods	IN	IN	IN
2. Improperly installed draft hood	IN	IN	IN
3. Loose, unsecured or unsafe joints	IN	OUT	IN
4. Holes or other hazardous conditions	IN	IN	IN
5. Connection with a solid fuel appliance chimney	IN	IN[13]	IN[13]
6. Proper termination above roof line	IN	OUT	IN-
7. Flue/vent cap presence/condition	IN	IN	IN
8. Proximity to evaporative cooler inlet	IN	IN	IN
3.3 Return Leaks Identified/Located			
1. Air leaks that depressurize the appliance enclosure	IN	OUT	IN-
2. Air leaks that draw in combustion byproducts from other appliances (e.g., nearby water heater)	IN	OUT	IN-
3. Air leaks that draw in fumes from attached garage or space where hazardous chemicals are stored	IN	OUT	IN-
3.4 Check of Appliance Components			
1. Appliance compartment door(s) must be in place	IN	IN	IN
2. Furnaces			
• Rollout shield must be present when appliance was manufactured with one	IN	OUT	IN
• Combustion chamber door(s) must be present	IN	IN	IN

[12] PG&E: GSR is called to inspect the heat exchanger when high levels of CO are found by the CAS inspector.

[13] SDG&E/SoCalGas: connection to chimney checked only when masonry chimney used as a raceway for vent.

	PG&E	SCG	SDG&E
3. Water Heaters			
• At least one of the two combustion chamber covers (rollout shield or access door) must be present[14]	IN	IN	IN
• Both rollout shield and combustion chamber access door must be present	NO	NO	NO
4. Excessive amounts of carbon or rust in/around:			
• Heat Exchanger	IN	IN	IN
• Draft Hood	IN	IN	IN
• Flue/Vent Pipe	IN	IN	IN
5. FAU Air Filter(s):			
• Check for properly-installed air filter(s)	IN	OUT	IN
• Clean existing air filter(s)	IN	NO	IN-
• Provide and install new air filter(s)	IN	NO	NO

[14] This is new policy accepted as part of the standardization effort, but does not reflect current practice for some utilities.

	PG&E	SCG	SDG&E
4.0 Combustion Air Evaluation			
4.1 Combustion Air Evaluation applies to:			
1. ALL open combustion natural gas appliances	NO[15]	NO	NO
2. ONLY open combustion natural gas Furnaces & Water Heaters fueled by a utility commodity	IN[16]	OUT	IN-
4.2 Combustion Air Vents			
1. Check for proper net free venting (NFV) area			
• Correction factor for mesh	IN	OUT	IN-
• Correction factor for louvers	IN	NO	IN-
2. Check for correct vent location(s)[17]			
• Existing upper vent OK if above draft hood	IN[18]	NO	NO
• Existing upper vent must be w/in 12" of ceiling	IN	NO	NO
• New upper vent must be within 12" of ceiling	IN	NO	NO
• All lower vents must be within 12" of floor	IN	NO	NO
3. Check appliance clearances for upper-vent-only	IN[19]	NO	NO
4. Check mesh on combustion air vent openings			
• No mesh on vertical duct from attic	IN[20]	NO	NO
• 1/4" mesh required on new vents	IN	NO	NO
• Mesh not to be obstructed (e.g., by insulation)	IN	OUT	IN-
5. Attic is Source of Combustion Air:			
• Attic venting must be adequate	IN	OUT	IN-
• Minimum 30" vertical clearance at peak	IN[21]	NO	NO
6. Crawl space is source of combustion air			
• Free flow of air under house required	IN	NO	NO
• Unobstructed vents 200% of required NFV	NO	NO	NO

[15] PG&E: Noted that UMC only requires combustion air for space heating and water heating equipment

[16] PG&E: Testing is also performed for non-utility commodities.

[17] Per SDG&E: "Min. 1sq in per 1,000 BTU's"

[18] PG&E: Door applications may apply or where allowed by local code officials.

[19] PG&E: Applies to single upper opening criteria only - UMC

[20] PG&E: Local code

[21] PG&E: New CVA Installation

	PG&E	SCG	SDG&E
5.0 Ambient CO Tests			
5.1 Conditions for *Initial* Living Space Ambient CO Test			
1. All combustion appliances, air handler, and exhaust devices off	IN	OUT	NO
2. Exterior doors and windows closed	IN	NO	NO
3. Interior living space doors open	IN	NO	NO
4. Appliance enclosure door closed	IN	NO	NO
5. Fireplace or wood stove damper closed	IN	NO	NO
6. No cooking within past 30 minutes	IN	NO	NO
5.2 *Initial* Living Space Ambient CO Test			
1. Zero CO Tester outdoors	IN	OUT	IN
2. Check Initial Living Space Ambient CO—before operating furnace	IN	OUT[22]	IN[22]
5.3 *Second* Living Space Ambient CO Test			
1. Operate all furnace(s) and heater(s) for 5 minutes	IN	OUT	IN
2. Recheck Living Space Ambient in same location	IN	OUT	IN
5.4 Appliance Ambient CO Test (Third in sequence)			
1. Performed immediately after *Second* Living Space Ambient CO Test			
• (FAUs) Sample CO inside supply register nearest the furnace	IN	NO	IN
• (Non-ducted) Sample CO in the atmosphere just above the heat exchanger	IN	OUT	IN

[22] SDG&E: Noted that "CO instrument is running during inspection," SoCalGas concurred with this.

	PG&E	SCG	SDG&E
6.0 Appliance CAS Test Conditions[23,24]			
6.1 Doors and Windows			
1. Exterior doors and windows closed	IN[25]	NO	NO
2. Appliance enclosure doors closed *except* during open-door tests	IN	OUT	IN
3. Doors to rooms containing exhaust fans/devices open	NO[26]	NO	NO
4. Hallway doors to open areas[27]	NO	NO	NO
5. All other interior doors without exhaust devices closed	IN[28]	NO	NO
6. *Exceptions:* Set doors per worst case conditions if Combustion Appliance Zone (CAZ) pressurization testing was performed	IN[29]	NO	NO
6.2 Open-Door and Closed-Door Tests (FAU Only)[30]			
1. When possible, CO and Draft Tests are performed with the doors to the room or space containing appliances both open and closed.	IN	NO	NO
2. Confined Area/Hallway:			
• Closed Door test with all doors closed	IN	NO	NO
• Open Door test with one or more doors to a common area open	IN	NO	NO
3. Garage:			
• Drive-through door closed during all tests	IN	NO	NO
• Closed-Door Test: All doors and windows closed	IN	NO	NO
• Open-Door Test: Door into house open	IN	NO	NO
6.3 FAU and other Appliances			
1. Operate all FAUs (air handler only if possible when furnace is not being tested)	IN	NO	NO
2. Operate all other combustion appliances which can affect operation of the appliance being tested	IN	OUT	IN-
6.4 Exhaust Devices			
1. Operate all devices which exhaust air from the space containing the appliance being tested, including:			
• Kitchen exhaust fan vented outdoors	IN	NO	NO

[23] SDG&E: SDG&E will do whatever is necessary to duplicate the conditions of a reported problem.

[24] SoCalGas: SoCalGas will check for possible CO problem with any gas-fired appliance that could in any way cause a danger to the customer.

[25] PG&E: This condition same as for Ambient CO Tests, Item 5.1

[26] PG&E: Only for FAU type systems.

[27] SDG&E: added to end of this item "…open to conditioned areas"

[28] PG&E: All interior doors closed.

[29] PG&E: For CAZ (Combustion Appliance Zone) Test only for Mobiles with fire places

[30] SDG&E Note: "SDG&E performs [neither?] CO checks nor CAS testing," assumed to be re: open/closed door test

	PG&E	SCG	SDG&E
• Bathroom and utility room fans	IN	NO	NO
• Clothes dryer	IN	OUT	NO
• Central vacuum system	NO	NO	NO
• Manually-controlled attic ventilator	NO	NO	NO
2. Excluding: Whole House Fan	IN	NO	NO
6.5 Filters			
1. FAU air filter(s) must be clean or removed	IN	NO	NO
2. Dirty filters in exhaust fans (e.g., greasy range hood filters) must be cleaned or removed	NO	NO	NO

	PG&E	SCG	SDG&E
7.0 Appliance CO Tests – Sampling & Max CO Levels			
7.1 Flue Gas Sampling Locations[31]			
1. In combustion gases free of/before dilution air	IN	OUT	NO
• *Exceptions:* Induced draft units and cook tops	IN[32]	NO	NO
7.2 Furnaces and Space Heaters—CO Sampling			
1. All Units			
• Operate at least 5 minutes before sampling CO	IN	OUT	IN
2. Natural Draft Furnaces/Space Heaters			
• Inside each exhaust port free of/before dilution air	IN	OUT	NO
• On each side of baffle, if present (e.g., in wall furnace)	IN	NO	NO
3. Induced Draft Open Combustion Furnaces			
• In draft test hole when present	IN[33]	NO	NO
• Inside flue termination when no draft test hole	IN	NO	NO
• Inside nearest register when no other location is feasible	IN	NO	NO
4. Closed Combustion Furnace (HiEff or MH type unit)			
• At flue termination	IN	NO	NO
• Inside supply register closest to supply plenum when no other location is feasible	IN	OUT	NO
• At register not inside	NO	OUT	IN
• When flue termination is inaccessible, ambient reading will suffice	IN	OUT	IN
7.3 Water Heaters—CO Sampling			
1. All Units, operate at least 5 minutes before sampling	IN	OUT	IN-
2. Natural Draft			
• Inside center tube flue	IN	OUT	NO
• On both sides of baffle	IN	NO	NO
3. Induced Draft			
• In draft test hole, if present	IN[33]	NO	NO
• In flue termination, if no draft test hole and if accessible	IN	OUT	NO

[31] SDG&E: SDG&E does not sample combustion products within the heat exchanger, draft diverter, or vent system.

[32] PG&E: Range top burners do not have a draft hood - can only take dilution reads for installations.

[33] PG&E Note: If no hole is present - only single wall metal "class C" vents may be drilled for test within 12-24 inches of induction motor.

	PG&E	SCG	SDG&E
4. Closed Combustion			
• At flue termination	IN	OUT	NO
• Ambient CO reading in conditioned areas	IN	OUT	IN-
7.4 Cook Tops—CO Sampling[34]			
1. One burner at a time operated and tested	IN	OUT[35]	NO
2. Burner operated on high for at least 15 seconds with grate in place	IN	NO	NO
3. Open burners—Probe held approximately 12" above flame	IN	NO	NO
4. Griddle—Probe held 2" above port opening	IN	NO	NO
7.5 Ovens—CO Sampling			
1. CO Sampling Locations:			
• Ovens Vented Indoors—Probe placed inside exhaust termination before dilution air	IN	OUT[36]	IN-[36]
• Ovens Vented Outdoors—Sample CO ahead of dilution air	IN	NO	NO
2. All Ovens and Broilers			
• Oven tested as-is (oven is not cleaned)	IN	OUT	IN-
• Operated at least 5 minutes before sampling CO	IN	OUT	IN-
• Operate additional 15 to 30 minutes and retest if initial CO sample is too high	NO[37]	NO	NO
3. Single-Burner Ovens			
• Operated at least 5 minutes on highest Bake setting or Broil setting before sampling CO	IN	OUT	IN-
4. Two-Burner Oven			
• First—Run on highest Bake setting at least 5 minutes before sampling CO	IN	OUT	IN-
• Second—Turn control to Broil, wait at least 5 minutes, and sample CO again (test separately)	IN	OUT	IN-

[34] SDG&E/SoCalGas: For cook tops, all they do is adjust the flame.

[35] SCG: This test is done with a pan of water on the burner, allowed to heat for 5 minutes.

[36] SDG&E: Sampling is done half way between stove and ceiling.

[37] PG&E: Additional test is performed after 15 minutes from original start time - test period 5-15 minutes

	PG&E	SCG	SDG&E
5. Separate Broiler			
• Operate on Broil at least 5 minutes before sampling CO	IN	OUT	IN-
7.6 Clothes Dryers—CO Sampling			
1. Will test regardless of whether moisture exhaust is vented indoors or properly vented outdoors.	IN	OUT	IN-
2. Lint filter must be clean and drum empty.	IN	OUT[38]	IN-[39]
3. Operate dryer on High heat for at least 2 minutes	IN	OUT	IN-
4. CO sampling locations:			
• At moisture exhaust termination acceptable on all units	IN	OUT	NO
• Deep inside the lint screen chamber acceptable on units with lint screen accessed from the top of the dryer	IN	NO	NO
7.7 Gas Logs and Gas Fireplaces—CO Sampling			
1. Decorative Gas Log Used as Primary Heater			
• Heat log at least 5 minutes.	IN[40]	OUT	IN-
• Check CO at least 1 foot above flame (probe directed away from flame)	IN	NO	NO[41]
2. Gas Fireplace Used as Primary Heater			
• Heat log at least 5 minutes	IN[40]	OUT	IN-
• Place L-shaped CO probe extension into the dilution air intake and point open end down into the flue gas stream [sample top edge of hearth][42]	IN	NO	NO
7.8 Maximum CO Levels[43]			
1. **Pre-Test** maximum CO levels (ppm) for all tests			
• Flue (ppm)	100	Varies[44]	N/A
• Ambient (ppm)	10	10	35
2. **Post-Service** maximum CO levels (ppm) for all tests			
• Flue (ppm)	100	Varies[44]	N/A
• Ambient (ppm)	10	10	35
3. **Other Post-Service** maximum CO levels (ppm)			
• Ovens and Broilers (flue)	225	Varies[44]	N/A
• Other appliances (flue)	100	Varies[44]	N/A

[38] SCG: Dryer is tested as-is, that is, in condition in which it is found.

[39] SDG&E: Added "Wet Towel needed," probably for those units that have humidity sensors.

[40] PG&E: Time period used is specified as 5-15 minutes

[41] SDG&E: Checked at hearth

[42] SDG&E: Even though they do not do this test, suggested adding "sample top edge of hearth" to this item.

[43] NOTE: The numbers given are "action" numbers, i.e. action is taken if measured CO levels exceed these values.

[44] SCG: CO levels vary by appliance type. SCG is also currently reevaluating and revising these limits.

	PG&E	SCG	SDG&E
8.0 Appliance Draft Tests			
8.1 Mechanized Draft Test with Pressure Sensing Instrument			
1. Draft Test hole:			
• May be drilled 12" to 24" above draft hood in a *straight* section of *rigid* single-wall metal pipe	IN	NO	NO
• May be drilled in <u>double</u>-wall metal pipe ***<u>except when</u>*** pipe is part of a listed vent system, drilling will void pipe manufacturer's warranty, or drilling will violate local code	NO[45]	NO	NO
• May <u>not</u> be drilled in an elbow, flexible vent connector, or pipe containing asbestos	IN	NO	NO
2. Test probe is placed approximately 1" inside test hole for both Natural Draft and Induced Draft units	IN[46]	NO	NO
3. Minimum draft is based on outdoor temperature:			
• Below 30°F: –5.0 Pa (–0.02 iwc)	IN	NO	NO
• 30°F to 80°F: –2.5 Pa (–0.01 iwc)	IN	NO	NO
• Above 80°F: –1.25 Pa (–0.005 iwc)	IN	NO	NO
4. Test hole is sealed after test(s):			
• Single-Wall—with snugly-fitting plug button	NO	NO	NO
• Double-Wall—with tight-fitting lag bolt; high-temp caulk on threads to seal inner hole	NO	NO	NO
5. Test hole is sealed with UL 181 metal tape	IN	NO	NO
8.2 Visual (Non-Instrument) Draft Test			
1. Performed on :			
• All furnaces & water heaters with a draft hood	IN	OUT	IN-
• Gas Log used as primary heater	IN	NO	NO
• Gas Fireplace used as primary heater	IN	NO	NO
2. Smoke is applied along entire draft hood opening	IN	OUT	IN-
3. Smoke must be consistently drawn inward for draft to be considered adequate			
• Perform Visual Draft Test along fireplace opening	IN	NO	NO
• Perform Visual Draft Test along dilution air intake opening	IN	NO	NO
8.3 Tactile Test for Spillage			
1. Performed on all units with a draft hood	IN	OUT[47]	IN-
2. Back of hand is moved along the entire draft hood opening	IN	NO	IN-

[45] PG&E: Added a note to emphasize that this is not permitted/strictly prohibited.

[46] PG&E: Probe is placed in the center of the vent

[47] SoCalGas: A match and mirror are used to perform this test.

	PG&E	SCG	SDG&E
9.0 Operational Examinations			
9.1 Burner Abnormalities			
1. Delayed ignition	IN	OUT	IN-
2. Excessive flame rollout	IN	OUT	IN-
3. (FAU) Flame interference when blower starts	IN	OUT	IN-
4. Flame abnormalities	IN	OUT	IN-
9.2 Pilot Abnormalities			
1. Pilot flame	IN	OUT	IN
9.3 Safety Device Operation Checked			
1. Cycling on high limit switch	IN	OUT	IN-
2. Thermocouple	IN	NO	IN-
3. Flame roll-out switch	IN	NO[48]	IN-
4. Vent spill switch	IN	NO	IN-
9.4 Control Device Operation Checked			
1. Thermostat	IN	OUT	IN-
2. Gas valve	IN	OUT	IN-
3. Fan limit switch	IN	OUT[49]	IN-
9.5 Kitchen Exhaust Fan Vented Outdoors			
1. Operable fan required with gas cooking appliances			
• In Mobile Homes	IN[50]	NO	NO
• In Conventional Homes	NO	NO	NO

[48] SCG: Not strictly tested, but will jumper this to see if there are any problems.

[49] SCG: Only checked for initial turn on of new furnace.

[50] PG&E: Mobile homes: Exhaust fan must be operational.

Appendix B

Ceiling Insulation Analysis

B.1 Introduction

This appendix discusses the Standardization Team's current approach to the analysis of ceiling insulation levels. The general approach is described in Section 2. As will be pointed out in Section 3, the implementation of this approach requires a variety of assumptions relating to insulation costs and benefits. At the present time, the analysis must be based on several highly uncertain assumptions with respect to electricity markets. Moreover, assumptions must be made that anticipate the recommendations of the RRM and LIMEC with respect to cost-effectiveness analysis. These issues are discussed in Section 4. As demonstrated in Section 5, variations in key assumptions can dramatically affect the results of the analysis. Section 6 offers some conclusions and recommendations.

B.2 General Approach

After discussion of existing policies, the reasons for those existing policies, and some of the issues surrounding ceiling insulation, it was decided that a cost analysis should be performed to help assess what levels of insulation made sense. The first attempt by the group was to examine cost effectiveness by comparing the value of customer energy savings versus installed costs. Installed cost estimates were derived from utility costs and an independent source, 1996 Means Residential Cost Data. However, calculation of the value of customer savings was a more involved process.

First, energy savings (in kWh and therms) had to be estimated. Standard ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) procedures were used for calculating U-Values.[1] These procedures are also incorporated in to the Title 24 Standards. Next, Heating/Cooling Degree Day (HDD/CDD) estimates were obtained from CEC Climate Zone weather data, and condensed down to the five climate zones to be used for the weatherization effort (see Appendix C). These two components were used to estimate heat loss/gain through the roof, which was then converted to source energy (gas/electric) energy use (therms or kWh). Assumed energy costs were then applied to obtain customer savings.

[1] 1997 ASHRAE Handbook of Fundamentals, Chapter 24.

An extensive range of insulation levels was examined for each climate zone. The base analyses were performed for both electric and gas heating systems with air conditioning. Since the team thought fuel-based insulation levels might be hard to implement, we also looked at an average of these two runs; one that weighted the natural gas/electric results as 90% /10% to reflect current fuels shares for space heating in California.

B.3 Assumptions

In order to conduct the analysis of ceiling insulation savings, several assumptions must be made. These assumptions relate to the installed cost of various levels of ceiling insulation, the lifetime of the insulation, the discount rate used to convert forecasted values to present discounted values, the current valuation of electricity and natural gas savings, and forecasted escalation rates for these valuations. Table B-1 contains the assumptions used in the baseline analysis.

Table B-1: Baseline Assumptions

Concept	Assumed Value
Installed Cost of Ceiling Insulation	
R-11	$0.35 per square foot
R-19	$0.47 per square foot
R-30	$0.63 per square foot
R-38	$0.75 per square foot
Lifetime of Ceiling Insulation	25 years
Discount Rate	8%
Retail Electricity Rate in 2000	$0.125
Avoided Electricity Cost (G, T & D) in 2000	$0.071
Natural Gas Rate in 2000	$1.00
Natural Gas Avoided Cost in 2000	$0.70
Escalation Rate for Retail Electricity Rate	3%
Escalation Rate for Avoided Electricity Cost	3%
Escalation Rate for Retail Natural Gas Rate	3%
Escalation Rate for Avoided natural Gas Cost	3%

Under the baseline scenario, we used the average of retail rates and avoided costs to value electricity and natural gas savings.

B.4 Issues Considered and Discussed

The issues that arose from team discussions are summarized briefly below.

- ***The Hardship/Comfort Issue.*** Adding insulation reduces heat losses/gains through the roof, and may also indirectly reduce infiltration. Increased comfort that might be experienced by the resident would include a reduction in radiative heat loss through the roof (similar to what is experienced when you stand next to a single-paned window in the winter time) and possibly a reduction in cold drafts originating from the attic. In the case of a bare, uninsulated attic, the comfort benefits are relatively clear. However, in the case where an existing level of insulation is present and more is to be added, the issue becomes one more of energy savings than comfort (i.e. running the heating system six hours instead of eight hours).

  However, comfort may be an important issue in the consideration of air conditioning savings. Because of the low air conditioning saturations among low income customers, the installation of ceiling insulation will affect cooling bills for only a small fraction of participants. However, insulation will affect comfort during hot days by keeping internal temperatures lower. In order to take this into account, we used an intentionally overstated assumption about the air conditioning saturation among low income customers: 50%.

  Comfort has also been taken into account indirectly through the use of engineering calculations of savings. These estimates ignore the well-documented fact that customers receiving conservation measures often take some of the potential savings from these measures in the form of comfort. That is, they choose a higher level of energy service (e.g., warmer homes in the winter) as a result of the increased efficiency of the home. This is sometimes called the "rebound effect." If we were to consider the rebound effect, we would use lower estimates of savings based on the general results of billing analyses of programs like this one. Ignoring the potential for the rebound effect essentially implies that we are treating increases in comfort associated with comfort tradeoffs as part of the benefits of insulation additions.

- ***Valuing Energy Savings.*** As noted in our Phase I Report, the valuation of energy savings could be conducted from the perspective of participants (using retail rates) or from a resource cost perspective (using avoided costs). Our Phase I report discussed the implications of using these alternative approaches in assessing program cost-effectiveness, and recommended that an average of retail rates and avoided costs be used. Our baseline analysis was based on this assumption. However, we conducted other analyses using retail rates or avoided costs.

- ***Forecasted Values.*** Whether avoided costs or retail rates or some combination of these is used to value energy savings from different ceiling insulation additions, a forecast of the chosen rate is necessary for the analysis. At this point, given recent events in the California electricity market, the accuracy of existing long-term forecasts of electricity prices and avoided costs may be subject to question.

In our baseline scenario, we used a 3% growth rate for retail rates and avoided costs. However, we tested the sensitivity of the results to this assumption by positing a 6% rte of escalation for one scenario.

- ***Specification of Insulation Level to be Installed.*** Two approaches are represented in the current policies and both were discussed. The PG&E approach is to install up to a specified, final R-value (R-30). The explanation for using this approach was ease of inspection and to address customer equity concerns. The approach utilized by the other utilities is to install a discrete R-value of insulation (R-11, R-19, R-30) based on the existing level of insulation. This explanation for using this approach was that it best reflects the standard practice of insulation installation for insulation contractors. The Team adopted the latter approach for the purposes of the analysis.
- ***Attic Access/Clearance Issue.*** Some homeowners may want to ensure adequate access to their attic. Installation of R-30 could drastically reduce homeowner access to attic. However, the customer now has the right to refuse the measure, which should prevent these types of situations, as long as the customer is presented with the option to refuse treatment.
- ***Fuel-Dependent Insulation Levels.*** The cost analysis showed clearly that the cost-effectiveness of attic insulation depends strongly on the heating fuel. However, some Program staff are reluctant to have separate policies on insulation levels for customers with gas and electric space heating. In recognition of this, the group developed analyses for three cases: electric space heating, gas space heating, and a mix of 90% gas and 10% electric. The analysis shown in this appendix focuses on the last approach.

B.5 Sensitivity of Results to Variation in Assumptions

B.5.1 Baseline Analysis

A baseline analysis was conducted using the baseline assumptions displayed in Table B-1. It also assumes a mix of 90% gas and 10% electric space heating. The results indicate *the present value of net benefits* associated with the installation of different levels of insulation in homes with different starting values. That is, they reflect the difference between the present value of 25 years' worth of energy savings and the installed cost of the insulation. Table B-2 presents the results of this analysis for the North Coast Climate Zone.

Table B-2: Baseline Results for North Coast Climate Zone

Initial R-Value	Amount of Ceiling Insulation Added to Existing Level			
	R-11	**R-19**	**R-30**	**R-38**
R-0	$4765.18	$5273.35	$5401.92	$5366.57
R-11	$296.10	$356.19	$350.86	>R-38
R-19	-$151.99	-$187.35	>R-38	>R-38

As shown in Table B-2, for a home with no existing ceiling insulation in the North Coast climate zone, the present value of net benefits is highest for the installation of R-30. For a comparable home with R-11 existing insulation, the present value of net benefits is highest for the installation of R-19. For homes with existing levels of insulation of R-19, no addition of insulation yields positive net benefits. As shown in Table B-3 for the North Coast, the implications of this analysis would be that R-30 would be installed where no insulation is present, R-19 would be installed where R-11 is present, and no insulation would be installed where R-19 is already present. The results of similar analyses for the other four climate zones are also presented in Table B-3.

Table B-3: Implied Ceiling Insulation Policies (Baseline Assumptions)

Climate Zone	*Existing* Ceiling Insulation Level	Insulation to be *Added*
North Coast	R-0	R-30
	R-11	R-19
	R-19	None
South Coast	R-0	R-19
	R-11	None
	R-19	None
Inland	R-0	R-30
	R-11	R-19
	R-19	None
Desert	R-0	R-30
	R-11	R-19
	R-19	None
Mountain	R-0	R-38
	R-11	R-19
	R-19	R-19

B.5.2 Impact of Variations in Assumptions

It should be recognized that the results of the analysis are very sensitive to specific assumptions about which there is considerable uncertainty. Tables B.3a, B.3b and B.3c illustrate the sensitive of the implied insulation policies for three alternative scenarios, defined as follows:

- ***Scenario 3a.*** Scenario 3a uses avoided costs to value gas and electricity savings, rather than an average of retail rates and avoided costs. Since avoided costs are lower than retail rates under our assumptions, scenario places a lower valuation on energy savings than the baseline case.
- ***Scenario 3b.*** Scenario 3b uses retail prices to value gas and electricity savings. This scenario places a higher valuation on savings than the baseline case.
- ***Scenario 3c.*** Scenario 3c uses retail prices, but assumes that retail rates escalate at 6% rather than 3% over the next 25 years. Of course, this implies a higher valuation of energy savings than the baseline case.

Table B-3a: Implied Ceiling Insulation Policies (Scenario 3a)

Climate Zone	*Existing* Ceiling Insulation Level	Insulation to be *Added*
North Coast	R-0	R-30
	R-11	R-19
	R-19	None
South Coast	R-0	R-19
	R-11	None
	R-19	None
Inland	R-0	R-30
	R-11	R-19
	R-19	None
Desert	R-0	R-30
	R-11	R-19
	R-19	None
Mountain	R-0	R-38
	R-11	R-19
	R-19	R-19

Table B-3b: Implied Ceiling Insulation Policies (Scenario 3b)

Climate Zone	*Existing* Ceiling Insulation Level	Insulation to be *Added*
North Coast	R-0	R-30
	R-11	R-19
	R-19	None
South Coast	R-0	R-30
	R-11	R-11
	R-19	None
Inland	R-0	R-30
	R-11	R-19
	R-19	None
Desert	R-0	R-30
	R-11	R-19
	R-19	None
Mountain	R-0	R-38
	R-11	R-19
	R-19	R-19

Table B-3c: Implied Ceiling Insulation Policies (Scenario 3c)

Climate Zone	*Existing* Ceiling Insulation Level	Insulation to be *Added*
North Coast	R-0	R-38
	R-11	R-19
	R-19	R-19
South Coast	R-0	R-30
	R-11	R-19
	R-19	None
Inland	R-0	R-38
	R-11	R-19
	R-19	R-19
Desert	R-0	R-38
	R-11	R-19
	R-19	R-19
Mountain	R-0	R-38
	R-11	R-19
	R-19	R-19

Table B-4 summarizes the results of the analyses under the four scenarios. As shown, the implied insulation values vary substantially across scenarios. Hidden in these results is the fact that implied values also change as assumptions with respect to installed costs and other factors vary.

Table B-4: Scenario Comparisons

Climate Zone	Existing Insulation	Most Cost-Effective Increases in Insulation			
		Baseline Scenario	**Scenario 3a** (avoided costs)	**Scenario 3b** (retail prices)	**Scenario 3c** (higher escalation)
North Coast	R-0	R-30	R-30	R-30	R-38
	R-11	R-19	R-19	R-19	R-19
	R-19	None	None	None	R-19
South Coast	R-0	R-19	R-19	R-30	R-30
	R-11	None	None	R-11	R-19
	R-19	None	None	None	None
Inland	R-0	R-30	R-30	R-30	R-38
	R-11	R-19	R-19	R-19	R-19
	R-19	None	None	None	R-19
Desert	R-0	R-30	R-30	R-30	R-38
	R-11	R-19	R-19	R-19	R-19
	R-19	None	None	None	R-19
Mountain	R-0	R-38	R-38	R-38	R-38
	R-11	R-19	R-19	R-19	R-19
	R-19	R-19	R-19	R-19	R-19

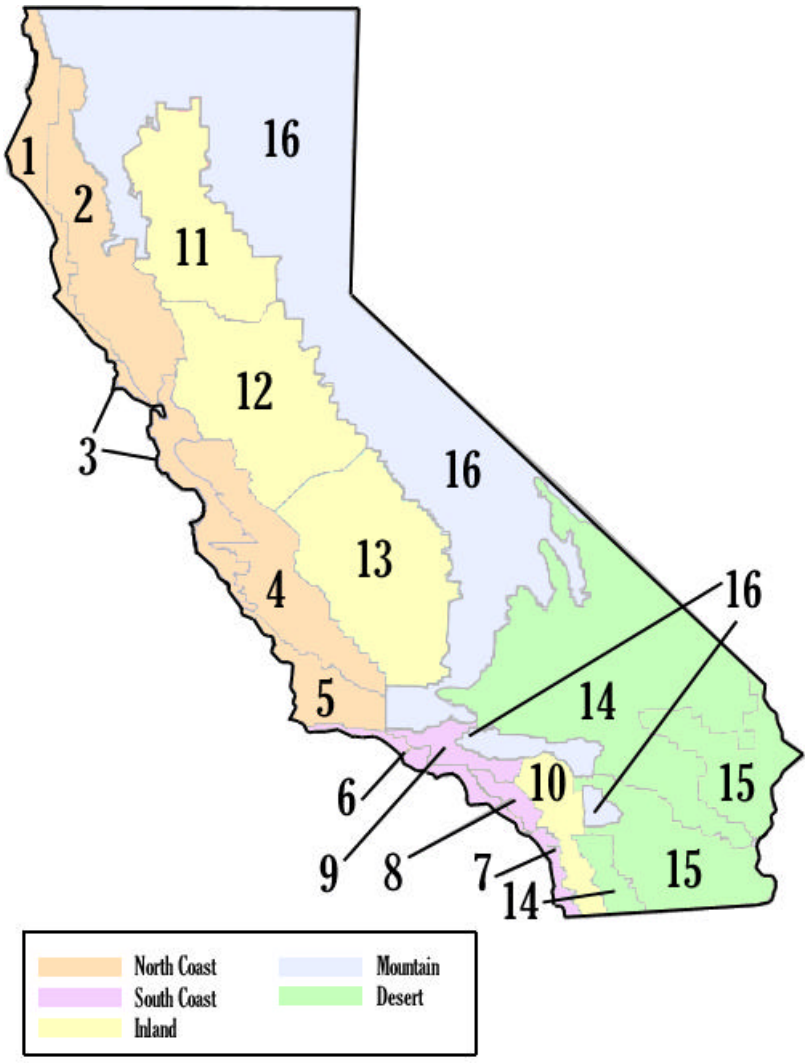
B.6 Conclusions and Recommendations

We conclude that there are several issues that need to be decided before the analysis discussed in this appendix can be finalized. Clearly, the results of discussions at RRM and LIMEC need to be reviewed carefully before the analysis is completed.

Appendix C

Climate Zones to be Used for Determining Attic/Ceiling Insulation Levels

Figure C-1: Proposed Climate Zones for Attic/Ceiling Insulation Levels



NOTE

California Energy Commission (CEC) climate zones (numbers on figure) are mapped to the five proposed ceiling/attic insulation climate zones as shown in Table C-1.

Table C-1: Attic/Ceiling Insulation Climate Zones versus CEC Climate Zones

Ceiling Insulation Climate Zone	CEC Climate Zone
NORTH COAST	1
	2
	3
	4
	5
SOUTH COAST	6
	7
	8
	9
INLAND	10
	11
	12
	13
DESERT	14
	15
MOUNTAIN	16