Final Report CPUC Program No. 1134-04

SCE0224.01

Statewide Codes and Standards Market Adoption and Noncompliance Rates

Prepared for:
Southern California Edison

May 10, 2007

Raising the bar in analytics™

Prepared by:
M. Sami Khawaja, Ph.D.
Allen Lee, Ph.D.
Michelle Levy

Quantec, LLC

In association with:
Lynn Benningfield
The Benningfield Group

K:\2006 Projects\2006-27 (SCE) Codes and Standards\Report\SCE_Draft_Report_021507.doc

Quantec Offices

720 SW Washington, Suite 400
Portland, OR 97205
(503) 228-2992; (503) 228-3696 fax
www.quantecllc.com

1722 14th St., Suite 210
Boulder, CO 80302
(303) 998-0102; (303) 998-1007 fax

28 E. Main St., Suite A
Reedsburg, WI 53959
(608) 524-4844; (608) 524-6361 fax

3445 Grant St.
Eugene, OR 97405
(541) 484-2992; (541) 683-3683 fax

20022 Cove Circle
Huntington Beach, CA 92646
(714) 287-6521

Table of Contents

1. Executive Summary

For over thirty years, the California Energy Commission has worked to advance energy efficiency through promulgation of energy codes and standards for buildings and appliances known as Title 20 (appliances) and Title 24 (buildings). These standards are updated periodically to reflect the emergence of new energy-efficiency technologies and methods.

The California Statewide Codes and Standards Program (C&S Program, or Program) is implemented by the state's investor-owned utilities and seeks to improve energy efficiency by influencing the periodic updates to the Title 20 and Title 24 standards. A consortium of representatives from each of the investor-owned utilities, called the Stakeholder Review Committee (SRC), works to propose the updates and monitor changes in energy use and market trends as a result of the codes. The most recent round of updates to the standards went into effect in late 2005 for the building standards, and in the period 2006-2008 for the appliance standards.

Past studies have worked to estimate the energy savings attributable to the Program, but due to a lack of empirical data, have typically assigned estimated, place-holder values for three key influencing factors:

- Initial market penetration and naturally occurring market adoption
- Noncompliance rate for selected building measures
- Noncompliance rate for selected appliances

These parameters are key factors in the calculation of the savings attributed to the Program and are entries in the *Savings Estimate Spreadsheet* that was created by the Heschong Mahone Group, Inc.

The goal of the study, conducted by Quantec, LLC, was twofold: 1) to refine the original estimates made of noncompliance, initial market penetration, and naturally occurring market adoption rates by researching and analyzing the factors contributing to each parameter; and 2) to test the 2006 California Energy Efficiency Evaluation Protocols (Evaluation Protocols) as it applies to determining net savings resulting from Program activities. This study was *not* intended to be an evaluation of the Program and did not revise the gross savings estimates or any savings inputs into the Savings Estimate Spreadsheet other than those listed above. In addition, modifying the spreadsheet was not in the research scope.

Initial Market Penetration and Naturally-Occurring Market Adoption

In order to improve the Savings Estimate Spreadsheet's assessment of the energy impacts of the introduction of new Title 20 and 24 standards, this analysis was designed to research and establish refined estimates for:

1) The initial market penetration of appliances and building measures meeting the standards

2) The future market adoption trends of these items if the standards had not been implemented, i.e., the naturally-occurring market adoption rates

Research Methodology

Our approach for estimating both initial market penetration and naturally-occurring market adoption was to solicit expert opinions to estimate a market adoption curve, using a typical S-shaped curve. We chose the Bass model to approximate the process.

We used a unique approach to obtain expert judgment about the market adoption curve. An interactive web-based tool was created that allowed experts to use sliders moved by their mouse to input their selection of leading and following behavior and maximum market penetration parameters. They were able to view the adoption curve in real time and make adjustments until they were satisfied with its shape. The web tool was interactive in real time as it enabled the following:

1) Allowed the experts to see the shape of the diffusion into the market over time: As the expert moves the sliders that determine the values of the three needed parameters, (leading behavior, following behavior, and maximum market penetration), the curve starts to take shape on the screen.

2) Provided the expert with a verbal description of the selected shape: Once the expert decides the shape looks right, he or she clicks a selection button and a verbal description of the curve is displayed. For example, the description might be that the selected curve implies that the market penetration will never exceed 50%, current market penetration is at 20%, and the market is expected to take off in three years.

When the expert is satisfied with the shape and the verbal translation, the selection is submitted and the data are saved. All opinions are aggregated to produce the average S curve using a mathematical procedure that best fits the average values at each point. A second round allowed the participating experts to review the average curve, and provide feedback on the differences between their curve and the average. Based on this feedback and follow-ups with the participants, we finalized the naturally occurring market adoption curve.

A subset of the building measures and appliances covered by the new Title 24 and 20 standards was selected for analysis and these are shown in Table 1. This subset was selected primarily based on their contribution to total expected first year savings. The expected savings, number of experts targeted for this study, and number of experts who participated are shown in Table 1.

Table 1. Market Adoption Analysis Building Measures, Appliances, and Experts

Title 20 and 24 Measures and Appliances	First-year Savings, GWh Equivalent	Targeted Number of Experts		Number of Experts Participating
		Manufacturers/ Distributors	Contractors	
Hardwired lighting, new residential	65	-	8	3
Lighting controls under skylights, new	26	-	8	3
Duct improvement, residential existing	16	-	8	3
Ducts, nonresidential existing	19	-	8	
Consumer electronics-TVs	68	6	-	5
Consumer electronics-DVDs	12	6	-	4
Consumer electronics-audio players	53	6	-	4
Residential pool pumps, 2-speed, Tier II	130	6	6	7
Pulse start metal halides	49	6	-	7
General service incandescent	79	6	-	4
Commercial dishwasher spray valves	76	3	-	4
Unit heaters/duct furnaces	19	6	-	5

Results

Table 2 summarizes the results of these analyses. For each high efficiency measure and appliance, the table shows the year from which the adoption curve analysis starts, the 2006 estimated market penetration, and the estimated naturally-occurring market adoption rates for two representative years, 2015 and 2030. It is important to note that the estimates of market behavior presented in Table 2 stemmed from the informed opinions of a relatively small sample of industry experts. These data are qualitative in nature, and represent the best point estimates available at this time. Since a key objective of this study was to test the Evaluation Protocols, these results serve the dual purpose of providing improved Savings Estimate Spreadsheet estimates, as well as demonstrating the effectiveness of the chosen approach and offering key lessons for future research (as outlined below).

Table 2. Initial Market Penetration and Naturally Occurring Adoption Results

Title 20 and 24 Measures and Appliances	Market Introduction Year	Initial Market Penetration 2006, %	Naturally Occurring Market Adoption, %	
			2015	2030
Hardwired lighting, new residential	2000	8	35	56
Lighting controls under skylights, new	2000	7	38	51
Duct improvement, residential existing	1990	10	17	19
Ducts, nonresidential existing	1990	2	7	19
Consumer electronics-TVs	2000	41	76	83
Consumer electronics-DVDs	2000	24	58	61
Consumer electronics-audio players	2000	26	46	50
Res pool pumps, 2-speed, Tier II	1995	6	23	33
Pulse start metal halides	1992	26	46	57
General service incandescents[1]	1970	47	50	52
Commercial dishwasher spray valves	1985	25	41	51
Unit heaters/duct furnaces	1965	50	58	65

Building Standards Noncompliance

As with initial market penetration and naturally occurring market adoption, the development of the Savings Estimate Spreadsheet used placeholder values for building standards noncompliance rates; this value was 30% for all measures.

Research Methodology

Data were collected via a combined approach of reviewing building department records and conducting site visits at a sample of buildings to estimate the noncompliance rates. The building measures investigated are shown in Table 3.

Building departments were selected to represent a mix of projects and climate zones across the state (nine building departments in Arcata, Ceres, Elk Grove, Sonoma County, Paso Robles, Anaheim, Fullerton, Riverside County, and San Diego).

In total, 418 records were examined, representing 437 measures. Of those, a total of 395 measures had permits that were available for complete review.

Sample sizes were drawn with the goal of yielding statistically defensible results for each of the identified measures with 90% confidence ±10%. Actual precision levels ranged from ± 1% to ±10%.

Beyond the noncompliance values themselves, this study also provided valuable insight into the varying building department processes and procedures in place across the state.

Table 3. Building Measures Updated in Title 24

Measure	1st Year Savings (GWh)
Residential	
Hardwired lighting	64.6
Window replacement	6.3 (0.3 Mtherms)
Duct improvement	5.7 (1.1 Mtherms)
Nonresidential	
Lighting controls under skylights	25.5
Cool roofs	14.6
Bi-level lighting controls	12.1
Ducts in existing buildings	9.7 (1.0 Mtherms)
Duct testing/sealing in new buildings	8.0

Compliance Scoring

Each permit reviewed was given a score in each of three possible compliance categories: process, design, and field.

Process reflects the completeness of the information contained in the permit file.

Design represents the compliance level of the submitted blueprints or plans.

Field corresponds to the observations made during the field inspections.

The scores themselves were derived from an evaluation of how close the component came to meeting the code requirement. Complete *noncompliance* existed when no evidence of knowledge or intent to comply with code existed (score =1). Partial compliance was given when some evidence was found of an attempt to comply with code, but compliance was incomplete (score = 0.5). Full compliance existed when the measure was present and was either fully documented, fully contained in the design or installed in the building (score = 0).

Determining Noncompliance Rates

During the permit review process, permit files were scored according to the system described above. These permit scores were used to obtain an *initial* estimate of compliance. Site visits were then carried out on a sample of buildings to assess the accuracy of the permit scores; the final site visit scores were then used to revise the initial compliance scores using a Bayesian statistical approach.

Results

Through this study, we found that *noncompliance* values varied widely by measure, ranging from 21% for hardwired lighting to 100% for nonresidential ducts (both new and retrofit). The noncompliance estimates for each measure studied are displayed in Table 4.

Table 4. Summary of Building Measure Noncompliance Estimates

Building Measure	Estimated Noncompliance rate	Precision of Estimate
Residential		
Hardwired lighting	28%	3%
Window replacement	68%	7%
Duct improvement	73%	1%
Nonresidential		
Lighting controls under skylights	44%	10%
Cool roofs	50%	3%
Bi-level lighting controls	n/a	n/a
Ducts in existing buildings	100%	2%
Duct testing/sealing in new buildings	100%	1%

We note that, since this study began shortly after the implementation of the updated 2005 building codes, utility-sponsored training and education (T&E) programs aimed at improving compliance rates had not been completed yet. These T&E efforts are carried out through IOU Energy Centers, the Savings by Design program, and statewide and local partnership programs. We expect that compliance with the 2005 standards will improve as these training efforts continue.

Appliance Standards Noncompliance

We assessed the noncompliance rates for nine appliance standards that went into effect in January 2006. The affected appliances were selected based on the magnitude of their estimated energy savings.

Appliance manufacturers are required to submit an application to the California Energy Commission (CEC) to have their product certified as meeting Title 20. For appliances manufactured after the effective date of these standards, only those certified can be sold legally in California. The CEC maintains a database listing the certified appliances of each type. The appliances included in our study and a description of the Title 20 energy-efficiency requirements are provided in Table 5. The table also indicates whether or not the appliance type was in the CEC compliance database when we conducted our study.

Table 5. Appliance Standards Included in Noncompliance Analysis

<table>
<tr><th>Appliance Category</th><th>In CEC Database</th><th>Standard</th></tr>
<tr><td>Televisions</td><td>Yes</td><td>Max. standby power usage =3W</td></tr>
<tr><td>DVD Players</td><td>Yes</td><td>Max. standby power usage =3W</td></tr>
<tr><td>Residential Pool Pumps, Tier 1</td><td>No</td><td>Motor may not be split phase or capacitor start-induction run type motor</td></tr>
<tr><td>General Service Incandescent, Tier 1</td><td>No</td><td>Max. wattage set for lumen output; applies to most incandescent and halogen lamps between 25 and 150 watts. Rough service, decorative, 3-way, and colored lamps are excluded.
Frost/clear: Max. W=(0.05*lumens)+21
Soft white: Max. W=(0.05*lumens)+22.5</td></tr>
<tr><td>Metal Halide Luminaires</td><td>No</td><td>Allows only pulse-start ballasts for vertical lamps with base up applications. Probe-start ballasts disallowed.</td></tr>
<tr><td>Walk-in Refrigerators/ Freezers</td><td>No</td><td>Usually custom made. Requires automatic closers on doors <4’ wide and <7’ high; R-28 insulation in refrigerators, R-36 in freezers; electronically commutated, permanent split capacitor type, or polyphase motors on condenser fans <1 HP; electronically commutated or permanent split capacitor type motors on evaporator fans <1 HP.</td></tr>
<tr><td>Pre-rinse Spray Valves</td><td>No</td><td>Flow rate ≤1.6 gpm @ 60 psi; cleans 60 plates at average of ≤30 seconds per plate.</td></tr>
<tr><td>Unit Heaters and Duct Furnaces</td><td>Yes</td><td>Natural gas-fired unit heaters and duct furnaces shall have either power venting or an automatic flue damper
<table>
<tr><th>Type</th><th>Fuel</th><th>Min. Efficiency @ Max. Capacity</th><th>Max. Watts during Standby</th></tr>
<tr><td>Duct furnaces</td><td>Nat gas</td><td>80</td><td>10</td></tr>
<tr><td>Duct furnaces</td><td>LPG</td><td>80</td><td>147</td></tr>
<tr><td>Unit heaters</td><td>Nat gas</td><td>80</td><td>10</td></tr>
<tr><td>Unit heaters</td><td>LPG</td><td>80</td><td>147</td></tr>
<tr><td>Unit heaters</td><td>Oil</td><td>81</td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Refrigerated Canned/Bottled Beverage Vending Machines</td><td>Yes</td><td>Max daily kWh=0.55*(8.66+(0.009*C)); C=rated capacity, # of 12 oz. cans</td></tr>
</table>

Methodology

Our primary approach to estimate noncompliance rates was to identify a sample of retailers and/or wholesalers for each appliance and conduct site visits to collect primary data on brands/models sold and their sales volumes. Our basic approach was to determine whether each brand/model complied with Title 20 and, using the sales volumes, calculate the overall noncompliance rate.

In addition to collecting information from wholesalers/retailers, we contacted distributors and manufacturers of each appliance and obtained relevant information from websites and requested and reviewed catalogs. A stratified cluster sampling approach was used to select retailers and wholesalers for site visits.

The site visits were conducted between July 26 and September 11, 2006, by Quantec field technicians. They began in Southern California and moved north.

The site-visit data were analyzed to determine which models at each outlet did or did not comply with the relevant California standard. We also intended to determine which models were manufactured prior to the effective date of the standards, but this was not possible since we found that manufacture dates were not provided for the products. The primary source of compliance information was the CEC databases of certified products. The noncompliance rate for each appliance was then estimated based on the rate for each outlet, approximate sales, and appropriate weights for the strata.

This general approach had to be tailored to each appliance. In the early stages of data collection, it was found that CEC certification databases existed for only four of the appliances studied. Instead of categorizing all these units as "not in compliance," a decision was reached to assess compliance of the products sold using supplemental information.

Results

Our estimates of noncompliance rates for each appliance are presented in Table 6. *Noncompliance* varied from virtually zero (all units complied) to 63%. The average noncompliance rate across all these appliances was 32%.

Table 6. Summary of Noncompliance Estimates for 2006

Appliance Category	Estimated noncompliance rate	Certainty level of estimate
Televisions	41%	Medium
DVD Players	57%	Medium
Residential Pool Pumps, Tier 1	15%	Medium
General Service Incandescents, Tier 1	27%	Medium
Metal Halide Luminaires	37%	Low
Walk-in Refrigerators/ Freezers	0%	Medium
Pre-rinse Spray Valves	4.2%	High
Unit Heaters and Duct Furnaces	44%	Low
Refrigerated Canned/Bottled Beverage Vending Machines	63%	Low

Lessons and Recommendations

Initial Penetration and Naturally-Occurring Market Adoption

The methodology used in this study to research naturally-occurring market adoption rates was a pioneering effort, and yielded a number of key lessons on how this process could be improved in future applications.

- Experts should be identified during the standards development process and they should be informed that their input will be required to estimate market trends.

- The amount of the incentive should be increased to an adequate level, as we found that $100 was inadequate to incentivize responses.

- Empirical data on the baseline market should be developed, and then used to provide an anchor point for the experts who will participate in the market estimation exercise.

- The process should be expanded to fully implement the Delphi approach by conducting one or two additional rounds to allow the respondents a chance to revise their estimates and exchange information on the range of estimates.

Building Standards Noncompliance

In order to pinpoint and correct flaws in the compliance chain so that energy savings predicted from the codes can be fully realized, we propose future research in the following areas:

- Conduct building surveys to determine the frequency of permitted vs. nonpermitted construction projects by measure and by jurisdiction to learn more about the penetration levels of the codes and standards.

- Identify existing building department processes and ensure that compliance and other implementation forms fit into these processes.

- Survey building industry professionals to identify barriers that may exist in implementing and complying with energy efficiency building codes. This information would be valuable in the design of training and educational efforts, as well as in the design of future code updates.

- Conduct studies on building performance. These studies characterize the market in a more complete way than do measure-specific studies, and allow more accurate predictions into the benefits of codes and standards, and the impact of enforcement.

Appliance Standards Noncompliance

The following lessons learned and recommendations were developed as a result of our research:

- When noncompliance is researched shortly after a standard goes into effect, special issues may arise that need to be addressed in the research approach and scope. Specifically, if databases are not available for identifying complying products then the approach and scope should be designed to implement other research that may be necessary to determine compliance.

- There are likely to be limitations in the accuracy of databases used to identify vendors for data collection site visits so it is important to verify during pre-site visit calls that vendors are correctly classified and carry the proper product. In addition, it is important to have the flexibility in the field to identify other vendors that can provide information.

- Special steps should be taken to enlist the cooperation of retailers and wholesalers including presenting a letter from the state or utility explaining the study and contacting corporate management to have them notify the local vendor that they have approved the site visit.

2. Introduction and Overview

For over thirty years, the California Energy Commission has worked to advance energy efficiency through promulgation of energy codes and standards for buildings and appliances. Known as Title 20 (appliances) and Title 24 (buildings), these standards are updated periodically to reflect the emergence of new energy-efficiency technologies and methods.

The California Statewide Codes and Standards Program (C&S Program, or Program) is implemented by the state's investor-owned utilities and seeks to improve energy efficiency by influencing the periodic updates to the Title 20 and Title 24 standards. A consortium of representatives from each of the investor-owned utilities, called the Stakeholder Review Committee (SRC), works to propose the code updates and monitor changes in energy use and market trends as a result of the codes. The most recent round of updates to the standards went into effect in late 2005 for the building standards, and in the period 2006-2008 for the appliance standards.

Past studies have worked to estimate the energy savings attributable to the Program – a complex task that is sensitive to many parameters. Most recently, a key study entitled "Codes and Standards Program Savings Estimate For 2005 Building Standards and 2006/2007 Appliance Standards" was conducted by Heschong Mahone Group Inc. (HMG).[1] This effort estimated the energy, demand, and gas savings attributable to the C&S Program, with calculations and results available in an Excel spreadsheet entitled *Savings Estimate Spreadsheet*. Due to a lack of empirical data, three key influencing factors were given place-holder values in the spreadsheet:

- Initial market penetration and naturally occurring market adoption
- Noncompliance rate for selected building measures
- Noncompliance rate for selected appliances[2]

The goal of the study conducted by Quantec, LLC was twofold: 1) to refine the original estimates made of noncompliance, initial market penetration, and naturally occurring market adoption rates by researching and analyzing the factors contributing to each parameter; and 2) to test the 2006 California Energy Efficiency Evaluation Protocols[3] as it applies to determining net savings resulting from Program activities. This study was *not* intended to be an evaluation of the Program and did not revise the gross savings estimates or any savings inputs into the Savings

[1] November 1, 2005.

[2] The Savings Estimate Spreadsheet assigned a 30% across-the-board noncompliance estimate for both appliances and building measures. For naturally -occurring market adoption, the HMG analysis estimated time (in years) remaining until full market adoption for that product, and then used a linear market adoption curve from the date C&S activities began to the date of full adoption.

[3] See *California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals*. Prepared for the California Public Utilities Commission by the Tec Market Works Team, April 2006.

Estimate Spreadsheet other than those listed above. In addition, modifying the spreadsheet was not in the research scope.

The following chapters describe the methods employed to refine these estimates, and present the findings of our research. The final chapter summarizes the data from our study that should be incorporated into the HMG Savings Estimate Spreadsheet. In addition, the report presents observations on lessons learned and provides recommendations for future research.

3. Initial Market Penetration and Naturally Occurring Market Adoption

Introduction

To estimate the impact of the introduction of the new Title 20 and 24 standards, the analysis needs to estimate:

1) The initial market penetration of appliances and building measures meeting the standards

2) The future market adoption trends of these items if the standards had not been implemented.

The initial market penetration represents the state of the market at the time the standards go into effect, in other words, what share of annual installations or purchases are already meeting the requirements of the standards. The naturally occurring market adoption rates project what the annual sales or installations of items that meet the standards would have been without the standards.

These market characteristics need to be assessed to estimate the incremental effect of new standards. The upper limit of the impact is the total annual sales or installations of measures covered by the standards, times their unit energy savings. The final estimates are used in estimating final impacts through the use of the Heschong Mahone Group (HMG) Savings Estimate Spreadsheet .[4] Quantifying the market penetration prior to the effective date of new standards permits adjusting the energy savings attributed to the standards by the savings that were already occurring. Quantifying the naturally occurring adoption rates allows extending this adjustment into the future.

Prior to this analysis, initial market penetration was estimated based on the market data available; in some cases, these data were quite limited. Naturally occurring market adoption was estimated as a linear increase in penetration over a specific number of years for each efficient measure or appliance

Methodology

Our approach for estimating both initial market penetration and naturally occurring market adoption was to solicit expert opinions to estimate a market diffusion curve.

[4] The latest version of this spreadsheet is Total CS Savings HMG – v3 DM.xls

Bass Curve

The Bass curve was adopted for analyzing naturally occurring adoption (both initial and future) rates.[5] The standard Bass curve can be represented by the following equation:

$$F(t) = \frac{1 - e^{-(p+q)t}}{1 + (q/p)e^{-(p+q)t}}$$

where

F(t) = the cumulative fraction of adopters,

p = coefficient of innovation,

q = coefficient of imitation, and

t = elapsed time

p captures the effect of consumers who are not influenced by the behavior of others and *q* captures the effect of consumers who are influenced by prior adopters.[6]

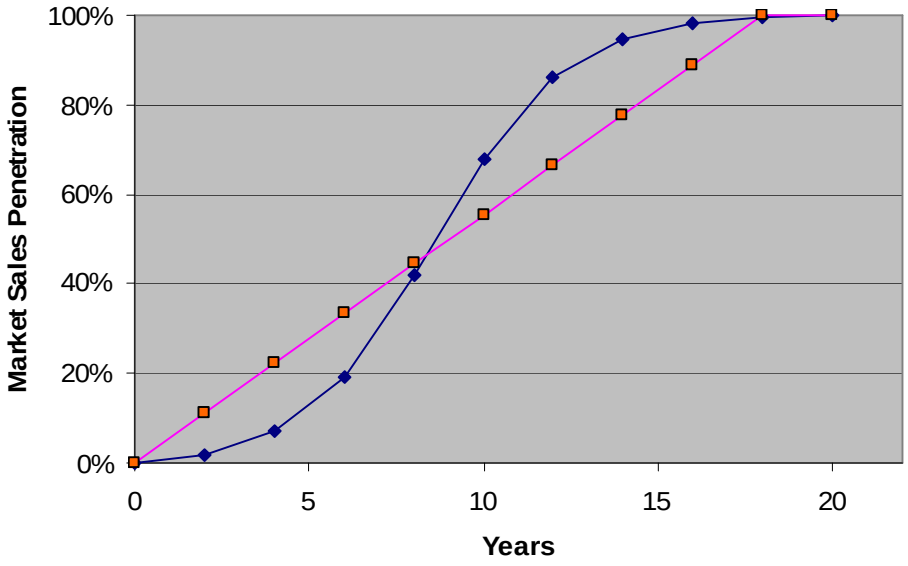
The HMG Spreadsheet incorporates the assumption that, in the absence of the Program, an equivalent standard would have been adopted for each appliance/measure at some point in the future. Consequently, the estimates of naturally occurring market adoption are significant only until an equivalent standard is assumed to be adopted in the future.

For the purposes of this analysis, the most critical part of the curve to estimate accurately was the part representing the initial years immediately following the introduction of the measure/appliance, since the S-shaped nature of the Bass curve is able to provide more realistic estimates of naturally occurring market adoption rates during those first years, as products gradually increase their market shares. The differences between the linear and S-shaped adoption curves are illustrated in Figure 1, which compares a Bass curve that produces 99% market penetration in 18 years to a linear curve that was assumed in the initial Savings Estimate Spreadsheet.

[5] For a good reference describing and comparing various methodologies for predicting market penetration rates, including the standard Bass curve, see S.T. Gilshannon and D.R. Brown."Review of Methods for Forecasting the Market Penetration of New Technologies." *Pacific Northwest Laboratory* PNNL-11428 (December 1996).

[6] The Bass curve is usually applied to characterize the trend in adoption of a new technology within a fixed group of adopters over time. We use this approach in a slightly different way here to estimate the trend in the sales of a specific product variation each year, where the annual sales of the product remain constant, but the proportion of high-efficiency units increases.

Figure 1. Comparison of Typical Bass and Linear Curves for 18-year Market Adoption



In the earliest years, the penetration rates based on the Bass curve are slightly less than the linear curve, and they exceed the linear rates in later years. In this example the naturally occurring adoption adjustment would be less with the Bass curve for about eight years, and more thereafter.

Mathematically, three of the following five parameters are needed to estimate the Bass curve:

1) Time (t_{max}) when maximum adoption rate will occur
2) Maximum adoption rate
3) Cumulative adoption at the maximum rate
4) Coefficient of innovation (p)
5) Coefficient of imitation (q)

It was essential to determine a start date for the market adoption curve for each appliance or measure. The objective was to identify a date when the efficient appliance or measure started to have a presence in the market that represented the beginning of its market growth. Some items have been available for many years, but have experienced little or no market growth. Others were present for some time and their market shares were already growing before the standards went into effect. Still others had little or no notable market presence at the time the standards went into effect. We selected a start date using an iterative process starting with a literature review for each item and relying heavily upon the information presented in the relevant CASE

report.[7] In all cases, we solicited the input from experts participating in the process to confirm or modify our proposed start dates.

Selection of Measures/Appliances and Experts

A subset of the building measures and appliances covered by the new Title 24 and 20 standards was selected for analysis. This subset was selected primarily by their contribution to total expected first year savings and to most efficiently use the resources available for this study.

Specifically, the study only included measures and appliance that were expected to contribute at least 2.3% of total savings for both gas and electricity. This resulted in a list of 12 measures/appliances (accounting for 47% of total electricity savings and 63% of natural gas savings) These are listed in Table 7.[8]

Table 7 also shows the number of industry experts we targeted from whom to collect input on the naturally occurring market adoption rates. For each appliance/measure, it was important to solicit inputs from experts knowledgeable about the market for that efficient technology. Based on the information contained in the CASE reports, we selected the type and number of industry experts to target for providing input on each building measure and appliance.

In addition to these industry representatives, it was thought that the inclusion of California Energy Commission (CEC) staff, utility representatives, and consultants would be beneficial to the analysis. Consequently, we solicited input from representatives of each of these groups.

[7] The CASE reports were studies conducted on behalf of the utilities to develop information in support of the Codes and Standards Program.

[8] Residential pool pump requirement included is the Tier II, two-speed standard, which does not go into effect until 2008. The SRC believed that it was more important and useful to include this than the Tier I requirement, which prohibits certain motor types, because the Tier II standard produced the highest estimated energy savings of all the standards.

Table 7. Market Adoption Analysis Building Measures, Appliances, and Experts[9]

Title 20 and 24 Measures and Appliances	First-year Savings, GWh Equivalent	Targeted Number of Experts	
		Manufacturers/ Distributors	Contractors
Hardwired lighting, new residential	65	-	8
Lighting controls under skylights, new	26	-	8
Duct improvement, residential existing	16	-	8
Ducts, nonresidential existing	19	-	8
Consumer electronics-TVs	68	6	-
Consumer electronics-DVDs	12	6	-
Consumer electronics-audio players	53	6	-
Residential pool pumps, 2-speed, Tier II	130	6	6
Pulse start metal halides	49	6	-
General service incandescents	79	6	-
Commercial dishwasher spray valves	76	3	-
Unit heaters/duct furnaces	19	6	-

Data Collection

Traditional methods of estimating the parameters to generate the Bass curve are to use values derived from curves for similar existing products, rely on market research, or apply expert judgment about how the product will perform. In conjunction with the SRC, we selected an innovative approach that relied on inputs from industry experts using a visual tool developed specifically for this purpose.

It was decided that a visual approach would maximize the efficacy of data collection regarding these parameters, as it would provide direct feedback, educate the participant on the concept, and be more intuitive and appealing to use. To implement this approach, we developed an interactive website as an effective and efficient way to obtain expert opinions on the inputs. The website was designed to introduce the process we were using and the overall approach by presenting an explanation of the inputs and parameters of the market-specific adoption curve, as well as a discussion of the influences that the experts should take into account in their assessments.

[9] We used a value of 9,648 Btu/kWh to make the conversion based on typical California heat rates (Klein, J. April 17, 1998. *The Use of Heat Rates in Production Cost Modeling and Market Modeling*. California Energy Commission) and estimated line losses of 7.2% (http://climatetechnology.gov/library/2003/tech-options/tech-options-1-3-2.pdf).

Macromedia Flash software was used to develop an interactive display that the respondents were able to adjust to reflect the innovative and imitative parameters used in the Bass model equation. For purposes of this exercise, we modified the terminology and referred to these parameters as "leading" and "following" behavior, respectively. Based on our pretests we determined that these terms were more understandable for participants. It was not necessary for the respondent to understand the details of the model in order to select appropriate values. Adjustable sliders were provided for the participants to vary until the curve best depicted their expectations about how market adoption would have occurred in the absence of the standards. Sample screen shots are presented in the Round 1 Data Collection section.

Pretests

Two pretests of the methodology were conducted. The first was implemented with Quantec staff to verify that the website link functioned, the language and instructions were clear, the curve drawing operated properly, and the electronic feedback worked. Based on this pretest, the tool was refined slightly.

The second pretest was conducted with members of the SRC. Each member was sent an email and electronic link to use to view the website and provide their inputs. Feedback from the SRC members was used to make a second set of modifications in preparation for Round 1 data collection from the expert group.

Identifying and Recruiting Experts

The solicitation of market segment experts was originally conducted by phone. Phone numbers were acquired using a variety of different means including the references provided by market affiliated associations, call lists purchased in coordination with site-visit efforts, and "snowball" methods where one contact provides the names of other respondents. The expert solicitation process began by providing the experts with contextual information. This included a description of the project, trends in the market for the appliance/measure (historical market penetration and current data as available), and a description of the Bass curve concept.

We offered each of the experts a $100 gift certificate for their participation in two rounds of data collection. The processes we used to identify and recruit industry experts for each of the appliances and building standard measures are described below, along with some conclusions and recommendations for future reference. In addition to the industry experts, we also solicited input from policy and program experts at the CEC and consultants who were knowledgeable about specific products and markets.

Appliance Standards Experts

The solicitation of these experts was conducted primarily by telephone calls. The strategy developed to find appliance experts typically included reaching a knowledgeable and amenable representative of a professional association. In some cases these associations were helpful and in other cases no representative from the related association would agree to assist our research. Calls were made to contacts suggested by consultants familiar with the market, as well as CEC policy experts. Manufacturers were often called directly from contact information contained in

their websites. Typically, we found that submitting comments on the corporate website resulted in no helpful responses and, hence, no progress toward contacting experts.

In most cases, calls that we made without our being able to reference someone who referred us to the person we were calling went unanswered. As an example, when we did reach the office of an executive of a large corporation, his assistant felt he might be interested, but added that he almost never responded to "cold calls."

Appendix A provides information on the process we conducted to identify and recruit appliance standard experts for the different products.

Building Standards Experts

In general, the building standards represented a different challenge from the appliance group. Instead of contacting a handful of larger corporations with their associated distributors, hundreds if not thousands of contractors had expertise with these standards. Lists of businesses used for the building standards noncompliance study were the initial sources for calls.

Details on how we contacted the building standards experts are provided in Appendix A.

Observations and Recommendations on Expert Recruitment

Overall, we made hundreds of calls to identify and recruit experts and we were unable to reach our targeted number of participants for some appliances and measures. It was most difficult to identify and recruit experts in the building measures area, largely because of problems getting good sources of contact information. In addition, it was challenging to find contractors who specialized in the specific building measures covered by the standards. In addition to the hundreds of recruitment calls we made, we often called and emailed each person who agreed to participate multiple times to ensure that they would follow through. In the end, several still did not complete the process.

The reasons behind the difficulty finding experts who would agree to participate in the program varied by market. We found that professionals in larger companies, such as those in the consumer electronics and incandescent lighting markets, have layers of bureaucracy to protect themselves from unsolicited contacts. Even when those layers were penetrated, many people expressed that they were too busy to participate and seemed suspicious of any calls not referred by a friendly colleague. While the financial incentive we offered encouraged some people to participate, it was not the main inducement for many to participate. In fact, three of the 27 industry experts said they could not accept the $100 gift certificates due to company policies. All three came from employees of large companies.

It was often difficult to reach potential participants employed by smaller companies, such as building contractors and distributors, because they had a receptionist who served as a protective gatekeeper. Phone messages were frequently left for bosses who were in meetings and never returned the calls. When someone was reached they were often so busy they simply were not interested in anything not directly helping their business.

Perhaps the single most important change we could have made to improve participation in any market would have been to have had our data acquisition web tool available when contacts were first reached. We chose to make an initial round of screening and recruitment calls while the tool was being tested, so when some interested participants were reached initially, the tool was not yet "live." After asking initial questions to ascertain the knowledge of the potential expert, this individual could have been emailed the internet link while still on the phone and asked to begin use of the market adoption web tool immediately. This would have served two purposes. First, the expert could have seen immediately that the tool was the product of a serious effort of professional organization to gain information, and we believe this would have alleviated some of the suspicions about the process. Second, and perhaps more important, this real-time approach could serve as a method to prevent procrastination. In many cases, we were able to engage an interested participant in an enlightening conversation over the phone, but this expert in the end never participated in the study. Unlike the common phone survey, this survey was done on the participants' own time and hence, given the busy lives and customer-centric focus of most companies, these experts never found time to complete their adoption curve over the web.

In the future, to increase participation we would recommend both a larger financial incentive for small business owners, and a greater effort toward building relationships in the industry with individuals who can then recommend the researcher to knowledgeable colleagues. For larger companies it is imperative to provide access to the web tool at the time of initial contact.

Round 1 Data Collection

A sample of the final Round 1 input display is shown in Figure 2. Experts were contacted and recruited by telephone. This process is described in more detail later. An introduction screen (not shown) presents an overview of the process and tells the participant how to navigate through the tool.

The sample input screen displayed in Figure 2 shows a market adoption curve drawn based on one expert's inputs. For each appliance and measure studied, this introductory screen provides a summary of the requirements of the new Title 20 or 24 standard. The sliders that the respondents adjust are shown on the right. Participants move the sliders by placing their mouse cursor on it and then moving it to the left or right; the curve immediately changes shape in response to the movements. The "Max Market Share" slider allows the user to set a maximum level he or she believes the market share for the efficient appliance or measure will reach. This allows for cases where the expert believes that the product would have never reached a 100% market share without the standard being in effect. The "Leading Behavior" slider adjusts the p value in the curve equation and the "Following Behavior" slider adjusts the q value. Note that the timescale starts at 1995, which happens to be the date for this measure when it was determined to start having a market presence. For some products or measures the start date was prior to 1995 and for others it was later. The curve exhibits a typical S-shaped trend over time and reaches a maximum of 79% of the annual market installations (or sales) in 2035. Based on the choices made by the respondent, the adoption curve reflects a relatively small value for leading behavior (p, or innovation) and a moderate value for following behavior (q, or imitation).

Figure 2. Initial Round Sample Input Screen

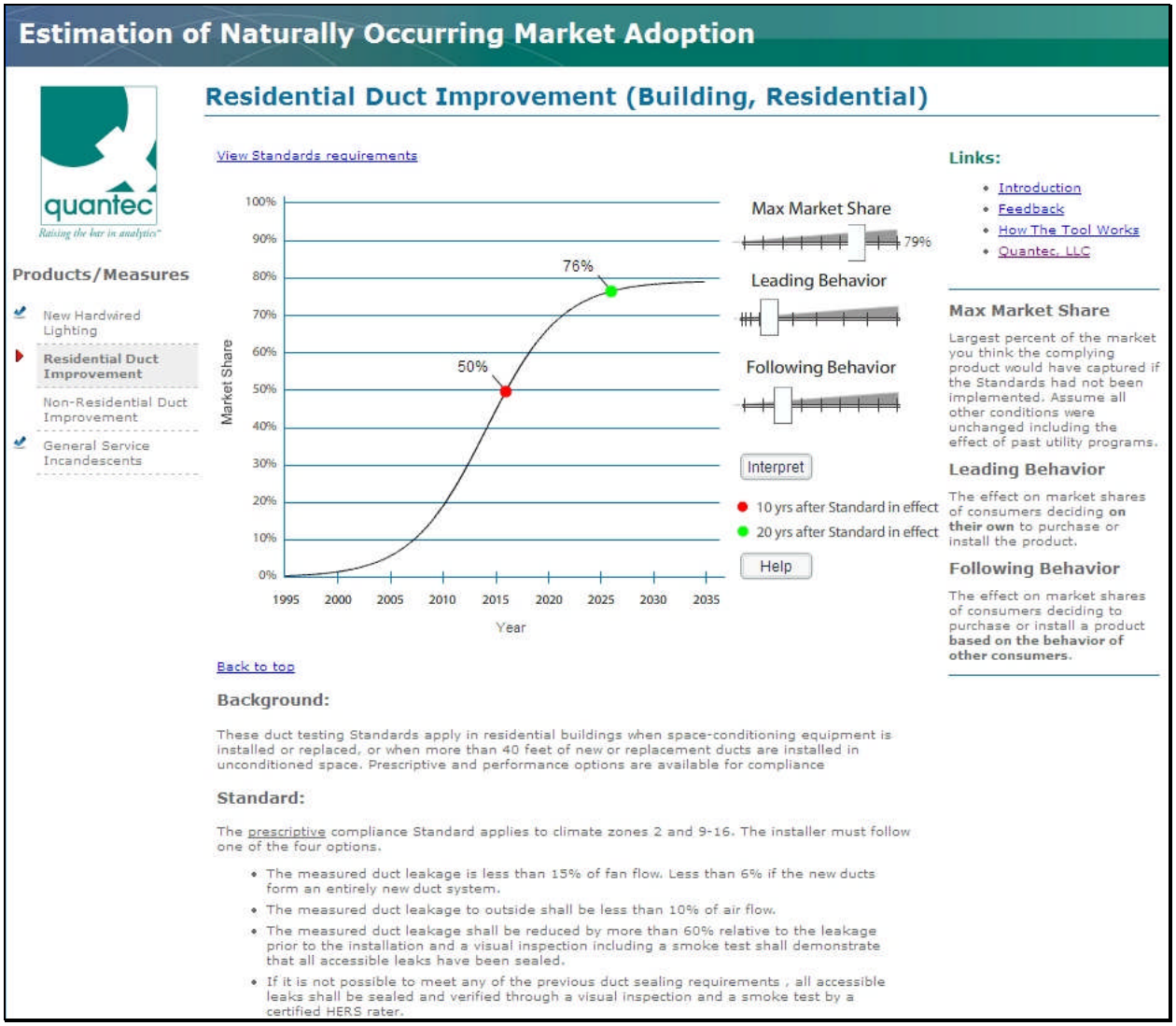


Table 8 shows the number of experts we contacted, the number who agreed to provide feedback during Round 1, the number who actually participated, and a description of the categories of participants. These numbers can be compared to the quantities we targeted initially. In some cases, we had to conduct more than 30 calls to recruit one person who agreed to participate. In the best case, we called about four people to get one who agreed. Even after we had some experts agree to participate, attrition occurred in a few situations. In one case, 70% of the people who had agreed to participate, failed to provide input during Round 1.

Table 8. Round 1 Respondents[10]

Appliance / Measure	Phone Calls	Targeted No. of Participants	Agreed to Participate	Round 1 Participants	Description
New residential hardwired lighting	197	8	6	3	All CA lighting contractors
Lighting controls under skylights	122	8	3	3	All CA lighting suppliers/ contractors
Residential/nonresidential ducts	128	8	10	3	All CA HVAC contractors
Televisions	58	6	5	5	3 manufacturers; 1 energy consultant; 1 CA public agency representative
DVDs	58	6	4	4	2 manufacturers; 1 energy consultant; 1 CA public agency representative
Audio players	58	6	4	4	2 manufacturers; 1 energy consultant; 1 CA public agency representative
Pool pumps	43	12	7	7	3 manufacturers; 2 vendors; 1 energy analyst; 1 CA public agency representative
Pulse-start metal halides	28	6	7	7	2 manufacturers; 2 vendors; 2 lighting consultants; 1 public interest group
General service incandescent lamps	51	6	4	4	1 manufacturer; 2 lighting consultants; 1 energy analyst
Pre-rinse spray valves	15	3	4	4	1 manufacturer; 1 technology expert; 1 energy analyst; 1 CA public agency representative
Unit heaters/duct furnaces	60	6	6	5	2 manufacturers; 1 industry expert; 1 energy analyst; 1 CA public agency representative
Totals	*818*	*75*	*60*	*49*	

[10] Note that we did not use responses from all the participants shown in the table because a small number did not complete the exercise correctly or withdrew their initial response after the first round.

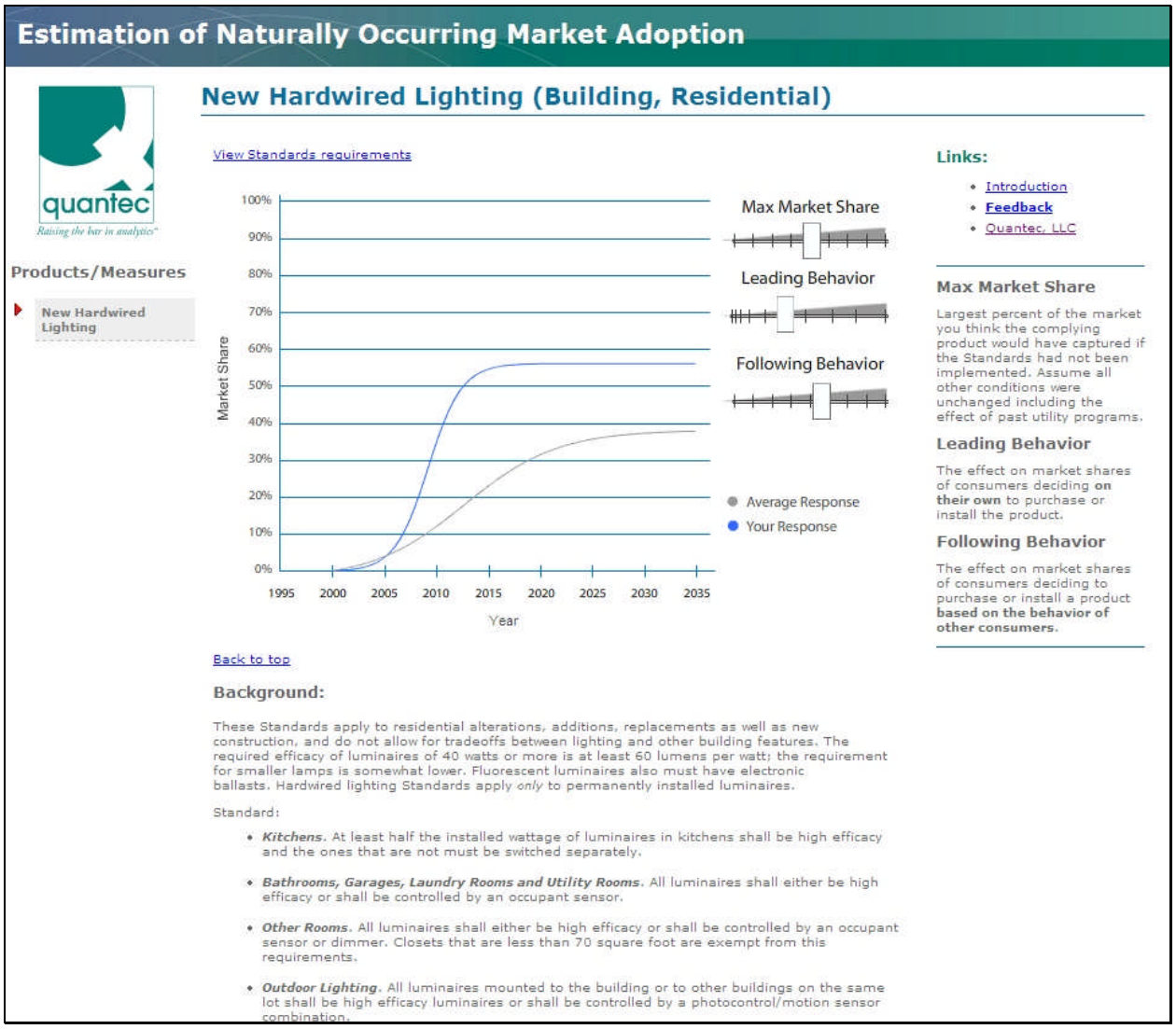
Although it was quite labor intensive to recruit participants and obtain their inputs, and although the number of participants failed to meet our target in several cases, we believe this method shows promise as a way to obtain information from experts on naturally occurring market adoption and other market estimates. Feedback from participants and the SRC members was generally quite positive. One of the limitations to our approach was that it was the first time this methodology had been applied and, to meet our schedule, pretesting was still occurring as we recruited participants. We believe several more experts would have agreed to participate if we had been able to direct them to the website at the time they were recruited, and to provide them with assistance as needed. In addition, it was not possible to fully implement the Delphi approach, using several rounds and providing comments and feedback to help inform participants of the rationale for the inputs of all participants. We believe that implementing this approach more fully would have provided higher quality information and generated more interest in participating in the process. Chapter 7 presents our overall observations and recommendations for improving the methodology. In the future, the choice of whether or not to use this tool should primarily be determined by the timeline.

Round 2 Data Collection

After receiving all Round 1 inputs, we generated an average market adoption curve. The market adoption rates provided by our experts were averaged for each year over the period analyzed. A SAS statistical analysis routine (PROC NLIN) was used to estimate the *p*, *q*, and maximum market share values that generated a Bass curve that best fit the average data.

Once these average curves were generated for each appliance/measure, we sent another email to each participant with a link to a revised website. A sample of the screen that participants viewed in this round is shown in Figure 3. This screen shows the average curve (lower curve) for each product the expert assessed and the curve that he or she input (upper curve). In this case the expert's curve indicated he expected hardwired residential lighting meeting the requirements of the new Title 24 would grow to about 55% of the new housing market by about 2017. The average, however, showed much slower growth and a peak penetration of only 38%. The respondents were asked to provide feedback indicating whether they believed the average curve or their original curve was a better predictor of the market adoption rates, and to also provide an explanation of why they made the choice they did.

Figure 3. Second Round Adoption Curve Comparison Screen



Effects of Prior Utility Programs

During discussions with the SRC, the issue was raised about how prior utility programs in California had affected the adoption rate of efficient appliances and measures covered by the new standards. The concern was that prior programs might have increased the adoption rate observed in the market and would bias estimates of naturally occurring market adoption provided by experts. To appropriately assess the behavior of the market in absence of the evaluated standards, it was necessary to identify the existence of any utility incentive programs that may have impacted adoption rates.

The consensus view was that the naturally occurring adoption curve should be estimated without the effects of these programs. This was based on two main arguments:

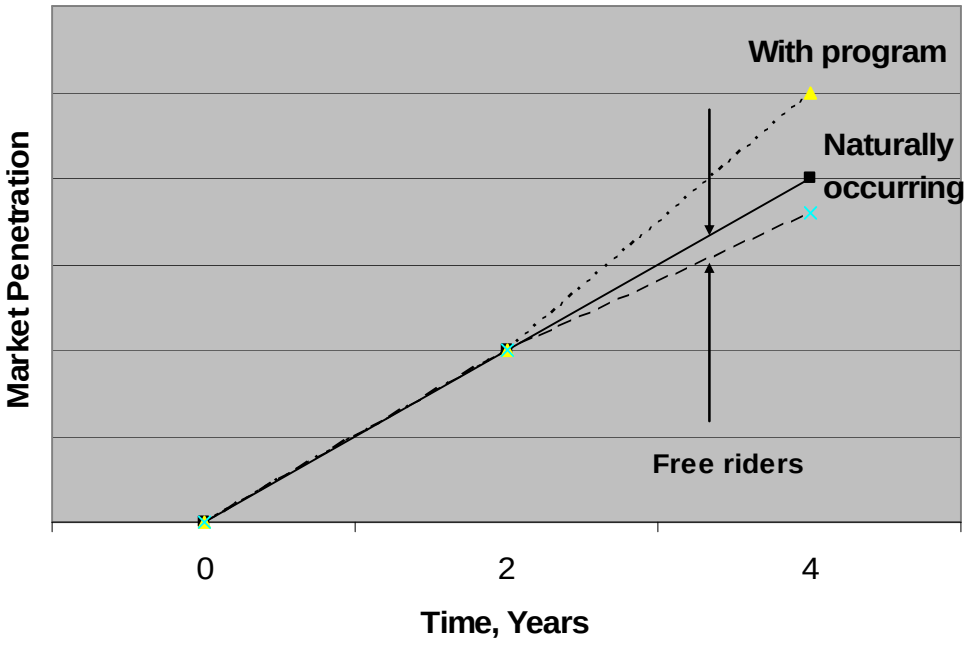
1) Although there was no good way to predict what market penetration would revert to when the programs stopped, most observers felt that the market would go back to the naturally occurring penetration of the high-efficiency appliances/measures, given that the programs were typically acquisition programs.

2) If the market were assumed to stay at the penetration level at the time the programs ended, then this full amount would be subtracted from the effects of the Codes and Standards Program, and neither this Program nor the previous utility programs would receive credit for these savings.

Our approach for tackling this is illustrated in Figure 4. Just for illustration purposes, the estimate of naturally occurring adoption without any utility programs is shown as a linear function of time. The upper dashed line in the figure shows the effect of a utility program starting in year 2. Over the next two years, the program increases market penetration above the level that would have occurred without any programs; finally, when asked to estimate market adoption rates, experts would estimate the upper curve, thus including the full effects of the existing program.

The gap between the bottom and upper curves shows the gross effects of the program estimated by an impact evaluation. Because typically some of the program participants would be free riders, subtracting out the full penetration and gross savings due to program participants would overstate the adjustment to arrive at the real naturally occurring market adoption. The difference between the naturally occurring curve and the bottom dashed line shows the portion of the market that would have adopted the efficient measure or appliance without the program, but participated in the program as free riders. Consequently, to get back to the naturally occurring curve, the program free riders have to be removed from the gross program effects.

Figure 4. Illustration of Naturally Occurring Adoption with Utility Program Effects



Making these adjustments requires:

- Identifying those measures/appliances for which there were utility programs
- Obtaining and reviewing impact evaluation reports for them to extract information on estimates of market penetration, savings, and net-to-gross ratios
- Incorporating this information in the analysis

Working with the SRC members and program implementers, we conducted a thorough process to identify programs that affected each of the appliances and building measures included in our study. Quantec reviewed evaluation studies and contacted program evaluators to try to obtain the data needed to assess these effects of observed market adoption rates.

Data and Findings

The naturally occurring market adoption curves for each appliance and building measure, as estimated by the experts participating in this process, are discussed below. In terms of Program cost effectiveness, the most important time segment is the early years since the benefits of future savings are significantly discounted. The maximum market adoption that would occur in the absence of the standards has a major effect on the savings attributable to the Program.

For each efficiency measure and efficient appliance analyzed, we show for comparison the original curve that was used to estimate naturally occurring market adoption. These curves are based on adoption growing linearly over a number of years, which vary by appliance and measure. In most cases, the original curve starts at zero market penetration. However, in a few cases the original analysis is based on an initial market adoption greater than zero. In the Savings Estimate Spreadsheet, this initial adoption rate is embedded in the gross savings estimates. For example, if the initial market penetration of an efficient appliance was estimated to be 50%, the gross savings used in the Savings Estimate Spreadsheet is 50% of the savings possible for the total annual sales of the appliance. If the naturally occurring market adoption for this efficient appliance was assumed to reach 100% in 10 years, then the original curve would start at 50% and increase linearly to reach 100% in 10 years.

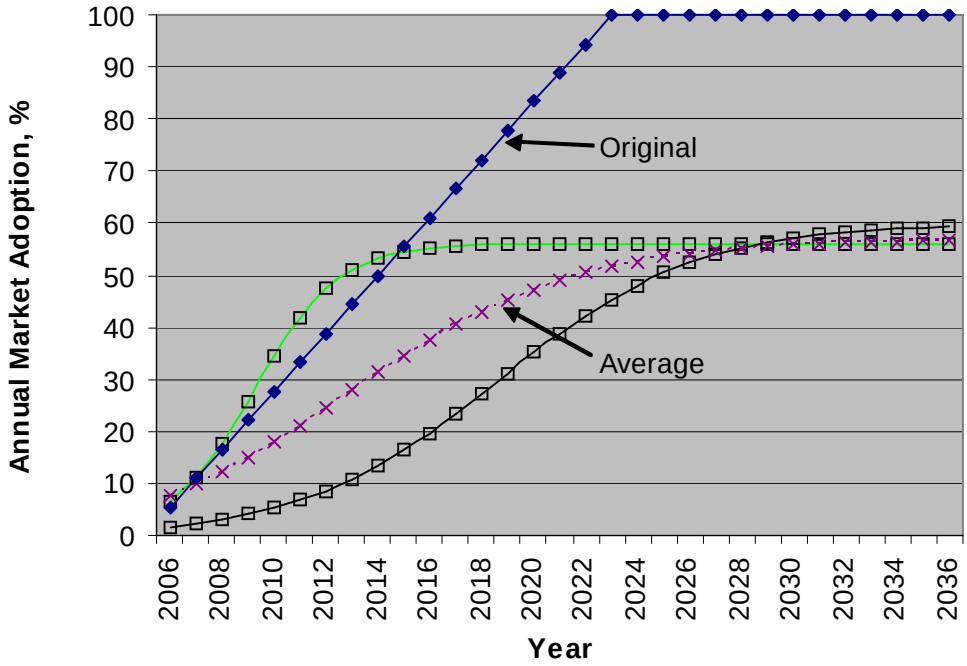
Hardwired Lighting, New Residential

We solicited input from four industry experts for market adoption estimates for new residential hardwired lighting meeting requirements of the new standards. Inputs from only two of the respondents were valid, however, because one did not complete the exercise and one misunderstood the request. The start date estimated for this technology was 2000. Figure 5 shows the adoption curves estimated by the two experts and the average curve fit to the data. (As a convention in all the market adoption rate graphs, the average curve is shown as a dashed line while all other curves are solid lines.)

The average adoption rate estimated in 2006 was 8%. The two experts agreed quite closely about the maximum level of market adoption that would be achieved without the standards, and the average estimate was 57%. The two experts differed, however, in their predictions of how quickly market penetration would grow. These differences were driven by differences in the "following" behavior expected in the market. The second curve from the top in Figure 5 shows that one expert felt the market would quickly adopt the measure once early adopters began implementing it, while the other believed this would happen more slowly.

Starting at 8% of the market in 2006, the average curve showed a fairly linear growth in the adoption rate, peaking at about 56% in 2029. The preliminary place holder estimate in the Savings Estimate Spreadsheet was based on linear growth starting in 2006 and reaching 100% of the market in 18 years (2023). This original estimate is the top curve in the figure and the original estimates of the penetration rates exceeded the average value we estimated over the entire period. We received no feedback from these two experts on the average adoption curve for this measure.

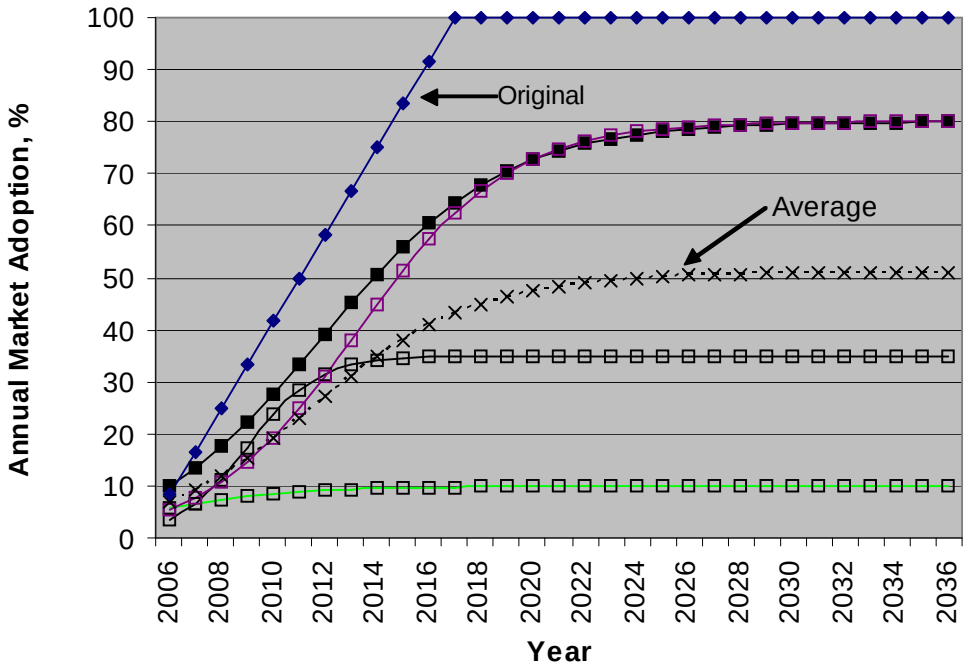
Figure 5. Complying Hardwired Lighting Market Adoption Estimates



Lighting Controls under Skylights, New Nonresidential

Four industry experts provided market adoption estimates for lighting controls under skylights. The start date estimated for this technology was 2000. Estimates of the market penetration in 2006 ranged from 3% to 10%, with an average value of 7%. Two experts predicted that without the standards the penetration rate would have eventually reached 80%. On the other hand, one predicted about 35%, and another predicted that only 10% of the market would have eventually adopted lighting controls specified by the standards. The individual responses and average

response are shown in

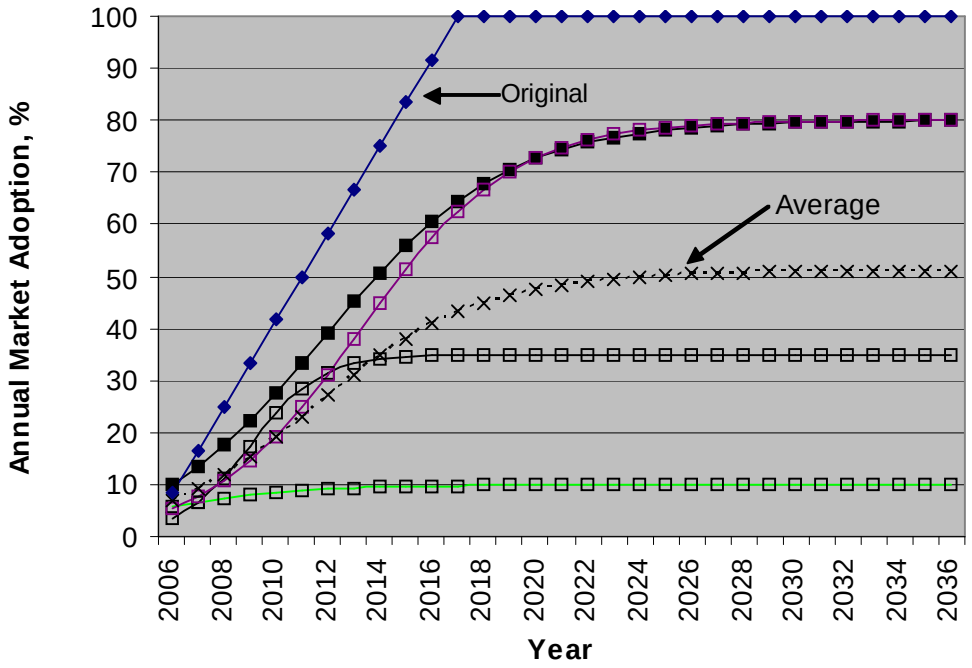


The average curve and all but the lowest curve were quite similar until about 2014. As noted earlier, the initial years are the most influential in determining the energy savings attributed to the Program. For comparison, the original value used in the Savings Estimate Spreadsheet assumed that lighting controls would penetrate 100% of the market within 12 years, starting in 2006.[11] This is shown in the top curve and this curve lies above the average curve from our analysis over the entire period.

The only follow-up received from the experts was from the person who provided the lowest estimate of the adoption curve. Given that no other experts provided additional comments, we assume that the average curve was acceptable to them. The person who provided the lowest estimate assessed four appliances or measures, and in all cases his estimate was the lowest. He indicated that, in general, his experience led him to conclude that the market was quite slow to adopt efficient technologies without standards, and this influenced his judgment.

[11] Note that from the information available it appears that the gross savings attributed to this measure in the Savings Estimate Spreadsheet assumes that the naturally occurring penetration of this measure would be 0% in the first year without the new standards.

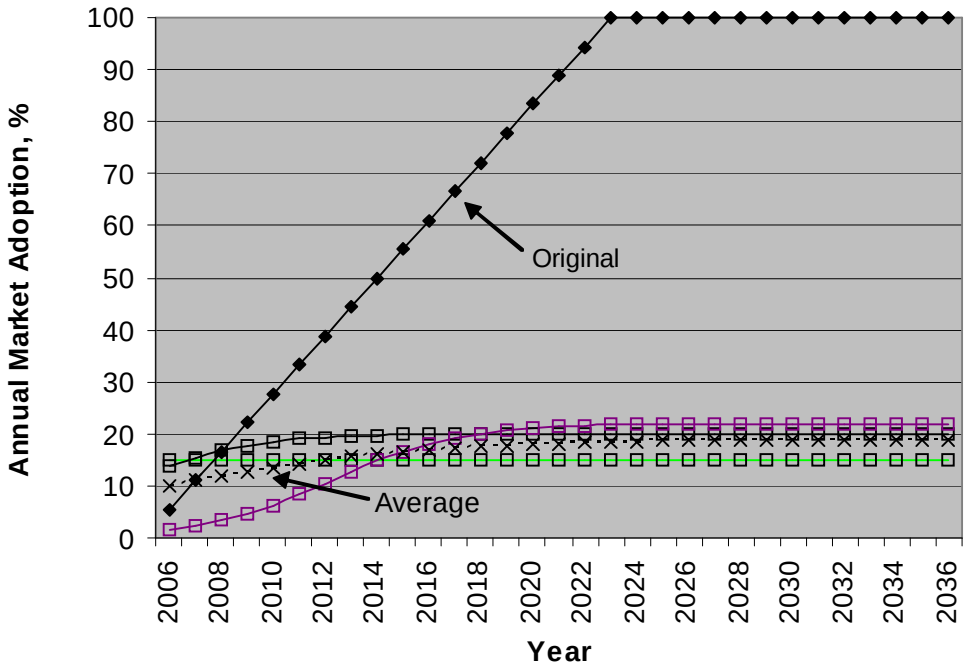
Figure 6. Complying Lighting Controls Market Adoption Estimates



Duct Improvement, Residential Existing

Three industry experts provided market adoption estimates for residential duct improvements equivalent to the new standards, using an estimated start date of 1990. The focus of their estimates was on the duct sealing aspect of the standard. Estimates of the market penetration in 2006 ranged from 2% to 15%, with an average value of 10%. Estimates of the ultimate market penetration without the standards ranged from 15% to 22%, with an average value of 19% in

about 20 years. The individual responses and average response are shown in

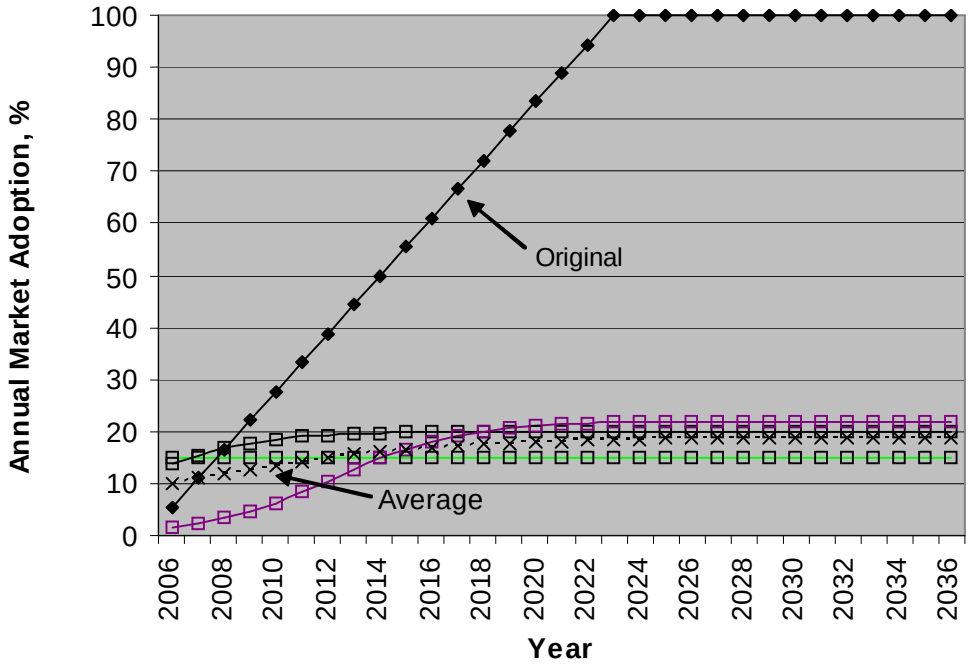


The experts had different views about near-term market growth, but agreement was good on what the final market adoption would have been without the standard. The average curve shows the expected market adoption growing gradually from about 10% currently to 19% over 20 years. The original estimate in the Savings Estimate Spreadsheet is shown in the top curve depicting growth starting in 2006 and reaching 100% in 18 years.[12] From 2008 on, the original estimate exceeded the average penetration curve produced by our analysis.

Only one participant provided feedback on the average curve. He indicated that he felt the average estimate was better than his original assessment, though there was little difference between the two.

[12] It was not possible to determine from the information available on the original savings estimates for this standard what original, naturally occurring penetration of this measure was assumed so for illustrative purposes we assume that original penetration would have been 0% in the absence of the new standard.

Figure 7. Complying Residential Duct Improvement Market Adoption Estimates



Duct Improvements, Nonresidential Existing

Two industry experts provided market adoption estimates for nonresidential duct improvements equivalent to the new standards. As with the residential ducts, the focus of the estimates was on the duct sealing part of the requirements. The start date estimated for this measure was 1990. Estimates of the market penetration in 2006 ranged from 1% to 3%, with an average value of 2%. Estimates of the ultimate market penetration without the standards ranged from 10% to 34%, with an average value of 23% in about 20 years. The individual responses and average response are shown in Figure 8.

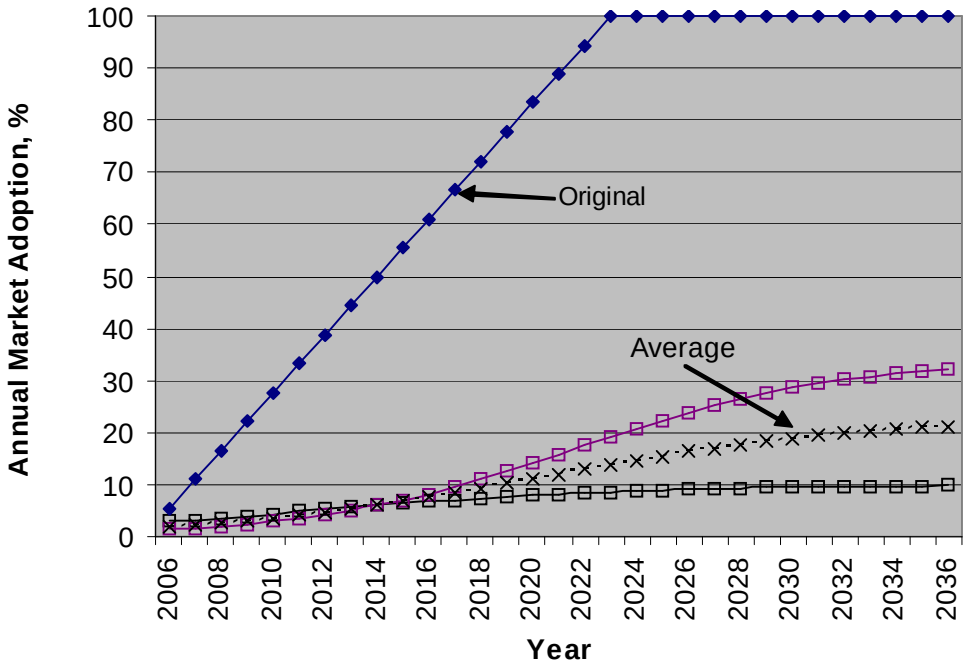
The experts had similar views about near-term market growth, but diverged after about 10 years. The average curve shows the expected market adoption growing gradually from about 2% currently to a little over 20% in about 30 years. The original estimate in the Savings Estimate Spreadsheet was that naturally occurring adoption would start in 2006 and grow to 100% in 18 years; the original estimate is above our estimate over the entire period.[13]

Only one participant provided feedback on the average curve. He indicated that he thought the light commercial market would have had a lower adoption rate than the average curve without the standards, based on his experience that light commercial buildings are more often not

[13] It was not possible to determine from the information available on the original savings estimates for this standard what original, naturally occurring penetration of this measure was assumed so for illustrative purposes we assume that original penetration would have been 0% in the absence of the new standard.

owner-occupied, and that there have not been any significant utility programs over the years that have targeted duct sealing in light commercial buildings.

Figure 8. Complying Nonresidential Duct Improvement Market Adoption Estimates



Consumer Electronics-Televisions

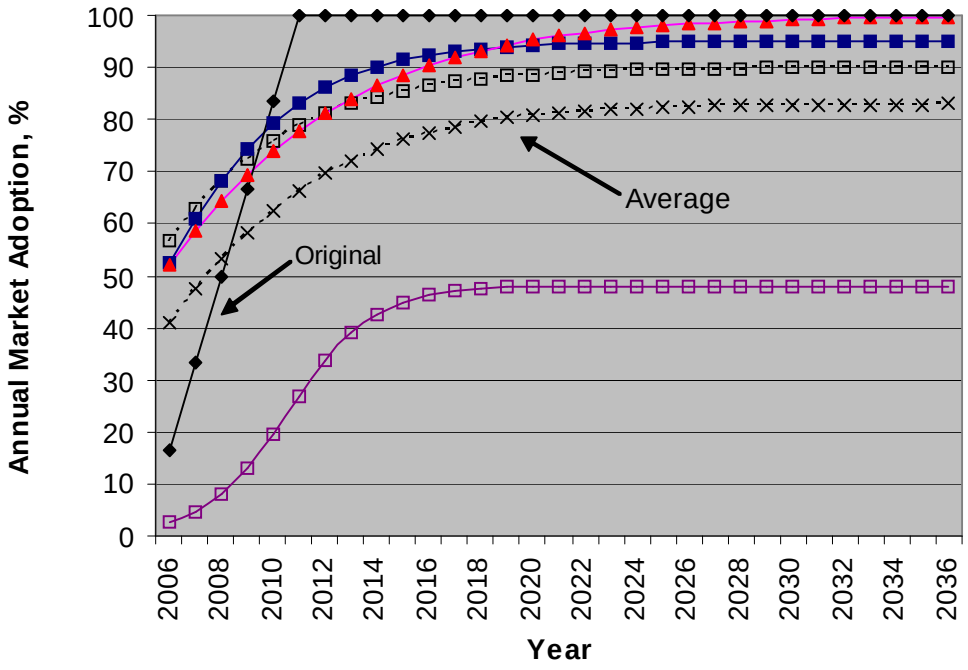
Three industry representatives and two policy/program experts provided market adoption estimates for televisions meeting the requirements of the new standards. The start date estimated for this measure was 2000. After being shown the average response provided by the expert group, one of the policy experts indicated she would defer to the estimates of the group, so her response was removed. The remaining policy expert's curve is shown with triangles in Figure 9. After removing the one response, estimates of the market penetration in 2006 ranged from 3% to 57%, with an average value of 41%. Estimates of the ultimate market penetration without the standards ranged from 48% to 100%, with an average value of 83% in about 20 years. The figure shows the individual responses and average response.

Three of the four respondents provided very similar growth curves, starting at more than 50% market penetration in 2006. The lowest curve was the estimate from an industry representative who indicated in his comments that his company's products had already been meeting the Title 20 requirements, but he felt other companies' products had not. Since the other curves represented the knowledge of other companies, he may have underestimated the existing market penetration. The average curve shows the expected market adoption growing gradually from about 40% currently to over 80% in about 20 years. The original estimate in the Savings

Estimate Spreadsheet was that naturally occurring adoption would start in 2006 and grow to 100% in six years. The original estimated market adoption exceeds our average curve from 2009 on.

Two industry experts provided comments in addition to the comment mentioned above. Both experts mentioned that Energy Star had played a major role in increasing adoption of televisions (and other consumer products) with reduced standby consumption.

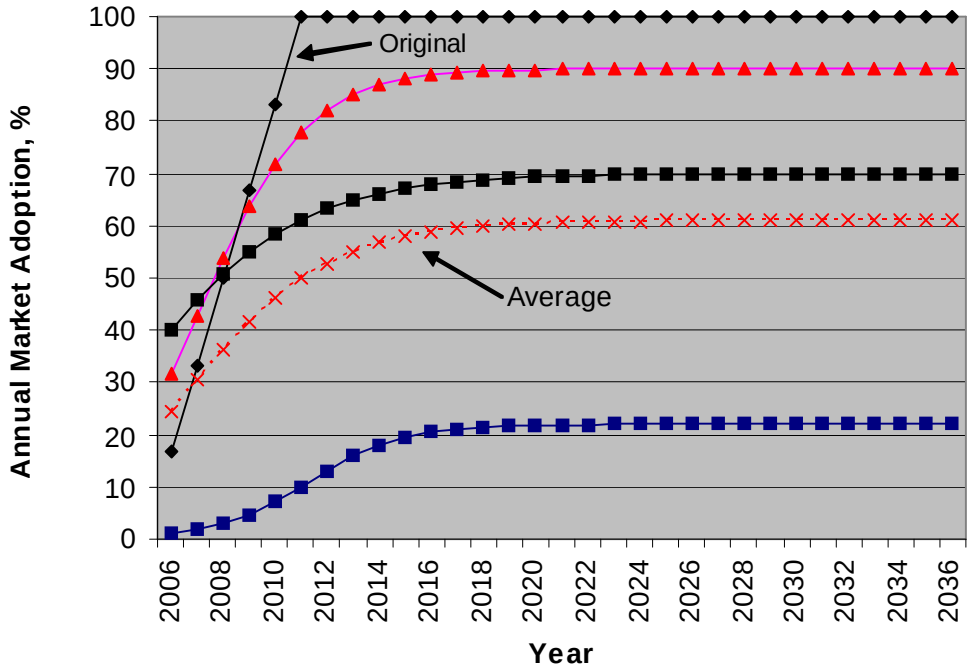
Figure 9. Complying Television Market Adoption Estimates



Consumer Electronics-DVDs

Two industry representatives and two policy/program experts provided market adoption estimates for DVDs meeting the requirements of the new standards. The start date estimated for this measure was 2000. After being shown the average response provided by the expert group, one of the policy experts indicated she would defer to the estimates of the group, so her response was removed. After removing this response, estimates of the market penetration in 2006 still covered a large range, from 1% to 40%, with an average value of 24%. The curve for the remaining policy/program expert (triangles) is the highest curve in Figure 10. Estimates of the ultimate market penetration without the standards ranged from 22% to 90%, with an average value of 61% in about 12 years. The figure shows the individual responses and average response.

Figure 10. Complying DVD Market Adoption Estimates



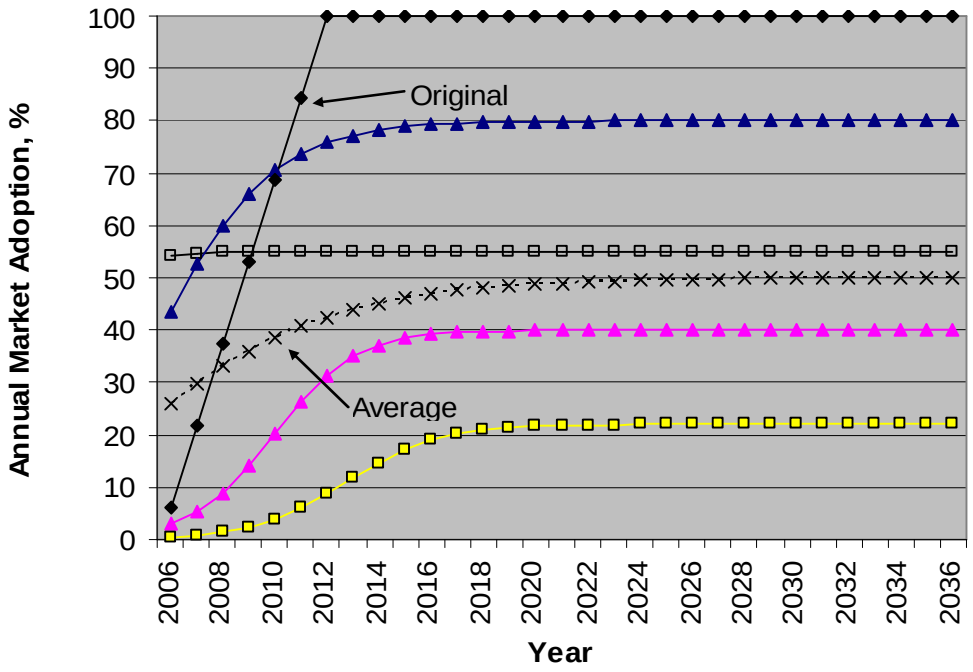
Two of the three experts provided very similar curves, starting at about one-third market penetration in 2006. The lowest curve was the estimate from the same industry representative who provided the lowest estimate for televisions; he provided the same comments for DVDs as he did for TVs. The average curve shows the expected market adoption growing gradually from a little over 20% in 2006 to about 60% in 12 years. As shown by the top curve in the figure, the original estimate in the Savings Estimate Spreadsheet was that adoption would start at the beginning of 2006 and grow to 100% in six years. The average curve estimated in our study lies below the original curve from 2007 on.

Two industry experts provided similar comments about the DVD market as they did for the television market.

Consumer Electronics-Audio Players

Two industry representatives and two policy/program experts provided market adoption estimates for audio player improvements equivalent to the new standards. The start date estimated for this measure was 2000. Estimates of the market penetration in 2006 ranged substantially, from less than 1% to 54%, with an average value of 26%. Estimates of the ultimate market penetration without the standards ranged from 22% to 80%, with an average value of 50% in about 15 years. The individual responses and average response are shown in Figure 11.

Figure 11. Complying Consumer Audio Player Market Adoption Estimates



Although the experts' assessments differed quite substantially regarding both the initial market penetration and growth in adoption, there was no consistent reason to prefer any responses over others. The industry experts' curves are shown with square symbols and the policy/program experts' curves are shown with triangles in Figure 11. There are no consistent differences between the responses of members in these two groups. When respondents were asked to provide feedback on the average curve shown in the figure, we received only one comment. This comment was from a policy/program expert (see the curve second from the bottom in the figure) who stressed the difficulties that had been encountered in getting manufacturers to certify their products to the new California standards. Although this argument is important, we note that the market curve estimated by this respondent agreed fairly closely with the average curve after about six years, even though the initial market adoption rates were quite different.

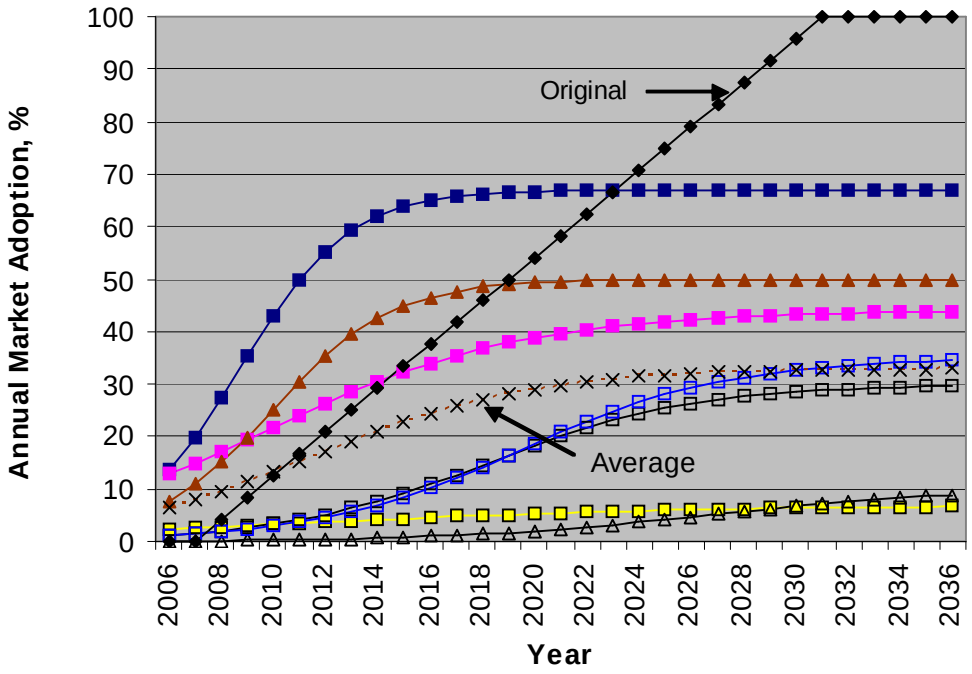
Based on this information, we chose to use the average as the basis for our estimate of the adoption curve. The average curve shows the expected market adoption growing gradually from about 24% in 2006 to a little over 50% in 12 years. The original estimate in the Savings Estimate Spreadsheet is shown in the top curve and it shows naturally occurring adoption in 2006 at about 6% and growing to 100% in six years starting in 2007.[14] Starting in 2008, this curve lies above our average curve over the remaining period.

[14] This is based on the results reported in the final project report by Energy Solutions et al., June 9, 2005.

Residential Pool Pumps, 2-speed, Tier II

Five industry representatives and two policy/program experts provided market adoption estimates for two-speed residential pool pumps. The start date estimated for this measure was 1995. Estimates of the market penetration in 2006 ranged from less than 1% to 14%, with an average value of 6%. For 2008 when the standard goes into effect the average value was 9%. Estimates of the ultimate market penetration without the standards ranged from 7% to 67%, with an average value of 33% in about 20 years. The individual responses and average response are shown in Figure 12. As before, the responses from the policy/program experts are shown with triangles in the figure.

Figure 12. Complying Two-speed Pool Pump Market Adoption Estimates



The experts had divergent views about near-term market growth, with about half projecting little growth in market adoption for 10 or more years and three projecting fairly rapid growth. The average curve shows the expected market adoption growing gradually from about 6% currently to a little over 30% in less than 20 years. The original estimate in the Savings Estimate Spreadsheet was that adoption would start in 2008 and grow to 100% in 24 years as shown in the top curve; this curve is above our average curve from 2011 on.

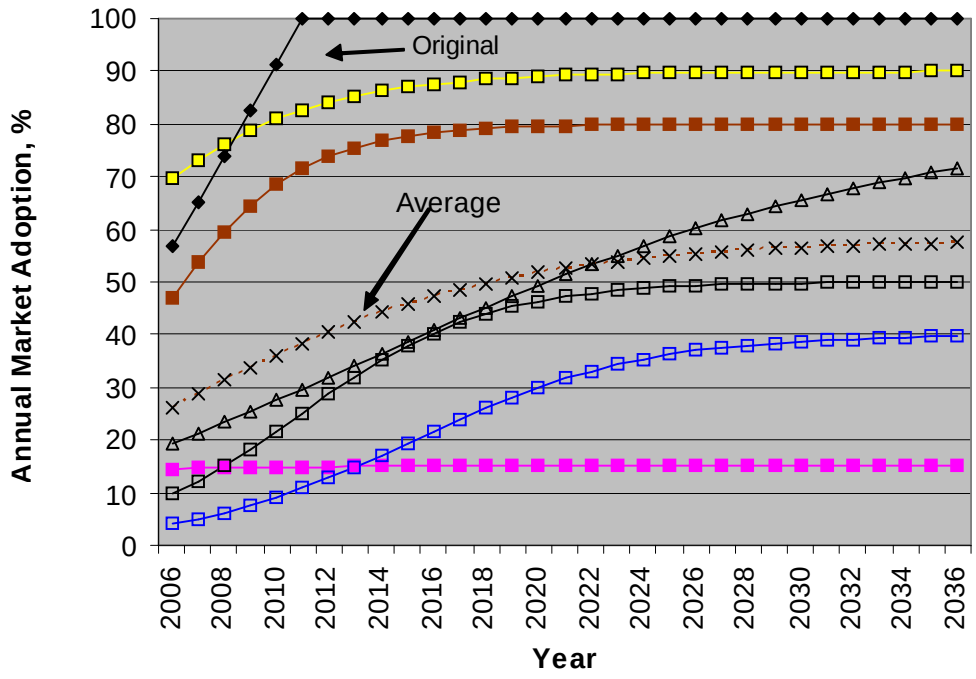
We received feedback from two respondents about the average curve; one was from a policy/program expert and one was from a pool pump retailer. The policy/program expert felt the adoption rate would have never exceeded 10% without the standard. This was based on the difficulties encountered getting the industry to comply with California's new and proposed standards overall. The industry representative commented that his curve produced a final market

adoption rate comparable to the average level, but that he had thought it would have taken longer to reach the plateau. He did note that some manufacturers had started to be very active in marketing new technologies (including a variable speed pump) that might have accelerated market adoption without the standards; as a result, he believed the actual curve might have been between his and the average, i.e., lying slightly below the group average.

Pulse-start Metal Halides

Five industry representatives and one policy/program expert provided market adoption estimates for pulse-start metal halide luminaires. The start date estimated for this measure was 1992. Estimates of the market penetration in 2006 ranged from 4% to nearly 70%, with an average value of 26%. Estimates of the ultimate market penetration without the standards ranged from 15% to 90%, with an average value of 57% in about 25 years. The individual responses and average response are shown in Figure 13. The response curve estimated by the one policy/program expert (triangles) lies close to the average curve.

Figure 13. Complying Pulse-start Metal Halide Market Adoption Estimates



Experts' estimates varied considerably from one who estimated that market adoption had already reached about 15% and predicted it to stay constant for the foreseeable future, to an estimate of current market adoption share of 70% increasing to 90%. The average curve shows the expected market adoption growing gradually from about 25% currently to a little over 50% in about 13 years. The original estimate in the Savings Estimate Spreadsheet shown in the top curve was that

initial naturally occurring adoption was 48% and starting in 2006 it would grow to 100% in six years; this curve lies above our average curve over the entire time period.[15]

We received feedback from several respondents on the average curve. The industry expert who estimated the highest adoption curve made several arguments for why he thought it applied. He stated that pulse-start units could be installed in smaller quantities than probe-start units, thus offsetting the higher equipment cost and reducing labor costs. He noted that the industry had shifted its R&D to pulse-starts so this technology would continue to improve, while probe-start technology was static. He stated emphatically, "There is no downside to pulse-start metal halides!" The individual who estimated the lowest curve provided comments on several products indicating that he believed the industry's projections were too optimistic in general, but he did not provide evidence supporting that view. The expert who estimated that market adoption would have reached only 40% ultimately, said that based on his market knowledge, the penetration prior to 2006 was nowhere near the 25% shown for the average response.

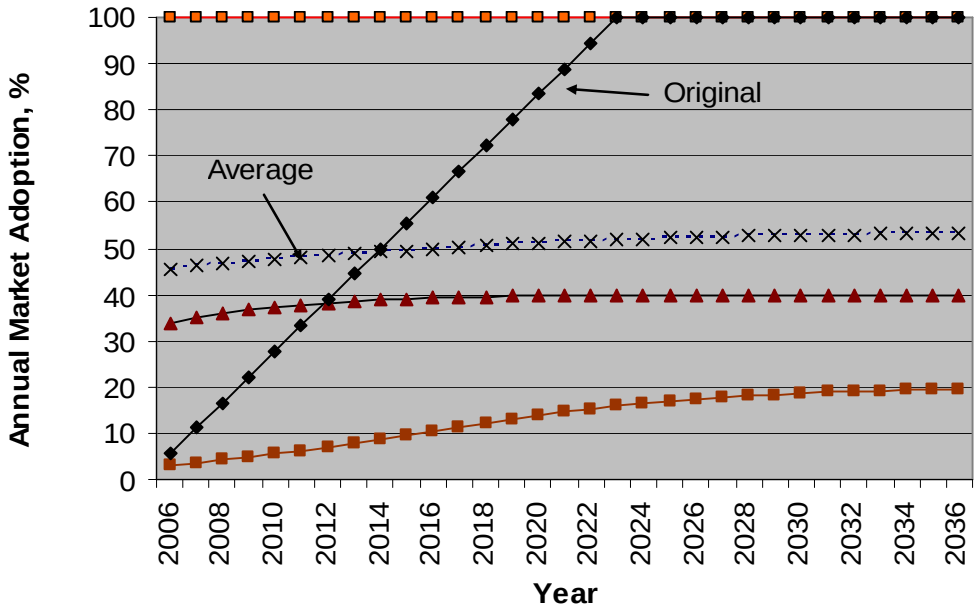
Overall, there were considerable differences among the views of these experts. Without an extensive effort to reconcile these differences, the average curve appeared to be a reasonable estimate that was a significant improvement over the original estimate.

General Service Incandescents

Two industry representatives and one policy/program expert provided market adoption estimates for general service incandescents. The start date estimated for this measure was 1970. The technology allowing these lamps to meet the standards has been available for a long time and, as one industry representative pointed out, the higher efficiency is generally achieved for a tradeoff in bulb life. There were major differences across the estimates, with the estimated market penetration in 2006 ranging from 3% to 100% and having an average value of 46%. Estimates of the ultimate market penetration without the standards ranged from 20% to 100%, with an average value of 53% in about 21 years. The individual responses and average response are shown in Figure 14. The response curve estimated by the one policy/program expert (triangles) lies close to the average curve.

Figure 14. Complying General Service Incandescents
Market Adoption Estimates

[15] This is based on the results reported in the final project report from Energy Solutions et al., June 9, 2005.



As the figure shows, experts' estimates varied widely. The average curve shows the expected market adoption growing gradually from about 45% in 2006 to 50% in about eight years. The growth based on the original estimate in the Savings Estimate Spreadsheet starts in 2006 and increases to 100% in 18 years. Our average adoption curve shows a higher adoption rate than the original estimate until about 2015.

Because of its extreme values, we contacted the expert who provided estimates for the top curve in the figure to get an explanation for his views. He indicated that the incandescents that were the most popular met the efficiency requirement of the new standard and only those rated as long-life did not. He argued that the analysis done to develop the standard established an efficiency level that was intended to allow one-third of existing lamps to comply, but the analysis was based on lamp models alone and did not take sales into account. We were able to confirm that this was the case. However, as the chapter in this report discussing appliance noncompliance shows, we found compliance with the new standard was only 74%, taking into account lamp inventory data. Consequently, we were not convinced that the current market adoption would have been 100% without the standard.

Given the results of this analysis and the findings from the noncompliance study, we believe that the average curve shown in Figure 14 is a reasonable estimate of market behavior without the standard.

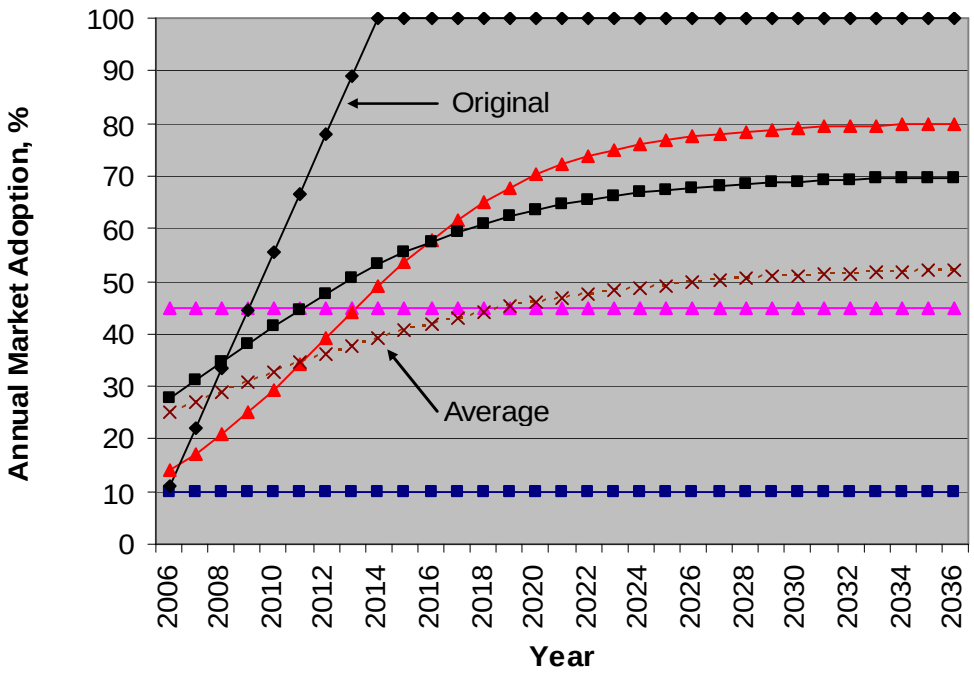
Commercial Dishwasher Pre-rinse Spray Valves

Two industry representatives and two policy/program experts provided market adoption estimates for pre-rinse spray valves. The start date estimated for this measure was 1985. There

were fairly consistent estimates of the market adoption that would have occurred in 2006 (except for one respondent), but significant differences were observed across the predicted trends. Two of the experts predicted two different flat market adoption rates from 2006 on (10% and 45%), while the other respondents projected that market adoption would have trended upward over time. The estimated market penetration in 2006 ranged from 10% to 45%, with an average value of 25%. Estimates of the ultimate market penetration without the standards ranged from 10% to 80%, with an average value of 52% in about 26 years. The individual responses and average response are shown in Figure 15. The response curve estimated by the policy/program expert are shown with triangles, and one of these curves lies quite close to the average curve.

There were no consistent differences between the predictions of the policy/program experts and the industry experts. The average curve shows the expected market adoption growing gradually from about 25% currently to a little over 50% by about 2030. The original estimate in the Savings Estimate Spreadsheet, as shown by the top curve, was that adoption would start in 2006 and grow to 100% in nine years. From 2008 on this curve lies above our average estimated curve.

Figure 15. Complying Pre-rinse Spray Valves
Market Adoption Estimates



Several respondents provided comments on their estimates. One policy expert noted that the industry had been slow to provide compliance data, and for this reason projections of natural adoption should be conservative. This expert's prediction of ultimate market adoption, however, was close to the average level that we estimated. One industry representative noted:

> "The shape of the average adoption curve starts out tracking the shape of my own curve quite well. However, I predicted the max. market share at 70% while the group average predicted 50%. Given the positive economic return on low-flow spray valves and the supporting utility rebate and educational programs, I have to believe that the penetration would have exceeded 50%. However, on another round, I might adjust downward to say, 60% max. market share. But it is still conceivable, that in 25 years, the market would have educated itself and been significantly transformed (e.g., 70%) without legislation."

The other industry representative who estimated market adoption at no higher than 10% provided no comments on his prediction. The remaining policy expert commented:

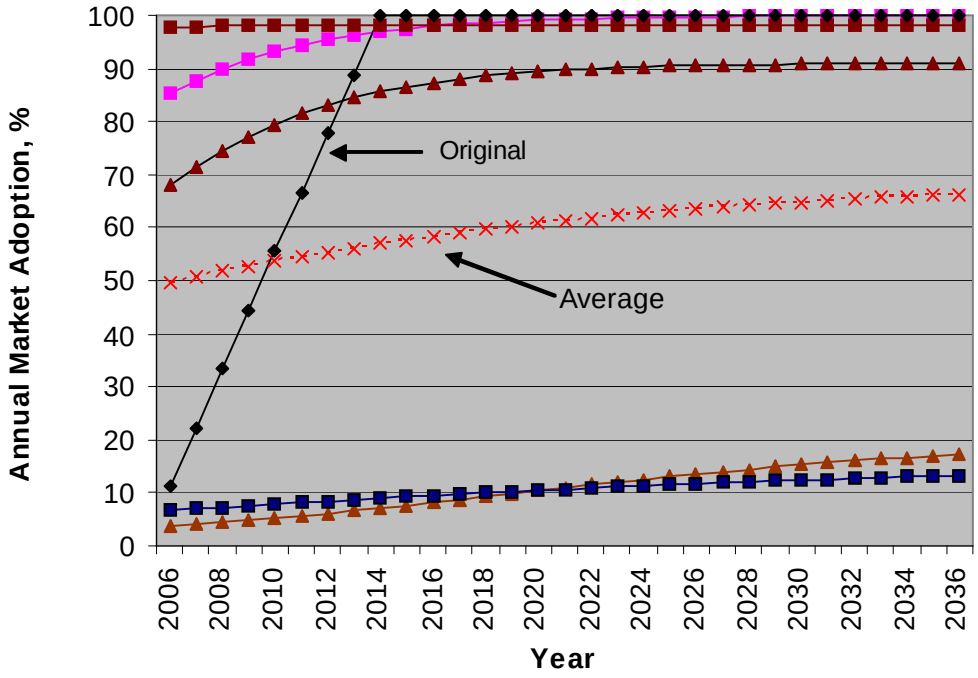
> "I will stick with my estimate [of 80% naturally occurring adoption in the long run], largely because voluntary programs, especially in the water utility industry have or will have seized on this opportunity over the next years making significant inroads in terms of saturation impacts. The current incremental cost is largely a function of demand and supply and as market share increases, I expect it to go down...it's just a chunk of metal shaped a little bit better. So manufacturing barriers are limited … *water* in my estimation is going to get *very* expensive in the out years creating a stronger market for the better products. On the other hand, I don't have good familiarity with the portion of the market that likes spray valves for filling large pots in addition to cleaning. If this is fairly common, then my estimate is overly aggressive at assuming 80% eventual penetration. At this point, I'd be inclined to split the difference to some extent but I think the average is a little pessimistic."

When we conducted our compliance/noncompliance analysis presented in Chapter 5, we found that nearly all spray valves being sold were meeting the standard. Consequently, we believe the average curve does not overstate what would have occurred in the market without the standard, and is a realistic projection.

Unit Heaters/Duct Furnaces

Estimating the naturally occurring adoption of unit heaters/duct furnaces meeting the requirements of the new standard was particularly challenging. Three industry representatives and two policy/program experts provided market adoption estimates. The technology was estimated to have become commercially available starting in 1965. The estimates provided were bi-modal—either very low or very high. The estimates of initial market penetration in 2006 varied widely, ranging from 4% to 98%, with an average value of 50%. For both the low and high estimates, the adoption curves from 2006 on were quite flat. Estimates of the ultimate market penetration without the standards ranged from 15% to 100%, with an average value of 69% by 2036. The individual responses and average response are shown in Figure 16; responses of the policy/program experts are designated by triangles.

Figure 16. Complying Unit Heater/Duct Furnace Market Adoption Estimates



The average curve shows the expected market adoption growing gradually from about 50% in 2006 to 69% by 2036, but continuing to grow beyond then. The original estimate curve shows adoption starting in 2006 and growing to 100% in nine years; it lies above our estimated average curve from 2010 on.

Comments from the experts, as well as our noncompliance analysis (presented in Chapter 5), provided conflicting evidence for different adoption rates. The two equipment manufacturers generated the highest adoption curves shown in Figure 16. One of those experts noted, "The market [for unit heaters/duct furnaces] began in approximately 1939, and was exclusively Gravity Vent (100%) until the 1960's or so and since that time Power Vent has grown to the dominant market share (67% by the end of 2005)." On the other hand, one of the policy experts commented:

> "[Under previous standards] 12 manufacturers with 3,751 natural gas models were certified. Even after being advised of the new requirements, [compliance information has been provided by only] three manufacturers on a total of 107 models. [This] appears to be one of the least-compliant of all [appliances] ... There are likely many manufacturers still missing. And, unless all manufacturers are willing to show compliance for all models, … the likelihood of those manufacturers meeting a specific standard level voluntarily (e.g., where the standard had not been enacted) is small."

When we assessed compliance based on data from the field (see Chapter 5), we found some vendors with high compliance rates (60% or greater), and some with very low compliance rates. Our overall estimate was 56%, but we noted that the estimate was conservative and uncertain because compliance was determined strictly based on whether a unit was in the CEC database, and sales data were rarely available.

Taking these factors into account, we believe that the average market adoption curve is a reasonable estimate of what would have happened without the standard. However, further interviews with industry representatives and an assessment of compliance would be useful to clarify how common complying units were before and since the standard went into effect.

Prior Utility Programs

As discussed earlier, we developed a method for adjusting our estimates of naturally occurring market adoption to take into account the effect of utility programs. Three steps were required:

- Identifying measures/appliances for which there were utility programs
- Obtaining and reviewing impact evaluation reports from which to extract information on market penetration, savings, and net-to-gross ratios
- Incorporating this information in the analysis

Working with the SRC members and program implementers, we conducted a thorough process to identify programs that affected each of the appliances and building measures included in our study. We contacted key consultants who had conducted overall work on the standards (primarily Energy Solutions and HMG) and utility staff familiar with various utility programs. The consultants were able to provide initial information about prior programs. Quantec then reviewed evaluation studies and contacted program evaluators to try to obtain the data needed to assess the effects on estimated market adoption rates.

Only a few appliances were identified by Energy Solutions as having been included in prior California utility energy-efficiency programs. One of these was a recent PG&E program for pulse-start metal halides that specified use of a pulse-start ballast in retrofits. Prior to that, they could have been implemented through the Express Efficiency Program. We obtained an evaluation of the Express Efficiency Program and talked to the study's author. The evaluation, did not quantify free-ridership, savings, or installation rates at the measure level. No other information about metal halide programs was available.

A recent PG&E program for pool pumps was identified. To qualify for rebates, pool pump motors had to meet certain efficiency or multiple speed capabilities. The program was very recent, however, and we were unable to locate any evaluation data for the program.

The 2004 and 2005 Express Efficiency Programs provided rebates for pre-rinse spray valves that met the basic requirements of the new standards. We were unable to obtain any evaluations or other analyses to provide the data needed to assess the effects of these programs. No programs or data were identified for the other appliances included in our study.

On the building measure side, HMG identified potential programs, but could not provide detailed information. We were referred to utility contacts to try to obtain the necessary information. We made multiple attempts to contact staff who were knowledgeable about specific building measure programs, but we were unable to obtain the additional information needed to analyze the programs.

In addition to incentive programs, the utilities undertook training and education efforts to increase awareness of the standards. These activities very likely influenced both the perceptions about market adoption rates and compliance with the standards. Disentangling the effects of these efforts was beyond the scope of our study, but the role of these programs will become increasingly important to ensure that each efficient appliance and building standard achieves its intended effect. Our analyses, particularly the estimates of noncompliance, should help identify the best targets for future training and education activities.

After collecting the information and studies that were available, Quantec found insufficient information to make adjustments to our estimates for either the appliances or building measures for which naturally occurring market adoption rates were estimated. We believe that the lack of information did not introduce a significant error in our estimates, however. This is because the incentive programs that were conducted were unlikely to have introduced major shifts in the market that would have influenced the experts' estimates of current and future adoption rates without the standards. Given this, it would be most appropriate to credit the utility programs with the savings demonstrated through program evaluations and studies, and not make any adjustment in the savings estimated for the Codes and Standards Program to account for prior programs.

4. Building Standards Noncompliance

Background

For the purposes of the original Savings Estimate Spreadsheet, the noncompliance rate for building standards was assumed to be 30% for all measures. Quantec and the Benningfield Group devised a research approach based on the collection of building field data to revise the compliance estimate for each measure. The data were collected via a combined approach of reviewing building department records and conducting site visits at a sample of buildings to verify the reported compliance rates.

Table 9 shows the building efficiency requirements of the 2005[16] Title 24 Standards that were assessed in the cited HMG 2005 report. Measures are listed in the order of estimated first-year electricity savings, first for residential and then for nonresidential buildings.

Table 9. Building Measures Updated in Title 24

Measure	1st Year Savings (GWh)
Residential	
Hardwired lighting	64.6
Window replacement	6.3 (0.3 Mtherms)
Duct improvement	5.7 (1.1 Mtherms)
Multifamily water heating	1.5 Mtherms
Nonresidential	
Lighting controls under skylights	25.5
Cool roofs	14.6
Bi-level lighting controls	12.1
Ducts in existing buildings	9.7 (1.0 Mtherms)
Duct testing/sealing in new buildings	8.0
Cooling towers	3.0
Relocatable classrooms	2.9

Given the limited time and resources available for this study, we proposed to focus on the largest energy savers and this approach was incorporated into our final work plan. As a result, multifamily water heating (1.5 Mtherms), nonresidential cooling towers (3 GWh), and relocatable classrooms (2.9 GWh) were not included in this study. The remaining measures account for nearly 90% of total first year savings. [17]

[16] The 2005 Title 24 Standards took effect on October 1, 2005.

[17] As described earlier, total savings were calculated as GWh (Mtherms converted to GWh equivalent).

Research Methodology

Initially, our work plan was designed to include the following components of data collection:

1) Visits to ten building departments, representing a mix of climate zones across California

2) Reviews of 400 building records, including permits and plans/drawings when available

3) On-site inspections of a sample of 100 building projects drawn from the 400 reviewed records

This initial plan was modified slightly when it was discovered that some building departments encompass multiple climate zones; for purposes of efficiency, nine building departments ultimately were visited.

This methodology was employed with the objective of providing statistically defensible results for each of the identified measures with 90% confidence ±10%. This level of precision was achieved, with absolute precision levels ranging from ± 0.9% to ±10%. Relative precision levels ranged from ± 1.2% to ±24%. Beyond the noncompliance values themselves, this study also was able to provide valuable insight into the varying building department processes and procedures in place across the state. These findings shed some light on the types of process holes that exist, and their likely impacts on overall building energy code compliance. These process findings, as well as general lessons learned through this research, are discussed later in this chapter.

Building Department Selection

Building departments were selected to maximize opportunities for viewing permits and plans from a mix of building projects and climate zones across the state. To maintain consistency with the California Energy Commission's *2005 Building Energy Efficiency Standards Compliance Manual*, California's 16 climate zones were grouped into five climate zone clusters for this study. Our goal was to pull records from those areas with ample building activity to provide a sample of building projects across the five climate zone clusters that were likely to contain our targeted measures. Our method for doing this began with viewing a climate zone map of California, and identifying the larger metropolitan areas in each climate zone cluster. Once a list of potential departments was assembled, we contacted building officials at each department to explain the study and request access to the records. In some cases, access was readily granted and the building department representatives were helpful. In others, additional effort was needed to secure cooperation. In the end, we were able to obtain data from nine building departments with adequate representation of the state.

Figure 17 shows the distribution of the building departments across the state.

Figure 17. Building Department Locations

Table 10 displays the nine building departments visited, each department's associated climate zone cluster, and the number of permits that were reviewed at each.

Table 10. Building Department Permit Review Breakdown

Building Department	County	Climate Zone Cluster	Permits Reviewed	Percent of Total	Residential Permit[a] Volume (County Level)	Percent of Total Permits	Nonresidential Building Valuation in Dollars (County Level)	Percent of Total Valuation
Arcata	Humboldt	1, 16	27	7%	326	1%	68,030	0.4%
Anaheim	Orange	6-9	36	9%	6,758	13%	3,688,049	21%
Fullerton			39	10%				
Riverside	Riverside	2, 10-13	50	13%	21,761	42%	5,551,340	32%
Ceres	Stanislaus	2, 10-13	51	13%	2,039	4%	752,999	4%
Elk Grove	Sacramento	2, 10-13	38	10%	5,239	10%	1,492,198	9
San Diego	San Diego	6-9	62	16%	8,944	17%	3,368,185	19%
Paso Robles	San Luis Obispo	3-5	39	10%	1,344	3%	410,523	2.4%
Concord	Contra Costa	10-13	8	2%	3,385	7%	1,435,469	8%
Sonoma	Sonoma	1, 2, 10-13 and 16	45	11%	1,594	3%	574,456	3.3%
Totals			***395***		***51,530***		***17,341,249***	

[a]Residential building permit volume and nonresidential building valuation figures represent the first nine months of 2006.

Data Collection

Building Department Permit Review

At each building department, we reviewed recent permit records and permit lists; typically, the permits studied were filed between November 1, 2005 through June 2006.[18] Permits that were likely to contain one of the study's target measures were selected, and, if available, specific records and plans for those projects were pulled for further review. For each record the following data were collected: permit number, address, owner's name, owner's phone number (when available), type of permit, details of work to be performed, target measure applicability, and various notes on documents in the file, including energy calculation results and comments on construction status to help determine if the project was suitable for a field visit.

[18] Few permits filed after June 2006 were reviewed to allow time for projects to be completed, and because the study aimed to give focused attention on compliance rates soon following code changes.

Background

Although we expected to find a certain level of procedural inconsistencies between building departments, we were surprised to learn just how unique each building department's policies were. To provide background to the findings in this study, and to help inform future studies, here we describe some examples of the nuances of the data collection effort.

All building departments keep records of permits by address, date and permit number; however, the methods by which they categorize, store, and support projects differ in every jurisdiction. In particular, we found that the level of project detail available for viewing was inconsistent throughout the state. For example, one city may file a permit for a particular project simply as a residential permit with no further detail. In order to learn more about this project, the file must be pulled and the building plans retrieved to obtain even basic details, such as type of residential construction (new subdivision, new single family residence, addition to existing residence, remodel of existing residence, or repair to existing residence). At some departments these broad sub-classifications did exist in the master record or permit list, and most provided at least "new" vs. "existing" distinctions. However, even within those classifications, there were inconsistencies. For example, some departments might catalog a studio addition or "granny flat" as an addition/remodel because there is an existing permit record for that address, while others would call it a new single family residence.

Another interesting permitting nuance lies in the area of subdivision construction. In California, most building departments allow what they classify as "master plans," where production builders may submit one complete set of plans for each type of residence they plan to construct within a subdivision. In these cases, if developers can prove, typically via the performance method, that each home type complies with minimum building codes, the master plan is deemed to comply with the code. Prior to actual construction, then, builders need only come into the building department with a plot plan/grading plan to obtain a permit for an individual address. Each building department has a different system for matching these mastered plan approvals to individual permits by address. For nonresidential permits, similar matching inconsistencies exist.

Finally, to ensure good customer service, most, if not all, building departments in California offer walk-in service and issue what are known as "counter permits" for many types of construction. To obtain a counter permit, applicants typically are able to simply complete a form and pay a fee, with little or no design or component documentation required. This is a key example of a building department policy that made data collection for this project more problematic than anticipated. One example of how counter permits complicated the review process is in the case of re-roofing. Many times, we pulled permits for these building project types and found that the permit did not describe the type, size or slope of the roof. Similarly, a counter permit can be issued for a replacement HVAC system or replacement windows. This issue is exacerbated by the fact that the technicians issuing counter permits typically do not have sufficient training or expertise to review energy compliance documentation or specifications. In short, the myriad processes and procedures we encountered, together with the wide range of project detail present in the building permits, created a challenging environment in which to make compliance determinations for the targeted measures in this study. More importantly, these inconsistencies will likely complicate future efforts to improve compliance and document energy

savings resulting from codes and standards, unless compliance chain issues are further identified and addressed.

Record Retrieval and Plan Review

For most building departments, we were able to scan a list of permits either provided by staff or retrieved from the departments' databases. After an initial review, those permits likely to contain one of the study's targeted measures were selected for more detailed evaluation, which included an examination of plans. In some jurisdictions, this was done through physical access to the plan room; in others, it involved having the permit staff retrieve plans for us.

It is important to note that although it often appeared that a building project "should contain" one of the study's measures, it was not always possible to make a compliance determination from the available records. This was due to a few different factors, including the type of measure (mandatory, prescriptive, or credit) and the presence or absence of plans containing finer project details. Here we discuss how different variables influenced the process of making noncompliance appraisals for each measure.

Type of Measure

In the standards, there are three types of requirements: mandatory, prescriptive and credit.

Mandatory measures are required each time the measure is included in a building design. For example, all appliance standards are considered mandatory measures. There are no exceptions and no tradeoffs. Documentation usually consists of confirming via a check mark on a form that the measure exists in the design. Residential hardwired lighting is another mandatory measure, although documentation of compliance with this measure is somewhat more involved, typically requiring completion of one or more special forms.

Prescriptive measures are slightly different. They are prescribed as part of the base-case design for a particular climate zone. Insulation requirements, for example, are prescriptively set for different climate zones. However, if and when a prescriptive requirement begins to restrict the building's design, that requirement can be "traded off" for another measure that saves approximately the same amount of energy. These substitutions, and the subsequent determination of project compliance with the energy code, are typically done via the ***performance compliance method***. The performance method requires that a certified computer program be used to model the building's overall energy use. The results of the computer model are then used to prove that the building meets the allowed energy use for a building of that type and configuration.

This trading off of measures to meet the energy requirements via overall building performance came into play during our analysis. For example, a prescriptive requirement like lighting controls under skylights in large warehouses is often traded off with other measures, and therefore may not have been present in the file or shown in the blueprints. However, the building as a whole may well have remained in conformance with the code, if the designer chose to add another feature (e.g., a more efficient HVAC unit) in order to make up for the energy lost due to the absence of skylights with lighting controls.

Credits, lastly, are present in the code as a means to encourage adoption of newer technologies. For example, the installation of dimming ballasts and dimming controls on fluorescent lamps provides a control credit in the form of a Power Adjustment Factor. This factor provides a compliance credit for using that technology, and allows a designer the option of utilizing a higher lighting power than is ordinarily allowed in the code.

Availability of Data

The prevalence of permits applicable to our project varied significantly by measure. In many cases, a feature is required only under certain conditions, reducing the number of potential records available to review. For example, cool roofs are only required for commercial re-roof projects where low-slope conditions exist, and even then there are some exceptions to the requirement that make the presence of that measure relatively uncommon.

This study also found that substantially fewer permits exist in the nonresidential sector. While the volume of nonresidential building projects is substantial from a valuation perspective, from a permitting perspective they are relatively underrepresented. Nonresidential buildings are larger, take longer to plan and construct, and are often built in phases with separate permits taken only for specific building components (e.g., unconditioned shell, demolition of previous building, grading, electrical, etc.). The availability of data is further restricted by the fact that contractors and owners sometimes neglect to take out the required permits. This phenomenon was reported to varying degrees at each building department, and appears to happen less frequently in smaller jurisdictions where the building department has a closer link to the community. The frequency of this occurrence anywhere, however, is anecdotal, because those who bypass the permit system cannot be tracked unless their illegal activity is reported to the department by a third party.

Building Department Policies

Building departments, governed by administrations that must answer to councils and boards of supervisors, often set polices that do not adequately recognize or accommodate some aspects of the building energy-efficiency codes. For example, the most current building energy efficiency codes went into effect on October 1, 2005. “Grandfathering” under an older code is permissible in cases where a permit was filed prior to October 1, even if project completion does not occur until well beyond this date. In some jurisdictions, however, residential permits issued *after* October 1 were grandfathered in. We found that some level of inappropriate grandfathering of old requirements into the new time frame was adopted policy in five of the nine building departments visited. As a consequence, hundreds of homes statewide are complying with outdated code requirements. In addition, the interpretation, application, and enforcement of codes was found to be inconsistent between building departments. For example, some jurisdictions have opted not to require permits (though they should) for commercial reroofs or for replacement of residential windows, rendering it impossible to study compliance for those measures in those departments.

Plan Review and Site Visit Protocols by Measure

The protocol used for the record review, plan review, and site visit is described in this section. Table 11 shows the types of forms reviewed at the building departments.

Table 11. Forms Applicable to Record Review and Field Inspection

Residential Forms	Nonresidential Forms
MF 1-R	FC-1 and/or FC-2
CF 4-R	LTG 1-C
CF 6-R	Mech 1-C
WS 5-R	Applicable acceptance testing documents
CF 1-R	Mech 1-A and back-up documents
Applicable specification sheets or notes	LTG 1-A and back-up documents
	Applicable specification sheets or notes

Hardwired Lighting

This measure is the most universally applicable of all the measures researched, as it is applicable to all residential new construction and alterations. It is a mandatory measure, so it cannot be traded off for another feature with equal or greater energy savings potential. Permits reviewed for this measure included all residential construction, including single and multifamily projects and subdivisions.

Research protocol. In the permit file, we looked for a MF-1 form and a WS5-R form. These forms document the designer/owner's intent to install the required lighting and to document that incandescent lights installed in the kitchen do not exceed the allotted maximum wattage. When reviewing plans, we looked for a lighting or electrical drawing that indicated location and types of fixture and controls. In the field, we observed and recorded the types of fixtures and controls that were installed.

Window Replacement

This is a prescriptive measure that applies to the replacement of windows in the residential sector. While the measure is universally applicable, except in rare cases where the requirement is traded off for another, only a small number of permits were located at the building departments. This is due to two factors: (1) window replacements represent a small subset of the residential market (alteration only), and (2) window replacement permits are not required by all building departments. Some departments require permits for all replacements, while others only require permits when there is a change in window size. Still others don't require them at all. Windows often are replaced in conjunction with another type of alteration, and the permit details may not always reveal whether windows were included in the scope of the alteration work.

Research protocol. In the permit file, we looked for a certificate of compliance and/or window specifications. These forms document the designer/owner's intent to install windows that conform to the U-factor and SHGC requirements specified in the code. Window replacement permits are often issued as counter permits, which limited the prevalence of documentation (e.g., drawings indicating location, size or type of windows to be replaced) that would have informed this study. In the field, we looked for window labels indicating type and U-factor. In the absence of a window label, we recorded the window and frame type.

Duct Sealing for Residential HVAC Replacement

This is a prescriptive measure that applies only to the replacement of a major component of the HVAC unit in certain climate zones (2 and 9-16). The requirement includes performing a duct test that verifies a maximum leakage rate of 15% (or 10% leakage to the outside), or a 60% leakage improvement over the existing system, verified through a smoke test. In certain areas and under certain conditions, homeowners can choose to install a higher efficiency HVAC unit instead of having the duct test performed.

Research protocol. In the permit file, we looked for a certificate of compliance, duct test results, or the presence of a testing form awaiting completion. These forms document the contractor/owner's notification of the results of the leakage test or the requirement to have a test. Since these are typically counter permits, no sketch or specification is usually provided. In the field, the measure was inspected for test results or the existence of compliance forms that would indicate a test had been performed. If neither was present, we noted the installation quality of the duct system. For this and all of the measures where duct sealing was required, records were checked against the HERS registry which would reveal all sites where data on duct test results were uploaded, as required by the code.

Skylights

Skylights are prescriptive measures that apply to a small number of very large buildings that have a warehouse or retail occupancy designation. For skylights (and future lighting controls to obtain the energy savings from daylighting) to be required, the building must be 25,000 square feet or larger, must have relatively high ceilings, and must have greater than 0.5 watts-per-square foot of lighting installed (or intended to be installed). Skylights are required to provide light to at least 50% of the floor area. Since it is a prescriptive requirement, it can be traded off via the performance method.

Research protocol. In the permit file, we looked for compliance forms that indicated the skylight was required and that it was either present or traded off against another feature. In design plans, we looked for the presence of skylights in qualifying buildings. We then attempted to verify that, if skylights were present, the area and size of the skylights might yield the amount of daylight to the space as required by code (50% of floor area). This is done by calculating the daylit area based on the size and spacing of the skylights. In the field, we verified the presence of skylights and, if lighting was installed, the presence of qualifying lighting controls.

Cool Roofs

A cool roof is a prescriptive measure that applies to certain low-sloped roof replacements. The re-roofed area must be $\geq$50% of the total roof area (or a minimum of 1,000 square feet). If that condition exists, then most roofs must meet the prescriptive requirements of a cool roof, unless the feature is traded off via the performance method or all of the exceptions listed in Section 149 (b) 1 B exist. During field visits, we learned that many roofs and roof repairs are completed without obtaining a permit. One jurisdiction in our study currently does not require permits for this type of construction activity. Another jurisdiction reported that the volume of permit activity for commercial reroofs dropped after the code change; it is suspected that increasingly restrictive requirements sometimes drive contractors away from the process completely.

Research protocol. In the permit file, we recorded the presence or absence of compliance forms that indicated that the applicant was aware that a roof was required to meet the requirements of a cool roof and that the product should be certified by the Cool Roof Rating Council (CRRC)[19]. Likely due to the fact that these are counter permits, we found no cases where any plans, sketches or specifications were found in the file. Occasionally the permit description indicated that a cool roof replacement was intended for that address. During the field visits, we noted the roof color and looked for a CRRC certificate or label.

Bi-level Lighting Controls

Bi-level lighting controls exist in the building energy efficiency codes as an optional control credit that may be taken to allow for increased lighting power. The lighting control credits are calculated in terms of "Power Adjustment Factors," which are multipliers that allow the actual lighting power used in compliance calculations to be reduced, giving a lower adjusted lighting power. This makes it easier to meet the allowed lighting power requirement.

Research protocol. In the permit file, we looked for permits pertaining to new small office spaces or tenant improvements where the lighting control credit may be used. Our study reviewed twelve permits where a bi-level lighting control would have been applicable, but did not locate any building projects that opted to take the credit.

Duct Sealing for Commercial HVAC Replacement

This is a prescriptive measure similar to that for residential systems. However, this measure was found to be required less frequently in nonresidential applications because duct systems are often located in conditioned spaces, or they serve an area greater than 5,000 square feet. The existence of either one of these features exempts a building from the requirement. In addition, building owners may choose to install a higher efficiency HVAC unit in some cases, in order to exempt them from the duct sealing requirement.

Research protocol. In the permit file, we noted the presence of compliance forms, a complete or incomplete duct test report, or other information indicating that the applicant intended to seal and test the duct system. Once again, this measure requires only a counter permit, so plans and sketches are typically absent. In the field, we looked for a duct test report. If one was not present, we noted the quality of installation of the duct system. As previously noted, all projects containing measures where duct sealing was required were checked against the HERS registry.

Duct Sealing for New Commercial HVAC

This is a prescriptive measure that applies to HVAC systems serving relatively small zones (5,000 square feet or less) that have greater than 25% of the ducts located in unconditioned space. When a project meets the applicability criteria, very often these systems are installed as part of small tenant improvement permits and the requirement is traded off against the lighting

[19] The Cool Roof Rating Council (CRRC) is an independent organization that has established a system for providing radiative property data on roof surfaces.

requirement via the performance method. If a "mechanical only" permit is pulled, typically the duct system is required to be sealed and tested.

Research protocol. At the building department, we noted the presence of compliance forms, a complete or incomplete duct test report, and other information indicating that the applicant intended to seal and test the duct system. Since these are counter permits, no plans or sketches are typically present for review. In the field, we looked for a duct test report. If one was not present, the reviewer noted the quality of installation of the duct system. For all of the measures where duct sealing was required, records were checked against the HERS registry.

Compliance "Scoring"

Each permit reviewed was given a score in each of three possible compliance categories: process, design, and field.

> ***Process*** reflects the completeness of the information contained in the permit file.
>
> ***Design*** represents the compliance level of the submitted blueprints or plans.
>
> ***Field*** corresponds to the observations made during the field inspections.

The scores themselves were derived from an evaluation of how close the component came to meeting the code requirement. Complete noncompliance existed when no evidence of knowledge or intent to comply with code existed (score =1). Partial compliance was given when some evidence was found of an attempt to comply with code, but compliance was incomplete (score = 0.5). Full compliance existed when the measure was present and either fully documented, fully contained in the design or installed in the building (score = 0). The one exception to this scoring scheme applied to window replacements, where a partial noncompliance score of 0.3 was given in certain cases. See Results section for more details.

As an example, a permit record may receive a *process* score of 0 for hardwired lighting if there is a completed MF1-R and a completed WS5-R form in the file. That same record may receive only a 0.5 *design* score if the blueprints show recessed cans in the kitchen, but do not specify those as high efficacy fixtures. Finally, that same record may receive a *field* score of 1 if the fixtures are in fact found to be incandescent, and there are no occupancy sensors in the bathroom areas.

Results

A total of 418 records were selected at nine building departments representing 437 measures. Of those, a total of 395 measures had permits that were available for complete review. This discrepancy in number of permits reviewed is due to missing information or the fact that records and plans were unavailable on the day of the visit. For example, some records indicated that a measure was present when it was not, and further investigation ultimately showed that the measure was not required after all. Other times it was not possible to prove that a measure was required based on the information provided. In still other cases, the file was located but not the plans that would have contained the information necessary to verify compliance. These are all

examples of permits that were evaluated but ultimately deemed "not applicable" to our study, and represent less than 5% of the total reviews. This is a finding that might be expected given the complicated nature of the system, the limited amount of available support from building department staff, and the time constraints on the building department reviews themselves. We found that noncompliance values through this study varied widely by measure, ranging from 28% for hardwired lighting to 100% for nonresidential ducts (both new and retrofit).

Since this study began relatively shortly after the implementation of these updated 2005 building codes, utility-sponsored training and education (T&E) programs aimed at improving compliance rates had not been completed yet. These T&E efforts are carried out through IOU Energy Centers, the Savings by Design program[20], and statewide and local partnership programs. We expect that compliance with the 2005 standards will improve as these training events continue.

Building department permit reviews were followed by 144 on-site or other verifications[21] to determine rates of noncompliance with code. Sample sizes of measures are presented in Table 12. Measures, permits, and site visits reviewed by building department are presented in Table 13.[22]

Table 12. Sample Sizes

Measure	Records of Measures	Permits Reviewed	Field Verification
Residential			
Ducts	84	82	82
Hardwired lighting	216	200	19
Windows	67	65	6
Nonresidential			
Bi-Level	12	0	0
Cool Roofs	17	17	11
Ducts--New	14	12	12
Ducts--Retrofit	11	7	7
Skylights	16	12	7

[20] Savings By Design is a program to encourage high-performance nonresidential building design and construction, and is sponsored by four of California's largest utilities under the auspices of the Public Utilities Commission.

[21] For measures involving duct sealing, verifications occurred via the Home Energy Rating System databases in California: CHEERS, CalCERTS, and CBPCA.

[22] In an effort to improve sample sizes and, correspondingly, precision, cool roofs and skylights are excluded from this analysis. Once permit reviews and site visits have been completed, an updated report will be provided.

Table 13. Measures, Permits, Site Visits

Building Department	Total Measures	Sites	Total Permits Reviewed	Field Verification
Anaheim	45	45	36	20
Arcata	29	28	27	3
Ceres	51	48	51	12
Concord	8	8	8	8
Elk Grove	42	37	38	26
Fullerton	40	39	39	16
Paso Robles	47	45	39	4
Riverside	51	51	50	19
San Diego	71	70	62	13
Sonoma	53	47	45	23

Table 14 summarizes the noncompliance estimates for all measures studied.

Table 14. Summary of Building Measure Noncompliance Estimates

Building Measure	Estimated Noncompliance rate	Absolute Precision of Estimate	Relative Precision of Estimate
Residential			
Hardwired lighting	28%	3%	11%
Window replacement	68%	7%	10%
Duct improvement	73%	0.9%	1.2%
Nonresidential			
Lighting controls under skylights	44%	10%	24%
Cool roofs	50%	3%	6%
Bi-level lighting controls	n/a	n/a	n/a
Ducts in existing buildings	100%	2%	2%
Duct testing/sealing in new buildings	100%	1%	1%

Determining Noncompliance Rates

During the permit review process, permit files were scored to indicate whether or not the measures were compliant with code. If, for example, the files revealed a measure was noncompliant, a score of 1 was assigned, reflecting 100% noncompliance. If the measure was shown to be compliant, a score of 0 was given. In some instances, paperwork was not complete,

but showed some indication of compliance and received a score of 0.5. These scores were used to obtain an initial estimate of compliance.[23]

In order to assess the accuracy of permit scores, site visits were carried out on a sample of buildings for each measure. Scoring was done using the same methodology described for the record reviews: a building project noncompliant with code received a score of 1 and compliant projects were given a score of 0. As with the review of permits, some measures could not be fully assessed on site, but appeared to be compliant and, therefore, received a score of 0.5. For example, a cool roof that appeared to have some cool roof properties (e.g. light in color) but was unable to be verified would receive a partial compliance score of 0.5.

There were two exceptions to this method. The first was with respect to residential window replacements. In most cases, windows lacked U-factor or NFRC[24] labels and could not be verified. However, if during inspection a window tested as low-e and was framed with vinyl, it was considered better than half compliant and was given a noncompliance score of 0.3.[25] The second exception was with regard to hardwired lighting. Though the scoring scheme remained the same, weights were applied to the scores in order to account for differences in construction type and scale. This additional step was applied after it was found that there was a large discrepancy in compliance between production housing and single family housing or additions. It was found that production homes were significantly more likely to be compliant with the code. In order to properly recognize this and to account for the relative impact of each construction type on the residential market as a whole, a weighting factor of 10 was applied to production housing, new single-family homes a weight of 2, and remodels a score of 1. This in part recognizes the large scale repetitive impact of one compliant design being built many times over in a particular subdivision.

In all cases, the final site visit scores were then used to update the initial compliance scores using a Bayesian statistical analysis as described below.

Finally, all noncompliance scores were weighted according to building department using building valuation figures for 2005 and 2006.[26] Using the total residential and commercial valuations for the nine building departments we visited for this study, weights were constructed as a proportion of total valuations. For example, the weight applied to residential noncompliance scores in Sonoma County is equal to the residential valuation in Sonoma divided by the total valuation of all nine building departments.

---

[23] For more details on the scoring protocol used, see *Compliance"Scoring"* section.

[24] The National Fenestration Rating Council provides energy performance ratings for window products.

[25] The 2005 Ducker Worldwide windows market study, *The Distribution of Residential and Nonresidential Windows and Doors in the 2003 U.S. Market*, applied a multiplier of 0.95 to low-e window sales to estimate Energy Star window sales. However, Energy Star requirements vary by climate zone, and Energy Star criteria and code criteria do not always exactly agree in California. Therefore, we used a more conservative estimate of 0.7 (0.3 noncompliance) for the purposes of this study.

[26] California construction valuation figures for 2006 were for the first 9 months of the year. Data were obtained from the Construction Industry Research Board (CIRB).

Bayes' Theorem

Revising probabilities when new information is obtained is the foundation of Bayes' Theorem. Often we begin an analysis with an initial or *prior* probability estimate for a specific event (in this case the probability that a building measure is noncompliant). Then as additional information is obtained, we update the prior probability values by calculating revised probabilities, referred to as *posterior* probabilities. Bayes' Theorem provides the means of computing these probabilities.

For this study, we obtained a sample of building permits from which we estimated the prior probabilities of noncompliance. We then obtained another sample comprised of site visits and database verifications for selected buildings from the initial review. The probabilities of noncompliance estimated from the site visits were then used to revise the priors to estimate the posteriors.

The initial estimated proportion of noncompliance and its corresponding standard error are computed as follows:

$$p_1 = \frac{\sum_{i=1}^{n_1} x_i}{n_1}$$

and

$$s_1^2 = \frac{p_1(1-p_1)}{n_1}$$

where x_i is the score (0 to 1; with 1 indicating 100% noncompliance) of a measure for a particular permit and n_1 is the number of permits reviewed for the measure in question.

This is the *prior* estimate, since it is the result of information collected at the outset of the study and is subject to updating by a subsequent sample. The prior estimate represents what is believed to be true about noncompliance until more detailed information can be collected to either support or refute those estimates. Once the site visit scores are incorporated, we then have *posterior* estimates, calculated as follows:

$$p = \frac{\frac{n_2^2}{1-p_2} + \frac{n_1}{1-p_1}}{\frac{n_2^2}{p_2(1-p_2)} + \frac{n_1}{p_1(1-p_1)}}$$

and

$$\sigma^2 = \frac{p_1(1-p_1)p_2(1-p_2)}{n_2^2 p_1(1-p_1) + n_1 p2(1-p2)}$$

where p_2 is the estimated rate of noncompliance estimated from the site visits (calculation is the same as for the prior estimate), and n_2 is the number of site visits for a given measure.

The following sections explain, by measure, the noncompliance rates found in this study.

Residential Hardwired Lighting

As shown in Table 15 below, we reviewed 200 residential permits for compliance with the hardwired lighting code. Of these, 46% were found to be noncompliant. Nearly ten percent of the reviewed permits were then selected for site visits. The inspected buildings were found to have a 21% noncompliance rate. Incorporating that information into the original 46% noncompliance estimate yields a posterior noncompliance estimate of 28%. At 90% confidence, this estimate has precision level of ±3%.

Table 15. Residential Hardwired Lighting

Permits		Site Visits		Posterior Noncompliance Rate	Precision
Reviewed	Noncompliance Rate	Completed Visits	Noncompliance Rate		
200	46%	19	21%	28%	±3%

Residential Windows

Sixty-five permits were obtained for review for the residential windows measure, with 82% of these determined to be noncompliant (Table 16). However, from the sample of 65, six sites were visited for compliance verification, and of those, only 31% were found to be noncompliant. This discrepancy illustrates the gap between documenting compliance with the code and complying with the requirements in the building itself. In this case, because window replacement permits are given as "counter permits," there is a poor process in place for requesting and reviewing the required paperwork that proves compliance. Conversely, window manufacturers, suppliers and contractors are commonly aware of the code requirement, which leads to a relatively high rate of compliance during the purchase and installation of windows. The posterior estimated noncompliance rate is 68%. The 90% confidence interval is 61% to 75% noncompliance (± 7%).

Table 16. Residential Windows

Permits		Site Visits		Posterior Noncompliance Rate	Precision
Reviewed	Noncompliance Rate	Completed Visits	Noncompliance Rate		
65	82%	6	31%	68%	±7%

Commercial Cool Roofs

Seventeen permits for cool roofs were examined for this study, of which eleven were reviewed by site visits. The initial noncompliance rate for cool roofs, as assessed through permit reviews is

99%, due to an almost universal lack of proper documentation. However, the eleven roofs inspected through site visits were shown to be only 8% noncompliant. The posterior estimated noncompliance rate is 50%, with the 90% confidence interval falling between 47% and 53% noncompliance (± 3%).

Table 17. Commercial Cool Roofs

Permits		Site Visits		Posterior Noncompliance Rate	Precision
Reviewed	Noncompliance Rate	Completed Visits	Noncompliance Rate		
17	99%	11	8%	50%	±3%

Ducts

Site visits for ducts were difficult to achieve in large part because of problems gaining access to sites. To overcome this barrier, state HERS registries[27] were consulted to assess compliance with code. Because HERS raters have to visit the site in order to determine compliance, when a HERS registry reported a site as having "passed," that was considered equivalent to a site visit showing 0% noncompliance. If a site was not present on all three registries, that site was scored as a 1, indicating full noncompliance, since passing a HERS rating test is required by code.

Residential Ducts

As shown in Table 18, over eighty permits were reviewed for residential duct replacements, of which 96% percent were found to be noncompliant. No permits were found where the applicant requested a waiver of the duct sealing requirement because the HVAC equipment efficiencies were improved to the level that allowed exemption. When considering field compliance, all 82 permits were able to be checked through either site visits or with the HERS registries. The field compliance check found that 77% of ducts were noncompliant. The posterior estimate of noncompliance, then, is 73%, $\pm$1%.

Table 18. Residential Ducts

Permits		Site Visits		Posterior Noncompliance Rate	Precision
Reviewed	Noncompliance Rate	Completed Visits	Noncompliance Rate		
82	96%	82	71%	73%	±1%

[27] The sample of permits and records containing duct-related measures were checked for presence/absence in the CHEERS, CalCERTS, and CBPCA databases.

Commercial Ducts--Retrofit

Seven permits were reviewed for commercial duct replacements of which 100% were noncompliant; this was further confirmed through site visits and checks with the HERS registries. The posterior estimate of noncompliance is 100%. The 90% confidence interval is 98% to 100% (Table 19).

Table 19. Commercial Ducts--Retrofit

Permits		Site Visits		Posterior Noncompliance Rate	Precision
Reviewed	Noncompliance Rate	Completed Visits	Noncompliance Rate		
7	100%	7	100%	100%	±2%

Commercial Ducts--New

Twelve permits were reviewed for new commercial ducts and were found to be 97% noncompliant (Table 20). Site visits and HERS registries revealed 100% noncompliance which resulted in a posterior estimate of 100% noncompliance and a corresponding standard error of 0.00007. The 90% confidence interval is 99% to 100% noncompliance.

Table 20. Commercial Ducts--New

Permits		Site Visits		Posterior Noncompliance Rate	Precision
Reviewed	Noncompliance Rate	Completed Visits	Noncompliance Rate		
12	97%	12	100%	100%	±1%

Commercial Skylights

This study was able to identify twelve permits containing the commercial lighting controls under skylights measure. Of these, seven were evaluated through site visits. The initial noncompliance rate determined through permit review was found to be 46%, while those that were inspected through site visits had a noncompliance rate of 44%. For this measure, two of the sites that were found to be in compliance traded off skylights for a different measure and used the performance compliance method to prove overall building energy efficiency. The posterior noncompliance rate is 44%, ±10%.

Table 21. Commercial Skylights

Permits		Site Visits		Posterior Noncompliance Rate	Precision
Reviewed	Noncompliance Rate	Completed Visits	Noncompliance Rate		
12	46%	7	44%	44%	±10%

5. Appliance Standards Noncompliance

Introduction and Background

The state of California's new appliance efficiency standards (Title 20) went into effect in January 2006. Nine of the affected appliances were selected for inclusion in this study based on the magnitude of their estimated energy savings:

- Unit heaters and duct furnaces
- General service incandescents, Tier I
- Metal halide luminaires
- DVD players
- Televisions
- Residential pool pumps, Tier I
- Refrigerated canned/bottled beverage vending machines
- Walk-in refrigerators/freezers
- Pre-rinse spray valves

Appliance manufacturers are required to submit an application to the California Energy Commission (CEC) with specified information in order to have their product certified as meeting Title 20. For appliances manufactured after the effective date of these standards (January 1, 2006 for all these products), only those that are certified can be sold legally in California. The CEC is required to maintain a current database that lists all the certified appliances of each type. These databases can be accessed at the CEC website.[28] A summary of the energy-efficiency requirements for each of the appliances listed above is provided in Table 22. This table also indicates whether or not a CEC database existed for each appliances when we conducted our study.[29]

The purpose of this research was to develop a more accurate estimate of the compliance/ noncompliance rates for each of the appliances based on empirical data. The existing methodology (Savings Estimate Spreadsheet) for calculating the impacts of these standards (and the new Title 24 building standards) starts with a preliminary place holder of 30% for all

[28] This information is located at http://energy.ca.gov/appliances/appliance/index.html.

[29] The most recent updates we used in our study were from September 2006.

products in the first and all future years. In reality, noncompliance rates are likely to vary by product and they are likely to change over time.

The objectives of this research were to collect and use the best available data to develop compliance/noncompliance rate estimates for each appliance. These estimates provide a snapshot of the rates when the study was conducted. In parallel, another objective was to lay the groundwork for future studies of the noncompliance rates by identifying research approaches and obstacles that needed to be overcome to maximize the quality of the data and estimates.

Table 22. Description of Standards

<table>
<tr><th>Appliance Category</th><th>In CEC Database</th><th>Standard</th></tr>
<tr><td>Televisions</td><td>Yes</td><td>Max. standby power usage =3W</td></tr>
<tr><td>DVD Players</td><td>Yes</td><td>Max. standby power usage =3W</td></tr>
<tr><td>Residential Pool Pumps, Tier 1</td><td>No</td><td>Motor may not be split phase or capacitor start-induction run type motor</td></tr>
<tr><td>General Service Incandescents, Tier 1</td><td>No</td><td>Max. wattage set for lumen output; applies to most incandescent and halogen lamps between 25 and 150 watts. Rough service, decorative, 3-way, and colored lamps are excluded.
Frost/clear: Max. W=(0.05*lumens)+21
Soft white: Max. W=(0.05*lumens)+22.5</td></tr>
<tr><td>Metal Halide Luminaires</td><td>No</td><td>Allows only pulse-start ballasts for vertical lamps with base up applications. Probe-start ballasts disallowed.</td></tr>
<tr><td>Walk-in Refrigerators/ Freezers</td><td>No</td><td>Usually custom made. Requires automatic closers on doors <4’ wide and <7’ high; R-28 insulation in refrigerators, R-36 in freezers; electronically commutated, permanent split capacitor type, or polyphase motors on condenser fans <1 HP; electronically commutated or permanent split capacitor type motors on evaporator fans <1 HP.</td></tr>
<tr><td>Pre-rinse Spray Valves</td><td>No</td><td>Flow rate ≤1.6 gpm @ 60 psi; cleans 60 plates at average of ≤30 seconds per plate.</td></tr>
<tr><td>Unit Heaters and Duct Furnaces</td><td>Yes</td><td>Natural gas-fired unit heaters and duct furnaces shall have either power venting or an automatic flue damper
<table>
<tr><th>Type</th><th>Fuel</th><th>Min. Efficiency @ Max. Capacity</th><th>Max. Watts during Standby</th></tr>
<tr><td>Duct furnaces</td><td>Nat gas</td><td>80</td><td>10</td></tr>
<tr><td>Duct furnaces</td><td>LPG</td><td>80</td><td>147</td></tr>
<tr><td>Unit heaters</td><td>Nat gas</td><td>80</td><td>10</td></tr>
<tr><td>Unit heaters</td><td>LPG</td><td>80</td><td>147</td></tr>
<tr><td>Unit heaters</td><td>Oil</td><td>81</td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Refrigerated Canned/Bottled Beverage Vending Machines</td><td>Yes</td><td>Max daily kWh=0.55*(8.66+(0.009*C)); C=rated capacity, # of 12 oz. cans</td></tr>
</table>

Data Collection and Analysis Strategy

Overview of Approach

Our primary approach to estimate noncompliance rates was to identify a sample of retailers and/or wholesalers for each appliance and conduct site visits to collect primary data on brands/models sold and their sales volumes. We planned to determine whether each brand/model complied with Title 20 and, using the sales volumes, calculate the overall noncompliance rate. Estimates were not derived by utility service area for three main reasons. Consumer products are often sold by chains that have outlets throughout the state and their sales patterns would not be expected to vary significantly by location. Many of the vendors we contacted sell products to customers across the state, so their sales were not affected by location. Finally, our sample was designed to ensure representative data were collected from across the state; the number of sites within individual utility service areas was not sufficient to estimate differences among the areas, if any exist.

A database of California industries was purchased to provide a listing of manufacturers, distributors, wholesalers, and retailers for each appliance.[30] Since compliance behavior is likely to vary by company size, particularly for retailers and wholesalers, we stratified our list to ensure that when we selected a sample for data collection both large and small companies would be represented. We used number of employees as the measure of company size and the sites were ranked by number of employees and the cumulative number of employees was calculated. We created two initial strata: those below and those above the 50th percentile in total employment. The resulting groups were reviewed and modified to ensure that adequate numbers of sites were in each group to permit us to collect data from at least two in each stratum in each of three general regions: southern, central, and northern California.

Table 23. Maximum Number of Employees for Sites in First Stratum

Appliance Category	Maximum No. of Employees in First Stratum
Televisions	<50
DVD Players	<50
Residential Pool Pumps, Tier 1	<20
General Service Incandescents, Tier 1	<50
Metal Halide Luminaires	<50
Walk-in Refrigerators/ Freezers	<20
Pre-rinse Spray Valves	<20
Unit Heaters and Duct Furnaces	<20
Refrigerated Canned/Bottled Beverage Vending Machines	<10

[30] This list was obtained from Alliance Direct Marketing Solutions, LLC.

In addition to collecting information from wholesalers/retailers, we planned to contact distributors and manufacturers of each appliance and obtain relevant information from websites and request and review catalogs. The mix of information obtained from the different supply-chain members was finalized after we conducted initial research and held discussions with the SRC.

We designed a stratified cluster sampling approach to select retailers and wholesalers for site visits. The planned number of outlets to sample was:

120 = 3 (regions) * 2 (strata) * 2 (average # stores in each stratum) * 9 (appliances)
+ 24 (adjustment for pool pumps and incandescents being sold at both retail and wholesale outlets)
– 12 (adjustment for sales of TVs and DVD players at same retailers)

In addition, we planned to collect website and catalog information from samples of the various members of the supply chains. For each appliance, we proposed selecting a sample of at least three manufacturers for information collection and possibly interviews to learn more about their supply chain. We targeted including three distributors of seven appliances in our data collection sample and one wholesaler in addition to those included in our site-visit sample to include in our website/catalog sample.

Data Collection

During the site visits, we planned to record information for each appliance including supplier name and address, brand, model, date of manufacture, number of units in stock, and approximate sales volume for the appliance type. Given that suppliers can legally continue to sell products manufactured prior to January 2006, we intended to document the number of products that were manufactured before this date.

The site visits were conducted between July 26 and September 11, 2006, by Quantec field technicians. They began in southern California and moved north. Cities visited included San Diego, Anaheim, Riverside, Bakersfield, Burbank, Santa Barbara and Oakland. In some cases, phone calls to retailers/wholesalers were substituted for the planned site visits (see discussion in next section). Table 24 presents summary information on the retailer/wholesaler data collection.

From our review of websites and catalogs we recorded characteristics of the appliances and any references to the availability of the appliance for sale in California. A database was created for recording all this information.

Once we started data collection, this approach had to be modified some to adjust to gaps and limitations in data availability. This is discussed in the next section.

Table 24. Summary of Site Visits and Phone Calls

Appliance	Stratum	Southern		Central		Northern		Total*	
		Phone Calls	Site Visits	Phone Calls	Site Visits	Phone Calls	Site Visits	Phone Calls	Site Visits
Televisions	Small	1	1	1	2	1	3	3	6
	Large		3		2		2		7
DVD Players	Small	1	3	1	2		2	2	7
	Large		4		2		2		8
Res. Pool Pumps, Tier 1	Small		2		2	2		2	4
	Large	1	1	1		2		5	1
Gen. Service Incandescents, Tier 1	Small		1		2				3
	Large		2		2		2		6
Metal Halide Luminaires	Small		1		1			7	2
	Large		2		2		2		6
Walk-in Refs/ Frzrs	Small	2		2		1		5	
	Large	2		1				3	
Pre-rinse Spray Valves	Small		2		4	1	2	1	8
	Large		2		1		2		5
Unit Heaters/ Duct Furnaces	Small	2		1		1		4	
	Large	2		1		2		5	
Vending Machines	Small		1				2		3
	Large		1				2		3
Totals		**11**	**26**	**8**	**22**	**10**	**21**	**37**	**69**

*Note that the totals shown in the final columns include additional contacts made that were to provide either statewide information or more general information about the market.

Data Analysis

The site-visit data were analyzed to determine which models at each outlet did or did not comply with the relevant California standard. We also intended to determine which models were manufactured prior to the effective date of the standards, but this was not possible since we found that manufacture dates were not provided for the products.

The primary source of compliance information was the CEC databases of certified products. The noncompliance rate for each appliance was then estimated based on the rate for each outlet, approximate sales, and appropriate weights for the strata. This general approach had to be tailored to each appliance and adjusted for differences in the types of data that we were able to obtain.

We also analyzed the data from our review of websites and catalogs. For several products, this information was critical for determining the characteristics of specific appliance models and then assessing compliance with the standards.

Data Gaps and Analysis Issues

In the early stages of data collection, it became apparent that several types of gaps and complexities would affect the analysis of the data collected for each appliance. For one, as Table 22 shows, CEC certification databases existed for only four of the appliances when this study was conducted. Because Title 20 requires appliance manufacturers to file certification information with the CEC to identify which specific units meet the standards and, therefore, can be sold legally in California, a strict interpretation of the requirements would suggest that only appliances listed in the databases met the standards.[31]

Quantec discussed this issue with the SRC and the group agreed that this interpretation was too rigid for the purposes of this study since the study was aiming to estimate effects on energy savings, not absolute compliance with all requirements of the standards. This decision both complicated the analysis (since determining compliance was not a simple matter of searching for products in the CEC databases) and introduced sources of uncertainty (such as gaps in other data that had to be obtained to ascertain compliance). To compensate for the added research effort required to deal with products for which there were no databases, agreement was reached on using phone calls to collect data in place of some of the site visits as long as the quality of the information was not diminished.

A related issue was that the CEC databases were updated during the course of our research as manufacturers submitted more information. We started our study with the databases available in mid-July, but updated our analysis using the databases available in mid-September, 2006.

Another issue was that appliances sold that were manufactured prior to 2006 did not have to comply with the standards, thus allowing retailers and wholesalers to sell their preexisting inventory of products. We found that it was not possible to determine the date of manufacture for individual items. During our outlet site visits, we examined products and packaging and were unable to locate manufactured date. Consequently, it was not possible to identify those items manufactured only in 2006 and calculate their noncompliance rates. In consultation with the SRC, the decision was made to document noncompliance of all products being sold during 2006, regardless of their date of manufacture. Because energy impacts of products sold in 2006 are determined by their characteristics regardless of when they were manufactured, this was an appropriate approach for calculating overall first-year impacts of the standards. Being unable to isolate appliances manufactured in 2006 did increase the scope of the data analysis beyond what was anticipated initially, however.

The biggest hurdles and uncertainties encountered in data collection and analysis were related to sales volume data. Our goal was to obtain actual sales data by model from each source. Although some of the sites we visited were able and willing to provide these data, many were either unable to provide them or refused. Some of the outlets said the information was proprietary. Others said the information had to be obtained from corporate offices and we had limited success obtaining these data when we contacted corporate offices. In some cases, the number of brands/models

[31] One argument for why manufacturers had not submitted certification information on all appliances was that the industry had challenged the standards in the courts and this issue was not decided until mid-2006.

sold was so large that the company representatives were unwilling to spend the time compiling the information. Our approach for resolving this issue varied by outlet and product. For some appliances, we counted the quantity of individual products on the shelves or in the store inventory and used this information to inform our estimate of noncompliance rates. In other cases, we had to conduct follow-up phone calls to request information such as the top selling models and their proportion of total sales. In all cases, we attempted to obtain the approximate number of the appliances each retailer/wholesaler sold in a year as a way to weight their noncompliance data.

Noncompliance Assessment

We used two general techniques to determine compliance and, hence, noncompliance. In one case, a CEC database of compliant units was available. In the second case, no compliance database was yet available. These approaches are described below.

Differences in the types of data available from the contacts for each appliance required flexibility and innovation in how we analyzed each. Appendix B presents our data and findings for each retailer/wholesaler and supplemental information we collected to provide the most complete picture possible of the types of information we relied on and the uncertainties inherent in the analyses.

Methodology—CEC database exists. As noted earlier, products for which a CEC database exists included televisions, DVD players, refrigerated canned/bottled beverage vending machines, and unit heaters and duct furnaces. Model numbers that were acquired during the site visits or preliminary phone calls were compared with the model numbers contained in the CEC database.[32]

Using Excel functions, we identified units with model numbers that matched a number in the database exactly and deemed the units to comply. We then used our "close" match subroutine to identify units with numbers very similar to ones in the database. We manually examined this second list further for typographical errors and permitted variance in "compliant" model numbers (e.g., ABC12F and ABC12G). This secondary analysis resulted in the ability to match additional model numbers to the database, which reduced the number of products in question. This process required the analysts to apply discerning judgment to make determinations about whether the appliance should be counted as compliant.

For all appliances for which a CEC database exists, it is possible that some units that are not in the database do, in fact, comply with the performance requirements of the standard. Our analysis relied directly on the database when one was available; therefore, noncompliance estimates for these products are likely to be somewhat conservative because other, possibly complying units were not included.

[32] Due to the extent of small variations in model numbers, we created a unique subroutine in Excel to identify "close" matches in addition to exact matches.

Methodology—no database exists. As noted above, the SRC agreed that we should develop compliance/noncompliance rate estimates for those five products for which no CEC database was available—residential pool pumps, general service incandescents, metal halide luminaires, walk-in refrigerators/ freezers, and pre-rinse spray valves. To do so required a data collection process similar to the one used for the other appliances, but expanded as needed to obtain data required to determine compliance (e.g., lumens and watts for incandescent lamps). In addition, we then had to perform the calculations or analysis for each appliance that was required to assess compliance. For incandescent lamps, for example, it was necessary to calculate the allowable watts for the lumen output and compare that with the level allowed by the standards.

Reporting Results

The data and analysis issues identified above were discussed with the SRC once they became apparent. There was general agreement that the steps being conducted were appropriate given the scope of this study. The group also felt that the lessons learned from this study would be useful for future noncompliance rate studies that were being designed.

As a result of these discussions, our analysis was structured to provide the following information in addition to the best estimates possible of compliance/noncompliance rates:

1. ***Discussion and assessment of uncertainties:*** For each appliance we discuss the types of factors that affected the uncertainties in the data and resulting noncompliance rate estimates. We provide a qualitative assessment of the accuracy of the estimates.

2. ***Lessons learned:*** To support future studies of noncompliance with Title 20, we document the types of problems encountered collecting and analyzing the required data and how we tackled these problems.

Summary of Noncompliance Findings

Our estimates of noncompliance rates for each appliance are presented in Table 25. The details of how the rates were determined for each product are presented in Appendix B. The table also shows our assessment of the certainty that can be attached to each estimate. This assessment is qualitative, based on the types of data available, number of observations, and other factors.

Table 25. Summary of Appliance Noncompliance Estimates for 2006

Appliance Category	Estimated noncompliance rate	Certainty level of estimate
Televisions	41%	Medium
DVD Players	57%	Medium
Residential Pool Pumps, Tier 1	15%	Medium
General Service Incandescents, Tier 1	27%	Medium
Metal Halide Luminaires	37%	Low
Walk-in Refrigerators/ Freezers	0%	Medium
Pre-rinse Spray Valves	4.2%	High
Unit Heaters and Duct Furnaces	44%	Low
Refrigerated Canned/Bottled Beverage Vending Machines	63%	Low

Consumer Electronics: Televisions

Electronic products that consume standby energy are included in the consumer electronic measures.

- The standby energy use associated with residential televisions in California is estimated at 7.3W. The standard provides that the maximum allowable standby power level for televisions would be 3W.

Data Collection and Methodology

Because this standard governs consumer products that are readily available for purchase at retail establishments, site visits were conducted in an effort to collect product and inventory information directly from the consumer's sources of these appliances. When possible, visits were scheduled with companies that market both televisions and DVDs for the purpose of efficiency. While on site, model numbers and inventory counts were recorded when available. However, in many instances only a display model was available for observation on the sales floor, while inventory was kept in a back stock room. Security and safety issues prevented some of the retailers from allowing inventory counts of these non-public stocking areas. Additionally, when knowledgeable sales representatives were available for questioning, an attempt was made to obtain sales data for the appliances; however, it was found that this information was not generally available to the sales clerks. To supplement the information collected from retail outlets, we conducted multiple calls to corporate offices and faxed information requests. It should be noted for future efforts that the corporate offices were largely non-responsive.

It should also be noted that while discontinued or clearance items were recorded as such when possible, this is not information that is generally presented to the public. Therefore, the compliance rates that are presented herein may include products that are not available for order, but are still available for purchase by the consumer.

Site visits were conducted to 13 businesses. Table 26 shows the regions and strata in which the outlets were located.

Table 26. Television Outlet Site Visits by Region and Stratum

	Stratum	Northern	Southern	Central
Televisions	Small	3	1	2
	Large	2	3	2

A CEC database was available for this product; therefore, model numbers were analyzed according to the methodology described previously for products in a compliance database. Given the lack of data on standby power use that we discovered during our data collection efforts, we did not attempt to expand the noncompliance assessment by conducting an independent assessment based on standby power use.

We recorded 876 different TV models during data collection. One method used to assess noncompliance was calculating the percent of the models found that were in the compliance database. Our second approach was to use the inventory data available from some of the stores as a proxy for sales of each model and then calculate the noncompliance rate taking the inventories into account. We also used our precalculated weights for the two size criteria to weight the noncompliance estimates to produce an overall value.

Overall Noncompliance

As shown in Table 27, we identified a total of 876 individual model numbers. Using the methodology described previously, 402 of the models were found in the CEC database, leaving 474 models for which we could not confirm compliance using the database. Next, we used the model numbers to calculate the noncompliance rate for only those sites where we had inventory data. Finally, noncompliance was calculated based on the actual number of units in the inventory of outlets where we had inventory data. The estimated noncompliance rates varied from 41% to 56% using these three methods.

Table 27. Televisions: Unweighted Noncompliance Estimates

Data Used	Total Count	Met Standard	Noncompliant	Noncompliance %
Total Models	876	402	474	54%
Only Models with Inventory Data	537	236	301	56%
Inventory	2,943	1,174	1,199	41%

Next, using the noncompliance rates based on models and inventory, the data were weighted to

reflect the two size strata established during the initial site selection process. The results based on the inventory data are presented in Table 28.[33]

Table 28. Televisions: Inventory Based Weighted Noncompliance Estimate

	Strata	Weights	Original Noncompliance	Weighted Noncompliance	Final Product Noncompliance
Total Models	Small	0.30	40%	12%	41%
	Large	0.70	42%	29%	

Since inventory counts were available at several of the sites, we were able to use them in the noncompliance rate calculation. Ideally, we would have used sales data in the analysis, but it was not possible to obtain sufficient sales data to produce accurate estimates. From our study of some of the other products for which we had both inventory data and sales data available, the inventory data appeared to be a reasonable proxy for sales.

- Our final estimate of overall noncompliance for televisions is 41%.

This is likely to be an overestimate of noncompliance because we did not attempt to assess compliance for models that were not included in the CEC compliance database*; we assumed that all unlisted models were noncompliant.* The noncompliance rate is probably increased also by the fact that stores continue to sell models manufactured before January 2006, which are not required to meet the new standards. Over time, noncompliance should decrease as these models are sold.

Given the data available, we assign a medium level of certainty to our final noncompliance estimate. Certainty was increased because the data were drawn from a large sample of stores that were distributed throughout California. When inventory data were available, we conducted complete counts so these estimates should be quite accurate. The main sources of uncertainty were possible differences between inventory counts and actual sales; incomplete matches of model numbers with the compliance database; and no compliance assessment of models not found in the database. The steps we took to match the recorded model numbers with those listed in the database where described earlier. The method was automated using Excel, but it was not perfect. The likely effect of these uncertainties was to bias our noncompliance estimate downward.

Consumer Electronics: DVDs

The standard establishes the same requirement for DVDs as televisions.

- The standby energy use associated with residential DVDs in California is estimated at 4.2 W. The standard provides that the maximum allowable standby power level for DVDs would be 3W.

[33] Using the model count data alone, the estimated noncompliance rate was 54% for both strata.

Data Collection and Methodology

As for televisions, site visits to retail stores were conducted to collect product and inventory information directly from the consumer's sources of these appliances. When possible, visits were scheduled with companies that market both televisions and DVDs for the purpose of efficiency. While on site, model numbers and inventory counts were recorded when available. However, in many instances only a display model was available for observation on the sales floor, while inventory was kept in a back stock room. Security and safety issues prevented many of the retailers from allowing inventory counts of these non-public stocking areas. Additionally, when knowledgeable sales representatives were available for questioning, an attempt was made to obtain sales data for the appliances; however, it was found that this information was not generally available to the sales clerks. Calls were made to multiple corporate offices, but for purposes of future research it should be noted that, as with televisions, corporate offices were mostly non-responsive.

It should also be noted that the noncompliance rates estimated include any products that are still being sold though they may have been produced before January 2006.

Site visits were conducted to 15 businesses, 12 of which were common to both televisions and DVDs. Table 29 shows the regions and strata in which the outlets were located. In addition to these site visits, we also conducted two telephone interviews with store representatives, but they provided only limited information.

Table 29. DVD Outlet Site Visits by Region and Stratum

	Stratum	Northern	Southern	Central
DVDs	Small	2	3	2
	Large	2	4	2

As with televisions, a CEC compliance database was available for this product; therefore, model numbers were analyzed according to the methodology described previously for products in a compliance database. We identified 448 individual models during our site visits.

Overall Noncompliance

As shown in Table 30, we identified a total of 448 individual model numbers. Using the methodology described previously, 137 of the models were found in the CEC database, leaving 311 models that were not found and were assumed to be noncompliant. Next, we used the model numbers to calculate the noncompliance rate for only those sites where we had inventory data. Finally, noncompliance was calculated based on the inventory counts. The estimated noncompliance rates varied from 41% to 69% using these three methods.

Table 30. DVDs: Unweighted Noncompliance Estimates

Data Used	Total Count	Met Standard	Noncompliant	Noncompliance %
Total Models	448	137	311	69%
Only Models with Inventory Data	199	136	63	68%
Inventory	2,943	1,174	1,199	41%

The results based on DVD inventories are shown in Table 31.[34] Noncompliance was more than twice as high for large stores as it was for small stores.

Table 31. DVDs: Inventory Based Weighted Noncompliance Estimates

	Strata	Weights	Original Noncompliance	Weighted Noncompliance	Final Product Noncompliance
Total Models	Small	0.301	30%	9%	57%
	Large	0.699	68%	48%	

Since inventory counts were available at several of the sites, we were able to use them in the noncompliance rate calculation. Ideally, we would have used sales data in the analysis, but it was not possible to obtain sufficient sales data to produce accurate estimates. As noted in the discussion of televisions, the inventory data appeared to be a reasonable proxy for sales.

- Our final estimate of overall noncompliance for DVDs is 57%.

This is likely to be a conservative estimate for the same reasons discussed earlier for televisions. These include assuming that all unlisted models were noncompliant and the fact that stores continue to sell models manufactured before January 2006.

Given the data available, we assign a medium level of certainty to our final noncompliance estimate. Certainty was increased because the data were drawn from a large sample of stores distributed throughout California. When inventory data were available, we conducted complete counts so these estimates should be quite accurate. The main sources of uncertainty were possible differences between inventory counts and actual sales; incomplete matches of model numbers with the compliance database; and no compliance assessment of models not found in the database.

Residential Pool Pumps

The new Title 20 standards prohibit all residential pool pump from using split-phase or capacitor start-induction run type motors. All pool pump motors manufactured in 2006 must meet this Tier 1 requirement. This standard eliminates use of the least energy-efficient motors. In Tier 2, the

[34] Noncompliance based just on model counts was 69%.

standard will require every motor of 1-horsepower or more to have multi-speed capabilities with pump controls. Tier 2 is effective on 2008 and will not be discussed in this section since the purpose is to verify compliance with the 2006 standard.

Data Collection and Methodology

Capacitor start–induction run motors, generally known as capacitor start motors, are considered the industry standard, and are less expensive than more energy-efficient types of motors. Capacitor run motors, on the other hand, have the distinction of being energy efficient or, as referred to by some motor manufacturers, as "conservationist" motors. According to the CASE report prepared for this standard, manufacturers offer high efficiency pump-motor combinations for most of their product lines, typically using capacitor start-capacitor run motors.

There was no compliance database available for pool pumps, so we had to develop an approach to assess noncompliance. In a prior study it was found that specific pump efficiency data are not generally published by manufacturers and are not readily available from other sources.[35] After performing research for this project, we also found that specific pump efficiency data are not generally published, thereby making it difficult to verify if specific pumps meet the new standards. Because of this, in some cases we had to make assumptions to assess noncompliance; these assumptions are discussed in detail below.

Sites visits to various pool pump retailers/dealers were made throughout California. These provided a snapshot of the inventory available, including model number, speed-type, and horse power rating. During our site visits we recorded 133 pump model numbers. This information is useful. However, it does not verify the motor type since pumps are sold as a unit; motors are only one part of the pump assembly and sourced from original equipment manufacturers (OEMs).

We developed a two-fold approach to assess noncompliance in the absence of a compliance database. First, we had to identify the part number for the motor used in each pump by reviewing the product manual. We found that the majority of all the pump manufacturers had motors made by only one manufacturer. Second, we had to cross-reference the pump motor part number with the motor manufacturer stock number.

One problem with this method is that not all pump motor part numbers were in the motor manufacturer's database. Also, characteristics of the motors are generally not disclosed without cross-referencing to secondary data such as *Motor-Master* and this source is not completely up to date or complete. The motor manufacturers, however, typically do provide notation for their energy-efficient models by classing them as "conservationist" motors, capacitor run, and these meet the standards. However, in cases where the notation is not present it is possible that the motor still may or may not meet the standards. Overall, then we had to apply four general assumptions to assess noncompliance:

[35] Codes and Standards Enhancement Initiative For PY2004: Title 20 Standards Development Analysis of Standards Options For Residential Pool Pumps, Motors, and Controls.

1) To remain conservative, all motors found without specific energy-efficiency notation by the motor manufacturers are considered capacitor start motors and, therefore, not compliant with the standard.

2) Where pump motor part numbers contain numbers very similar to the available motor manufacturers' list, the motor type is assumed to be the same.

3) For some pumps, certain similarities in the model numbers occurred that appeared to be related to energy efficiency. For example, "EE" was in the motor part number for some units labeled "conservationist" and we assumed that this meant "energy efficient" and extended this assumption to other motors that were not found in a manufacturer's motor list.

4) All dual-speed (or variable speed) motors meet the standard.

The validity of several of these assumptions were confirmed during phone interviews after our assessment began. To obtain this type of information, we contacted a range of market actors knowledgeable about pool pumps.

Our initial data were collected through a combination of site visits (5) and phone calls (6) to 11 pool pump business locations, distributed as shown in Table 32. One additional phone call was made to obtain information of relative to statewide data.

Table 32. Residential Pool Pumps, Number of Outlets Contacted by Region and Stratum

Stratum	Northern	Southern	Central
Small	2	2	2
Large	2	2	1

The small businesses were distributed uniformly across the three regions. The larger companies visited have multiple locations throughout California. These companies distribute and install their products across the state. The large stratum businesses represent only two different companies, although we visited six different locations for them.

During our site visits, we recorded all of their display or inventory pool pump model numbers. As stated before, 133 different model number were recorded. However, since there was overlap in the models carried among the different sites, we actually recorded a total of 214 pool pump models.

After we recorded the pump model number at each site, we found the corresponding motor ID number in manuals we obtained from the manufacturers. As noted above, we then cross-referenced that ID number to the motor manufacture stock information to verify motor type and assess noncompliance with the standard. Table 33 summarizes the information collected on pool pump models; the distribution of motor types; how many required application of one or more of the assumptions described above to determine noncompliance; and the assumptions that were applied.

Table 33. Site Visit Summery of Pool Pump Models and Assumptions Made

Motor Type	Number of Pool Pump Models	Number Determined Using Assumptions	Assumptions Applied
Capacitor Start	43	28	1, 2
Capacitor Run / Other	127	77	2, 3
Dual Speed	25	25	4
Not Found	19	0	-
Total	214	130	-

1=No energy-efficiency notation found
2=Motor number similar to number of known motor
3=Part of motor number indicated compliance in known motor
4=Dual (or variable) speed motor

Of the total recorded, 19 pool pump models were not found in any reference base and we were unable to apply any of our assumptions other than to be conservative and assume these models do not comply. We note that it is likely that a significant share of the pumps found during our visits were stock left over from 2005 and were not required to comply with the new standard.

A lack of consistent and complete information provided by the businesses during the site visits made it necessary to make follow-up calls to fill some gaps, clarify some of the information, and obtain sales data. Out of the 11 surveyed locations there are eight different companies represented. We visited all 11 sites and contacted the eight companies by phone.

Overall Noncompliance

We calculated overall weighted noncompliance using two approaches; one used the site visit model data and the other incorporated the sales information obtained through the follow-up phone survey. It is important to note that two to three months elapsed between the time the site visits and phone surveys were conducted, so the compliance picture would be expected to change and improve based on the phone survey information.

The model-based noncompliance rates from the site visits were weighted to reflect the two strata that were established during our site selection process. This resulted in an overall noncompliance rate of 25%, as presented in Table 34.

Table 34. Pool Pumps: Site Survey Model Number Noncompliance

Strata	Weights	Original Noncompliance	Weighted Noncompliance	Final Product Noncompliance
Small	0.547	34%	19%	25%
Large	0.453	14%	6%	

The noncompliance rates for those companies from which we were able to obtain additional information during the follow-up phone survey were also weighted to reflect the two strata. This resulted in an overall noncompliance rate of 15%, as presented in Table 35.

Table 35. Pool Pumps: Follow-Up Phone Survey Top Sales Noncompliance

Strata	Weights	Original Noncompliance	Weighted Noncompliance	Final Product Noncompliance
Small	0.547	16%	9%	15%
Large	0.453	13%	6%	

We believe the sales-weighted estimate is the more accurate of the two estimates because it takes into account the sales volume for different models. It shows that the noncompliance rate for small businesses is very similar to the rate for large businesses. It may also reflect the decrease in noncompliance rate that was expected over time since these data were collected later in the year.

- Our final estimate of overall noncompliance for pool pumps is 15%.

This is a conservative estimate because of our assumptions about compliance. The main factor was the assumption that units did not comply if we were unable to find product information. This occurred most often when respondents provided sales information for the top sellers and lumped all other units together without providing model numbers.

Given the data available, we assign a medium level of certainty to our final noncompliance estimate. Certainty was increased because the data were drawn from a reasonably large sample of suppliers and they were distributed throughout California. Additionally, there were partial sales data available and the results were quite consistent across sites. Uncertainties resulted from the sales data provided by respondents being in terms of percent of total sales so it was not possible to adjust for total sales volume. Also, the sales data were best estimates by the respondents rather than documented counts. However, the data provided, and the anecdotal information from the respondents, suggested that this market was approaching a very high level of compliance and it was just a matter of time until inventory of non-complying units was sold off and noncompliance would approach 0%.

General Service Incandescent Lamps

Included in this standard are non-reflectorized, medium screw-based, incandescent lamps that are intended for general applications. Specifically, A-lamps, PS-lamps, and halogen BT and MB-lamps that are rated between 25 and 150 Watts and are full spectrum, vibration service, or "soft white" lamps are included. Lamps that are excluded from this standard include rough service, decorative, 3-way, and colored styles.

Site Visits and Data Collection

In total, we conducted site visits to nine businesses distributed throughout California . Most were identified through the business database that was purchased. Sites were selected randomly and supplemented during our data collection trip by opportunistic drop-ins at other stores.

Of the stores visited, we categorized six as large businesses and three as small. Table 36 shows the regions and strata in which these businesses were located.

Table 36. General Service Incandescent Lamps: Number of Businesses Contacted by Region and Stratum

Stratum	Northern	Southern	Central
Small	0	1	2
Large	2	2	2

When we conducted our site visits, no manufacturers had submitted their compliance information so no CEC database was available for this product. The standard is written in terms of allowable wattage for a given lumen output. To check noncompliance, we recorded the two characteristics during our site visits that we needed, labeled lumen and rated wattage, for the purpose of applying the formulas established by the standard:

1. Frost or Clear: Max. Watts=(0.05*lumens)+21
2. Soft White: Max. Watts=(0.05*lumens)+22.5

In addition, product model numbers, inventory counts, and some sales data were recorded during the site visits. Unfortunately, lamp type such as "soft white," "rough-service," "frost," or "clear" was not recorded consistently while on site. This information is needed to ascertain whether the standard applies and, if so, which specific formula must be met. We were able to use internet research using product model numbers to fill in much of this missing information.

Due to the gaps and inconsistencies in the information provided by the businesses during the site visits, follow-up calls were made to each of the sites in an effort to supplement the original information. The staff we were able to reach often did not have the information we were seeking. This may be due, in part, to the fact that most of the businesses selected for site visits were large, retail chains with corporate offices that had the required data, but may not have even been located in California.

Noncompliance Analysis Methodology

A multi-step process was developed for the purpose of determining compliance based on lumen and wattage ratings. First, the recorded lumen value for each lamp was input into the calculation specified for Frost or Clear type lamps, which was the stricter of the two formulas set forth in the standard. If the recorded wattage was found to be less than the maximum allowed, as determined by the formula, then the lamp was considered compliant whether it was Frost/Clear or Soft White.[36]

If the recorded wattage was found to be greater than the wattage allowed, then the recorded lumen value was input into the formula for Soft White type lamps. If the recorded wattage was

[36] It is important to note that since we did not have complete information on lamp type, it was possible that some lamps that passed this test were of a type not required to meet the standard. By potentially including some of these lamps in our calculation, the compliance rate could be overstated. On the other hand, if some of these lamps were not required to meet the standard, but did anyway, then these products were more efficient than required by the standard.

less than the maximum allowed for this style of lamp then it was treated as *possibly* compliant since we did not know from the data collected at this point whether the lamp was, in fact, Soft White. For those that met the Soft White criterion only, additional research was necessary in order to determine whether or not the lamp in question was of the Soft White style. For those that were found to be noncompliant with the Soft White formula, further research was necessary to ascertain whether the lamp was actually excluded from the standard. To address both these issues, internet research was conducted using the model numbers that were collected on-site. In many instances, this research provided enough information to determine compliance or noncompliance, or to exclude the lamp from the analysis.

Overall Noncompliance

We estimated overall noncompliance in two ways. First, we used the model counts alone. Second, we used the inventory or sales data to estimate the noncompliance rate and calculated the rate both with and without weights for the two size strata we defined.

As shown in Table 37, we identified a total of 280 individual model numbers. Using the procedure described earlier, 138 of the lamps were found to be compliant, leaving 142 lamps that might be compliant under the soft white standard, or that did not meet the criteria set forth in the standard. Of these, it was not possible to determine compliance for 37 and 23 were not covered by the standard. Next, we used the model numbers to calculate the noncompliance rate for only those sites where we had inventory data. Finally, noncompliance was calculated based on the raw inventory counts. The estimated noncompliance rates varied from 26% to 37% using these three methods.

Table 37. General Service Incandescent Lamps: Unweighted Noncompliance Estimates

Data Used	Total Count	Met Standard	Noncompliant	Excluded	Unidentified	Adjusted Count	Noncompliance %
Total Models	280	138	82	23	37	220	37%
Only Models with Inventory Data	179	88	32	22	37	120	27%
Inventory	11,295	5,793	1,999	1,192	2,311	7,792	26%
*Inventory counts were not performed at two sites.							

Next, using the noncompliance rates for those seven sites for which inventory counts were available, the data were weighted to reflect the two size strata established during the initial site selection process.[37] These results are presented in Table 38.

- Our final estimate of overall noncompliance for general service incandescent lamps is 27%.

[37] We did not use the sales data that were available because reliable data were available for only one store.

Table 38. General Service Incandescent Lamps
Weighted Noncompliance Estimates

Strata	Weights	Original Noncompliance	Weighted Noncompliance	Final Product Noncompliance
Small	0.31	31%	10%	27%
Large	0.69	24%	17%	

We assign a medium level of certainty to this estimate. Noncompliance rates calculated for individual stores using the different methods we applied ranged from 14% to 80%, but most were clustered between 20% and 40%. The sample we selected was randomly chosen and represented all areas of the state. A reasonable number of stores was included in both the large and small strata. Compliance was easy to determine from the watt and lumen ratings, but there were some difficulties determining which standard, if any, applied since we did not always have the lamp type information available. Although sales data were not typically available, inventory appeared to be a good proxy for sales volume since there was considerable turnover in the store stocks and it would be reasonable to stock lamps based on expected sales volume.

Metal Halide Luminaires

A metal halide luminaire is comprised of two components – the lamp (or bulb) and the ballast. Metal halide lamps are a type of high-intensity discharge (HID) lamp that generally offer longer lamp life and energy efficiency[38]. Metal halide lamps require a ballast to operate. The 2006 California standard requires that vertically mounted metal halide luminaires rated at 150 to 500 watts contain pulse-start lamps and ballasts, and not a probe-start ballast.

Data Collection and Noncompliance Assessment Approach

Noncompliance assessment proved to be the most challenging for these products. There was no existing compliance database of certified metal halide luminaires available to determine compliance so we had to directly seek information about individual products.

The assessment of noncompliance was complicated by the fact that the market for metal halides includes new construction, major renovation, and retrofit applications. In retrofits, the choice is to replace an existing lamp or replace the entire luminaire; given cost considerations, purchasers are likely to replace existing probe-start lamps (or ballasts) rather than purchase a whole new luminaire. Since the standard applies to the whole luminaire, penetration in the retrofit market will probably be relatively low. Given the size of the retrofit market for lamps, probe-start lamps and ballasts will likely continue to be sold for some time. This complicates assessment of compliance with the new standard since vendors will carry probe-start equipment until demand drops off. Consequently, though we found it was possible to obtain information on the

[38] Reference material regarding metal halide lamps was found from the National Lighting Product Information Program at the Lighting Research Center: www.lrc.rpi.edu/programs/nlpip/lightingAnswers/mwmhl/abstract.asp

availability of pulse-start lamps and ballasts as individual components, such data provided little information about compliance with the standard for luminaires.

In addition, identifying either a pulse-start lamp or ballast does not guarantee that it will be used in a pulse-start luminaire. We found some lamp information that clearly stated the lamp had to be used with a pulse-start ballast, but this was not always the case.

According to the retail sites we visited for this study, the majority of their sales is comprised of the lamp alone. In a few cases, retailers sell metal halide "kits" with both elements of the luminaire. One respondent observed that the life-time expectancy of a ballast is 5 to 10 times greater than it is for a lamp so lamps are replaced and purchased with much greater frequency than the ballasts.

We conducted site visits to eight lighting supply stores to collect data on metal halides and supplemented these data with telephone interviews. Given the difficulty of obtaining useful information on entire luminaires, we also conducted subsequent telephone interviews with manufacturing companies and electrical distributors. Our team supplemented this data collection with product research.

Confirming our expectations, all of the retail and distribution contacts reported that the majority of their sales were derived from replacement bulbs – only a small percentage of sales was comprised of ballast sales or from the sales of metal halide luminaires.

Information from our site visits and vendor phone calls is presented below. Given the limitations of the available data and information, we report on our findings for lamps, ballasts, and, where possible, the luminaires. Pertinent findings from the interviews of manufacturers and other industry experts are reported in the Expert Interview section.

Site Visit Information

The field team visited eight different locations throughout the state, as detailed in Table 39. The businesses visited were primarily retail stores. We categorized the stores as either small or large depending on the number of employees (large companies refer to those with more than 50 employees). The large stores that were visited included five different home improvement/hardware stores. As described later, however, the most useful information was gathered through subsequent phone calls.

Table 39. Metal Halide Site Visits by Region and Stratum

Stratum	Northern	Central	Southern
Small	0	1	1
Large	2	2	2

Sixty distinct metal halide lamps with unique brand and model numbers were observed in the field. Of these, the standard was not applicable to 10; two of these were for a horizontal base position and an additional eight were for fixtures of less of than 150 watts. For the majority of

the lamps observed, however, it was not possible to determine if they would be installed in a compliant ballast or not – no conclusion could therefore be made about their final compliance. As noted earlier, however, some lamps are designed specifically for pulse-start applications, such as Philips MS175 BU PS, or Philips lamps with model numbers beginning in MHC or MHS[39]. However in most cases, the model number alone cannot provide this information. Nor does the model number necessarily indicate the orientation of the lamp upon application.

Expert Interviews

In addition to the retail site visits, the project team also interviewed a number of lighting manufacturers, manufacturer representatives, electrical distributors and other lighting industry specialists. These included one lighting manufacturer, one ballast manufacturer, two manufacturer representatives, two electrical distributors, and a specialist from the Lighting Research Center at Rensselaer Polytechnic Institute.

The answers received from electrical distributors and lighting specialists varied. In general, the manufacturers were less familiar with sales specific to the state of California, whereas the distributors were more focused on a given territory.

When asked about sales in California, one electrical distributor reported that his company sells approximately 500 metal halide luminaires annually. He stated that approximately 20% of these include a pulse-start ballast, but he did not specify the share among vertical mount units.

Another lighting distributor reported that 60% to 70% of the metal halide luminaires that he sells in the state of California are pulse-start luminaires. He further reported that for vertical orientation applications the pulse-start share was in the range of 80% to 100%.

A manufacturer's representative who sells predominately in the state of California reported that "most if not all" of the metal halide fixtures that they sell are pulse-start. "In the last two years, this is becoming the standard." He further stated that even the lower end (i.e., less expensive models) are now pulse-start. Metal halide fixtures with pulse-start ballasts continue to be more expensive, but that the price difference has become smaller in recent years. For a $530 fixture, for example, the cost of including a pulse-start ballast is $19 (approximately a 3.5% increase in cost).

According to another lighting manufacturer, metal halide luminaires that his company currently sells across the country are predominately probe-start. He reported that the most commonly sold metal halide fixture in North America is a 400 watt probe-start. Somewhat in contrast to what the other manufacturer representative said, he stated that while the pulse-start technology is about 15 years old, the price differential between pulse-start and probe-start ballasts continues to be a deterrent to their sales. This same expert estimated that the price difference between pulse-start and a probe-start luminaires ranges from 20% to 50%, depending upon the size and features of a given luminaire.

[39] Interview with Philips Lighting representative October 12, 2006.

Importantly, this respondent noted that a change in the California market has occurred as a direct result of the new standards. His company no longer provides non-pulse-start ballast fixtures for sale in the state. He also predicted that the market share in North America for pulse-start ballasts will grow, as other states follow California's lead.

The president of a lighting manufacturing company commented that more than 60% of his company's 2005-06 sales in California were supported by utility incentives (across all categories). He noted that there is a current trend that is increasing the popularity of electronic HID lamps. He reported that this trend is being positively influenced by increased investments in energy-efficient products, an increased number of products, utility subsidies, and actions such as California's standards.

Overall Noncompliance

Unfortunately, collecting the needed data to assess noncompliance of metal halide luminaires through site visits proved to not be very productive. This effort was complicated by the factors stated earlier. Consequently, we took several steps to obtain supplemental information, but these were only marginally productive since sales and inventory data were lacking. There were qualitative indications that the market was reacting to the standard. The lighting and ballast manufacturers interviewed were aware of and said they had responded to the new Title 20.

To derive an estimate of overall luminaire noncompliance, we relied on the information provided through the three expert interviews cited above. Table 40 summarizes this information. These responses were interpreted conservatively and then averaged.

- Our final estimate of overall noncompliance for metal halide luminaires is 37%.

Table 40. Metal Halide Luminaire Noncompliance Estimates

Source	Compliance Description	Inferred Noncompliance
Distributor 1	20% of all luminaires	80%
Distributor 2	80% to 90% of vertical mount luminaires	15%
Manufacturer	"Most, if not all"	15%
Average		37%

We assess the certainty level of this estimate as low. This is because of the lack of field data, sales information, and industry quantitative estimates of compliance. Despite the degree of uncertainty in this estimate, we believe the information from the industry showed there was a growing knowledge of the standard and awareness of trends toward pulse-start units.

Given the lack of conclusive information we were able to gather on noncompliance of this product, we recommend that subsequent research and interviews focus more directly on electrical distributors and possibly lighting contractors who install luminaires. The co-existence of probe- and pulse-start equipment is likely to persist for some time as existing probe-start

lamps and ballasts are replaced when they fail; this will continue to make it difficult to assess compliance of the luminaires covered by the new standard. Once the industry has submitted certification information and a compliance database has been assembled, however, this task should become more straightforward.

Walk-In Refrigerators/Freezers

The appliance standard for walk-in refrigerators and walk-in freezers (WIRF) does not require labeling and, since they are usually custom built, the standard is not performance-based as it is for several other appliances. Instead, there are prescriptive requirements for individual components of walk-in refrigerators and walk-in freezers. The 2006 Title 20 standard for WIRF are summarized in Table 41.

Table 41. Title 20 Standards for Walk-in Refrigerators and Walk-in Freezers

Motor Type	Required Components
All	Automatic door closers that firmly close for all doors, except doors that are larger than 4 feet wide or 7 feet tall.
All	Refrigerator envelope insulation > R-28
All	Freezer envelope insulation > R-36
Condenser Fan Motors < 1 HP	One of the following: Electrically commutated motors Permanent split capacitor-type motors Polyphase motors > ½ HP Motors of equivalent efficiency as determined by the Executive Director
Single-phase Evaporator Fan Motors < 1 HP and < 460 Volts	One of the following: Electronically commutated motors Permanent split capacitor-type motors

Data Collection and Methodology

There was no compliance database available for WIRF and, given the custom nature of individual units, it is unlikely one could be compiled. Our methodology for collecting and analyzing noncompliance data was two-fold. First, we made an initial contact with businesses that offer walk-ins throughout the state, either by phone or site visit. Second, a follow-up call was performed to obtain sales data and compliance information.

Collecting data from California businesses that offer WIRF proved to be difficult since they do not carry inventory and almost all walk-ins are custom order so there are no model numbers to verify. In the few cases where non-custom designs (standard sized units) were sold, the products were not in stock and were still considered a special order. Even in the case of these standardized units, it was very difficult to confirm that all the components comply to the standard.

Seven locations were contacted by phone initially and eight were contacted in the follow-up calls, as shown in Table 42. The eighth location was chosen after the initial calls since we wanted to diversify the feedback across the state.

Table 42. Walk-in Refrigerators/Freezers, Outlets Contacted by Region and Stratum

Stratum	Northern	Southern	Central
Small	1[1]	2[2]	2
Large	0	2	1

[1] This eighth company was contacted during the follow-up calls and was not a part of the initial site survey. It was added to ensure that we had a business located in the northern region.
[2] One location in this region was head-quartered out of the state, but distributes to southern California. Phone surveys, initial and follow-up, were to the headquarters.

A lack of consistent information provided by the businesses during the initial contact made it necessary to make follow-up calls. This was done to verify and supplement the original information requested as well as gather additional information. Again, however, contacts were unable to provide very complete information. In the end, noncompliance was assessed based on feedback from contacted businesses that were either retailers, distributors, or manufacturers. Sales data were recorded whenever possible for each business.

Overall Noncompliance

A summary of the sales and noncompliance information is presented in Table 43. For those sites that were directly involved in sales or distribution of WIRF in California and had some experience selling units in 2006, the respondents all indicated that compliance was 100% and, therefore, noncompliance was 0%.

Table 43. WIRF Summary of Sales and Noncompliance by Site

Site	Strata	Region	Estimated Annual Sales	Noncompliance Based on Respondent Feedback
1	Small	Southern	-	0%
2	Small	Southern	24	N/A
3	Small	Central	20	0%
4	Small	Central	-	N/A
5	Small	Northern	50	0%
6	Large	Southern	1	N/A
7	Large	Southern	85	0%
8	Large	Central	2	0%

Since nearly all orders are custom and the vendors and distributors do not have an inventory, there are no older, non-complying units in the pipeline for sale in 2006. It is the responsibility of the distributor or vendor to order units and the manufacturer to comply with the new standard. As one respondent noted, if a manufacturer was not able to comply with the 2006 standard in time, they would not provide price quotes.

- Our final estimate of overall noncompliance for walk-in refrigerators and freezers is 0%.

We assign a medium certainty level to this noncompliance estimate. Although most respondents demonstrated a good understanding of the requirements of the standard and consistently said that compliance was 100%, we were unable to obtain any independent evidence of the compliance level. Such evidence would probably have to come from observing actual units delivered to customers this year or examining specifications and order sheets. None of this information was available to us for this study.

Pre-Rinse Spray Valves

The pre-rinse spray valve is a handheld device that uses a spray of water to remove food waste from dishes prior to cleaning in a commercial dishwasher. Pre-rinse spray valves consist of a spray nozzle, a squeeze lever that controls the water flow, and a dish guard bumper. The new California standard requires all pre-rinse spray valves that are manufactured after January 1, 2006, to have a maximum flow rate of 1.6 gallons per minute (gpm) at 60 psi and a cleanability average of 30 seconds or less per plate. Models may include a spray handle clip, allowing the user to lock the lever in the full spray position for continual use.

No CEC database listing complying models was available when we conducted our research. However, according to one source the following models are considered to meet all the new standards:[40]

- Encore KN50-Y002-12
- Fisher Ultra-Spray 2949
- Krowne Metal Water Saver 21-129
- Niagara N2180
- Strahman Kwik-Clean II
- T&S B-0107
- T&S B-0107-C
- T&S Equip 5SV
- T&S JetSpray B-0108
- T&S JetSpray B-0108-C

Data Collection Methods

The project team conducted site visits to outlets in all three areas of California. During the site visits, they attempted to collect model numbers, brand names, inventory, manufacture dates, and any sales volume information available to them. This research was conducted in restaurant supply retail stores in person. Site visit information was also supplemented by subsequent telephone interviews.

During the site visits, we discovered that some units were integrated into an entire fixture (usually for residential applications), so we did not record information for these units since there was nothing available specific to the spray valves. In most cases, the team recorded model

[40] http://www.fishnick.com/saveenergy/sprayvalves/

numbers, brand names, and flow rate; we also attempted to collect sales volume and manufacture date.

In most cases, however, the manufacture dates and flow rates were not available on the product packaging. The team completed follow-up telephone inquiries to the manufacturer to attempt to collect this information. The team also experienced complications in some cases as a result of limited cooperation from the retail stores' employees who were not able or willing to share sales information or who could not accurately identify the specifics of a given spray valve.

Our team was able to identify six specific pre-rinse spray valve units. Of the six observed, four complied and two did not.

Sales Information Gathered

Site visit locations were gathered from commercially available retail and distribution lists, and various internet resources including two internet sites: Google.com and Local.com. Stores were divided into two strata based on the number of employees at a given location. Stores with less than 20 employees at a location were classified as small; stores with 20 or more employees were classified as large.

In total, 14 businesses were successfully contacted by our field technicians for this product. Table 44 indicates the regions and strata represented. Of the total, we conducted site visits to 13 and collected information by phone from one site. We note, however, that useful data were available for only 11 of the sites because the other three did not sell the spray valve separately.

Table 44. Pre-rinse Spray Valves: Location of Sites Visited or Called

Strata	Northern	Southern	Central	Total
Small	3	2	4	9
Large	2	2	1	5

Summary information is provided in Table 45 for the spray valves found in the field. Fisher models 2990 (noncompliant) and 2949 (compliant) were the most commonly stocked models . However the demand for model 2990 has dwindled since the start of 2006. A total of five of the fourteen site visit locations sold Fisher's model 2990. According to Fisher, the company stopped manufacturing this product as of January 1, 2006, due to the improved efficiency of other Fisher models. Therefore, four out of the five locations that were distributing the 2990 are now trying to sell out any that remain in stock. More efficient models include the Fisher 2949 or the Franklin 1111032 model. Based on the flow rate specifications for these units, both of these models meet California's new efficiency standards, as seen in the table below. We obtained the flow rates using a comprehensive search of product catalogs, websites, and other sources.

Table 45. Compliance of Pre-rinse Spray Valve Models at Contacted Sites

# of Stores that Stock Model	Manufacturer	Model Number	Flow Rate (gpm/psi)	Compliance Status
1	Blanco	157084ST	2.2 gpm at 60 psi	Noncompliant
5	Fisher	2990	2.65 gpm at 80 psi	Noncompliant
8	Fisher	2949	1.15 gpm at 60 psi	Compliant
1	Fisher	2210WB	1.6 gpm at 60 psi	Compliant
1	Franklin	1111032	1.42 gpm at 60 psi	Compliant
1	T&S	B-0107	1.6 gpm at 60 psi	Compliant

*Number of stores that stock models field may add up to more than total sites because some of these models were carried by multiple stores.

Noncompliance Rate

Table 46 summarizes compliance, sales, and inventory data gathered from the sites we included in our sample. To estimate the noncompliance rate, we used all information in the table for those stores where both inventory and estimated unit sales data were available. Noncompliance rates were calculated separately for outlets in the small and large strata. Within each stratum, we multiplied the number of units sold per month times the percent of the inventory units that did not comply. These values were totaled and divided by the number of units sold to calculate the average noncompliance within a stratum.

For the small stores, our estimated noncompliance rate was 11%. For large stores, it was 1%. The higher rate for the small stores was probably due in part to the lower turnover rate in inventory that would clear out older, non-complying units. Consequently, our noncompliance rate estimate for small stores may be an overestimate. The overall noncompliance rate was then calculated by weighting the rate for the small and large strata based on the data we had for the number of employees at sites within each strata.

Table 46. Noncompliance of Models Available at Sampled Stores*

Site	Strata Classification	Compliant Model(s) Observed	Compliant Model Inventory	Noncompliant Model(s) Observed	Noncompliant Model Inventory	% of Stock Comprised of Noncompliant Models	Approximate Units Sold per Month
1	Small	-	-	Blanco: 157084ST	1	100%	-
2	Small	-	-	Fisher: 2990	1	100%	2
3	Small	Fisher: 2210WB	15	-	-	0%	20
4	Small	Fisher: 2949; Franklin: 1111032	Special Order, none in stock	Fisher: 2990	Special order, none in stock	37%	-
5	Small	Fisher: 2949	22	Fisher: 2990	24	50%	5
6	Small	Fisher: 2949	3	-	-	0%	4
7	Small	Fisher: 2949	12	-	-	0%	12
8	Large	Fisher: 2949; T&S: B-0107	22; 17	-	-	0%	40
9	Large	Fisher: 2949	10	-	-	0%	35
10	Large	Fisher: 2949	Special order, none in stock	Fisher: 2990	Special order, none in stock	50%	-
11	Large	Fisher: 2949	5	Fisher: 2990	1	50%	3

*As noted in text, we were unable to determine noncompliance levels at three stores included in our sample because they sold only units that had spray valves built into the fixture and no information was available for the spray valves separately.

- Our final estimate of overall noncompliance for pre-rinse spray valves was 4.2%.

We believe this estimate has a high level of certainty. This is our assessment for several reasons. For one, the sample we selected was randomly chosen and represented all areas of the state. Though the number of stores included was not large, they were well distributed geographically and in terms of size. There is little uncertainty about noncompliance since it is determined primarily by the flow rate, which we were able to document for each model. Finally, our discussions with industry representatives indicated that they were knowledgeable about the new requirements and most were in the process of clearing their inventory of units that did not comply.

Nonresidential Duct Heaters and Unit Furnaces

The new Title 20 standards for these units require power venting or automatic flue dampers along with specific efficiency levels as shown in Table 22. The unit heater is a space heater with sizes ranging from 25,000 Btu to 6,000,000 Btu per hour. Typically, these units are installed in ceiling mounted locations used primarily to heat industrial and commercial buildings. Previous Title 20 standards have effectively required that all natural gas fired models have an intermittent ignition device. Duct furnaces are similar but the fan or blower is provided separately. Duct furnaces are available in sizes ranging from 56,000 to 1,200,000 Btu per hour.

Data Collection and Methodology

Upon reviewing the purchased company database, it was determined that most of the companies listed in the furnace category were vendors of residential equipment. Consequently, we decided that phone calls would be placed with equipment manufacturers for the purpose of collecting contact information for distributors of duct heaters and unit furnaces. Since this occurred while the site visits were in progress and an agreement had been reached regarding the collection of data via phone calls, a decision was made to contact these distributors by phone. Due to the manufacturers referral, the distributors were generally helpful over the phone in providing the necessary information.

In total, nine businesses were successfully contacted by phone for this product. Table 47 shows the regions and strata in which the outlets were located.

Table 47. Unit Heaters and Duct Furnaces: Number of Outlets Contacted by Region and Stratum

Stratum	Northern	Southern	Central
Small	1	2	1
Large	2	2	1

A CEC database was available for this product; therefore, model numbers were analyzed according to the methodology described previously for products in a compliance database. We counted a total of 631 models sold by the nine businesses contacted with the initial calls.

Due to the lack of consistent information provided by the businesses during the initial contact, secondary calls were made to each of the sites to supplement the original information. Generally, contacts were unable to identify top sellers among the list of identified models. For this product, model numbers frequently represent Btu output and it was observed by multiple contacts that customers purchase specific models based on the amount of heat that is required for the situation. Consequently, some contacts were able to identify common sizes, though not specific models, that they believed were more likely to sell than others.

Noncompliance Results

For the benefit of future studies, we note that deriving an overall compliance/noncompliance rate estimate for this product was very challenging for several reasons. For one, sales and inventory data were very hard to obtain and, in the end, useful quantitative data were available for only a small number of sites. This made it difficult to properly weight the responses from individual sites. Second, most businesses we contacted said they carried a single brand so there was little diversity in the units carried by each site. Third, only a few manufacturers had listed their products with the CEC as certified, but because units were not listed did not necessarily mean they did not comply with the requirements of the standard. Fourth, there were significant changes in some cases between what we observed during site visits and what we were told during follow-up phone calls. This may have been due to businesses responding to the standard or changing their product lines for other reasons, or respondents' lacking the information required to provide the needed data.

Table 48 summarizes the data and noncompliance estimates for each of the nine sites included in our study. The table indicates whether sales or inventory data were available at each business. For those where no sales or inventory data were available, the noncompliance estimate is based directly on the percent of the model numbers that did not comply. Where sales or inventory data were available, we used that information to estimate noncompliance if it was sufficient. The noncompliance rates appeared to be bimodal—either the rate was close to 100% or it was in the 20% to 40% range.

To develop an overall noncompliance estimate, we elected to use the most reliable data available. The sites for which no sales or inventory data were available were excluded since it was not possible to know how much they might affect the average noncompliance rate. We included the most conservative estimate for those sites where we had at least some information on sales, including top-selling models. The sites excluded from our estimate were 1 and 2 shown in Table 48. We took the average of the values remaining for each stratum, and then weighted the average noncompliance rates for small and large businesses using the weights calculated initially. The results are shown in Table 49.

- Our final estimate of overall noncompliance for duct furnaces and unit heaters is 44%.

Table 48. Summary of Unit Heater and Duct Furnace Noncompliance Estimates Using Sales or Inventory Data Where Possible

Site	Stratum	Inventory Data?	Sales Data?	Noncompliance	Comments
1	Small	No	No	100%	
3	Small	No	Identified best selling models, but not quantities	21%	Based on model counts of top-selling units
5	Small	Yes	No	36%	Based on inventory
6	Small	No	Identified best selling models, but not quantities	45%	Based on model counts of top-selling units Using total model counts gives 28%.
8	Small	No	Partial	100%	Two identified as top sellers.
2	Large	No	No	100%	
4	Large	No	Only for best selling model	50%	Used estimate based on model count of top-selling units. Using total model count gives 25%; using count based on best-selling size, noncompliance is close to 0%.
7	Large	No	Yes	36%	Based on sales data. Estimate based on model count was 31%.
9	Large	No	No	98%	Estimate based on model count.

Table 49. Unit Heaters/Duct Furnaces Weighted Noncompliance Estimate

Strata	Weights	Original Noncompliance	Weighted Noncompliance	Final Product Noncompliance
Small	0.126	50%	6.3%	44%
Large	0.874	43%	38%	

In general, we attempted to be conservative in calculating this estimate. One reason it is conservative is that we determined compliance based strictly on whether a model was included in the CEC database. We did not assess the compliance of models that were not listed in the database so some of them might meet the standard's requirements, even though the manufacturer had not supplied the necessary information to the CEC. In addition, we used conservative assumptions and choices when calculating the noncompliance rates for individual sites. We note that representatives of two major manufacturers (see Chapter 0) indicated during the exercise to estimate naturally occurring market adoption that the industry had already moved toward technologies that would comply with the standard. However, it is important to note that our screening to eliminate observations where we had no sales or inventory data at all led to dropping two sites with very high noncompliance estimates (because available models were not in the CEC database).

Given the data available from these sites, we assign a low level of certainty to our final noncompliance estimate. The largest uncertainties resulted from the lack of sales data that would

have allowed us, at a minimum, to weight the noncompliance rates for individual sites. As Table 48 shows, there is a large variation in the estimated noncompliance rates. If sales volumes had been available by site it would have been possible to weight the noncompliance values at each site to get a more accurate average rate.

Refrigerated Beverage Vending Machines

The 2006 California standard for refrigerated beverage vending machines sets a maximum daily kWh consumption that is determined by the following formula:

$$\text{Max daily kWh} = 0.55*(8.66+(.009*C))$$

where C = capacity based on the number of 12 oz. cans unit holds

According to a representative from one supplier, the machines that they sell typically hold 620 cans. Therefore, a machine with that capacity would be required to consume no more than 7.83 kWh per day.

Methods for reducing the energy use of these units include approaches such as equipping them with programmable thermostats that allow the machine to automatically adjust their temperature and lighting controls depending upon the time of day. Refrigerated beverage vending machines are included in a CEC compliance database so we were able to use that information to assess compliance and noncompliance.

Data Collection Methodology

Beverage vending machine companies were initially identified from purchased contact lists. Six businesses that sell beverage vending machines were identified for data collection in northern and southern California. None of the businesses contacted in central California agreed to a visit. Site visits were conducted to the six companies and they were also contacted via telephone following the initial site visit to collect sales information.

Our purchased list contained other businesses that turned out to be either repair and service or leasing companies and were therefore not included. Table 50 provides the distribution of these businesses by strata and region.

Table 50. Contacts for Refrigerated Beverage Vending Machines

Strata	Northern	Southern
Small	2	1
Large	2	1

Overall Noncompliance

Of the complete set of observed models, 14 are products listed in the CEC database. Table 51 shows the distribution of models found to be compliant and those that were not.

Table 51. Refrigerated Beverage Vending Machines: Models Found in Database

Total Models Identified	In Database	Not In Database	% Noncompliant based on Database
33	14	19	58%

We determined the overall noncompliance rate by calculating the weighted average for the two size strata using the model counts. For the each size stratum, we calculated the noncompliance rate by totaling up the number of non-complying and total units across all the members of that group. Using the findings from this sample set of six locations, the final noncompliance rate for refrigerated beverage vending machines was determined as shown in Table 52. The final noncompliance rate is determined by taking the sum of the weighted noncompliance rates for each stratum.

Table 52. Weighted Noncompliance – Refrigerated Vending Machines

Strata	Weights	Original Noncompliance	Weighted Noncompliance	Final Product Noncompliance
Small	0.123	33%	4%	63%
Large	0.877	67%	59%	

We were unable to make adjustments for inventory or sales since only one site provided any useful information. It is worth noting that the noncompliance rate for the one site where stock data were obtained decreased significantly when this information was incorporated in the analysis. However, given that one of the small and large businesses had no complying models at all suggested that having stock data would not have decreased the overall noncompliance estimate very much.

- Our final estimate of overall noncompliance for refrigerated vending machines is 63%.

This estimate is probably conservative since it was likely that not all complying models had been submitted to the CEC for inclusion in the compliance database. Supporting evidence for this was that one contact indicated the models they sold met Energy Star requirements, which would have made them compliant with the California standard. Nevertheless, the units were not yet listed in the compliance database and a preliminary review of the Energy Star compliance list did not show some of the models.

Given the relatively small sample size, and the lack of comprehensive sales and stock information provided by the contacted beverage vending machine companies, the final product noncompliance rate is stated with a low level of certainty.

This report was designed to review noncompliance levels among companies that sell refrigerated vending machines. Many of the refrigerated vending machines in service in California are leased rather than purchased. While beyond the scope of this study, it may be a valuable exercise to review noncompliance rates among leased machine vendors as well.

6. Adjustments to Savings Estimate Spreadsheet

Our analyses provide revised estimates of three key inputs to the spreadsheet for each Title 20 efficient appliance and Title 24 building measure studied. First, we estimated the initial market penetration for each appliance and measure using the approach described in Chapter 0. Second, the naturally occurring market adoption rate over time for each appliance and measure was estimated using the same methodology. Third, Quantec estimated the initial non-compliance rate for a selected set of appliances and building measures covered by the new standards. The approach and detailed findings for building measures and appliances are presented in Chapters 1 and 5, respectively. The results of these analyses are summarized below.

In each research area, we learned valuable lessons about the methodology that should be useful in future studies. This chapter ends with a summary of the lessons learned and our recommendations for future research.

Initial Penetration and Naturally Occurring Market Adoption

We revised the standard Bass curve equation presented earlier to the following form:

$$F(t) = \frac{(1 - e^{-(p+q)t})}{(1 + (q/p)e^{-(p+q)t})} \times Max$$

where

$F(t)$ = the market penetration in year t (%),

p = coefficient of leading behavior (innovation),

q = coefficient of following behavior (imitation),

Max = maximum penetration rate (%)

t = elapsed time from initial market presence.

Table 53 summarizes the results of these analyses. For each high efficiency measure and appliance, the table shows the year from which the adoption curve analysis starts. These dates were derived for each measure and appliance as described earlier and represent the point in time when the item was beginning to have a commercially available presence in the market. Next, the estimated values of the variables shown in the equation above are presented. The 2006 estimated market penetration based on the adoption curve is then shown. Finally, the estimated naturally occurring market adoption rates are shown for two representative years, 2015 and 2030.

Out of all the items analyzed, only one—general service incandescents—presented modeling difficulties. Consequently, the values shown for this product in the table should be used only to estimate naturally occurring market adoption from 2006 on.[41]

Table 53. Initial Market Penetration and Naturally Occurring Adoption Results

Title 20 and 24 Measures and Appliances	Market Introduction Year	Adoption Curve Coefficients			Initial Market Penetration 2006, %	Naturally Occurring Market Adoption, %	
		p	q	Max, %		2015	2030
Hardwired lighting, new residential	2000	0.0122	0.2131	57	8	35	56
Lighting controls under skylights, new	2000	0.00863	0.3026	51	7	38	51
Duct improvement, residential existing	1990	0.01050	0.1819	19	10	17	19
Ducts, nonresidential existing	1990	0.00129	0.1571	23	2	7	19
Consumer electronics-TVs	2000	0.07250	0.1698	83	41	76	83
Consumer electronics-DVDs	2000	0.03150	0.3283	61	24	58	61
Consumer electronics-audio players	2000	0.08170	0.1566	50	26	46	50
Residential pool pumps, 2-speed, Tier II	1995	0.00451	0.2346	33	6	23	33
Pulse start metal halides	1992	0.01720	0.1403	58	26	46	57
General service incandescents[1]	1970	0.055	0.01	53	47	50	52
Commercial dishwasher spray valves	1985	0.00735	0.1303	53	25	41	51
Unit heaters/duct furnaces	1965	0.00990	0.0632	69	50	58	65

[1] See discussion in text about the use of these values.

To update the Savings Estimate Spreadsheet, both the initial penetration rates and annual naturally occurring market adoption rates can be obtained from this analysis. We note that the

[41] As noted previously, the estimates of naturally occurring market adoption provided by respondents for this product differed greatly. When we attempted to use our methodology to develop a curve to fit the average response over the time period it did not converge because of the behavior of the average curve in the period close to introduction in 1970. As a result, we developed a curve that fit the average of the responses closely from 2006 on so this curve should not be used to try to estimate naturally occurring adoption for earlier periods.

current Savings Estimate Spreadsheet has embedded in the initial gross energy savings values the effect of initial market penetration that was estimated during the development of the new standards. Therefore, the initial penetration rates presented in Table 53 will have to be applied to modify the gross savings estimate appropriately. Given this, we recommend that the Saving Spreadsheet be modified in two ways. The gross savings in the Spreadsheet should be changed to the value reflecting no initial market penetration. Second, the estimated initial market penetration should be added to the Spreadsheet as factor to adjust the gross savings. With these changes, the Spreadsheet can be updated easily and transparently as new data become available about market penetration and changes in the gross savings potential.

Noncompliance Rates

A summary of our estimated noncompliance rates is presented in Table 54. The estimated rates are shown for each appliance and building measure we analyzed. In addition, the table presents an assessment of the certainty level that applies to each estimate.

Table 54. Noncompliance Rates

Appliance or Building Measure	Estimated noncompliance rate	Certainty level of estimate*
Appliances		
Televisions	41%	Medium
DVD Players	57%	Medium
Residential Pool Pumps, Tier 1	15%	Medium
General Service Incandescents, Tier 1	27%	Medium
Metal Halide Luminaires	37%	Low
Walk-in Refrigerators/ Freezers	0%	Medium
Pre-rinse Spray Valves	4.2%	High
Unit Heaters and Duct Furnaces	44%	Low
Refrigerated Canned/Bottled Beverage Vending Machines	63%	Low
Residential Building Measures		
Ducts	73%	± 0.9%
Hardwired lighting	28%	± 3%
Windows	68%	± 7%
Non-residential Building Measures		
Bi-Level	n/a	n/a
Cool Roofs	50%	± 3%
Ducts--New	100%	± 1%
Ducts--Retrofit	100%	± 2%
Skylights	44%	± 10%

* Certainty levels for appliances are qualitative, case-specific judgments; these estimates were based on types of data available, number of observations, and other factors. Building measure certainty levels refer to absolute precision measurements based on the sample size for each measure.

The values presented in Table 54 can be used directly in the Savings Estimate Spreadsheet. It is important to note, however, that these values are empirically derived and apply only to the first year after the standards have gone into effect. The spreadsheet incorporates estimates of noncompliance over the entire forecasting period. The current estimate is a constant of 30% for each appliance and building measure over the period. At this point it is necessary to determine what revisions should be made to the existing Spreadsheet to modify the 30% estimate in future years to take into account the findings from our study.

These new estimates of noncompliance are very useful in two respects. First, they provide the best data available on initial compliance in the market, thus allowing much better estimates of the initial energy savings resulting from the Program . Second, they identify areas in which efforts should be dedicated to improve compliance. The utilities and the CPUC can use this information to examine alternative strategies for reducing noncompliance and can analyze the results by applying the revised Savings Estimate Spreadsheet.

7. Lessons Learned and Recommendations for Future Research

Initial Penetration and Naturally-Occurring Market Adoption

The method we used to estimate initial penetration and naturally-occurring market adoption rates was devised specifically for use in this project, and was applied for the first time here. The cornerstone of our approach was an interactive Web-based tool that industry experts were able to modify in order to draw market adoption curves. As the use of this approach was a pioneering effort, several lessons were learned through the process.

The Value of Pretesting

We employed two pretest rounds to fine-tune the Web tool and research process, which were shown to be critical to the successful implementation of the methodology with the experts. During pretests, we received feedback on the instructional text, screen design, and overall functionality of the tool; these comments were incorporated into subsequent revisions of the tool. The value of pretesting is unquestionable. No such effort should ever be undertaken without as much pretesting as time allows.

Market Start Dates

A key finding in this study area was the importance of estimating realistic market adoption start dates for each measure and appliance. This is critical in creating an accurate adoption curve. We modified our initial respondent recruitment process to include a short survey containing questions about when the efficient appliance or building measure was first substantially present in the market. This could be considered the point in time when the item was considered commercially available. We recommend that future studies also pay close attention to establishing meaningful dates as the starting point of the market adoption curve, and to use a similar approach of soliciting this information from the same experts that will provide market adoption curve inputs.

Participant Recruitment

Overall, we contacted approximately ten potential experts for each one who ultimately provided their adoption curve estimates. In a resource-intensive effort, we employed several techniques to identify potential respondents, including contacting participants in the standards development process, purchasing business contact lists, conducting Web searches, and making numerous phone calls. When we were able to reach a knowledgeable and willing respondent, we used a snowball approach where contacts were asked to recommend others to recruit. Participants also were provided a financial incentive to participate as an inducement to complete the process.

A related issue is that the final number of respondents was relatively small for some measures/appliances, and it was unclear whether some of the experts were knowledgeable enough about the specific markets to provide informed estimates. We did make a concerted effort to ensure that all respondents understood the markets and technologies for which they provided inputs, but the significant differences in some of the estimates suggest that there may have been notable differences in relative knowledge levels.

Timing of Participant Recruitment

To expedite the data collection process, we began contacting experts to recruit them while the Web-based tool was being pretested. This was useful because it allowed us to conduct several activities concurrently, and shorten the schedule for this phase of the project. However, we found that some experts, when initially contacted, expressed an interest and willingness to participate that led them to want to go to the Web site and begin the process right then. However, because the tool was not finalized when recruitment started, several of these interested and willing experts never did complete the exercise because other things intervened in the meantime. In the future, therefore, we recommend that recruitment wait until the data collection instrument is live, so that potential respondents can be directed to the Web site and assisted with the tool if needed.

Data Quality

In reviewing the curves submitted by the experts, there were occasions where it was clear that the participants either did not completely understand the process, or there was a technical problem in capturing their inputs. Because all the inputs were reviewed in batches, occasionally a quality problem was not identified until a few days after the respondent submitted his or her inputs. Although we followed up with the participant in each of these cases, and most were able to revise their estimates, there were a few cases where the respondent never submitted revised data, and was ultimately dropped from the analysis. For future studies, we recommend, as suggested above, that at the time of recruitment, respondents be directed to the Web site and walked through the data entry process with the recruiter. When this is not possible, we recommend that quality reviews be conducted as soon as possible following participant submittals.

In an effort to arrive at refined estimates, we asked respondents to provide feedback on their input relative to the group average adoption curve. However, the scope of this study did not allow us to fully implement a Delphi process in which respondents would be able to revise their inputs, and exchange information about their assessments. We strongly recommend that future efforts fully utilize Delphi, incorporating at least two additional rounds beyond the initial data gathering effort.

Recommendations for Future Research

Given our experiences trying to recruit participants, and the uncertainties around some of the responses we received, we believe there are a number of ways that this process could be improved in the future.

- First, experts should be identified during the standards development process and they should be informed that their input will be required to estimate market trends.

- Second, the amount of the incentive should be increased to provide more motivation for the professionals solicited to invest the time required to participate.

- Third, empirical data on the baseline market should be developed, and then used to provide an anchor point for the experts who will participate in the market estimation exercise.

- Fourth, the process should be expanded to fully implement the Delphi model by conducting one or two additional rounds to allow the respondents a chance to revise their estimates and exchange information on the range of estimates.

Finally, our study proposed employing a method for adjusting the initial penetration and market adoption rates to reflect the effects of utility programs. However, we were unable to find sufficient information on the utility programs to support any adjustment to our estimates. As the number of California program evaluations increases and as the new evaluation protocols are implemented, this should become less of a problem as more of the required data become available on a consistent basis.

Building Standards Noncompliance

Research Process

Each building department is unique, and has its own processes and procedures in place, which results in inconsistencies not only with permitting requirements across the state, but also with the level of access that is granted to the files themselves for the file review. At some building departments, access was denied or significantly restricted. Future research should allow ample time for building department screening and scheduling, permit volume and valuation research, as well as time to navigate a learning curve at each department, as procedures and requirements vary widely between jurisdictions.

Our research revealed that a review of permits, while a good indicator of process compliance with code requirements, was not a consistent indicator of actual installation of compliant measures. For example, the commercial lighting controls under skylights were found to be present and compliant in the permit files the majority of the time, and field inspections confirmed this estimate (46% and 44% noncompliance, respectively). Conversely, commercial cool roofs were found to be almost universally noncompliant through permit review (99%), while field inspections showed a noncompliance rate of only 8%. These examples illustrate that, while one would assume that improved paper compliance equals improved field compliance, that is not always the case. Compliance is highly dependent on the measure, the building department and the local design community. Nonetheless, the more information that is available on all aspects of compliance, the better we will understand how to improve compliance on a measure-by-measure basis .

Compliance Chain

The compliance chain is complex and each link represents potential for compromised energy savings if not executed properly. When code change proposals are initially researched and developed, proper thought must be given to the implementation strategy in light of existing delivery mechanisms (building department permit processes). During and following code adoption, documentation forms must be developed that clearly communicate code requirements, and must tie in directly to the design drawings themselves. During transition, the utilities play an important role in setting the groundwork for successful compliance through their incentive programs and ongoing education and training activities. Implementation largely rests on the building departments; in order to be successful the energy code implementation method must conform to their overall process. Third party rating, verification and commissioning agents also have an important role. Finally, the building industry itself must recognize and embrace code changes in their design and construction practices.

Assigning Noncompliance Rates

Because records of a building department don't always provide a complete and clear path to determining compliance, we used all possible clues from the permit record, building drawings, and existing field conditions to ascertain whether a building project complied with the intent and letter of the code.Each of these steps speaks to the effectiveness of the Codes and Standards Program and the resultant energy savings. The three scores were given to represent the cumulative effect of these stages on code compliance, while also helping to pinpoint areas where the process may be broken.

On one level, assigning noncompliance to each of three phases, process, plan review and field, was a very objective exercise. If the proper documentation was absent from all three phases, then it was determined that energy savings were not achieved. However, we recognize that this methodology has the potential to artificially inflate the level of noncompliance for two reasons:

1) There is a difference between meeting the letter of the code and complying with the intent of the code.

2) It is not always possible to verify product performance in the field absent a certificate or label, although it is possible in some cases for visual clues to provide an indication of compliance, though this is particularly measure dependent.

Another noteworthy finding is that a substantial number of building designers utilize the performance method to document energy compliance, particularly in residential new construction, complex residential additions and large nonresidential buildings. While the base case for the performance method is built on the prescriptive measures, the final design merely has to prove that the energy use is the same or less than a similar building built with the prescriptive measures in place. This comprehensive model provides a measure of overall building compliance (as opposed to individual measure compliance) that would be useful to include in further studies.

In short, although it could be argued that, absent proper code compliance documentation the Codes and Standards Program has not fully reached its objectives, ultimately, energy savings goals are achieved through the correct installation of the measure itself, not from the documentation path. In future studies, we recommend performance modeling to determine levels of whole-building compliance to help provide some insight into the actual energy impacts of permit and process noncompliance, as well as partial compliance.

Future Research

We recommend additional future research to pinpoint and correct flaws in the compliance chain so that energy savings predicted from the codes can be fully realized. Research should be centered around these areas:

Market Behavior. Surveys should be conducted to determine the frequency of permitted vs. nonpermitted construction projects by measure and by jurisdiction to learn more about the penetration levels of the codes and standards. More should be learned about permit volumes relative to number of building projects, and the rationales behind allowing exceptions to some of the codes. Finally, permit data should be collected and reviewed on an ongoing basis.

Building Department Processes and Compliance. Commonalities among the building departments' electronic and paper processes should be identified, understood, and referenced in the development of new codes and standards. Compliance and other implementation forms should fit into existing building department processes, rather than requiring the processes to conform to changes in the code.

End-User Surveys. Building industry professionals, from both the design and build perspectives, hold important insights into the key barriers to implementation of new codes. These barriers may exist on the process and paperwork side of a building project, on a customer satisfaction level, or on a practical installation level. For example, this study found that skylights in >25,000 ft^2 retail space were absent in some cases due to the final end use of that building shell being uncertain (subdivision of the space was likely but undefined, and the installation of drop ceilings was likely). A survey of the end-users of energy efficiency codes, including more field and phone surveys, could serve to illuminate the reasons why compliance with some measure codes are so low. Research of this nature could also help define whether a measure correctly installed in the field can be traced back to the codes and standards efforts. This information would be valuable in the design of training and educational efforts, as well as in the design of future code updates.

Comprehensive Building-Specific Studies. Studies on building performance characterize the market in a more complete way than do measure-specific studies. These types of studies require development and modification of computer models and are time intensive. However, once a certain number of models are created that reflect specific construction types, these models can be used to more accurately predict the benefits arising from the codes and standards and the impact of proper enforcement.

Appliance Standards Noncompliance

Overall, the approach used in this study provided a good snapshot of first-year noncompliance for the appliances studied. We applied an approach of the following steps:

1) Identifying the best point in the supply chain to obtain the necessary data

2) Developing a sample of supply-chain actors stratified by size and distributed throughout California

3) Conducting site visits to document products being sold (supplemented, as needed, by other data sources)

4) Assessing compliance and noncompliance rates for individual sites

5) Aggregating noncompliance estimates to develop a statewide noncompliance rate for each efficient appliance

Compliance Information Gap

Ideally, the compliance databases maintained by the CEC should have been used to identify appliance models that were compliant with the new standards. However, at the time of this study, those databases did not exist for every product, as some manufacturers had not submitted their lists of complying products (due in part to legal challenges made in response to the standards). The methodological complications caused by the missing compliance databases may not recur in the future. However, if this problem persists, the procedures we used to address the issue could be of value to future studies.

As a result of the compliance information gap, we applied alternative approaches to determine compliance rates for the appliances carried by vendors. In most of these cases we recorded the product models in the stores in our sample and then reviewed product documents and catalogs to determine compliance. This significantly increased the effort required, and it was not always possible to find the performance or specification information needed to assess compliance, so some uncertainties were introduced in the results.

Another complication was that it was not possible to determine when the products sold had been manufactured. The standards apply to products manufactured starting in 2007, and Title 20 requires the manufacture date to be displayed on complying products. However, we were not able to find manufacture dates on most of the products we viewed in stores, and it would have been excessively time consuming to try to determine the date through product codes or serial numbers. Lacking this information increased the uncertainty in our noncompliance estimates, and we took that into account in our certainty assessments. For the future, this should be less of an issue as manufacturers provide compliance information and ensure that products carry the manufacture date.

Sample Site Selection

To select our vendor samples for data collection, we purchased a list of California businesses as our main information source. In some cases, however, we found during our visits that the stores were misclassified or did not carry the proper products. Once this problem was encountered we started verifying by telephone that each business actually carried the correct appliances. We recommend for future studies that pre-visit telephone contacts be made, not only to set up site visits, but also to verify that the proper products are carried by the vendors.

In the course of making the phone calls, we determined that some stores were willing and able to provide their product information over the phone, so site visits were not necessary. However, this approach was possible only with stores that carried just a few different models. In future studies, this phone verification approach, where feasible, may function as a viable alternative to site visits, with the quality of the data obtained over the phone verified with site visits on a sampling basis.

Retailer/Wholesaler Cooperation

The responses and cooperation of retailers and wholesalers varied. In general, smaller stores were cooperative, but due to small staff sizes they often could not provide the time required to assist our field staff collect the necessary data. We found that some big box stores were very cooperative and willing to let us review their floor inventory and databases. The letter we obtained from the CPUC describing the study and requesting the stores' cooperation was often helpful, so we recommend that future efforts use a similar approach. Some large retailers were unwilling to cooperate, however, without approval obtained from their corporate offices and, even though we attempted to obtain this approval, it was not possible in all cases. We recommend in similar future studies that researchers contact store representatives a few months prior to data collection, determine whether corporate approval would be required or helpful, and then obtain the necessary contact information.

In general, it was necessary to be flexible in planning and scheduling data collection. Before our field team made site visits, they identified all the sites to be included. However, on some occasions the targeted store did not cooperate when our team arrived. On other occasions (as mentioned earlier), the store did not carry the correct products or was not appropriate for other reasons. Consequently, we used an adaptive approach where our team conducted Web searches for other vendors when they were in a location where it was not possible to meet our desired quota of site visits. We recommend that this option be included in similar future studies.

Use a Flexible Data Collection Approach

There were a few unique situations we encountered that required special approaches. For the metal halide luminaires, we found that there was a lot of information available on metal halide *lamps,* and that a range of stores sold them. However, there was considerably less information available on-line for *luminaires,* and few of the vendors we contacted sold entire luminaires. In this case, distributors, contractors, and manufacturers turned out to be the best sources of information on this product. Adequate attention should be paid to the unique characteristics of

the markets for specific products, and the data collection strategy should be designed with these characteristics in mind.

Appendix A: Adoption Curve Expert Identification and Contact Information

This appendix summarizes information about the process we used to identify, contact, and recruit experts to participate in the naturally-occurring market adoption estimation exercise. This information should be useful for future studies.

Pool Pumps

We began by calling two industry associations: the Association of Pool & Spa Professionals (APSP) and the National Swimming Pool Foundation (NSPF). Within two phone calls we reached a representative from one of the two associations. He forwarded an email to the association members that we prepared describing the nature of the research and the incentives we were offering. Four members replied expressing interest. These replies were forwarded to us, supplying us with contact information. Even though they expressed interest in an email to their association, only three of the four company representatives participated. In some cases only one or two phone calls were required to get the information we needed, while others required several phone calls to reach the right person, and explain the requirements of the research over the phone. The company that did not participate returned one phone call and left a message, but then did not respond to a subsequent call. As marketers or sales managers, these manufacturer representatives were knowledgeable about the pool pump market. Asking some of these experts for distributors they work with resulted in a few phone numbers of contacts, but, unfortunately, no one who ended up participating in the survey.

We found other contacts through persistent calling of numbers found on company websites. Finding major distributors who were interested in participating proved to be difficult. After several phone calls we reached one distributor who agreed to participate.. However, he never responded to the emails or reminder calls. One third of the pool pumps installed pass through one specific chain of stores. However, several calls to this chain resulted in long waits; we left two messages with two different individuals who never responded.

We were able to reach two remaining contacts as a result of calling numerous other pool supply stores and reaching the president/manager of the store. In the end, we made about 40 phone calls and sent many emails, resulting in the participation of five experts.

Incandescent Lamps

Incandescent lamp manufacturing is dominated by three large corporations, GE, Osram Sylvania, and Philips, each of which dwarfs the largest pool pump manufacturers. Consequently, following the strategy outlined above proved to be less effective. Initial calls to the National Electrical Manufacturers Association (NEMA) regional offices were not returned. The national office was initially unresponsive; later in the process we uncovered that the contact person to whom we directed had retired. Later in the process we reached the new official who proved to be helpful.

The American Lighting Association (ALA) representative was also helpful, offering assistance and additional referrals to recommended contacts. However, when we reached the referral contacts, many of them felt they were not qualified, and declined to a participate.

By contacting other consulting firms and people who had worked on the standards, we received referrals to knowledgeable consultants who had not worked on the standards, as well as other engineers within the large manufacturers. Eventually we made contact with the correct parties in the manufacturing association, and we were able to conduct productive discussions. Since there are only three major lighting manufacturers, it was difficult to find more than three independent participants among the companies. Through extensive research on incandescent lamps, we also identified academics who offered advice, and contacts among metal halide manufacturers that we used to research that product.

We were provided contact information for only three distributors, and we attempted to contact them all, but none returned our calls. Overall, at least 40 calls were made to manufacturers, consultants, and distributors, resulting in five contacts who said they would participate.

Metal Halides

We initially had significant difficulties trying to identify and reach industry experts. Searches on the internet resulted in contact phone numbers, but led us only to answering machines, and we received no return phone calls as a result of the messages we left. However, by following a chain of people (including the leads obtained through the research on incandescent lamps) we eventually reached some well-connected consultants who were happy to refer su to a comprehensive list of influential contacts in business and government. These referrals returned calls at a high rate and, in general, were very helpful. Unlike with the larger corporations in the incandescent and consumer electronics industries, in this case executives were more willing to talk about their businesses, and to share their opinions of the future of the market.

After the slow start, 28 calls resulted in six expert contacts who agreed to participate in our research.

Pre-rinse Spray Valves

With only three major spray valve manufacturers, Fisher, Chicago Faucets, T&S Brass and Bronze Works, and each of moderate size, we had to make only a few calls to find an interested, knowledgeable participant at each of the three companies. Unfortunately, one manufacturer who agreed to participate never responded again to repeated phone calls, and a second declined to participate.

It was difficult to identify and reach distributors. We contacted two distributors, and one initially agreed to participate, but then reversed his decision, citing a busy schedule as the reason. We identified one additional expert who was employed by a testing facility, and he agreed to participate. In the end, two experts agreed to participate out of the thirteen that we called.

Consumer Electronics: TVs, DVDs, and Compact Audio Players

Consumer electronics was a difficult market for which to find expert contacts. The manufacturers and distributors all tended to be large multinational corporations with a strong sense of proprietorship over their information. We contacted the Consumer Electronics Association (CEA), but their representative was unwilling to provide assistance in reaching industry experts.

When we called one manufacturer, we were put on hold for 30 minutes without reaching anyone. We were able to obtain additional referrals by reaching a representative of the ENERGY STAR program. While the first set of referrals were duplicates of contacts previously received from a consultant, another person we eventually reached within the same agency gave us a new set of contacts that resulted in some new interested parties.

Without the access afforded by trade groups, however, we were unable to identify engineers and marketers from these corporations who could be helpful. Overall, we placed about 60 phone calls, resulting in four contacts, three of whom were knowledgeable enough to answer questions in all three consumer electronics markets.

Unit Heaters/Duct Furnaces

Unit heaters and duct furnaces form a market that is more accustomed than most others to regulation and market research. Many smaller businesses are run by owners or managers who also handle sales, and have time for little else. Like the distributors and contractors we contacted for other products, these representatives were often unwilling to take the time away from their businesses to participate in our data collection efforts. Despite this, the occasional knowledgeable person was quite forthcoming and interested in this research. While it took a month for the proper people in the professional association to return requests for information, they eventually did offer to help, but by then most contacts had already been made. Approximately 60 calls resulted in six experts who were willing to participate in our research.

Hardwired Residential Lighting

Almost 200 calls were made to various contractors, resulting in six contractors who agreed to participate and provide information about hardwired residential lighting. The vast majority of those called simply felt they did not have any time for questions, and were suspicious of financial inducement, choosing not to participate in anything that took time from their customers. Stated reasons ranged from “trying to run a business, not interested” to the contractor’s only doing commercial hard-wiring. Messages left on voice mail were almost never returned, even messages left with receptionists who sounded very interested.

Daylighting For Commercial Buildings

Unlike the other markets we researched, very few businesses had experience with this standard. Many of the large retailers have their own in-house design team and, like many of the large

corporations previously described, are difficult to reach. Approximately 80 calls were made to various energy management contractors resulting in only one expert in the industry who agreed to participate.

By contacting architectural organizations and contacts made from the lighting market research, we eventually made over 120 calls to find four contacts.

Residential and Commercial HVAC Ducts

Judging from their responses to phone calls asking about their background and suitability for participating in research, HVAC contractors are consistently very busy. We had problems similar to those described earlier about the hardwired lighting market. We made more than 100 calls that resulted in ten experts who agreed to participate. Unfortunately, of the ten who initially agreed, only three participated when the survey requests were presented to them.

Appendix B: Appliance Noncompliance Site-by-Site Information

This appendix presents the information collected from each site for the appliances included in the noncompliance analysis.

Televisions

Site-by-site information is presented below for sources providing data on televisions.

Site 1

This business operates in Northern California, and was designated as a member of the large stratum under the previously defined classification system. Our site visit identified 83 unique model numbers for multiple brands available from this outlet. Of these model numbers, 22 were found in the database. (See Table 55)

Table 55. Televisions: Products in CEC Database - Site 1

Unique Models Identified	Models Found in Database	Models Not Found in Database	% in Database
83	22	61	27%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 2

This company operates in Southern California, and was designated as a large business. Our site visit identified 153 unique model numbers for multiple brands available from this company. Of these model numbers, 57 were found in the database. (See Table 56)

Table 56. Televisions: Products in CEC Database - Site 2

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
153	57	96	37%

While on site, an inventory was recorded for each of the model numbers. As a result, compliance based on inventory was estimated as presented in Table 57. Sales data were not available at this location.

Table 57. Televisions: Inventory Compliance - Site 2

Total Inventory	Compliant	Not Compliant	% Compliant
432	207	225	48%

Site 3

This company operates in Central California, and was categorized as large. Our site visit identified 175 unique model numbers for multiple brands available from this company. Of these model numbers, 64 were found in the database. (See Table 58)

Table 58. Televisions: Products in CEC Database - Site 3

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
175	64	111	37%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 4

This company operates in Central California, and was designated as a member of the large stratum. Our site visit identified 115 unique model numbers for multiple brands available at this location. Of these model numbers, 76 were found in the database. (See Table 59)

Table 59. Televisions: Products in CEC Database - Site 4

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
115	76	39	66%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 5

This company operates in Northern California, and was a large business. Our site visit identified 102 unique model numbers for multiple brands available from this company. Of these model numbers, 57 were found in the database. (See Table 60.)

Table 60. Televisions: Products in CEC Database - Site 5

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
102	57	45	56%

The retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 6

This company operates in Southern California, and was designated as a large business. Our site visit identified 134 unique model numbers for multiple brands available from this company. Of these model numbers, 81 were found in the database. (See Table 61)

Table 61. Televisions: Products in CEC Database - Site 6

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
134	81	53	60%

While on site, an inventory was recorded for each of the model numbers. As a result, we were able to estimate compliance based on inventory as presented in Table 62. Sales data were not available at this location.

Table 62. Televisions: Inventory Compliance - Site 6

Total Inventory	Compliant	Not Compliant	% Compliant
473	320	153	68%

Site 7

This company operates in Southern California and it was defined as a large business. Our site visit identified 40 unique model numbers for multiple brands available from this company. Of these model numbers, 11 were found in the database. (See Table 63.)

Table 63. Televisions: Products in CEC Database - Site 7

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
40	11	29	28%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 8

This company operates in Central California, and was designated as a member of the small stratum under our classification system. Our site visit identified three unique model numbers for multiple brands available from this company. Of these model numbers, all were found in the database. (See Table 64)

Table 64. Televisions: Products in CEC Database - Site 8

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
3	3	0	100%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 9

This company operates in Northern California, and was designated as a small business. Our site visit identified six unique model numbers for multiple brands available from this company. The data are summarized in Table 65.

Table 65. Televisions: Products in CEC Database - Site 9

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
6	0	6	0%

Due to security concerns, the retailer did not permit an inventory count of these products. However, it was estimated that 36 of each model was sold annually, totaling 216 televisions sold each year. Because none of these models were found in the database, the sales-based compliance was also 0%, as shown in Table 66.

Table 66. Televisions: Sales Compliance - Site 9

Total Annual Sales	Compliant Sales/Year	% Compliant Sales
216	0	0%

Site 10

This company operates in Northern California, and was designated as a small business. Our site visit identified four unique model numbers for multiple brands available from this company. Of these model numbers, one was found in the database. (See Table 67.)

Table 67. Televisions: Products in CEC Database - Site 10

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
4	1	3	25%

While on site, an inventory was recorded for each of the model numbers. The inventory-based compliance estimate is presented in Table 68. Sales data was not available at this location.

Table 68. Televisions: Inventory Compliance - Site 10

Total Inventory	Compliant	Not Compliant	% Compliant
12	3	9	25%

Site 11

This business operates in Central California, and was designated as a member of the small stratum under the previously defined classification system. Our site visit identified three unique model numbers for multiple brands available from this company. Of these model numbers, one was found in the database. (See Table 69)

Table 69. Televisions: Products in CEC Database - Site 11

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
3	1	2	33%

Due to security concerns, the retailer did not permit an inventory count of these products. However, it was estimated that 120 of each model was sold annually, totaling 360 televisions sold each year. Because only one of these models was found in the database, it was possible to estimate the sales-based compliance as shown in Table 70.

Table 70. Televisions: Sales Compliance - Site 11

Total Annual Sales	Compliant Sales/Year	% Compliant Sales
360	120	33%

Site 12

This company operates in Southern California, and was designated as a member of the small stratum under our classification system. The site visit identified 48 unique model numbers for multiple brands available from this company. Of these model numbers, 27 were found in the database. (See Table 71)

Table 71. Televisions: Products in CEC Database - Site 12

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
48	27	21	56%

While on site, the inventory was recorded for each of the model numbers. As a result, compliance based on inventory can be estimated at 60%, as presented in Table 72.

Table 72. Televisions: Inventory Compliance - Site 12

Total Inventory	Compliant	Not Compliant	% Compliant
2,026	1,214	812	60%

It should be noted that of the 48 unique models that were identified, two models with a total of 46 units, were reported as having been discontinued. Removing these discontinued items from the analysis results in a compliance rate of 59% based on model numbers, and 61% based on inventory.

Sales data were not available at this location.

Site 13

This company operates in Northern California, and was designated as a small business. Our site visit identified 10 unique model numbers for multiple brands available from this company. Of these model numbers, two were found in the database. (See Table 73)

Table 73. Televisions: Products in CEC Database - Site 13

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
10	2	8	20%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

DVDs

Site-by-site results are presented below for DVDs.

Site 1

This company operates in Northern California, and was designated as a member of the large stratum under the previously defined classification system. Our site visit identified 22 unique model numbers for multiple brands available from this company. Of these model numbers, eight were found in the database. (See Table 74)

Table 74. DVDs: Products in CEC Database - Site 1

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
22	8	14	36%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 2

This company operates in Southern California, and was a large business. Our site visit identified 59 unique model numbers for multiple brands available from this company. Of these model numbers, 16 were found in the database. (See Table 75)

Table 75. DVDs: Products in CEC Database - Site 2

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
59	16	43	27%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 3

This company operates in Central California, and was designated a large business. Our site visit identified 57 unique model numbers this business carried. Of these model numbers, 15 were found in the database. (See Table 76)

Table 76. DVDs: Products in CEC Database - Site 3

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
57	15	42	26%

While on site, an inventory was recorded for each of the model numbers. As a result, we estimated compliance based on the inventory count as presented in Table 77. Sales data were not available at this location.

Table 77. DVDs: Inventory Compliance - Site 3

Total Inventory	Compliant	Not Compliant	% Compliant
44	18	26	41%

Site 4

This company operates in Southern California, and was designated as a large business. Our site visit identified 95 unique model numbers for multiple brands available from this company. Of these model numbers, 20 were found in the database. (See Table 78)

Table 78. DVDs: Products in CEC Database - Site 4

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
95	20	75	21%

While on site, the inventory was recorded for each of the model numbers. This allowed us to estimate based on the inventory as presented in Table 79. Sales data were not available at this location.

Table 79. DVDs: Inventory Compliance - Site 4

Total Inventory	Compliant	Not Compliant	% Compliant
338	82	256	24%

Site 5

This company operates in Central California, and is a large business. Our site visit identified 42 unique model numbers available from this company. Of these model numbers, 13 were found in the database. (See Table 80)

Table 80. DVDs: Products in CEC Database - Site 5

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
42	13	29	31%

While on site, an inventory was recorded for each of the model numbers. We used the inventory data to estimate compliance as presented in Table 81. Sales data were not available at this location.

Table 81. DVDs: Inventory Compliance - Site 5

Total Inventory	Compliant	Not Compliant	% Compliant
74	28	46	38%

Site 6

This company operates in Northern California, and was designated as a large business under the previously defined classification system. Our site visit identified 35 unique model numbers for multiple brands available from this company. Of these model numbers, 15 were found in the database. (See Table 82)

Table 82. DVDs: Products in CEC Database - Site 6

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
35	15	20	43%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 7

This company operates in Southern California, and was designated as a large business. Our site visit identified 31 unique model numbers for multiple brands available from this company. Of these model numbers, 15 were found in the database. (See Table 83)

Table 83. DVDs: Products in CEC Database - Site 7

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
31	15	16	48%

While on site, the inventory was recorded for each of the model numbers. We used the inventory data to estimate compliance as shown in Table 84. Sales data were not available at this location.

Table 84. DVDs: Inventory Compliance - Site 7

Total Inventory	Compliant	Not Compliant	% Compliant
98	52	46	53%

Site 8

This company operates in Southern California, and was a large business. Our site visit identified 38 unique model numbers available from this company. Of these model numbers, 11 were found in the database. (See Table 85)

Table 85. DVDs: Products in CEC Database - Site 8

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
38	11	27	29%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 9

This company operates in Central California, and was a small business. Our site visit identified five unique model numbers for multiple brands available from this company. Of these model numbers, two were found in the database. (See Table 86)

Table 86. DVDs: Products in CEC Database - Site 9

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
5	2	3	40%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 10

This company operates in Northern California, and was designated as a small business under the previously defined classification system. Our site visit identified eight unique model numbers for multiple brands available from this company. Of these model numbers, two 2 were found in the database. (See Table 87)

Table 87. DVDs: Products in CEC Database - Site 10

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
8	2	6	25%

Due to security concerns, the retailer did not permit an inventory count of these products. However, it was estimated that 12 of each model were sold annually, totaling 96 DVDs sold each year. We used these sales estimates, and the fact that only two models were found in the database, to estimate sales-based compliance as shown in Table 88.

Table 88. DVDs: Sales Compliance - Site 10

Total Annual Sales	Compliant Sales/Year	% Compliant Sales
96	24	25%

It should be noted that of the 8 unique models that were identified, 2 models were reported as having been discontinued. As with the other models, each of these were estimated to sell at the rate of 12 per year. Removing these discontinued items from the analysis results in a compliance rate of 33% based on model numbers, and 33% based on sales.

Site 11

This company operates in Northern California, and was designated as a member of the small stratum under the previously defined classification system. Our site visit identified 11 unique

model numbers for multiple brands available from this company. Of these model numbers, 3 were found in the database. (See Table 89)

Table 89. DVDs: Products in CEC Database - Site 11

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
11	3	8	27%

While on site, we recorded an inventory for each of the model numbers. As a result, compliance based on inventory can be estimated at 27%, as presented in Table 90. Sales data were not available at this location.

Table 90. DVDs: Inventory Compliance - Site 11

Total Inventory	Compliant	Not Compliant	% Compliant
33	9	24	27%

Site 12

This company operates in Central California, and was categorized as small. Our site visit identified eight unique model numbers for multiple brands available from this company. Of these model numbers, three were found in the database. (See Table 91)

Table 91. DVDs: Products in CEC Database - Site 12

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
8	3	5	38%

Complete sales data were not provided by this retailer. Instead, the contact was able to attribute 90% of the company's DVD sales to the eight unique model numbers that were recorded, and provided the percentage of annual sales attributable to those specific models as shown in Table 92. Using this information, 39% of the company's annual sales are compliant, 51% are not, and 10% are models for which we had no information. Table 93 presents the same data, but adjusted by excluding the 10% of sales for which no model information or compliance data were available.

Table 92. DVDs: Sales Compliance, % of Sales - Site 12

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Unknown
Compliant		9%			15%	15%			10%
Non Compliant	9%		9%	9%			9%	15%	

Table 93. DVDs: Sales Compliance, % of Sales Adjusted – Site 12

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Compliant		10%			16.7%	16.7%		
Non Compliant	10%		10%	10%			10%	16.7%

Site 13

This company operates in Southern California, and was designated as a small business. Our site visit identified nine unique model numbers for multiple brands available from this company. Of these model numbers, three were found in the database. (See Table 94)

Table 94. DVDs: Products in CEC Database - Site 13

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
9	3	6	33%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 14

This company operates in Southern California, and was categorized as a small business. Our site visit identified 15 unique model numbers for multiple brands available from this company. Of these model numbers, thee were found in the database. (See Table 95)

Table 95. DVDs: Products in CEC Database - Site 13

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
15	3	12	20%

Due to security concerns, the retailer did not permit an inventory count of these products. Sales data were also unavailable.

Site 15

This company operates in Southern California, and was designated as a member of the small stratum. Our site visit identified 13 unique model numbers for multiple brands available from this company. Of these model numbers, eight were found in the database. (See Table 96)

Table 96. DVDs: Products in CEC Database - Site 11

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
13	8	5	62%

While on site, an inventory count was recorded for each of the model numbers. As a result, compliance based on inventory was estimated as presented in Table 97.

Table 97. DVDs: Inventory Compliance - Site 15

Total Inventory	Compliant	Not Compliant	% Compliant
547	398	149	73%

It should be noted that of the 13 unique models that were identified, one was reported as having been discontinued. Twelve of these units were in stock. Removing these discontinued items from the analysis results in a compliance rate of 67% based on model numbers, and 74% based on inventory. Sales data were not available at this location.

Residential Pool Pumps

The results of our site visits and follow-up calls are presented by site below.

Site 1

This company operates in Southern California, and was designated as a small business under our previously defined classification system. Data collected during the site visit included 35 model numbers on the shelf. Table 98 shows product compliance based on the model numbers that were recorded on site; note that the percent compliant value includes the Not Found (unidentified motor types) units and treats them as noncompliant. We use this approach in the remaining assessments for pool pumps.

Table 98. Pool Pumps: Model Number Compliance – Site 1

Total Models	Capacitor-Run (Compliant)	Dual-Speed (Compliant)	Capacitor-Start (Not Compliant)	Not Found (Not Compliant)	% Compliant
35	10	8	15	2	51%

While neither sales data nor a full inventory count were provided during the site visit, a follow-up call was performed to gather sales information of the top sellers. Table 99 provides the compliance rate based on sales information for the top sellers. In this table and all similar tables for this product, we make the conservative assumption that none of the units that are not top sellers comply. The resulting estimate is considerably higher than the value based on a count of the models available and shows the importance for this product of weighting by sales.

Table 99. Pool Pumps: Top Sales Compliance – Site 1

Top Seller	Compli-ant (Y/N)?	% of Total Sales	Estimated Annual Sales of the Top Sellers	Compliance Based on Complying Top Sellers
Whisper Flow ¾ HP (WFE3)	Y	80%	31	95%
Whisper Flow 1HP (WFE4)	Y	15%		
Everything Else (Not Top Sellers)	N	5%		

During the follow-up call, the contact stated that their company always recommends energy-efficient pool-pump models. They encourage customers to downsize from their old pumps and argue that pump capacity (flow rate) and energy-efficient design are better now than for older pumps.

Site 2

This company operates in Southern California, and was designated as a small business under our system. Data collected during site visits included 24 model numbers on the shelf at this location. Table 100 shows product compliance based on the model numbers that were recorded on site.

Table 100. Pool Pumps: Model Number Compliance – Site 2

Total Models	Capacitor-Run (Compliant)	Dual-Speed (Compliant)	Capacitor-Start (Not Compliant)	Not Found (Not Compliant)	% Compliant
24	20	0	3	1	83%

While sales data were not provided during the site visit and a full inventory count was not available, a follow-up call was performed to gather sales information for the top sellers. After repeated phone calls, however, this respondent would not agree to provide sales information. The only information relayed was manufacturers of units sold: Pentair Whisper Flow and Hayward TriStar. This information was verified during the site visit.

Site 3

This company operates in Central California, and was designated as small. Data collected during the site visit included six model numbers on the shelf. Table 101 shows product compliance based on the model numbers that were recorded on site.

Table 101. Pool Pumps: Model Number Compliance – Site 3

Total Models	Capacitor-Run (Compliant)	Dual-Speed (Compliant)	Capacitor-Start (Not Compliant)	Not Found (Not Compliant)	% Compliant
6	5	0	0	1	83%

We made a follow-up call to obtain sales data. Table 102 presents the compliance estimate based on data for the top sellers. The respondent stated that 95% to 100% of all pool pumps were the top three Hayward models (¾, 1, and 1½ HP). According to the respondent, all pumps they sold were considered to be energy-efficient and were manufactured by Hayward. To be conservative, however, we assume that those for which we had no specific information did not meet the standard. This estimate is higher than the value based on model count alone.

Table 102: Pool Pumps: Top Sales Compliance – Site 3

Top Seller	Compliant (Y/N)?	% of Total Sales	Estimated Annual Sales of the Top Sellers	Compliance Based on Complying Top Sellers
Hayward ¾ HP (SP3007EEAZ)	Y	40%	150	95%
Hayward 1HP (SP3010EEAZ)	Y	30%		
Hayward 1½ HP (SP3015EEAZ)	Y	25%		
Everything Else (Not Top Sellers)	N	5%		

Site 4

This company operates in Central California, and was classified as small. Data collected during a site visit included five model numbers on the shelf at this location. Table 103 shows product compliance based on the model numbers that were recorded on site.

Table 103. Pool Pumps: Model Number Compliance – Site 4

Total Models	Capacitor-Run (Compliant)	Dual-Speed (Compliant)	Capacitor-Start (Not Compliant)	Not Found (Not Compliant)	% Compliant
5	4	0	0	1	80%

To supplement this information we conducted a follow-up call to obtain sales data. Table 104 shows the compliance data based on sales information for the top sellers. The 90% compliance rate is a little larger than the value based on the model count alone.

Table 104. Pool Pumps: Top Sales Compliance – Site 4

Top Seller	Compl-iant (Y/N)?	% of Total Sales	Estimated Annual Sales of the Top Sellers	Compliance Based on Complying Top Sellers
Whisper Flow ¾ HP (WFE3)	Y	80%	35	90%
Whisper Flow 1HP (WFE4)	Y	10%		
Everything Else (Not Top Sellers)	N	10%		

The respondent stated that 95% of all pool pumps were Pentair Whisper Flow, and that all Whisper Flow pumps sold are considered to be energy-efficient. However, this claim was not adequate to determine that they complied with the Title 20 standards, so we assumed that all units other than the top two sellers were not compliant.

Site 5

This business operates in Northern California, and was designated as small. Data collected during our site visit included seven model numbers on the shelf at this location. Table 105 shows product compliance based on the model numbers that were recorded on site.

Table 105. Pool Pumps: Model Number Compliance – Site 5

Total Models	Capacitor-Run (Compliant)	Dual-Speed (Compliant)	Capacitor-Start (Not Compliant)	Not Found (Not Compliant)	% Compliant
7	6	0	1	0	86%

To supplement data collected on site, we made a follow-up phone call to obtain sales data. Table 106 shows the estimated compliance rate based on information provided for the top sellers at this site. Using this approach as well as the conservative assumption that all units that were not top sellers did not comply with the standard, leads to a 50% compliance rate estimate, which is considerably less than the value estimated from model numbers alone. Using this conservative assumption clearly understates compliance, since we determined from the model number review that an additional three models sold at this site complied with the standard. During our phone interview, the respondent stated that the company sells only energy-efficient models manufactured by Pentair and Sta-Rite.[42] To be consistent with our other analyses, we calculated the sales weighted compliance estimate by assuming that all units for which no sales information was provided do not comply with the standard, with the proviso that this estimate is likely to be very conservative.

[42] Pentair recently bought Sta-Rite and the two companies have merged.

Table 106. Pool Pumps: Top Sales Compliance – Site 5

Top Seller	Compl-iant (Y/N)?	% of Total Sales	Estimated Annual Sales of the Top Sellers	Compliance Based on Complying Top Sellers
Whisper Flow ¾ HP (WFE3)	Y	20%	45	50%
MaxPro ¾ HP (Sta-Rite)	Y	15%		
Whisper Flow ½ HP (WFE2)	Y	15%		
Everything Else (Not Top Sellers)	N	50%		

Site 6

This company operates in Northern California, and was designated as small under our classification system. Data collected during site visits included 74 model numbers on the shelf. Table 107 shows product compliance based on the model numbers that were recorded on site.

Table 107. Pool Pumps: Model Number Compliance – Site 6

Total Models	Capacitor-Run (Compliant)	Dual-Speed (Compliant)	Capacitor-Start (Not Compliant)	Not Found (Not Compliant)	% Compliant
74	35	12	19	8	64%

Since sales data were not gathered during the site visit, a follow-up call was performed to obtain sales information for the top sellers. Table 106 shows the compliance rate estimate based on these data.

Table 108. Pool Pumps: Top Sales Compliance – Site 5

Top Seller	Compl-iant (Y/N)?	% of Total Sales	Estimated Annual Sales of the Top Sellers	Compliance Based on Complying Top Sellers
Whisper Flow ¾ HP (WFE3)	Y	90%	-	90%
Everything Else (Not Top Sellers)	N	10%		

The respondent did not know the annual units sold of any model, but he did state that Pentair Whisper Flow pumps account for 95% of their pool pumps sold. They are phasing out older Sta-Rite pumps for the newer Pentair Whisper Flow pumps (as noted earlier these two companies have merged). According to the respondent, motors from older pump models are being replaced with more energy-efficient motors. He stated that roughly 40% of the models will be replaced with more energy-efficient motors. This is consistent with our site visit data, which showed that 36% of the pool pump models found at this site did not comply with the new standards.

Sites 7 and 8

This company operates throughout California and was designated as a large business. Two locations were visited in our site survey; one in southern and one in northern California. Data

collected during the site visits included a total of 51 model numbers on the shelves of these locations. Table 109 presents the product compliance information based on the model numbers that were recorded on site.

Table 109. Pool Pumps: Model Number Compliance – Sites 7 and 8

	Models	Capacitor-Run (Compliant)	Dual-Speed (Compliant)	Capacitor-Start (Not Compliant)	Not Found (Not Compliant)	% Compliant
Site 7 (N)	33	22	5	3	3	82%
Site 8 (S)	18	14	0	2	2	78%
Total	51	36	5	5	5	80%

No sales data were obtained during the site visits so we performed a follow-up call to gather sales information of the top sellers. Table 110 shows the compliance rate information based on sales data for the top sellers. As in most other cases, the sales weighted compliance estimate exceeds the estimate based on model numbers alone.

Table 110. Pool Pumps: Top Sales Compliance – Sites 7 and 8

Top Seller	Compl-iant (Y/N)?	% of Total Sales	Estimated Annual Sales of the Top Sellers	Compliance Based on Complying Top Sellers
Whisper Flow 2 HP (WFE8)	Y	40%	1600	95%
Whisper Flow 1½ HP (WFE6)	Y	30%		
Whisper Flow 1 HP (WFE4)	Y	20%		
Hayward 2 HP (Super-2)	Y	5%		
Everything Else (Not Top Sellers)	N	5%		

Note: Sales estimates are based on data provided for one location.

This company is a distributor supplying contractors and representatives at various locations throughout California. Currently, Pentair Whisper Flow pumps are most common, and comprise 90% of pumps sold. For these sites, the top three Whisper Flow models constitute roughly 1,500 unit sales annually, and all comply with the new standards.

Sites 9, 10, and 11

This company operates throughout California and was designated as a large business. Three locations were visited in the site survey, one in each of the three geographic regions. Data collected during the three site visits included a total of 12 model numbers on the shelves of these locations. Table 111 presents our product compliance estimate based on the model numbers that were recorded on site.

Table 111. Pool Pumps: Model Number Compliance – Sites 9, 10, 11

	Models	Capacitor-Run (Compliant)	Dual-Speed (Compliant)	Capacitor-Start (Not Compliant)	Not Found (Not Compliant)	% Compliant
Site 9 (N)	4	4	0	0	0	100%
Site 10 (C)	4	4	0	0	0	100%
Site 11 (S)	4	3	0	0	1	75%
Total	12	11	0	0	1	92%

We supplemented our site visit data by conducting a phone interview to obtain sales information for the top sellers. The respondent was able to provide sales shares for only one of the sites, and could provide no total sales volumes. We used this information to estimate compliance shown in Table 112. The respondent stated that units in the Hayward RS series were the best sellers and all Hayward RS pumps have energy-efficient motors. However, we were unable to find information on the smallest (1/2 horsepower) model and, to be conservative, assumed that it did not comply.

Table 112. Pool Pumps: Top Sales Compliance – Sites 9, 10, 11

Top Seller	Compl-iant (Y/N)	% of Total Sales	Estimated Annual Sales of the Top Sellers	Compliance Based on Complying Top Sellers
Hayward ¾ HP (RS 750)	Y	45%	75	79%
Hayward 1 HP (RS 1000)	Y	23%		
Hayward 2 HP (RS 2000)	Y	11%		
Hayward ½ HP (RS 500)	N	11%		
Everything Else (Not Top Sellers)	N	10%		

Note: The sales information was only available at one location.

This particular company plans to switch motor manufacturers for their pool pumps. According to the respondent, the current motor is considered to be energy efficient, but another company's motors provide even better efficiency overall.

General Service Incandescent Lamps

General service incandescent lamp data collection and results are presented for each site below.

Site 1

This retail company is located within central California, and was designated as a small business under our previously defined classification system. Data collected during site visits included nine unique model numbers available from this location. Of these model numbers, it was found that seven were compliant under the Frost/Clear or Soft White standard, one was not required to meet the standard, and none were unidentified. Table 113 shows product compliance based on the model numbers that were recorded on site; note that the percent compliance value does not include the excluded or unidentified products.

Table 113. General Service Incandescent: Model Number Compliance – Site 1

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
9	7	1	1	0	88%

An inventory count was not performed at this location. When we made follow-up calls in an effort to supplement the data we originally collected, the contact was unwilling to provide an inventory count. However, this contact was able to estimate the company's annual lamp sales at approximately 10,000 lamps/year, and identified three particular wattages, 60, 75, and 40 as being the most popular. There were some inconsistencies between information provided by phone and from our site visit that cast some doubt upon the accuracy of the data that were provided by phone.

Site 2

This retail company is located within central California, and was designated as a small business. Data collected during site visits included 92 unique model numbers in stock at this location. Of these model numbers, it was found that 43 were compliant under the Frost/Clear or Soft White standard, none were excluded from the standard, and none were unidentified. Table 114 shows product compliance based on the model numbers that were recorded on site; as before, the compliance percent does not include the excluded or unidentified products.

Table 114. General Service Incandescent: Model Number Compliance – Site 2

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
92	43	49	0	0	47%

An inventory count was not performed at this location. When follow-up calls were made to supplement the site data, the contact was unwilling to provide an inventory count. However, this contact was able to estimate the company's annual lamp sales at approximately 66,000 lamps/year based on monthly estimates, and identified the 60 Watt lamps as the most popular. From the list of models that had been provided, 19 were found to be 60 Watts. Of these only three were compliant; therefore, of the top selling lamps, a very conservative estimate of compliance would be 16%.

Site 3

This retail company is located within central California, and was designated as large under our classification system. Data collected during site visits included 22 unique model numbers in stock. Of these model numbers, it was found that nine were compliant under the Frost/Clear or Soft White standard, none were excluded from the standard, and seven were unidentified. Table 115 shows product compliance based on the model numbers that were recorded on site. The compliance value does not include the excluded or unidentified products.

Table 115. General Service Incandescent: Model Number Compliance – Site 3

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
22	9	6	0	7	60%

While sales data were not provided during the initial site visit, a full inventory count was performed as shown in Table 116. Note that the compliance rate does not include excluded or unidentified products.

Table 116. General Service Incandescent: Inventory Compliance – Site 3

Total Inventory	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
1,308	568	367	0	373	61%

When a follow up call was made to obtain sales information, the original contact was unavailable and the call was transferred to multiple people who were unable to provide the appropriate information.

Site 4

This retail company is located in northern California, and was designated as a large business under our classification system. Data collected during site visits included 29 unique model numbers in stock at this location. Of these model numbers, we found that 17 were compliant under the Frost/Clear or Soft White standard, none were excluded from the standard, and eight were unidentified. Table 117 shows product compliance based on the model numbers that were recorded on site.

Table 117. General Service Incandescent: Model Number Compliance – Site 4

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
29	17	4	0	8	81%

Though sales data were not provided during the site visit, a full inventory count was performed as shown in Table 118. The compliance rate was calculated based on the inventory data.

Table 118. General Service Incandescent: Inventory Compliance – Site 4

Total Inventory	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
1,357	842	213	0	302	80%

When a follow up call was made to try to obtain sales information, the original contact was

unable to estimate monthly or annual sales or even identify a top selling lamp. When the contact was asked for a referral to the sales department or to someone who would have knowledge of the company's sales, the contact stated that no one at the store could provide such information.

Site 5

This retail company is located Southern California, and was designated as a large business. Data collected during site visits included 20 unique model numbers in stock. Of these model numbers, it was found that 10 were compliant under the Frost/Clear or Soft White standard, eight were excluded from the standard, and one was unidentified. Table 119 shows product compliance of 91% based on the model numbers that were recorded on site.

Table 119. General Service Incandescent: Model Number Compliance – Site 5

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
20	10	1	8	1	91%

Sales data were not provided during the site visit, but we conducted a full inventory count providing the data shown in was performed as shown in Table 120. Using these values, the compliance rate was estimated at 96%.

Table 120. General Service Incandescent: Inventory Compliance – Site 5

Total Inventory	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
1,146	520	22	537	67	96%

A follow-up call was not made to this location to try to obtain sales data since calls made to other branches of the same company had not resulted in any additional data. Attempts were made to reach knowledgeable staff within the corporate office of this company, but the automated phone system did not permit our call to be transferred to the appropriate department or person.

Site 6

This retail company is located in Southern California, and was designated as a large business. Data collected during site visits included 30 unique model numbers in stock at this location. Of these model numbers, it was found that 10 were compliant under the Frost/Clear or Soft White standard, 12 were excluded from the standard, and five were unidentified. Table 121 shows product compliance based on the model numbers that were recorded on site.

Table 121. General Service Incandescent: Model Number Compliance – Site 6

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
30	10	3	12	5	77%

Sales data were not provided during the site visit, but a full inventory count was performed as shown in Table 122, giving a slightly higher compliance rate. We were unable to obtain any sales information through a follow-up call.

Table 122. General Service Incandescent: Inventory Compliance – Site 6

Total Inventory	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
2,076	687	127	590	672	84%

Site 7

This retail company is located in Southern California, and was designated as small. Data collected during site visits included five unique model numbers in stock at this location. Of these model numbers, it was found that one was compliant under the Frost/Clear or Soft White standard, none were excluded from the standard, and none were unidentified. Table 123 shows the product compliance based on the model numbers that were recorded on site.

Table 123. General Service Incandescent: Model Number Compliance – Site 7

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
5	1	4	0	0	20%

Sales data were not provided during the site visit, but a full inventory count was performed as shown in Table 124. Using the inventory information, the estimated compliance rate was considerably higher than the model number data alone suggested.

Table 124. General Service Incandescent: Inventory Compliance – Site 7

Total Inventory	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
1,879	1,300	579	0	0	69%

When a follow up call was made to obtain sales information, the original contact was able to estimate sales at approximately 1,000 lamps/month or 12,000 lamps/year. Additionally, the contact stated that the 60 Watt lamp, which was also the only lamp found to be in compliance, was the top selling product, which was consistent with the inventory data.

Site 8

This retail company is located in central California, and was designated as a large business under our classification system. Data collected during site visits included 36 unique model numbers in stock. Of these model numbers, we found that 20 were compliant under the Frost/Clear or Soft White standard, one was excluded from the standard, and eight were unidentified. Table 125 shows product compliance based on the model numbers that recorded on site.

Table 125. General Service Incandescent: Model Number Compliance – Site 8

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
36	20	7	1	8	74%

Unlike most other cases, our contact at this site provided general sales data during the site visit. The contact gave us annual sales estimates for individual lamps: 25 of the models sold approximately 1,000 units each/year, while three sold 1,100 units each/year. Sales estimates were not provided for eight lamps. Using these sales data and our compliance information, we estimated the compliance rate shown in Table 126.

Table 126. General Service Incandescent: Sales-Based Compliance – Site 8

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
36	16,200	7,000	N/A	5,100	70%

A full inventory count was also performed providing the data shown in Table 127. Based on these data, the estimated compliance rate was 68%.

Table 127. General Service Incandescent: Inventory Compliance – Site 8

Total Inventory	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
1,736	844	389	63	440	68%

Follow up calls were made to collect additional sales data, but the contact stated that this information was not available and transferred the call to another party who also could not provide any additional information.

Site 9

This retail company is located within northern California, and we defined it as a large business. Data collected during site visits included 37 unique model numbers in stock. Of these model numbers, it was found that 21 were compliant under the Frost/Clear or Soft White standard, one was excluded from the standard, and eight were unidentified. Table 128 shows the estimated product compliance based on the model numbers were recorded on site.

Table 128. General Service Incandescent: Model Number Compliance – Site 9

Total Unique Models	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
37	21	7	1	8	75%

Sales data were not provided during the site visit, but a full inventory count was performed providing the data shown in Table 129. Based on these values, we estimated the compliance rate.

Table 129. General Service Incandescent: Inventory Compliance – Site 9

Total Inventory	Compliant	Not Compliant	Excluded	Unidentified	% Compliant
1,793	1,032	302	2	457	77%

When a follow-up call was made to obtain sales information, the original contact was unavailable and an appropriate substitute was not identified.

Metal Halides

Site-by-site results are presented for metal halides below.

Site 1

This large company operates in southern California. This retail location specializes in lighting products. We obtained information on their ballast sales; less than 5% of their sales are derived from ballasts. Summary information is provided in Table 130.

Table 130. Metal Halide Ballasts – Site 1

Brands Reported	% Compliant	Sales Volume
2	Can not determine	50-100 units annually

The brand names reported were Hovell and Simkar. The company did not report information on metal halide luminaires and it was not possible to assess compliance of the ballasts.

Site 2

This small company operates in central California. Like Site 1, this is a lighting retail company. Information for this site is summarized in Table 131.

Table 131. Metal Halide Kits – Site 2

Brands Reported	% Compliant	Sales Volume
1	Can not determine	Approx 100 metal halide kits annually

The store reported that their top three selling lamps are Ushio 400 watt, Ushio 250 watt and Ushio 175 watt. The store also sells a metal halide kit that is made by Advance. The Ushio lamps may be fitted with either an Enclosed or Open fixture Mogul base and both are pulse-start ballasts. However, the use of the product following sale could not be determined so it was not possible to estimate compliance of the actual luminaire.

Remaining Sites

The remaining six sites were comprised of both small and large companies. Three different locations were visited for one of the large businesses, in each of state's three regions. The stores could not provide sales or inventory information for metal halide luminaires. Again, the stores were found to sell primarily replacement metal halide lamps. Repeated attempts to gather information on the phone were made over a multiple week period, followed by written notification requesting information. These attempts failed to produce any further useful information.

According to one of the lighting retail locations, less than 5% of their ballast sales are pulse-start. This reflects the very small customer demand that she has encountered. Another retailer was asked if he had observed any change in demand for pulse-start ballasts. He stated that the store was beginning to carry a few more pulse-start models, and he attributed this to an anticipated increase in demand.

One of the stores (a small company in northern California) offers a number of products over their national website. The website showcased only one metal halide luminaire; however, it features a 70 watt lamp and is, therefore, not covered by the standard.

Walk-In Refrigerators/Freezers

The walk-in refrigerator and freezer (WIRF) information is presented below for each of the sites included in our study.

Site 1

This company operates in Southern California, and was designated as a small business under our classification system. This particular company manufacturers WIRF and delivers them across the country. Table 132 shows product compliance based on feedback by the respondent that was contacted.

Table 132. WIRF Sales and Compliance Based on Feedback – Site 1

Stratum	Region	Estimated Annual Sales1	Compliance Based on Feedback
Small	Southern	-	100%

1Annual sales could be not confirmed when the follow-up call occurred. At the initial contact the respondent stated that 250 to 300 units were sold a year to California customers. During the second call, however, the same respondent could not provide an estimate. Consequently, we do not report sales.

The manufacturer stated that all their WIRF are compliant with the new standards and are all custom orders. According to the respondent, the envelope insulation values, auto-doors, and motors all meet the 2006 standard. They sell to dealers, distributors, and customers throughout the country and all products sold in California meet the standard. However, it is worth noting that the respondent stated that units sold outside of California may or may not meet the Title 20 standards.

Site 2

This company is headquartered in Wisconsin but distributes directly to southern California, and was designated as small under our classification system. This particular company is a manufacturer of the insulation for WIRF. They deliver products across the country. Table 133 shows product compliance based on feedback from the respondent contacted.

Table 133. WIRF Sales and Compliance Based on Feedback – Site 2

Stratum	Region	Estimated Annual Sales	Compliance Based on Feedback
Small	Southern	24	-

Unfortunately, the respondent was unable to answer if the products sent to California comply with Title 20 standards. Feedback was limited since insulation for WIRF was their primary product.

Site 3

This company operates in Central California, and was classified as small. This particular company is a wholesaler of WIRF and delivers them across the state. Table 134 shows product compliance information based on feedback from the respondent.

Table 134. WIRF Sales and Compliance Based on Feedback – Site 3

Stratum	Region	Sales by Region			Estimated Annual Sales	Compliance Based on Feedback
		North	Central	South		
Small	Central	1/3	1/3	1/3	20	100%

In some cases this site purchases bulk walk-in components and custom builds the units. Based on the feedback, all custom units meet the new Title 20 standards. According to the respondent,

most manufacturers were able to meet the January 1, 2006, compliance deadline. In a few cases he said, certain manufacturers weren't able to meet the new requirements in time, therefore the manufacturer refused to give quotes to companies in California.

This respondent did raise a concern: when policy makers mandate new standards. He requested that policy makers consult with the industry to verify that manufacturers can deliver the new changes in time. For example, increasing the R-value (door thickness) standard may not be achievable either due to technology (e.g., foam technology) or within the time frame available to make all the changes needed.

Site 4

This company operates in Central California, and was designated as a small business. Limited information was obtained from this site. During the initial contact, the respondent said annual sales were 60 units; during follow-up calls, though, no one was able to verify this number. We made numerous repeat calls and we got conflicting and incomplete information. We were able to verify that this site custom orders WIRF and carries multiple brand names including Kolpak, Leer, and W.A. Brown. After communicating with representatives from other dealers of Kolpak and Leer, we were told that both manufacturers have complied with the new standard.

Site 5

This company operates in Northern California, and was designated as small. This particular site is a distributor/dealer of WIRF and delivers them across California. Table 135 shows product compliance based on feedback from the respondent.

Table 135. WIRF Sales and Compliance Based on Feedback – Site 5

Stratum	Region	Sales by Region				Estimated Annual Sales	Compliance Based on Feedback
		North	Central	South	Out of State		
Small	Northern	75%	10%	10%	5%	50	100%

According to the respondent, 95% of all orders are custom-built. He stated that the initial transition was difficult to complete and meet the January 1st deadline. The increased R-value requirement was difficult to manufacture by the deadline. The respondent said, however, that today it is not a problem at all and everything produced meets the standard.

Site 6

This company operates in Southern California, and was designated as a large business. This particular site is a distributor/dealer of WIRF and delivers them across California. Table 136 shows product compliance based on feedback from the respondent.

Table 136. WIRF Sales and Compliance Based on Feedback – Site 6

Stratum	Region	Estimated Annual Sales	Compliance Based on Feedback
Large	Southern	1	N/A

This representative could not provide definite information about compliance since their sales volume was so small. The small volume for WIRF at this location is due to fact that the primary business of this site is not walk-ins. When they do sell WIRF, the biggest sellers are semi-custom orders in two sizes: 5'x7' or 8'x6'. When the product is shipped it is in pieces and professional installers put it together, creating a custom fit. According to the respondent, several months ago a vendor representative visited the company and told them that all new models are more energy efficient. We had no information, however, about the characteristics of these models that would allow us to assess compliance.

Site 7

This company operates in Southern California, and was designated as large. This particular site is a distributor/dealer of WIRF. Table 137 shows product compliance based on respondent feedback.

Table 137. WIRF Sales and Compliance Based on Feedback – Site 7

Stratum	Region	Sales by Region				Estimated Annual Sales	Compliance Based on Feedback
		North	Central	South	Out of State		
Large (2)	Southern	0%	0%	90%	10%	85 to 100 units	100%

The respondent at this site verified that all their WIRF meet the new Title 20 standard. This site distributes only Kolpak walk-in units. According to the respondent, the baseline design model comes standard meeting all requirements of the 2006 California standards and is sold as such across the country.

Site 8

This company operates in Central California, and was designated as a large business. This particular site is a wholesalers of WIRF and other products. Table 138 shows product compliance based on respondent feedback.

Table 138. WIRF Sales and Compliance Based on Feedback – Site 8

Stratum	Region	Estimated Annual Sales	Compliance Based on Feedback
Large	Southern	2	100%

The low sales volume for WIRF at this location is because the primary business of this site is not walk-ins. Since this site sells walk-ins manufactured by only one company, we were able to confirm that their walk-ins meet the standard.

Unit Heaters and Duct Furnaces

The results for each of the unit heater/duct furnace sites from which we obtained compliance data are presented below.

Site 1

This company operates in Southern California, and was designated as a member of the small stratum under the previously defined classification system. Our initial phone call identified 11 unique model numbers for a single brand available for order by this company. Of these model numbers, none were found in the database. (See Table 139)

Table 139. Unit Heater/Duct Furnace Products in CEC Database - Site 1

Unique Models Identified	Inventory Count	Models Found in Database	Models Not Found in Database	% Compliant
11	N/A	0	11	0%

When follow-up calls were made to this contact in an effort to obtain sales information, the respondent could not provide sales information, but indicated that additional brands were available for order that were not mentioned during the initial communication. Specific model numbers for these additional brands were not provided by the contact, however, so it was not possible to ascertain whether these models complied.

Site 2

This company operates as a distribution center within Northern California, and was in the large stratum. Our initial phone call identified 14 unique model numbers for a single brand available for order by this company. As Table 140 shows, none were found in the compliance database.

Table 140. Unit Heater/Duct Furnace Products in CEC Database - Site 2

Unique Models Identified	Inventory Count	Models Found in Database	Models Not Found in Database	% Compliant
14	N/A	0	14	0%

We conducted a follow-up call to obtain sales data, but the respondent was unable to provide any such data or additional model numbers. The contact went further to say that annual sales information was not available because multiple sales people operated at the same location, none of whom were aware how many others were selling.

Site 3

This company operates as a distribution center within Northern California, and was designated as small under our classification system. Initial phone calls identified 191 unique model numbers for a single brand available for order by this company. During the initial call to this contact, one model number was identified as a "top seller" at 1,000 units per year. This model number was not found in the compliance database.

When we conducted a follow-up call to get additional information this contact identified 14 specific models and noted that unit heaters were their most popular selling item, with approximately 600 of each sold each year. It appeared that the sales pattern had changed considerably from the first call. Interestingly, the previously identified best seller was not included in the resulting list of 14 unit heaters. Of these 14, 11 were found in the database, as shown in Table 141.

Table 141. Unit Heater/Duct Furnace Product Sales in CEC Database - Site 3 Follow-up Information

Top Models Identified	Top Models Found in Database	Models Not Found in Database	% in Database	Sales of Each/Year	Compliant Sales/Year
14	11	3	79%	600	6,600

Site 4

This company operates in Central California, and was designated as large under our classification system. Initial phone calls identified 52 unique model numbers of one brand available for order by this company. Of these model numbers, 39 were found in the database (see Table 142).

Table 142. Unit Heater/Duct Furnace Products in CEC Database - Site 4 Initial Information

Unique Models Identified	Inventory Count	Models Found in Database	Models Not Found in Database	% Compliant
52	N/A	39	13	75%

During the initial call to this contact, one model number series was identified as a "top seller" at 350 units each per year. Of the 10 model numbers in this series, 50% were found in the database as shown in Table 143.

Table 143. Unit Heater/Duct Furnace Product Sales in CEC Database - Site 4

Top Models Identified	Top Models Found in Database	Models Not Found in Database	% in Database	Sales of Each/Year	Compliant Sales/Year
10	5	5	50%	350	1,750

However, during the follow-up call this contact was unable to identify a top selling model and stated only that models rated at 100,000 Btu were the most popular. Additionally, it was discovered that an additional brand was also sold by this company, but model numbers were not provided by the contact. When we determined the four model numbers rated at 100,000 Btu all four were found in the database, implying a compliance rate of close to 100%.

Site 5

This company operates as a distribution center within Southern California, and was designated to be in the small stratum. Initial phone calls identified 68 unique model numbers from one brand available for order by this company. Of these model numbers, 45 were found in the compliance database. In addition, an inventory list was provided by this company. The summary data are shown in Table 144.

Table 144. Unit Heater/Duct Furnace Products in CEC Database - Site 5

Unique Models Identified	Models Found in Database	Models Not in Database	% Models in Database	Inventory Count	% Compliant based on Inventory
68	45	23	66%	361	64%

This contact was not able to provide any sales data, and would not identify any "top sellers" whether by model number, output rating, or any distinguishing feature.

Site 6

This company operates as a distribution center within Southern California, and was designated as a small business under our classification system. Initial phone calls identified 36 unique model

numbers from one brand available for order by this company. Of these model numbers, we found 26 in the database as seen in Table 145.

Table 145. Unit Heater/Duct Furnace Products in CEC Database - Site 6

Unique Models Identified	Inventory Count	Models Found in Database	Models Not Found in Database	% Compliant
36	N/A	26	10	72%

Sales data were not collected during the initial call to this contact. When a follow-up call was made to the company it was discovered that the original contact had retired and that the territory had been reassigned to the same person used as a contact for Site 3. This contact was not able to provide any sales data. He thought, however, that general sales patterns would be the same, with the same series of model numbers being most popular as had been identified for Site 3, only with fewer units sold than the 600/year reported for the northern location. Twenty-two model numbers matched this criterion, 12 of which were found in the database as displayed in Table 146.

Table 146. Unit Heater/Duct Furnace Product Sales in CEC Database - Site 6

Top Models Identified	Top Models Found in Database	Models Not Found in Database	% Compliant Sales	Sales of Each/Year	Compliant Sales/Year
22	12	10	55%	<600	<7,200

Site 7

This company operates as a distribution center within Southern California, and was designated as a large business under our system. Initial phone calls identified 106 unique model numbers for one brand available for order by this company. Of these model numbers, 73 were found in the database (see Table 147).

Table 147. Unit Heater/Duct Furnace Products in CEC Database - Site 7

Unique Models Identified	Inventory Count	Models Found in Database	Models Not Found in Database	% Compliant
106	N/A	73	33	69%

During the initial call to this contact, sales data were provided for each of the model number series carried, with sales reported at either 200 or 350 per month. This additional information made it possible to calculate a compliance rate of 64% based on sales, which is comparable to the rate that was calculated based on the unique models available for order. These results are presented in Table 148.

Table 148. Unit Heater/Duct Furnace Product Sales in CEC Database - Site 7

Total Sales Volume/Month	Compliant Sales/Month	% Compliant Sales	Compliant Sales/Month x 12 months
2,900	1,865	64%	22,380

Site 8

This company operates as a distribution center within Central California, and we designated it as a small business. Initial phone calls identified 18 unique model numbers for one brand available for order by this company. Of these model numbers, none were found in the database. Sales data were not provided during the initial call. When a follow up call was made to obtain this information, the same contact reported that the original brand identified was no longer carried by this company. Instead, he said they now carried a different brand and, based on the six model numbers provided, none of these were found in the compliance database. This information is summarized in Table 149.

Table 149. Unit Heater/Duct Furnace Products in CEC Database - Site 8

Unique Models Identified	Inventory Count	Models Found in Database	Models Not Found in Database	% Compliant
6	N/A	0	6	0%

In total, it was reported that approximately 600 units were sold each year, with two models identified as top sellers. However, as mentioned previously none of the models were found in the compliance database.

Site 9

This company operates as a distribution center within Northern California, and was designated as a large business under our system. Initial phone calls identified 135 unique model numbers of one brand available for order by this company. Of these model numbers, three were found in the database as shown in Table 150.

Table 150. Unit Heater/Duct Furnace Products in CEC Database - Site 9

Unique Models Identified	Inventory Count	Models Found in Database	Models Not Found in Database	% Compliant
135	N/A	3	132	2%

Sales data were not collected during the initial call to this contact. Multiple follow-up calls were made, but the contact was unavailable or did not return the calls. A corporate office was contacted as well, but again no calls were returned.

Refrigerated Beverage Vending Machines

Site-by-site results are presented below for vending machines.

Site 1

One of the sites visited was a small store located in Northern California. The store reported two different brands of vending machines, and nine different model numbers. The majority of the models were listed in the CEC database. Table 151 presents these data.

Table 151. Vending Machines: Products in CEC Database - Site 1

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
9	8	1	89%

It should be noted that a number of the model numbers provided were similar to the base model numbers of machines found in the CEC database, but lacked an alphabetical suffix. In these cases, the model numbers were assumed to be the same. For example, DN600E was assumed to be the same as DN600EDD; 621 was assumed to be the same as 621C. This assumption was verified as a generally reliable approach by staff at the store in subsequent telephone conversations.

Site 2

A large business in Southern California also reported 9 different models. The compliance information for this site is presented in Table 152.

Table 152. Vending Machines: Products in CEC Database – Site 2

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
9	4	5	44%

Site 2 was the only location to provide current stock information for their machines. The store had 47 machines in stock at the time of the July 2006 site visit. The results are shown in Table 153.

Table 153. Vending Machines: Compliance Based on Inventory – Site 2

Individual Machines in Stock	Units in CEC Database	% Compliant
47	30	64%

The store primarily carried two to five machines per model number, with one exception. For one of the models in the CEC database, the store had 20 machines, which increased the estimate of the compliance rate significantly. Integrating the stock information then, had a positive impact on the compliance rate for this particular site

Site 3

A small business in Northern California reported only two different products for sale. Of these, one was listed in the CEC database (i.e., its model number was the same as the CEC database less an alphabetical suffix – more specifically, 501E was assumed to be equivalent to 501ER).Table 154 presents this information.

Table 154. Vending Machines: Products in CEC Database - Site 3

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
2	1	1	50%

Site 4

At this large business site, three different beverage vending models were found. One of these was in the CEC database. The results for this business located in Northern California are shown in Table 155.

Table 155. Vending Machines: Products in CEC Database - Site 4

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
3	1	2	33%

Site 5

Another of the vending machine companies visited was a small business in Southern California. As shown in Table 156, none of the five models that they provided were found in the CEC database. They were also of a brand name that is not currently included in the CEC database. No additional data were provided about the machines in order to determine if they might meet the standard.

Table 156. Vending Machines: Products in CEC Database - Site 5

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
5	0	5	0%

Site 6

Three different models were found at this location, which was classified as a large company located in Northern California. None of the models were included in the CEC database as shown in Table 157. These models were manufactured by the same company as those found at Site 5.

Table 157. Vending Machines: Products in CEC Database - Site 6

Unique Models Identified	Models Found in Database	Models Not Found in Database	% Compliant
3	0	3	0%