Determining Compliance with Appliance Energy-Efficiency Standards

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ABSTRACT

This paper discusses the methodology applied to evaluate compliance with energy-efficiency standards for a diverse set of appliances. It describes the methods used in both a 2006 study and an ongoing follow-up evaluation that is estimating the savings attributable to a statewide appliance standards support program implemented jointly by the California investor-owned utilities. The primary purpose of the appliance compliance component of the evaluation is to determine what portion of the potential energy savings from the standards is not being realized if appliances that do not comply with the standards are still being sold. The standards being studied include those for residential pool pumps, walk-in refrigerators/freezers, general service incandescent lamps, and televisions, among other appliances. We were unable to identify in the literature a comparable study conducted prior to 2006.

The compliance analysis methodology we are conducting is distinctive and challenging in several ways. Because of fundamental differences in the types of products covered by the standards, the methodology is tailored to each appliance. The approach for choosing a suitable sampling strategy for collecting compliance data varies by appliance. In some cases, reported compliance data were not available, and we had to determine for individual units in the market whether the products complied with the standards or not.

This paper highlights the numerous challenges that have been overcome in the course of this research and the best practices developed to resolve them. The paper provides recommendations for future studies based on lessons learned in the 2006 study and the current evaluation.

Introduction

Codes and Standards Background[1]

Energy-efficiency standards set minimum efficiency levels that new appliances or buildings must meet or exceed. Because they eliminate low-efficiency products from the market, standards have become an important mechanism for reducing energy consumption. In the 1970s, states began establishing regulatory frameworks for developing, adopting, and implementing such standards. In addition, the federal government began adopting national appliance/equipment standards and issuing mandatory, voluntary, and model building efficiency standards. Both the federal government and states have continued developing and upgrading their efficiency standards.

In California, the California Energy Commission (CEC) was charged with adopting appliance standards starting in the 1970s. Since the late 1990s, California investor-owned utilities have played a significant role in researching, proposing, and promoting codes and standards to reduce loads. Over time, these efforts have evolved into the statewide Codes & Standards Program (C&S Program, or Program). More so than demand-side management (DSM) programs, savings from utility codes and

[1] The terms "codes" and "standards" are often used interchangeably. A common convention is to refer to regulatory energy-efficiency requirements as "codes" if they are for buildings and "standards" when they apply to appliances or equipment.

standards programs are difficult to estimate and attribute to utility actions. Still, utilities and the California Public Utilities Commission (CPUC) are highly motivated to overcome the challenges so that savings from the C&S Program can become another asset in the energy-efficiency portfolio.

Towards this end, in 2002, initial efforts began to determine C&S Program savings that could be recognized by the CPUC. However, a formal evaluation protocol for C&S Programs did not exist at the time and the analysis was subject to several uncertainties and based on limited data. In 2006, California adopted an evaluation protocol[2] that included a methodology for evaluating such programs in a prescribed, consistent way [Hall, et al. 2006]. The protocol was based upon the preceding analytic approaches. For both the 2006 and current study, this basic methodology is being used to quantify energy savings related to investor-owned utilities' advocacy work supporting adoption of codes and standards in effect during the period 2006 through 2008. Recognition of these savings represents a significant step forward for the utilities and their long-time support of the C&S Program.

Elsewhere, utilities increasingly are investigating the options of pursuing building energy codes and appliance standards because of the potential they provide for substantial, cost-effective energy savings. Again, however, experience remains very limited in evaluating the impacts of programs promoting code and standard upgrades.

Study Objectives

In 2007, The Cadmus Group began using the California protocol in the current evaluation, enhancing and refining it as the evaluation progressed.[3] The broad objectives of the evaluation are estimation of C&S Program savings and refinement of the protocol.

The degree that appliances being sold in California comply with the applicable standards is one of the key components needed to evaluate energy savings from the standards.[4] This quantity is referred to as the compliance rate or level. In a prior study initiated in 2006, two of the co-authors quantified appliance standard compliance in California; the current study builds upon methods developed at that time [Khawaja et al. 2007].[5]

Purpose and Organization of This Paper

This paper focuses on the approach used to assess compliance with the appliance standards using market research throughout the state. The specific standards analyzed are those that started going into effect at the beginning of 2006, and we refer to them as the 2006 Title 20[6] standards. Although compliance was also assessed in the prior study [Khawaja et al. 2007], compliance rates are expected to have increased as time has elapsed. The 2006 Title 20 also included several standards that went into effect in 2008, and these are being evaluated for the first time in the current study.

The next section of this paper describes the methodology used for determining the appliance standard compliance rate. The current CPUC-sponsored evaluation is still in progress, and the compliance analysis is based on the methodology used in the prior study, with some key alterations to account for lessons learned. The third section discusses results from the 2006 study and presents

[2] The California Energy Efficiency Evaluation Protocols, written by TecMarket Works, provide a framework for technical, methodological, and reporting requirements for evaluation professionals.

[3] The Cadmus Group is a subcontractor to KEMA (formerly RLW Analytics, Inc.), which is the prime contractor to the California Public Utilities Commission for this evaluation.

[4] See *An Update on the Evaluation of Energy-Efficiency Standards in California* from the 2009 IEPEC conference for an overview of the complete evaluation methodology.

[5] The prior study was conducted by Quantec, LLC, before it was acquired by The Cadmus Group.

[6] Title 20 refers to the California appliance energy efficiency regulations.

observations from the current evaluation. The final section focuses on lessons learned and best practices from the appliance compliance portion of both the 2006 study and the present evaluation.

Both the 2006 and current studies covered a wide range of appliances. In this paper, we focus on standards for six appliances: (1) walk-in refrigerators and freezers, (2) residential pool pumps (Tier 1 and 2), (3) general service incandescent lamps, (4) televisions, (5) pre-rinse spray valves, and (6) unit heaters and duct furnaces. Several of these appliances, such as incandescent lamps and pre-rinse spray valves, lent themselves to a fairly straightforward analysis where, to some extent, a generic approach was taken. This generic approach is representative of the methods used to analyze many of the appliances not discussed in this paper. Others, such as pool pumps, unit heaters and duct furnaces, and walk-in refrigerators and freezers were chosen for their uniqueness, so the specific methods used to study each can be shared with readers.

Appliance Compliance Methodology

Understanding Standard Requirements

Our current methodology for assessing compliance with the Title 20 standards evolved from the approach used in the 2006 study, taking into account lessons learned, primarily regarding field data collection.

For an appliance to comply with California's Title 20, it has to meet all standard requirements, and have been certified and listed in the CEC database[7]. The CEC database provides a complete list of all products that have been certified as compliant with Title 20. Therefore, all models not listed in the CEC compliance list are considered non-compliant regardless of whether the product meets the standard requirements or not. This resource provides a unique way for the CEC to be able to identify all currently fully compliant models. However, since this study aims to understand the energy impacts (savings) due to appliances meeting the standards, even if they are not officially listed, additional analysis was often needed to assess compliance of those products for sale but not listed in the databases.

In the 2006 study, we found that CEC databases listing compliant models existed for only four of the nine appliances evaluated then.[8] Databases are now available for most appliances, with listings of compliant models along with each models' product-specific details. There are still two appliances (walk-in refrigerators/freezers and external power supplies) for which databases are not available; manufacturers are not required to submit compliance listings for these products because of the nature of the appliances and the way they are distributed.

When databases are available, they provide us with a straightforward way to check for compliance. Technically, all products covered by Title 20 that are not registered and listed in the CEC database are noncompliant. For the 2006 study, however, it was decided that the evaluation team would relax this condition and use the product specifications for each model number that was collected to determine whether products met the performance requirements of the standard. Additional calculations were needed to determine the compliance rates for the appliances where a database did not exist. This approach was taken primarily because the standards had not been in effect very long when the 2006 study was conducted and there were so few databases available. In these cases, we calculated compliance for each model based on each individual product's specifications. The methods employed in these cases provide a useful framework for evaluators attempting to study appliance standards in states that do not have a database of certified products.

[7] 2007 Appliance Efficiency Regulations, Section 1606 (a) p. 133.

[8] Manufacturers are responsible for submitting compliance information to the CEC and when the prior study was done producers of several products had not submitted this information.

Once the compliance databases were downloaded and reviewed, it was important to become familiar with each appliance standard before starting data collection. Early in the 2006 study data collection process, we learned that failure to understand nuances of the standards before going into the field could result in collecting incomplete data since the data needed are often specific to a standard.

Selecting a Sample

For each appliance, an appropriate population of vendors and a data collection sample had to be selected. This provided some challenges. The population had to include different types of vendors to ensure data were collected from each of the primary sources of distribution for each product: manufacturers, retailers, and wholesalers. In the 2006 study, we learned that the type of retailer we needed to contact was dependent on the type of appliance. Although the data collection team attempted to collect data from all of these sources, more emphasis was placed on retailers for commonly sold appliances such as televisions and light bulbs. For specialty products such as walk-in refrigerators and freezers, we learned that manufacturers are the best vendors to contact since these products are usually custom made.

For both studies, we purchased a contact list based on Standard Industrial Classification (SIC) codes. To ensure the sample included businesses covering the range of sizes and we anticipated that compliance would depend on vendor size, we used these lists to create strata based on a business-size metric for each appliance. We used the number of employees as the size stratification variable and created two initial strata: those below and those above the 50th percentile in total employment. The resulting groups were reviewed and modified to ensure adequate numbers of sites were in each category.

In addition to categorizing vendors by size, it was also important to collect data across California to account for differences due to location. We decided to break the state into three geographic regions: Southern, Central, and Northern. Because no source was readily available to provide accurate counts of vendors selling each appliance and the study scope did not permit extensive market analysis, it was not possible to determine accurately the number of vendors in each stratum.[9] The stratified sampling approach we adopted was to select equal sample sizes from each stratum in each region. The number of vendors included in the study was largely limited by the budget available. The confidence intervals were calculated for the estimated compliance rates, when sufficient data were available, to give an indication of how accurately the compliance rates were estimated. We designed a stratified cluster sampling approach to select retailers and wholesalers for site visits in both studies using the following allocation for each appliance category:

3 (regions) * 2 (strata) * 2 (average # vendors in each stratum) = 12 vendors total

Methods for Evaluating Compliance

Methodology Used for Data Collection and Analysis. The data collection approach used in the 2006 and current studies is essentially the same. Most data were (and are being) collected on site, but this process was supplemented with both Internet and catalog research as needed to verify the specifications of each model. We found it was most efficient to have two field technicians collect the onsite data together. The primary data we attempted to collect on each site for each appliance included: the supplier name and address, brand, model number, date of manufacture, number of units in stock, and approximate sales volume for both the specific models and the appliance type.

[9] We found the purchased business lists were not always consistent in providing information that could be used to determine products sold by a specific business.

According to Title 20, "no appliance may be sold or offered for sale in California unless the appliance complies with the standard"[10] and "Each provision applies only to units manufactured on or after the effective date of the provision."[11] By collecting manufacture dates, we hoped to determine whether the specific product being sold was required to meet the standard. In the 2006 study, we learned the manufacture date is rarely shown on the boxes placed on floor display. Due to vendor unwillingness to allow our field technicians into the stocking rooms to get this information, we were unable to collect the manufacture date for any of the products in the 2006 study. In the current study, we have not found a working solution to get around this as vendors are largely resistant to permitting entry into stocking rooms.

We also found there were barriers to getting sales data from retailers, especially from corporate chains. In instances where we were unable to get specific sales data, we used shelf stocking data to estimate sales patterns. Comparing shelf stocking data against sales data (in cases where we were able to collect both) confirmed this method was a good indicator of sales patterns.

In the 2006 study, site visits were conducted during July 26 and September 11, 2006, by our field technicians. Data collection for the current study took place between March 1 and June 5, 2009. The initial stages of data collection for both projects began with phone calls to determine how much data could be collected by phone and to schedule site visits. The effectiveness of data collection by phone varied for the different appliances, and worked best with unit heaters/duct furnaces, walk-in refrigeration, and pool pumps. The usefulness of different methods for data collection is explained in the appliance cluster sections below along with appliance-specific data collection methods. The clusters discussed were organized based on commonality of the methods used in both data collection and in determining compliance.

After completing the site visits during the 2006 study, the data were analyzed to determine which models at each outlet did or did not comply with the standards. As noted earlier, compliance was determined according to the CEC database if one existed or by applying calculations based on the standard if a database did not exist. We also analyzed the data from our review of Web sites and catalogs, primarily to confirm individual product specifications that were unclear in the data collected. For several products, this information was critical for determining the characteristics of specific appliance models, then assessing compliance with the standards. A similar approach is being applied in the current study.

Determining Compliance Rates. The aggregate compliance rate for each appliance was estimated based on the rate calculated for each outlet, approximate sales, and appropriate weights for the stratum. This general approach had to be tailored to each appliance and adjusted for differences in the types of data we were able to obtain.

The level of difficulty associated with calculating the compliance rate varied from standard to standard. When a compliance database did not exist, appliances with simple standards with only one or two requirements were the most straightforward to evaluate. This was the case with pre-rinse spray valves in the 2006 study. The standard for pre-rinse spray valves states the "flow rate shall be equal to or less than 1.6 gpm at 60 psi in addition to being capable of cleaning 60 plates at an average time of not more than 30 seconds per plate."[12] Although, in some cases, we had to contact the manufacturer to obtain the flow rate and plate cleaning time, determining compliance was simple because there were no calculations. Either the product provided the required flow and could clean 60 plates at an average time of 30 seconds or it did not.

[10] 2007 Appliance Efficiency Regulations, Section 1605 (c) p. 77.
[11] Ibid., p. 1.
[12] Ibid., Section 1605.3 (h) (3) (A) and (B), p. 120.

For other appliances for which a database was not available, determining compliance for each model required collecting and analyzing additional data needed to determine compliance (e.g., lumens and watts for incandescent lamps). In addition, we then had to perform the calculations or analysis required to assess compliance for each appliance. 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 standard for each model.

Determining the compliance rate for other products, such as walk-in refrigerators and freezers, proved to be much more difficult. In the 2006 study, for a walk-in refrigerator/freezer to be compliant, it had to meet the 2006 appliance specifications summarized in Table 1.

Table 1. Title 20 2006 Walk-in Refrigerator/Freezer Requirements

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

As the table shows, compliance for a walk-in refrigerator/freezer was dependent on satisfaction of numerous component requirements. In most cases, walk-in refrigerator/freezer manufacturers and distributors were aware of the standard and said they only manufactured and/or sold models that complied with the standard. Since most units are custom-built, however, their statements were difficult to verify. In the current study, in an attempt to gain these hard-to-obtain product-specific details, we asked vendors for the product specifications for a sample of the walk-in refrigerator/freezers that they sold and/or manufactured in 2008 in California. The success of this approach has not been determined yet, but this change in methodology provides an example of how the complexity of evaluating compliance rates ranges in difficulty among appliances and how methods must be tailored individually for each product.

Another complication is the lack of specifications listed for each product if a compliance database is not available. For most products, we had to conduct a large amount of online and catalog research to obtain the specifications needed to determine compliance. Having to go through this process for each model number, when hundreds of individual models exist for an appliance type, adds a significant amount of time to the analysis process. Evaluators must be aware of this challenge initially and plan appropriately.

Even for products covered by a CEC database, the process was not always straightforward. We compared model numbers acquired during the site visits or preliminary phone calls with model numbers in the database. Due to the possibility of human error in data collection, we used "fuzzy" functions in

Excel to identify units with model numbers that were a "close" match to a number in the database, then manually examined whether these models were the same as those listed in the database. Additional research was done for these products to determine if human error were to blame and if the models were in fact the same. Some of the appliances where this complication occurred were televisions and unit heaters.

For all appliances for which a CEC database exists, it is possible some units not in the database do, in fact, comply with the requirements of the standard. However, with a few exceptions, Title 20 requires manufacturers to file product compliance information with the CEC; so, regardless of whether the model meets the performance requirements of the standard, if it was not listed in the database, it does not fully meet the standard, and on this strict level we assume it is noncompliant. To account for the possibility that some appliances do meet the standard efficiency requirements, but have not been listed in a database available from the CEC, we will also apply the approach described above to assess compliance when sufficient product specifications are available to determine compliance with the performance requirements. Our intention is to report, when possible, compliance rates that are based only on the CEC database of complying products and the rate based on an analysis of unlisted products that meet the performance requirements of the standards.

Additional calculations were used to extrapolate the data to the statewide level. Compliance rates were calculated separately for outlets in the small and large strata. Within each stratum, we multiplied the estimated number of units sold per month by the percent of the inventory units that complied with the standard. These values were totaled and divided by the number of units sold to calculate the average compliance rate within a stratum. The overall compliance 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 all sites within each strata. The final compliance rate was determined by taking the sum of the weighted compliance rates for each stratum and aggregating the results at the state level.

The 90% confidence intervals were calculated when the required data were available. In general, the information required included the sales within each stratum represented by the sampled vendors, total sales for the population within the stratum, and variance of the compliance rates across the sampled vendors. Since all these data were generally not available for a product, it was necessary to estimate values based on the available data, such as the average number of units sold by small vendors of a specific appliance.

Discussion of Specific Appliances

The following sections discuss the data collection and analysis approach used to assess compliance for several different standards. As noted earlier, they are grouped according to similarity in terms of the data collection and analysis approach applied. Most of the information is based on the 2006 study, but similar approaches are being used in the current study.

Televisions and Unit Heaters/Duct Furnaces. Televisions and unit heaters/duct furnaces are categorized together in this paper because both product types had CEC databases available for the 2006 study. This determined the analysis methodology used to evaluate compliance. However, separate issues were encountered in data collection for these appliance types.

The unit heaters and duct furnaces regulated by Title 20 are all non-residential. Typically, these units are installed in ceiling-mounted locations and are used primarily to heat industrial and commercial buildings. Since a CEC database was available for the 2006 study, model numbers were analyzed according to the methodology described previously for products with a compliance database. However, even though a compliance database existed for the 2006 evaluation, very few manufacturers had registered their models with the CEC at the time of our analysis.

The field technicians collected brand names and model numbers to compare to the database to determine compliance. In many cases, it was possible to collect data for this appliance through phone interviews. Sales data were also collected whenever available. For unit heaters and duct furnaces, model numbers frequently represent Btu output, and it was observed by multiple contacts that customers purchase specific models based on the amount of heat required for the situation. Consequently, some contacts were able to identify common sizes, though not specific models, they believed were more likely to sell than others. This made it difficult to analyze the data provided by these contacts.

Deriving an overall compliance 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 vendors. 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, although they technically did not comply, it did not necessarily mean they did not comply with the efficiency expectations 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 that occurred several months later. 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.

Televisions provided other data collection challenges. Because this standard governs consumer products readily available for purchase at retail establishments, site visits were conducted in an effort to collect product and sales/inventory information directly from the consumers' sources of these appliances. While on site for both the 2006 and current studies, 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, and vendors did not permit access to 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 or they were unwilling to disclose the information due to corporate policy. In the 2006 study, to supplement information collected from retail outlets, we conducted multiple calls to corporate offices. The corporate offices were largely non-responsive, so we did not repeat this process for the current evaluation.

Since a CEC database was available for televisions, model numbers were analyzed according to the methodology described previously for products with a compliance database. One method used to estimate the compliance rate was calculating the percent of the models observed that were in the compliance database. Our second approach was to use inventory data available from some stores as a proxy for sales of each model, then calculate the compliance rate, taking the inventories into account. 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. We also used our pre-calculated weights for the two size strata to weight the compliance estimates to produce an overall value.

General Service Incandescent Lamps. Included in the general service incandescent lamp standard are non-reflectorized, medium screw-based, incandescent lamps 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 excluded from this standard include rough service, decorative, three-way, and colored styles. When we conducted our site visits for the 2006 study, no manufacturers had submitted their compliance information, so no CEC

database was available for this product. The Tier 1 standard is written in terms of allowable wattage for a given lumen output. To check compliance in the 2006 study, we recorded the labeled lumen and rated wattage during our site visits 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 types such as "soft white," "rough-service," "frost," or "clear" were not recorded consistently while on site. This information is needed to ascertain whether the standard applied and, if so, which specific formula must be met. We were able to use Internet research of models to fill in much of this missing information. Given that most of the businesses selected for site visits were large, retail chains with corporate offices that maintained sales data, we again used inventory data to approximate sales. Data were primarily collected through on-site visits.

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, then the lamp was considered compliant whether it was Frost/Clear or Soft White.

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 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 for all lamps at this point whether the lamp was, in fact, Soft White. For those that met the Soft White criterion only, additional research was needed to determine whether or not the lamp in question was of the Soft White style. For those found to be noncompliant with the Soft White formula, further research was necessary to ascertain whether the lamp was excluded from the standard. To address both these issues, Internet research was conducted, as noted above, using the model numbers collected on site. In many instances, this research provided enough information to determine compliance or noncompliance, or to exclude the lamp from the analysis if necessary.

Data collected in the 2008 evaluation were much more complete due to lessons learned in 2006. A CEC database was available this time, so compliance was determined by comparing brand names and model numbers to those in the certified list. In January 2008, Tier 2 standards came into effect, which mandated more stringent energy requirements for incandescent light bulbs. This has added an additional challenge for the current study. Although a compliance database exists, it does not distinguish between registered products that only meet Tier 1 standards and those that meet Tier 2 standards. Additional calculations, similar to those done in the 2006 study, will be necessary to determine compliance at both tier levels. We believe the methods developed to analyze these products could prove to be useful in studies conducted by other researchers.

Pre-Rinse Spray Valves and Residential Pool Pumps. Although entirely separate products, pre-rinse spray valves and residential pool pumps presented similar challenges in the evaluation process. For the current study, CEC databases exist for both appliances, but, in the 2006 evaluation, all calculations were done manually for each individual model. Both pre-rinse spray valves and pool pumps are specialty items, sold at both the wholesale and retail levels. The primary outlets visited were restaurant supply wholesalers and retailers for the spray valves and pool supply retailers for the pool pumps. The details needed to determine compliance were not posted on packaging information or readily available on the Internet. Additional follow-up phone calls were made to the manufacturers for both of these appliances to obtain the specifications needed to determine compliance for individual models.

In 2006, the Title 20 standards prohibited all residential pool pumps from using split-phase or capacitor start-induction run type motors. However, since pumps are sold as a unit, motor parts are only

one element of the pump assembly and sourced from original equipment manufacturers. After obtaining model numbers for the pump itself, further research had to be done to verify the motor type. We discovered the motor type data were not readily available in manufacturer databases. Also, characteristics of the motors were generally not disclosed without cross-referencing to secondary data such as Motor-Master, and this source was not completely up-to-date or complete. The motor manufacturers, however, typically 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 was not present, it was possible the motor might still meet the standards. Overall, we had to apply four general assumptions to assess compliance:

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

2) Where pump motor part numbers contained numbers very similar to the available motor manufacturers' list, the motor type was 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"; we assumed this meant "energy efficient" and extended this assumption to other motors not found in a manufacturer's motor list.

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

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

Pre-rinse spray valves provided less of a challenge in data collection and evaluation, but, nonetheless, unique methods were needed. 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 California standard required all pre-rinse spray valves 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.

During site visits for the 2006 study, we discovered 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. As we found with the pool pumps, not all specifications needed to determine compliance were readily available. We had to conduct additional research and contact manufacturers to determine the flow rate and average cleaning time. To avoid giving manufacturers a reason to give false answers, we did not mention the study when calling. We also avoided asking specifically whether it was under 1.6 gpm at 60 psi with a cleanability average of 30 plates per second, which might have given them a reason to be untruthful. We called simply inquiring about the product details on a model. Once these data were collected, it was a matter of comparing the flow rate and average clean time rating to the standard for each model to determine whether or not it complied.

For the current study, a CEC compliance database exists for pre-rinse spray valves. For the 2006 study, however, a database was not yet available, and all analysis to determine compliance was done manually.

Walk-in Refrigeration. Due to the unique nature of walk-in refrigerators and freezers, a different approach was created for collecting and analyzing data. The appliance standard for walk-in refrigerators and walk-in freezers 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. As shown above in Table 1, walk-in refrigerators and freezers have multiple

requirements that must be assessed in relation to each other to determine whether a unit is compliant or not. In the 2006 study, it was very difficult to confirm all components complied with the standard. Businesses were not able to provide enough information to determine compliance on specific products. In the end, compliance was assessed based on feedback from contacted businesses that were retailers, distributors, or manufacturers. Sales data were recorded whenever possible for each business.

A different approach was attempted for the current study, due to the complications encountered in 2006; however the approach was largely unsuccessful. Most of the businesses contacted are manufacturers or large refrigeration distributors and restaurant supply companies that sell products in California. The new approach targeted specific custom orders, manufactured by these businesses in 2008, instead of relying on interviews to provide information on what the vendors claim they sell. To obtain these data, we tried using phone interviews to ask for the specific product details for each of the individual orders placed in 2008, explicitly asking the vendor for the door closure type, the envelope insulation, the freezer envelope insulation, and the motor type and capacity for each product sold. Unfortunately, the vendors we contacted were unwilling or unable to supply order-specific data, so the approach used in the 2006 study was relied upon instead.

Results

Compliance Results of 2006 Study

The results for noncompliance rates from the 2006 study are presented in Table 2, along with the estimated 90% confidence interval. Results for the 2008 study are not yet available.

Table 2. Summary of Appliance Compliance Estimates for the 2006 pretest of the 2008 study

Appliance Category	Estimated Compliance Rate	Estimated 90% Confidence Interval
Televisions	59%	±40%
DVD Players	43%	±38%
Residential Pool Pumps, Tier 1	85%	±18%
General Service Incandescents, Tier 1	73%	±27%
Metal Halide Luminaires*	63%	N/A
Walk-in Refrigerators/ Freezers*	100%	N/A
Pre-rinse Spray Valves	95.8%	±6%
Unit Heaters and Duct Furnaces	56%	±23%
Refrigerated Canned/Bottled Beverage Vending Machines	37%	±23%

*The compliance rate estimates for these products were based on self-reported data, rather than field observations. Because of this we did not calculate a confidence interval.

The confidence intervals, in general, are conservative estimates based on the count of vendors sampled, rather than sales quantities. This approach was used in most cases because sales data were not available. The confidence intervals could not be estimated for metal halides and walk-in refrigerators/freezers because the compliance rates were estimated from self-reported data, rather than observations.

Best Practices for Evaluating Appliance Compliance

Some valuable lessons were learned in both the 2006 and 2008 studies that can be used to improve on the methodology used to evaluate appliance standard compliance:

1) The contact lists based on purchased SIC codes were not a very reliable source for finding appliance distributors. The SIC fields were too broad to provide a specific enough list. Using Internet search engines allowed us to do product-specific searches. We discovered it is also important to call ahead to verify the appliance is actually sold at the businesses (instead of being repaired, etc.) before attempting a site visit.

2) It is necessary to be flexible in planning and scheduling data collection since many vendors will not be willing to participate.

3) Corporate offices are often nonresponsive. Many large retailers were willing to let us record brand name, model numbers, and shelf stocking inventory, but directed us to the corporate office for questions about sales data. We found considerable variability in the willingness of specific retail chains to cooperate.

4) It is important to identify the specific data to be collected to determine the compliance rate before starting data collection. Although most of the product specifications needed to determine compliance could be found through Internet research after the brand and model number had been collected, this process was very time consuming.

5) Do not expect to find manufacture dates easily. The manufacture dates were rarely available for appliances evaluated in either the 2006 or 2008 studies.

6) 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.

7) It is possible to collect data for some smaller retailers and wholesalers over the phone, depending on the appliance. Phone interviews are effective in collecting data for pre-rinse spray valves, pool pumps, and walk-in refrigerators/freezers, and sometimes unit heaters and duct furnaces, but data for the other standards evaluated usually had to be collected on site.

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