CALIFORNIA
ENERGY
COMMISSION

FUEL DELIVERY TEMPERATURE STUDY

COMMISSION REPORT

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ABSTRACT

This report was prepared in response to AB 868 (Davis, Chapter 398, Statutes of 2007). The bill directs the California Energy Commission to conduct a cost-benefit analysis and make recommendations relative to the implementation of Automatic Temperature Compensation devices at retail service stations. Like many other liquids, fuel experiences expansion and contraction with temperature change. So the warmer the fuel, the less energy and fewer miles to the gallon a vehicle will receive. The Energy Commission analyzed and compared the options of retaining the current reference temperature of 60 degrees Fahrenheit, establishing a different statewide reference temperature, and requiring the installation of automatic temperature compensation equipment at retail.

Keywords: ATC, automatic temperature compensation, diesel, fuel dispensers, fuel temperature, gasoline, prover temperature, reference temperature, temperature compensation, volume correction factor, weights and measures

EXECUTIVE SUMMARY

The issue of reduced volumes of gasoline or diesel when distributed at high temperature, or "hot fuel," is not new. It is, however, a controversial subject that has created strong and divergent opinions. Some stakeholders believe that if temperature compensation was practiced at retail stations, motorists would realize significant monetary benefits in the warmer areas of the United States. Other stakeholders representing business interests believe that the costs to retail station owners will be significant.

Hawaii is the only state that has adopted temperature compensation at retail outlets by allowing existing retail fuel dispensers to be modified to distribute an additional quantity of fuel (as measured in cubic inches) to compensate that the fuel sold is warmer. Hawaii's retail sales unit of gasoline is now 233.8 cubic inches, roughly equivalent to how much a standard gallon of gasoline would expand when warmed from 60 to 80 degrees Fahrenheit. Canada, too, has adopted regulations and standards for automatic temperature compensation (ATC) at retail. Even though ATC at retail is voluntary in Canada, more than 90 percent of the retail stations have converted to using the equipment. Most of the time in Canada, the temperature of the fuel is colder than the reference standard of 60 degrees Fahrenheit. The ATC dispensers compensate for colder fuel temperatures by decreasing the average size of the liter dispensed to motorists in that country.

This national debate has continued for several years but without any analysis being performed to determine if ATC at retail stations would be a net benefit to retail motorists. As a result of these activities and the lack of analysis, in October 2007 the California Legislature passed and the Governor signed Assembly Bill 868 (Davis), which directed the California Energy Commission to conduct a cost-benefit analysis.

This report quantifies the benefits and costs associated with temperature compensation for retail sales of gasoline and diesel fuels in California. The cost-benefit analysis concludes that the results are negative or a net cost to society under all the options examined, however when quantified by cents per gallon these costs are small. The estimated total annual recurring net costs to society, if completely passed through to consumers, could amount to between eight hundredths (8/100) and 18 hundredths (18/100) of a cent per gallon. It is also unlikely that there are any plausible circumstances consumers could receive a small net benefit with installed ATC devices at California's retail stations.

The primary issues associated with the ATC debate is best characterized in a series of questions.

- *Is the temperature of gasoline and diesel fuel sold to California consumers warmer, on average, than the 60 degree Fahrenheit reference standard?*

California is considered a warmer state regarding fuel temperature at retail stations. Based on the results of a recent survey of retail stations, the average temperature of regular grade gasoline during the base period from April 2007 through March 2008 was about 71 degrees Fahrenheit. Diesel fuel was a little warmer with an average temperature of nearly 73 degrees Fahrenheit.

- *If temperature compensation has been instituted for most wholesale transactions to remove the inequity of temperature variations, why has that practice not extended to the California retail consumer?*

Currently, no retail station owner has chosen to install and operate ATC-ready dispensers in California. Whether California law currently permits the voluntary installation and activation of ATC devices by retail station owners for retail sales transactions of gasoline and diesel fuel has been disputed by stakeholders.

- *If ATC was mandated at retail stations in California, how would businesses and consumers be impacted? Would the overall costs outweigh any potential benefits?*

California retail motorists are expected to receive slightly larger gallons (as measured in cubic inches) that vary in size with changes in temperature. ATC devices adjust for warmer fuel temperatures by slightly increasing the size of the gallon dispensed to California consumers (in cubic inches). The adjustment for the motorist would be approximately 1 percent for every 15 degree Fahrenheit increase in the temperature of gasoline greater than the reference standard of 60 degrees Fahrenheit. The slightly larger and variable sized gallons (in cubic inches) would not have changed the total amount of fuel consumed in the state as measured in cubic inches, but would have reduced the actual number of net or adjusted gallons purchased by motorists.

If ATC had been installed at retail gasoline stations during the one-year study period, the quantity of net gasoline gallons sold would have been approximately 15.5 billion or about 117 million gallons less compared to status quo (no ATC at retail outlets) because the fuel was warmer (71.1 degrees Fahrenheit) than the 60 degree Fahrenheit reference standard.

Under the ATC scenario, the quantity of net diesel fuel gallons sold would have been approximately 3.037 billion or about 19 million gallons less compared to the status quo (no ATC at retail) of 3.056 billion because the fuel was also warmer (72.9 degrees Fahrenheit) than the 60 degree Fahrenheit reference standard.

Currently, motorists compare retail fuel prices when deciding where to purchase fuel for their vehicle. Prices posted by two retail stations at an intersection showing identical prices may appear to be equivalent in value by the consumer, but if the fuel temperature at one station is higher than the other, the motorist would want to select the station with the cooler fuel temperature. If ATC were mandated for use at retail stations, consumers would be able to more accurately and fairly compare prices because variations in temperature would be corrected by the ATC equipment. California consumers could expect a slight financial benefit of approximately $258,000 per year due to this increased price transparency.

California retail station owners would experience additional expenses for the ATC retrofit equipment and slightly higher inspection fees. If ATC devices are mandated, California businesses would incur a total first cost between $103.8 million and $127.4 million, or between $10,704 and $13,136 per retail outlet. Recurring costs for more expensive ATC-ready dispensers, maintenance, and higher inspection fees would total between $7.4 million and $20.6 million per year.

The initial ATC retrofit costs combined with the recurring annual expenses would average between eight hundredths (8/100) and 18 hundredths (18/100) of a cent per gallon, if retail station owners pass through all of the retrofit expenses by raising fuel prices over 10 to 15 years.

- *Would retail station owners charge the same price if ATC equipment is installed and dispensed slightly larger sized gallons when fuel is warmer than the 60 degree Fahrenheit standard? If so, would consumers still receive anticipated financial benefits?*

If retail station owners and operators continue to grow and remain profitable, then retail station owners will most likely raise their fuel prices to compensate for selling fewer "gallons." If this is the case then expected benefits for retail motorists will be essentially zero. It should be noted, however, that some stakeholders assert that there is a degree of uncertainty regarding the ability of retail station owners to completely and successfully maintain their profit margins over the long-term if ATCs are mandated at California retail stations.

- *If a new reference temperature was mandated, would the overall costs to businesses and governmental agencies to implement and oversee the program outweigh any potential benefits?*

The estimated costs of adopting a new reference temperature and a larger gallon size (in cubic inches) could total between $9 million and $27.9 million or from $925 to $2,879 per retail station. On a per-gallon basis these additional expenses incurred by retail station owners would be between five hundredths (5/100) and 15 hundredths (15/100) of a cent per gallon for only one year. After the modifications were completed, there would be no additional recurring costs for businesses or consumers.

Primary Recommendations

- If the ***only criterion*** for assessing the merit of mandatory ATC installations for use at California retail stations is a net benefit to consumers, the Transportation Committee (Committee) of the California Energy Commission concludes that ATCs should not be required since the results of the cost-benefit analysis show a net cost for consumers.

- However, the Committee recommends that the Legislature also consider whether the possible value of increased fairness, accuracy, and consistency of fuel measurement, in addition to the benefits quantified in the cost-benefit analysis, justify mandating ATC at California retail stations.

- If the Legislature chooses to mandate the use of ATC at retail stations, two options are available: (1) require all retail stations to retrofit their fuel dispensers over a two-year period, or (2) a more gradual phase-in approach, requiring new and refurbished stations to install, ***but not activate***, ATC devices over a five-year period. The remainder of retail stations would be required to install ATC devices during the fifth year, and all stations would activate their devices at the end of that year. Such a phase-in approach is the least-cost option for mandatory ATC, although it would still result in a net cost to society.

- If the Legislature chooses not to mandate the use of ATC at retail stations, the Legislature may wish to clarify whether the current intent of the existing statutes is to permit or prohibit voluntary ATC at retail outlets for gasoline and diesel fuel.

- If the Legislature chooses to permit or mandate ATC at retail, they should direct the California Division of Measurement Standards to develop standards addressing equipment approval, certification testing, compliance enforcement, and consumer labeling provisions for ATC at retail stations.

- Based on the report analysis, the Committee concludes that establishing a new statewide reference temperature, or different regional reference temperatures for the state, would not successfully address temperature compensation at the retail level and therefore does not recommend this approach.

Areas for Further Research

Research in the following areas is recommended to supplement the cost-benefit analysis presented in this report.

- The possible value of increased fairness, accuracy, and consistency benefits of ATC to consumers, which was not included in this analysis, should be estimated through focus groups and survey methods that assess consumers' willingness to pay for such benefits.

- The value of increased price transparency associated with ATC, as calculated in this report, should be refined through further research on the fuel temperature variation between adjacent retail stations.

CHAPTER 1: Introduction

Background

Expansion and Contraction of Liquids

Liquids, regardless of type, expand and contract within the space they occupy under varying temperatures. Increasing temperatures will cause a liquid to expand and occupy a slightly larger volume. The converse is also true, as decreasing temperatures will cause a liquid to contract in volume. Usually, the less dense a liquid is, the greater its capacity to expand and contract with equivalent temperature changes. These expansion and contraction characteristics only apply as long as the material remains a liquid.[1]

The importance of these physical changes in volume due to changes in temperature has been known for more than a century by the petroleum industry. It was determined that fluctuation in a liquid's temperature could alter the quantity of product available for sale or use. For example, a refiner would purchase warm crude oil from an oil field producer and place the oil in storage tanks before processing. Before distillation, the oil cools down to ambient temperature, and the volume that the liquid occupies shrinks in size, resulting in fewer barrels available to the refiner than were originally purchased from the producer. Likewise, petroleum fuels stored in above ground tanks at refineries or distribution terminals can expand at warmer (and contract at cooler) ambient temperatures, creating variation in the energy content of a gallon of fuel sold at wholesale.

To remedy these types of potential wholesale transaction inequities, a national standard reference temperature of 60 degrees Fahrenheit was adopted, enabling a seller and buyer to calculate the exact number of standard gallons (231.0 cubic inches at 60 degrees Fahrenheit) involved in a transaction, regardless of the temperature of the fuel at the time of the sale. However, gasoline and diesel fuel sold at retail in California is not adjusted to compensate for variations in temperature, leading to concerns over potential inequities for motorists.

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[1] Liquids that reach a temperature point when a transition to a gaseous phase initiates will no longer adhere to their coefficient of expansion. Also, as liquids cool to the point that a transition to a solid phase begins, the material will begin to exhibit different properties of contraction or possibly expanding as in the case with water freezing.

Net (Standard) and Gross (Non-standard) Gallons

Various units of measurement are used in this report when describing petroleum sales transactions. Gallons of transportation fuel are normally expressed in common usage in two ways: net or gross.

"Net gallons" is a phrase used throughout this document and is a shorthand version familiar to most people and the petroleum industry alike. However, the more precise terminology is standard or temperature-assigned gallons. A standard gallon is a specific volume of fuel (231.0 cubic inches) at an exact temperature (60 degrees Fahrenheit), which is why net gallons are also expressed as temperature-assigned gallons. The other phrase, "gross gallon", is normally used to express the types of gallons transacted at retail stations. The more precise terminology, although, is either "non-standard" or "unit" gallons. A non-standard gallon is a specific volume of fuel (231.0 cubic inches) dispensed at any temperature. A standard (net) and non-standard (gross) gallon of gasoline would only be equivalent in volume (231 cubic inches) when the temperature is exactly 60 degrees Fahrenheit). At any other temperature, these two different forms of expressing gallons would not be equivalent. Temperature compensation means that the transaction would be expressed in standard or net gallons.

California wholesale fuel market transactions are measured in standard or net gallons that account for variations in density and temperature. California retail market transactions, on the other hand, are measured in non-standard or gross gallons that do not account for variations in density and temperature. A non-standard or gross gallon is measured as 231 cubic inches, regardless of temperature. A change from gross to net gallons at retail stations in California would not be similar to a conversion to the metric system, as some stakeholders have suggested, because the cubic inches dispensed to retail motorists would vary according to temperature. The number of cubic inches dispensed to retail motorists if stations converted to liters would be fixed under varying temperatures.

Petroleum Transactions - Standard of Measurement

The National Bureau of Standards is credited with having published, in 1916, the first handbook of liquid hydrocarbon thermal expansion tables based on temperature and density. By 1952, the American Society for Testing and Materials (ASTM) and the Institute of Petroleum (IP) published an expanded set of tables using three types of measurement standards: metric, British (or Imperial), and U.S. units.[2] The reference temperatures used were 60 degrees Fahrenheit and 15 degrees Celsius. Density values were represented by American Petroleum Institute (API) gravity, relative density, and density measured in kilograms per cubic meters (kg/m^3). These new tables enabled market participants to determine what the actual delivered volume of any transaction should be if the temperature of the petroleum liquid varied from the reference standard of 60 degrees Fahrenheit.

The process for determining how many net gallons are involved in a wholesale transaction require knowing the gross gallons, average temperature, and density of the fuel involved in the sale. This information is then used with mathematical equations related to the reference volume correction factor tables to calculate the quantity of net gallons.

It is uncertain exactly when the majority of wholesale transactions for liquid petroleum products in the United States were consummated using the 60 degree Fahrenheit reference

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[2] ASTM has expanded and is now referred to as ASTM International [http://www.astm.org/].

standard and volume correction factors from published tables, but it is reasonable to accept that this practice has been commonplace for at least 50 years.

Temperature Compensation at Wholesale

Today, temperature compensation for wholesale transactions has advanced to the point that electronic devices and software programs are readily available and can continuously monitor the temperature of liquid hydrocarbons being transferred to a tanker truck, barge, or marine vessel and can determine what volume of fuel would have been loaded if the temperature of the fuel had been 60 degrees Fahrenheit. Through this technology, temperature has now been removed as a variable in wholesale transactions of petroleum product liquids at most locations throughout the world.

According to a recent California Energy Commission (Energy Commission) survey of the distribution terminals serving California,[3] transactions at the terminal are measured in gross gallons and then a software calculation using the API gravity and temperature of the dispensed fuel is used to calculate the quantity of net gallons. The net gallons are then multiplied by the posted net gallon price to calculate the total cost for that load of fuel.

Retail station owners have the option of purchasing deliveries on either a gross or net basis for a year. California Business and Professions Code Section 13520 states:

> "It is unlawful for any distributor or for any broker to sell any product to a retailer or to any person, when the quantity distributed in any single delivery to a single location is 5,000 or more gallons, as, or purporting to be, gasoline or diesel fuel, unless the distributor or broker, as the case may be, offers to invoice the purchaser for such gasoline or diesel fuel on the basis of temperature-corrected gallonage to 60 degrees Fahrenheit for all such deliveries to the purchaser over a period of 12 consecutive months and settles his accounts with the purchaser on the same basis."

Energy Commission staff learned that the majority of retail stations buy on a net basis. Since temperature compensation does not occur at the retail level, the transactions that occur throughout the entire distribution chain of transportation fuels do not use a standard unit of measure.

Retail Transactions and Temperature Compensation

The practice of compensating for differences in temperature during sales transactions for petroleum products at wholesale has not been extended to retail station sales to consumers. The technology necessary to enable automatic temperature compensation (ATC) at retail locations was developed during the 1980s. Advances in electronics, miniaturization, and computing capability have reduced the costs to a level that improved economic affordability for retail operators.

Retail ATC devices do not function the same way as the temperature compensation units used at the wholesale level. A retail ATC unit dispenses either a greater or lesser quantity of cubic inches based on the volume correction factor (VCF) calculated using the temperature and density characteristics of the dispensed fuel. The density value is input into the software of the

[3] California Energy Commission sent out a terminal survey in August 2008. See Appendix F for a copy of the survey questions.

device and will remain fixed over the life of the unit unless a technician manually changes the input value.

No California retail fuel outlets currently practice temperature compensation. If temperature compensation was implemented at retail stations in California, distribution of fuel under warmer temperature conditions would be adjusted by dispensing (compared to the volume indicated by the device) slightly more gasoline or diesel fuel in cubic inches provided to motorists. Conversely, if the fuel is colder than 60 degrees Fahrenheit, fewer cubic inches would be dispensed to motorists.

California law stipulates that retail gasoline must abide by the latest standards as recommended by the National Institute of Standards and Technology (NIST) Handbook 44 that states that a gallon is 231 cubic inches and does not mention the temperature of the fuel.[4] California law specifies the following:

- Requires retailers to sell motor fuel by the gallon.[5]
- Requires retailers to advertise prices on a per gallon basis on its dispensers.[6]
- Defines a gallon as "231 cubic inches (exactly)."[7]

Whether California law currently permits the voluntary installation of ATC devices by retail station owners for retail sales transactions of gasoline and diesel fuel has been disputed by stakeholders.

County sealers of weights and measures inspect fuel dispensers to ensure compliance with California law, making certain that five gallons dispensed measure 1,155 cubic inches, within a tolerance level of plus or minus six cubic inches. California Business and Professions Code Section 12240(d) states: "Retail gasoline pump meters, for which the above-fees are assessed, shall be inspected as frequently as required by regulation, but not less than once every two years."

National ATC Debate

The debate involving temperature compensation at retail in the United States has been ongoing for several decades. The primary discussion and analysis has been carried out by the National Conference of Weights and Measures (NCWM). This organization consists of state agencies that develop measurement standards and enforcement procedures to strive for a balance of fairness for both businesses and consumers. Active members include representatives of private companies that have some connection to the product measurement in transactions. Careful deliberation and methodical development of proposed new standards are hallmarks of this organization.

The NCWM has compiled an extensive body of information and analysis regarding ATC that cannot be adequately characterized in this section. One of the most difficult ATC issues involves the national versus regional approach. Based on retail fuel temperature data presented at NCWM proceedings, it is clear that some portions of the United States have annual fuel temperatures warmer than the reference standard of 60 degrees Fahrenheit, while other regions

[4] Handbook 44, Appendix C – General Tables and Units of Measure.
[5] See California Business and Professions Code §12107 (incorporating Handbook 44 § 3.30 ¶ S.1.2.1 (2007 Ed.) ("[d]deliveries shall be indicated and recorded … in …gallons and decimal subdivisions or fractional equivalents thereof []").
[6] See Title 4 C.C.R. § 4201.
[7] See Business and Professions Code §12107; Title 4 C.C.R. §§ 4000; 4001 (incorporating Handbook 44, App. C at pp. C-3, C-9 and C-16).

are below the reference standard. These regional variations can complicate a perceived "one-size-fits-all" regulatory action being called for by stakeholders representing consumers. Although national standards could be developed for use by individual states or regions of the United States, the matter of mandating ATC at retail could ultimately be decided by individual state legislative and regulatory bodies. However, almost all aspects of this ATC debate have been addressed by the organization.[8]

[8] Presentations and other documentation involving ATC may be viewed by accessing the NCWM meeting archive site at: [http://www.ncwm.net/events/index.cfm?fuseaction=meeting_archives].

California Issues

The debate in California regarding retail temperature compensation (TC) is similar to the one at the national level, an issue that involves perceptions of fairness, concerns over costs, and the valuation of potential consumer benefits. There are a number of questions that Energy Commission staff has attempted to address in this report. These are:

- *Is the temperature of gasoline and diesel fuel sold to California consumers warmer, on average, than the 60 degree Fahrenheit reference standard?*

- *If temperature compensation has been instituted for most wholesale transactions to remove the inequity of temperature variations, why has that practice not extended to the California retail consumer?*

- *If ATC was mandated at retail stations in California, how would businesses and consumers be impacted? Would the overall costs outweigh any potential benefits?*

- *Would retail station owners charge the same price if ATC equipment is installed and dispensed slightly larger sized gallons when fuel is warmer than the 60 degree Fahrenheit standard? If so, would consumers still receive anticipated financial benefits?*

- *If a new reference temperature was mandated, would the overall costs to businesses and governmental agencies to implement and oversee the program outweigh any potential benefits?*

- *Are there some factors that may be difficult to quantify, yet have a potentially significant bearing on the primary conclusions?*

- *If ATC was mandated, what types of standards should be adopted that address:*
    - *Timing of the transition?*
    - *Labeling?*
    - *Differences in fuel density?*
    - *Enforcement of the standard?*

Assembly Bill 868

Assembly Bill 868 (Davis, Chapter 398, Statues of 2007) requires the California Energy Commission, in partnership with the Department of Food and Agriculture and the California State Air Resources Board, to conduct a cost-benefit analysis and to make recommendations relating to ATC reference temperature for fuel dispensation. The bill requires that the Energy Commission evaluate and compare the following options for temperature compensation:

- Retaining the current reference temperature of 60 degrees Fahrenheit.
- Establishing a different statewide reference temperature.
- Establishing different regional reference temperatures for the state.
- Requiring the installation of temperature correction or compensation at the pump.

The Energy Commission also was directed to include in its analysis how ATC may apply to alternative fuels and the low-carbon fuel standard (LCFS).

After the Governor signed the legislation in October 2007, the Energy Commission held three staff workshops in January, March, and June 2008, as well as a publicly open advisory group meeting in April 2008. Following a Committee workshop in December 2008, the report is scheduled for adoption at an Energy Commission Business Meeting. Following the adoption the report will be sent to the Legislature in February of 2009.

In January 2008, the Energy Commission convened an advisory group that included equipment manufacturers, consumer groups, fuel industry representatives, agricultural commissioners/ sealers of weights and measures, representatives of government agencies, and other interested parties who would provide guidance on the analysis and recommendations for the study. The advisory group communicated directly with Energy Commission staff, had an active role in the workshops, and provided expertise on the issue of temperature compensation. The advisory group included:

- AAA of Northern California, Nevada and Utah
- American Petroleum Institute
- American Trucking Association
- Arizona Department of Weights and Measures
- Arizona Petroleum Marketers Association
- Boyett Petroleum
- California Air Resources Board
- California Department of Food and Agriculture (Division of Measurement Standards)
- California Independent Oil Marketers Association
- California Trucking Association
- Former head of Hawaii Department of Weights and Measures
- Kraus Global, Inc.
- Los Angeles County Weights and Measures Department
- Measurement Technology International, Ltd.
- Metercal
- National Association of Convenience Stores
- National Association of Truck Stop Operators
- Natural Resource Defense Council
- New York Department of Agriculture and Markets, Bureau of Weights and Measures
- Owner Operator Independent Driver Association
- Petroleum Marketers Association of America
- Public Citizen's Energy Program
- Sacramento County Department of Weights and Measures
- Society of Independent Gasoline Marketers
- The Foundation for Taxpayer and Consumer Rights

Energy Commission staff interpreted the legislation (see Figure 1) to mean that a cost-benefit analysis would be used to compare three options: implementation of temperature compensation at retail outlets, a new reference temperature, and status quo. Staff divided temperature compensation into two subsets: the installation of retrofit kits for dispensers and the installation of new dispensers.

Upon the recommendation of the California Department of Food and Agriculture's Division of Measurement Standards and other stakeholders, the Energy Commission staff decided to exclude the option of regional reference temperature in the analysis due to inspection complications and confusion that would result from that option. Instead, the Energy Commission staff analyzed the statewide reference temperature option (deemed the "Hawaii example") that involves changing the amount of fuel dispensed at the retail level and not changing any operations at the wholesale level. A higher reference temperature would mean that the 231-cubic-inch gallon mandated by law at retail stations would change to a gallon that would be larger than 231 cubic inches in volume.

The Division of Measurement Standards requested county sealers begin surveying fuel temperature in California before passage of Assembly Bill 868. The fuel temperatures were recorded during the regular inspection by county sealers at retail sites between April 2007 and March 2008. The data collected does not yield information of differences in temperatures between retail sites in a particular county or local location.

Figure 1: Assembly Bill No. 868

An act to add Article 19 (commencing with Section 13630) to Chapter 14 of Division 5 of the Business and Professions Code, relating to gasoline dispensing.

[Approved by Governor October 10, 2007. Filed with Secretary of State October 10, 2007.]

LEGISLATIVE COUNSEL'S DIGEST

AB 868, Davis. Gasoline dispensing: weights and measures.

Existing law regulates gasoline temperature and measurement for purposes of dispensing fuel at retail facilities.

This bill would require the California Energy Commission, in partnership with the Department of Food and Agriculture and the State Air Resources Board, to conduct a cost-benefit analysis and survey, as specified, and to make recommendations to the Legislature regarding future legislation and regulations, regarding the reference temperature for fuel dispensation, as specified, not later than December 31, 2008.

The people of the State of California do enact as follows:

SECTION 1. Article 19 (commencing with Section 13630) is added to Chapter 14 of Division 5 of the Business and Professions Code, to read:

Article 19. Fuel Delivery Temperature Study

13630. (a) The California Energy Commission in partnership with the Department of Food and Agriculture and the State Air Resources Board shall conduct a comprehensive survey and cost-benefit analysis, as follows:

(1) The department shall conduct a survey on the effect of temperatures on fuel deliveries. The survey shall be conducted during routine dispenser inspections by determining the accuracy of fuel delivery, and recording fuel temperature, air temperature, and storage tank temperature at fuel stations and other fuel facilities subject to inspection. It is the intent of the Legislature that the department use data collected by the survey that the department started on April 1, 2007, and will complete on March 31, 2008.

(2) The department shall transmit the results of the survey to the California Energy Commission, which shall conduct a cost-benefit analysis and comparison of various options relative to temperature-corrected gallon temperatures for the following:

(A) Retaining the current reference temperature of 60 degrees Fahrenheit.

(B) Establishing a different statewide reference temperature.

(C) Establishing different regional reference temperatures for the state.

(D) Requiring the installation of temperature correction or compensation equipment at the pump.

(b) The commission shall evaluate how different reference temperatures or temperature correction devices apply to alternative fuels and low-carbon fuel standards.

(c) The California Energy Commission shall convene an advisory group no later than January 25, 2008, including, but not limited to, equipment manufacturers, consumer groups, fuel industry representatives, agricultural commissioners, appropriate government agencies, and other interested parties to provide guidance on the study pursuant to this section and provide guidance on the analysis and recommendations.

(d) The California Energy Commission, in partnership with the Department of Food and Agriculture and the State Air Resources Board, shall conduct public hearings on the results of the cost-benefit analysis and report to the Legislature regarding recommended legislation and regulations based on the results of the study not later than December 31, 2008.

CHAPTER 2:
Other Approaches and Studies

Other Approaches to Retail Temperature Compensation

To date, temperature compensation at retail stations has been adopted in Hawaii, Canada, and Belgium. This section describes the approach used by Hawaiian officials to change the reference size of their retail gallon (adopting a different reference temperature for retail fuel). In addition, this section details Canada's voluntary use of automatic temperature compensation (ATC) at retail outlets and the recent changes in Belgium for a phased-in mandatory use of ATC at their retail stations.

Hawaii

With an average daily temperature slightly above 80 degrees Fahrenheit, Hawaii has a consistently warm climate. Hawaii approached the thermal expansion issue by adopting a new reference temperature of 80 degrees Fahrenheit.[9] In 1974, Hawaii enacted law to allow retail fuel dispensers to be modified such that the size of each dispensed retail sales unit would be slightly larger than the gross or non-standard gallon of 231 cubic inches at any temperature.[10] Hawaii's retail sales unit of gasoline is now 233.8 cubic inches, roughly equivalent to how much a standard gallon of gasoline would expand when warmed from 60 to 80 degrees Fahrenheit. A retail sales unit of diesel fuel dispensed in Hawaii now contains 233.3 cubic inches at any temperature.

George Mattimoe (former Deputy Director, Division of Weights and Measures, Department of Agriculture, State of Hawaii, and former chair of the National Conference of Weights and Measures) spear-headed the campaign to have a standardized unit of measure for Hawaii and advocated for a national standard of measurement for fuel for the United States.[11]

In 1974, at the 69th National Conference on Weights and Measures, Mr. Mattimoe presented the work done in Hawaii to address the thermal expansion issue.[12] In Hawaii, they adjusted the dispensers to deliver a larger gallon to accommodate the average temperature for Hawaii. He stated that the adjustment process occurred over a year. In total, 80 to 85 percent of all dispensers were recalibrated by the meter inspectors during their routine inspections.[13]

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[9] Although Hawaii's average temperature is slightly higher, the reference was rounded down to 80 degrees Fahrenheit (interview with George Mattimoe, April 4, 2008).

[10] Act 239 revised statutes 486-50, [http://www.capitol.hawaii.gov/hrscurrent/Vol11_Ch0476-0490/HRS0486/HRS_0486-0052.htm].

[11] George Mattimoe invented the first known Automatic Temperature Compensated retail gasoline dispenser in the United States. A thorough review of the history and technical issues associated with temperature compensation is covered by Mr. Mattimoe in his paper, The Intellectually Dishonest Myth Regarding The Accurate Delivery of a Standard Gallon of Gasoline at Retail, January 13, 2009. [http://www.energy.ca.gov/transportation/fuel_delivery_temperature_study/documents/comments/2009-01-13_George_Mattimoe-Intellectually_Dishonest_Myth_Re_Accurate_Deliver_of_a_Gallon_of_Gas_TN-49799.PDF]

[12] George Mattimoe, presentation at 69th National Conference on Weights and Measures, 1974.

[13] 69th National Conference on Weights and Measures, 1974.

Mr. Mattimoe advocated that all transactions throughout the year should be equitable to the buyer and seller. Despite improving the situation and reportedly saving consumers money by having a higher reference temperature, he does not favor advocating a new reference temperature. In his 1974 presentation, he mentioned that "two wrongs don't make a right" in that shorting the consumer in the warm season and shorting the retailer in the cold season does not result in equity. He also states the disparity is amplified when the average American motorist drives more in the summer season than in the winter season.

Energy Commission staff believes that a reference temperature is more viable in Hawaii because there is little seasonal volatility in climate temperatures throughout the year, as well as small geographic differences in temperature in areas dispensing gasoline on any given day. California, on the other hand, has many climate zones that have large variations in seasonal temperatures throughout the year. The existence of the diversity and range of temperatures at any given time in California would also make the reference temperature option not as preferable as it is in Hawaii.

As mandated by the AB 868 legislation, the Energy Commission evaluated the effects of implementing a new statewide reference temperature for California. The Energy Commission staff assumes that the only change in operation would be the retail station dispensing a fixed gallon larger in size than 231 cubic inches and that there would be no changes in wholesale operations at refineries and distribution terminals.

Canada

In the early 1990s, Canada established standards that allowed retailers to sell temperature-compensated fuel, but did not require temperature compensation for the entire country. According to Measurement Canada, in 1984, a Canadian electronics manufacturer designed an ATC device that could readily measure the temperature of liquids and perform the calculations necessary for fuel compensation. Today, more than 90 percent of Canadian fuel retailers voluntarily sell temperature-compensated fuel.[14] All temperature compensation devices must be operating throughout the year and cannot be turned off. The pumps with automatic temperature compensation must be identified by having a sticker on the register that says "Volume Corrected to 15°C."[15]

According to an ATC retrofitter, the information printed on the receipt is limited due to the inability of the ATC technology to communicate with the dispenser receipt printing technology. A Canadian receipt can show only the net gallon amount and whether the gallons dispensed were temperature compensated. The receipts will not have any information on the temperature nor will the receipt post both net and gross quantities sold.

Energy Commission staff learned that the ATC was marketed to retailers by ATC retrofitters as a cost-saving technology that provides a more accurate method of measuring fuel and addresses inventory loss issues caused by the cold Canadian climate. Retailers soon learned that the operation of retail ATC in a colder fuel temperature climate would result in less volume (in cubic inches) being dispensed to customers using a reference of 15 degrees Celsius. Additional revenue could be obtained, therefore, by charging the same price for the slightly smaller sized liters. Retailers who could successfully increase their revenues in this manner used the

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[14] Measurement Canada (an agency of Industry Canada), *Information Bulletin - Automatic Temperature Compensation and the Retail Sale of Gasoline and Diesel Fuel*, April 8, 2005 (updated February 21, 2008), [http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00116.html].

[15] Measurement Canada Information Bulletin, revised January 1, 2008, [http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00116.html].

additional money to recoup the cost of purchasing and installing the ATC devices over some reasonable period of time. In fact, Canadian fuel retailers prioritized their higher-volume petroleum product fuel dispensers (regular grade gasoline) for conversion because the payback period for this investment was shorter when compared to premium grade gasoline sales.[16]

Without any ad hoc policy report detailing the effects of ATC in Canada, Energy Commission staff perceives that the standard unit of measure for fuel for 90 percent of the distribution chain benefited retailers and consumers, but retailers benefited more by dispensing a smaller gallon. Retailers now have a technology that fixes the problem of inventory loss reconciliation from colder temperatures, and consumers can now more accurately compare prices among competing retail fuel stations because the number of volume units (liters) received and the associated unit prices (price-per-liter) equally reflect those transaction components at a standard reference temperature.

Energy Commission staff understands that a retailer's incentive to implement ATC can be influenced by a state's climate. Retailers have the incentive to incorporate ATC in a "cold fuel state." In a "hot fuel state" consumers will demand temperature compensation since the retailer will not have the incentive to implement ATC unless it is a marketing advantage for them. The voluntary status and widespread implementation of ATC in Canada implies that a mandatory policy could be necessary to deal with thermal expansion in "hot fuel states."

[16] Measurement Canada, *Policy on Use of Automatic Temperature Compensation*, Bulletin V-19 (rev.1), issued May 13, 2005, page 1, [http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00116.html].

Belgium

Belgium passed laws mandating temperature compensation for retail sales of fuel beginning in January 2008. The phase-in period to comply with the law is underway, and retailers are purchasing ATC retrofits. The Energy Commission has learned that retrofit companies are marketing universal retrofit kits that can be installed on most dispensers regardless of the dispenser make and model. The universal retrofit kits are broken down by the number of products a dispenser distributes. The law's intention is to require a standard unit of measure throughout the entire distribution chain.

Other Studies

Temperature compensation of retail fuels has been debated for an extensive period. Periodically, various entities undertake analysis or research for purposes of assessing the potential merits of ATC at retail stations. This section highlights three of those studies that have been published over the last nine years in the United Kingdom, Australia, and most recently by the Federal Government Accountability Office (GAO).

United Kingdom

In 1999, the United Kingdom's National Weights and Measures Laboratory (NWML), a government agency, released a report on temperature compensation prepared by its contractor, National Engineering Laboratory (NEL), an industrial research organization.[17] NWML commissioned the study to investigate the effects of temperature on petroleum transactions from the gantry loading meter (called "distribution terminal" in California) through the retail level, including underground storage tanks. Concern over product loss due to temperature change, primarily between the wholesaler and retailer, motivated the study. The result was a list of 15 recommendations to improve the petroleum distribution chain. Specifically, the report recommended a voluntary adoption of standard temperature accounting, which accounts for volumes at a standard temperature, since reduced capital and labor costs from technology improvements would allow for improved efficiency and reduce operating costs.

To gather information and data, NEL requested information from industry representatives and trade organizations using forms, outreach letters, and a seminar. NEL contacted 16 retailers, 56 oil and supply managers, and 19 trading standards officers, in addition to contacts with oil and retail organizations. One of the surveys was sent out to oil depots requesting information involving the temperature of gasoline and diesel, the source, storage temperature, and seasonal fluctuations of the fuel. They received responses from 16 depots and 6 companies, which were categorized based on their fuel supply source, such as sea, pipeline, or refinery. NEL found that there were temperature differences among different oil depots. While differences occurred both above and below the 15 degrees Celsius (59 degrees Fahrenheit) petroleum standard, the average fell below that mark and typically followed trends in the ambient air temperature.

Some of the data was gathered by other organizations as well. The Petrol Retailers' Association sent NEL results from a survey of 67 retail stations. This data shows some stock loss for gasoline that could possibly be due to temperature. The results for diesel differed, however, showing gains as well as losses for diesel stocks. Their survey classified stations into two categories: motorway or other stations.

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[17] Boam, D. and Paton, R., National Engineering Laboratory, *Temperature Compensation of Liquid Fuels*, a study for National Weights and Measures Laboratory, Project No. NWM006, Report No: 184/99, July 21, 1999, [http://www.nwml.gov.uk/Docs/FAQs/MID/NEL%20REPORT%20Temp%20Comp%20on%20LF.pdf].

The NEL investigated the situation in the United Kingdom but also interviewed stakeholders from other countries, particularly within Europe, to understand their current practices with temperature compensation. At the time of their study, Canada, the Netherlands, Switzerland, and Germany had temperature compensation while Australia, the United States, Austria, Poland, Spain, Sweden, Ireland, Denmark, the Czech Republic, Iceland, and France did not. The study strongly recommended Australia and Canada as contacts due to their well-documented history with temperature compensation.

Among other things, the NEL report found that the petroleum industry should adopt standard temperature accounting (known as automatic temperature compensation in the United States) to 15 degrees Celsius, but the standard "should be voluntary and based on contract negotiation."[18] This includes temperature accounting at the wholesale level as well as the retail level for consumers. As a requirement, the report recommended disclosure of temperature on the bill of lading. To ensure that volume changes due to temperature are accounted for after the fuel has left the gantry meter, NEL also recommended delivery trucks should be fitted with temperature probes, but only for accounting and not contract purposes. The NEL also believed it was important to have a system of self-verification and audit by trading standards officers at the gantry meters.

Australia

In 2001, the Australian government released a regulatory impact statement (RIS).[19] Similar to California, Australia has a warm climate and has fuel that is warmer on average than the reference temperature. Citing a 1996 Australian study on temperature compensation,[20] the 2001 RIS focused on the effects of temperature compensation implementation on independent wholesale/retail establishments along with the effects on Australian motorists.

Concerned about the competiveness of the retail fuel market in the absence of temperature compensation, the RIS recognized an unfair competitive edge to oil majors that do have temperature compensated transactions at the wholesale level over independent stations that do not have temperature compensated transactions. The regulatory proposal was to increase the transparency of volume measurement and pricing of petrol and diesel fuel within the oil industry. Considering all other alternatives,[21] the RIS recommended mandatory temperature compensation of fuel from refineries and terminals due to its very low cost and increased confidence in the market from the elimination of market distortion between oil majors and independent oil companies. The RIS stated that mandatory temperature compensation at the retail level would involve considerable costs and assessed it as an inferior alternative compared to other options.

The Australian study determined that mandatory temperature correction is not justified by stating that the costs associated with temperature compensation at retail would put upward

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[18] Ibid.

[19] Consumer and Business Affairs Victoria, Trade Measurement Victoria, and Office of Regulation Reform Victoria. *Regulatory Impact Statement: Temperature Compensation of Petrol and Diesel Fuel*, November 2001, [http://www.consumer.vic.gov.au/CA256902000FE154/Lookup/CAV_Publications_Fuel_Pricing/$file/of_fuel_tempcomp.pdf].

[20] Australian Institute of Petroleum, *The Temperature Correction of Petrol*, March 1996.

[21] List of alternatives: (1) Temperature compensation at refinery/terminals (the regulatory proposal), (2) status-quo, (3) temperature compensation at both refinery/terminals and depots, (4) temperature compensation phased-in at depots, and (5) temperature compensation at all wholesale and retail sites.

pressure on fuel prices, and argued that market pressures compensate for slight inaccuracies in the measurement in fuel.

Government Accountability Office Report

In September 2008, the United States Government Accountability Office (GAO) released a report on temperature compensation.[22] This report provided information on (1) the views of stakeholders in the United States on the costs to implement automatic temperature compensation, (2) the views of stakeholders in the United States on who would bear these costs, and (3) the reasons some state and national governments have adopted or rejected automatic temperature compensation.

GAO presented all the arguments and ambiguities before concluding that the issues have not changed, despite the weights and measures community debating over the costs and benefits of automatic temperature compensation for more than three decades. The report provided examples of what was done with temperature compensation in other countries like the United Kingdom, Australia, Belgium, and Canada. GAO summarized that the supporters of ATC argued for improved transparency in retail fuel prices, while the opponents argued that ATC would be too costly for retailers.

GAO concluded that the cost of implementation remains unclear and that it was also uncertain whether consumers or retailers would end up paying those costs. It also stated that none of the states or countries that have experienced temperature compensation has ever studied the effects on the retail fuels market. The report concluded that there was a clear need for an objective analysis of the cost and benefit issues raised by stakeholders. The report also noted that the Energy Commission cost-benefit analysis being prepared for California could help resolve the national debate on automatic temperature compensation.

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[22] United States Government Accountability Office, *Motor Fuels: Stakeholder Views on Compensating for the Effects of Gasoline Temperature on Volume at the Pump*, September 25, 2008, GAO-08-1114, [http://www.gao.gov/products/GAO-08-1114].

CHAPTER 3:
Data Collection and Analysis

This chapter includes details associated with the various sources of information used and analysis performed by staff to determine fuel consumption, retail prices, average fuel temperatures, and fuel density properties throughout the study period of April 2007 through March 2008.

Transportation Fuel Volumes

The volume of transportation fuel sold at retail stations during the study period is important for two reasons -- averaging the fuel temperature data and quantifying the initial consumer benefits before incorporating the revenue shift recapture by retail station operators (discussed later in the cost section of this report).

California Demand for Transportation Fuels

Approximately 23 billion gallons of gasoline, diesel and jet fuel were consumed by California motorists and businesses during 2007. Gasoline demand is estimated at 15.64 billion gallons for 2007, based on taxable sales figures reported by the California State Board of Equalization (BOE).[23] For the study period April 2007 through March 2008, taxable gasoline sales were 15.62 billion gallons, reflecting a slightly lower demand due to historically high retail prices.

Taxable sales for diesel fuel are also reported by BOE and totaled 3.08 billion gallons in 2007 and about 3.06 billion gallons during the study period.[24] A significant portion of total diesel demand is either exempt from state excise taxes (referred to as red-dyed diesel) or excluded from taxable sales figures on the basis of refunds for fuel used in an exempt manner (such as agricultural use). Staff estimates that the exempt portion of total diesel fuel sales (demand) could be between 30 and 40 percent of total demand. Since the ATC study is focused on the retail level application, excluding the exempt volumes is acceptable because the majority of these sales are through wholesale distribution terminals, rather than through retail stations or truck stops. Therefore, the taxable diesel fuel figures reported by BOE were used for this study.

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[23] BOE taxable sales figures for gasoline on a monthly basis may be viewed at the following link: [http://www.boe.ca.gov/sptaxprog/reports/MVF_10_Year_Report.pdf]. These totals also include aviation gasoline taxable sales that must be subtracted to obtain gasoline sales figures. The link to the aviation gasoline volumes is at: [http://www.boe.ca.gov/sptaxprog/reports/AVGAS_10_Year_Report.pdf].

[24] BOE taxable sales figures for diesel fuel on a monthly basis may be viewed at the following link: [http://www.boe.ca.gov/sptaxprog/reports/Diesel_10_Year_Report.pdf].

California County Demand for Transportation Fuels

The analysis performed to quantify fuel temperatures, consumer benefits, and business costs was conducted at the county level. BOE does not report taxable fuel sales by each county, so Energy Commission staff estimated monthly county fuel demand figures between April 2007 and March 2008. Staff used the *2007 California Motor Vehicle Stock, Travel, and Fuel Forecast* (MVSTAFF) produced by the California Department of Transportation (CalTrans).[25] The MVSTAFF produced gasoline and diesel demand estimates for each county for 2007. Staff used the county-specific MVSTAFF values to estimate the percentage of total California gasoline and diesel consumption for each county. Staff took these county percentages and multiplied each one by the total monthly California consumption that came from the BOE to estimate monthly fuel demand for each county (Appendix A).

For example, Los Angeles County accounted for 24.1 percent of total California gasoline consumption in 2007 according to MVSTAFF estimates. Applying this percentage to the statewide BOE taxable gasoline sales total of 15.64 billion gallons for the period April 2007 through March 2008, yielded a value of 3.76 million gallons, the estimated consumption of gasoline in Los Angeles County during the study period. Staff recognizes that applying the annual county sales portion consistently for each month may not capture seasonal fluctuations that can occur on a regional or county level. However, individual county fuels sales figures are not available. For example, the annual portion of gasoline demand for Los Angeles County of 24.1 percent may actually fluctuate between 23 and 25 percent during any particular month.

Gasoline Grades – County Estimates

Quantifying the volume of gasoline consumed in a specific county was the first step in the temperature and benefit analysis. Fuel temperature data obtained from the DMS Temperature Survey, however, included data for regular and premium grades of gasoline. Since the estimate of total gasoline demand by county does not specify the ratio of different grades of gasoline consumed, staff estimated the ratio of different gasoline grades.

Staff used information collected through an annual Energy Commission survey of retail outlets (referred to as the A15 survey) that contained sales volumes by grade of gasoline by individual retail station.[26] Using the A15 survey results from calendar year 2007, staff calculated that regular grade gasoline sales averaged 76.2 percent of total sales, followed by mid-grade at 9.9 percent and premium grade at 13.9 percent. Staff then applied these various ratios to the individual county gasoline demand totals to estimate gasoline sales volumes by grade for each county. These final gasoline demand estimates were then used to volume-weight the fuel temperature data collected through the DMS Temperature Survey and were also used for the initial step of quantifying potential consumer benefits by county.

Retail Fuel Prices

California retail prices of transportation fuels were used by staff to help quantify any potential consumer benefits associated with ATC. Staff determined the average monthly price of retail gasoline and diesel fuel for each county, then applied these prices to the change in the size of the petroleum gallon (in cubic inches) that would have resulted if ATC equipment had been in

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[25] California Department of Transportation, *2007 California Motor Vehicle Stock, Travel, and Fuel Forecast*, May 2008, Table 3, page 48, [http://www.dot.ca.gov/hq/tsip/smb/documents/mvstaff/mvstaff07.pdf].
[26] California Retail Fuel Outlet Annual Report, CEC Form A15. A blank A15 form may be viewed at: [http://www.energy.ca.gov/piira/forms_instructions/CEC_A15_RetailSurvey_Dec07_Rev.pdf].

place at all California retail outlets during the study period. During warmer months, the average size of the petroleum gallon dispensed would be greater than the standard 231 cubic inches at 60 degrees Fahrenheit. The difference in volume is determined by the temperature of the fuel and the coefficient of expansion associated with the type and density of fuel that result in a volume correction factor (VCF) that would be some fraction either greater or less than one. These VCFs were then applied to average retail prices as part of the initial step to quantify potential consumer benefits.

Conversely, during the colder periods of the year, the opposite would apply. Temperature below the reference standard of 60 degrees Fahrenheit would result in slightly smaller petroleum gallons being dispensed to consumers during the study period. During this part of the year for some counties, consumers would have received less fuel if ATC had been installed at the retail level. County-specific retail prices were used to quantify the value of the fuel that consumers would not have received during this portion of the year.

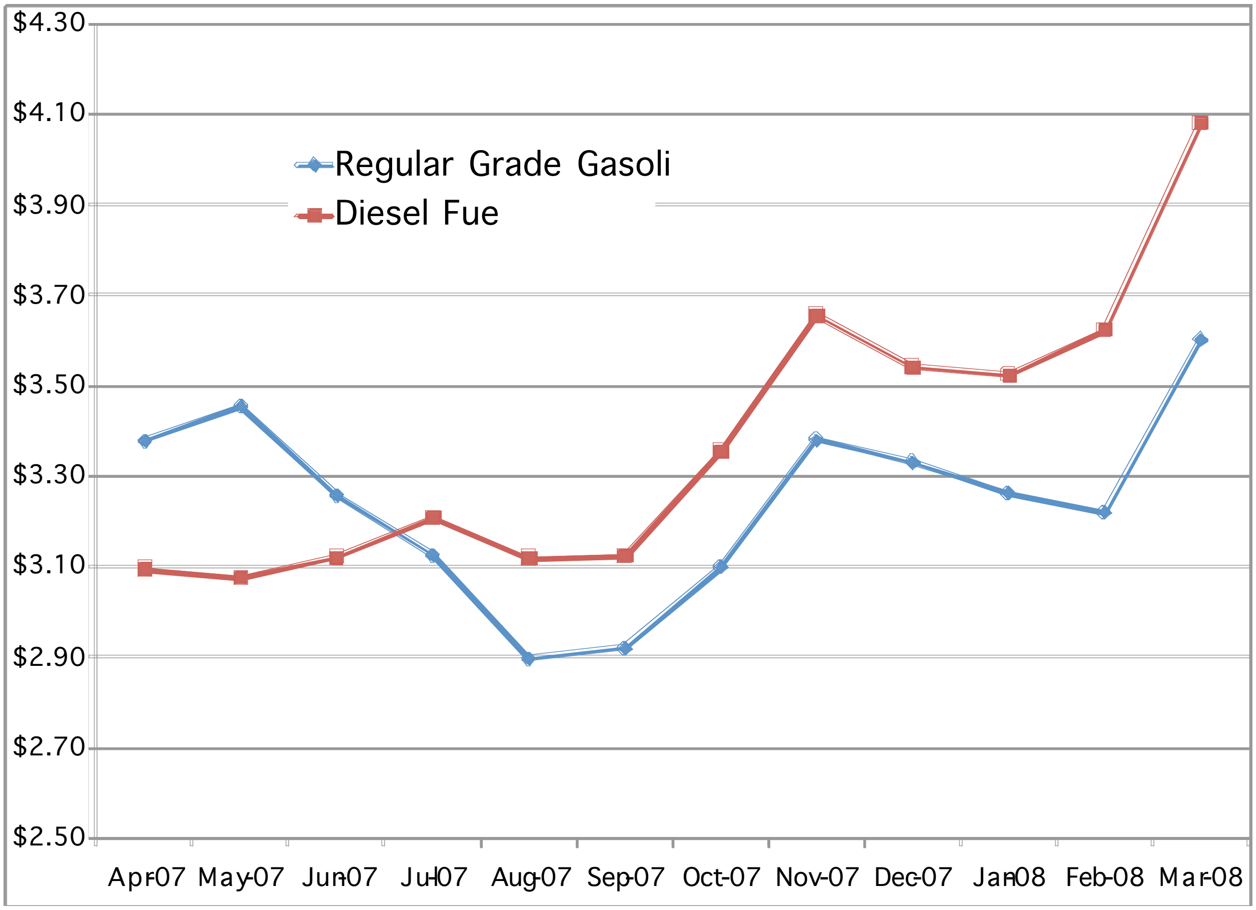
To collect retail gasoline and diesel prices for this study, staff used existing databases (as described below). Staff organized the data by county for each month from April 2007 to March 2008. The statewide average retail price for regular grade gasoline in California was $3.29 per gallon, with a downward trend in the summer of 2007 and an upward trend in the late fall of the same year (see Figure 2). For diesel, the statewide average retail price was $3.41 per gallon with upward trends in the fall of 2007 and spring of 2008.

The retail prices for regular grade gasoline (87 octane) used in this study were obtained from the Oil Price Information Service (OPIS).[27] This company provides daily price transactions at individual retail stations and truck stops. In addition to the data from OPIS, staff also used prices from the Energy Information Administration (EIA) to estimate prices for midgrade (89 octane) and premium (91 octane) gasoline.[28] Since the information from EIA is weekly, however, staff needed to estimate monthly prices for midgrade and premium. This estimate was done by looking at the EIA data and calculating the differences between regular and

[27] [http://www.opisnet.com/].

[28] Energy Information Administration, Petroleum Navigator, Weekly Retail Gasoline and Diesel Prices, [http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm].

Figure 2: California Monthly Average Retail Fuel Prices



Source: Energy Commission staff analysis of OPIS daily retail fuel prices.

midgrade as well as the differences between regular and premium. Staff then applied those differences to the regular grade data from OPIS to obtain an estimate for monthly mid-grade and premium prices. On average, staff found that the difference between regular and midgrade was 10.8 cents per gallon (ranging from 10.2 to 11.4 cents). The difference between regular and premium grades averaged 20.8 cents per gallon (ranging from 20 to 21.4 cents). Using this approach, staff was able to calculate monthly average gasoline retail prices for each of the 58 California counties over the study period.

Retail diesel fuel prices were not available for all California counties. The diesel retail prices Energy Commission staff used came from these sources:

- Oil Price Information Service (OPIS)
- California American Automobile Association (AAA)
- Staff estimates (where data gaps occurred)

Staff first collected OPIS daily diesel fuel price transactions by individual retail stations and truck stops. Truck stop data was available from OPIS for 17 counties, representing 65 percent of the diesel consumption in California. For those counties where OPIS data was unavailable, staff used AAA diesel retail price data, representing 28 percent of diesel consumption.[29] If a county had both OPIS and AAA prices, staff used the OPIS data if there were at least four reporting stations. For those counties with fewer than four OPIS reporting sites, the AAA retail price was used to estimate the retail diesel fuel price. Using these two data sources, staff calculated average monthly retail prices for 34 of California's 58 counties -- a total of 93 percent of California's diesel consumption, including the major population centers such as Los Angeles, San Diego, and San Francisco counties.

For the remaining 7 percent of diesel consumption, represented by 24 counties in California's primarily rural regions, staff estimated diesel fuel prices by comparing the differences between various counties for gasoline prices, less all applicable taxes. Staff assumed that these differentials for gasoline would be similar for diesel fuel. This estimate was based on the prices in counties where diesel prices were available (called "origin" counties). The staff chose a few selected origin counties that have a gasoline and diesel wholesale rack, or distribution terminal, supplying the destination county.

To remove differences in prices due to taxes, staff took out sales, excise and other taxes so a price comparison would be focused on differentials due to transportation costs and market conditions in each respective county. To find a gasoline differential between the origin and destination county, staff subtracted gasoline prices without tax between the origin and destination counties. Then taxes were taken out for diesel prices in the origin county. Next, the gasoline differential between the pairs of origin and destination counties were added to the diesel prices (less all applicable taxes) in the origin county to obtain a diesel price (less all applicable taxes) for the destination county. The final step for determining an estimated retail diesel price for the remaining 24 counties involved the addition of all applicable excise (state and federal) and sales taxes.

Fuel Temperature Study

The Fuel Temperature Study is an analysis of temperature data collected by county sealers throughout the state over a 12-month period, beginning in April 2007 and ending in March 2008. This data collection determined the average fuel temperature levels for retail gasoline and diesel fuel for California. The findings are similar to an earlier National Institute of Standards and Technology (NIST) investigation that indicated California retail gasoline temperatures were, on average, warmer than the reference standard of 60 degrees Fahrenheit. The information collected under the DMS Temperature study had greater detail and included a larger sample size compared to the earlier NIST work.

Previous Fuel Temperature Survey Work

According to a NIST study, the temperature of gasoline and diesel fuel stored in storage tanks at retail establishments varies nationally by geographic location and season.[30] NIST collected temperature data from approximately 1,000 retail stations located throughout the United States, primarily between April 2002 and February 2004. The annual gasoline temperature averaged 64.3 degrees Fahrenheit. On a seasonal basis, the summer average was 75.3 degrees Fahrenheit, while the winter fuel temperature averaged 51.2 degrees Fahrenheit. Additionally,

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[29] California AAA, Daily Fuel Gauge Report. Data provided by Oil Price Information Service in cooperation with Wright Express, [http://www.fuelgaugereport.com/CAavg.asp].

[30] National Institute of Standards and Technology, *State Charts for Temperature of Gasoline in Filling Station Holding Tanks*, presented at National Conference on Weights and Measures, Automatic Temperature Compensation (ATC) Steering Committee meeting, Chicago, Illinois, August 27-29, 2007, [http://www.ncwm.net/events/atc2007/item9_avg_temp_states.pdf].

this study noted that Hawaii's 80 degree Fahrenheit reference temperature was suited to Hawaii due to the state's warm, stable tropical climate. However, NIST also found that, as a result of climate variability in the United States as a whole, a 60 degree Fahrenheit temperature at 231 cubic inches made sense nationwide.[31]

The NIST database indicates that California appears to be one of the warmer states where the gasoline temperature in storage tanks averaged 74.7 degrees Fahrenheit (Figure 3). Based on the data collected by county sealers as part of the DMS fuel temperature study, the annual statewide average regular grade gasoline temperature was 71.1 degrees Fahrenheit, slightly lower than the earlier NIST survey results.[32] It should be noted that the DMS temperature survey results used in this report are the fuel from the fuel dispenser versus the fuel temperature in the storage tanks at retail stations. Differences in fuel temperatures between the underground storage tank (UST) and the fuel dispenser can be as great as 15 to 20 degrees Fahrenheit. However, such large differences are uncommon, based on staff analysis of the DMS temperature survey data that shows that more than 70 percent of the UST-to-dispenser fuel temperature differentials are within plus or minus 3 degrees Fahrenheit for a typical California retail station (discussed in greater detail later in this chapter).

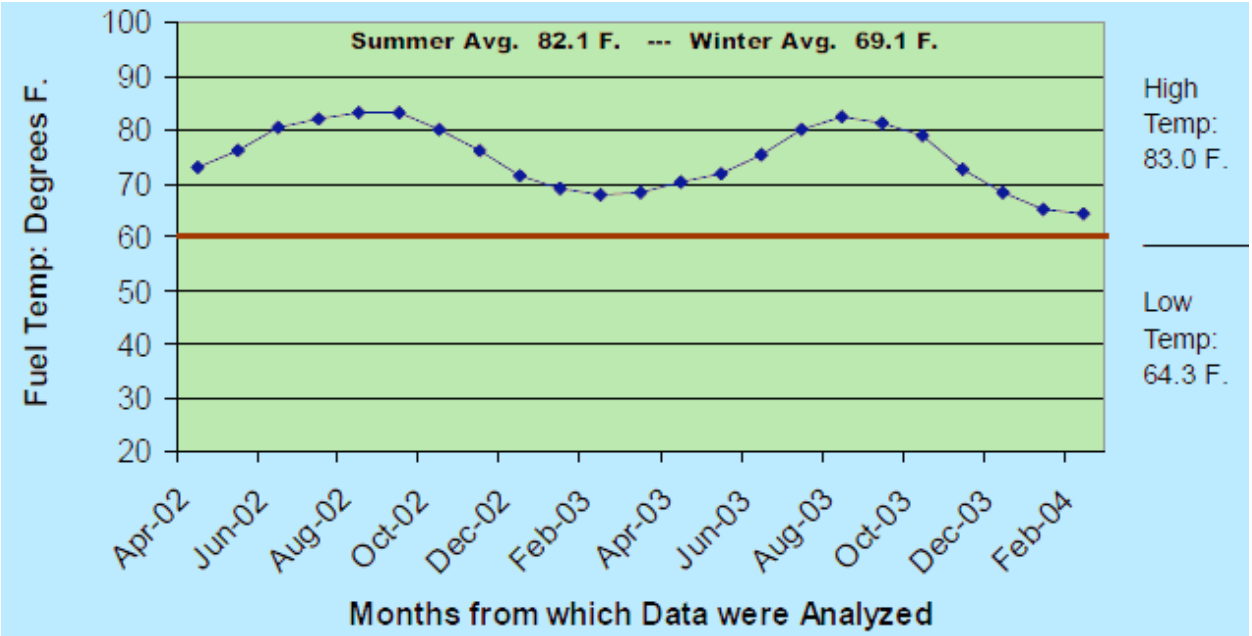
This small difference in temperature is not surprising considering that most California retail stations process one tanker truckload of fuel every couple of days.[33] The fuel stored in the USTs is dispensed to consumers within 48 hours, with little time for the fuel to change temperature due to the insulated double-walled underground storage tanks.

Figure 3: NIST Results for California

[31] Suiter, Richard, National Institute of Weights and Measures, *Hot Fuels – The Impact on Commercial Transactions of the Thermal Expansion of Gasoline*, testimony before the House of Representatives, Committee on Oversight and Government Reform, Subcommittee on Domestic Reform, June 8, 2007, [http://www.nist.gov/testimony/2007/rsuiter%20hover-govt%20subc%20dom%20pol%206-8-07.htm].

[32] Average is a weighted value based on ratio of estimated fuel consumption per county. Source is the 2007-2008 DMS fuel temperature study.

[33] Staff assumed that an average tanker truckload of gasoline is about 8,000 gallons. Over the study period (April 2007 through March 2008), California motorists consumed 15.62 billion gallons of gasoline that was purchased at about 9,700 retail stations, equating to an average daily throughput per station of 4,412 gallons. This is roughly equal to an 8,000 gallon delivery every 1.8 days.



Source: NCWM presentation materials.

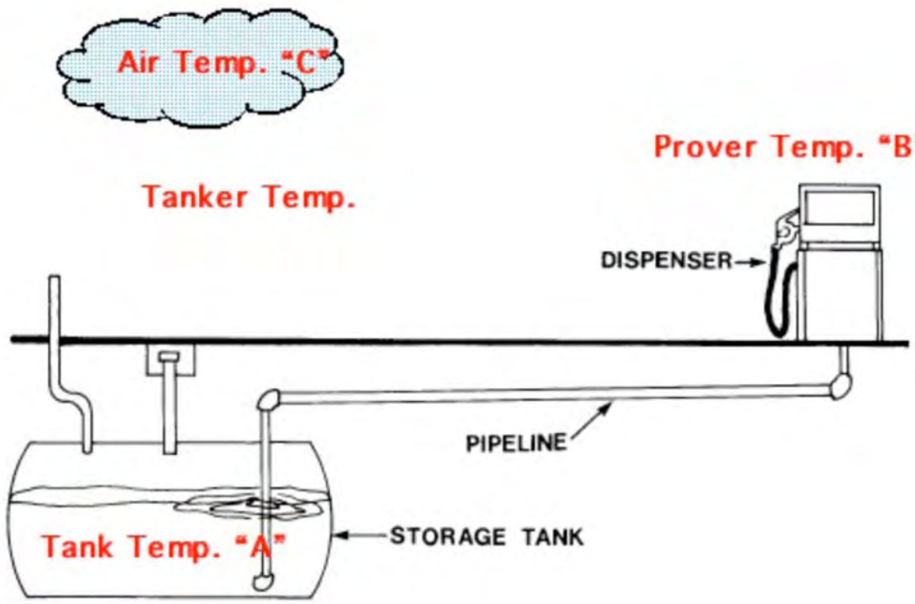
DMS Temperature Study Background

As a warm state, California's mean gasoline and diesel temperatures average above 60 degrees Fahrenheit. Also important, however, is the distribution of gasoline and diesel temperatures within California. To determine this distribution and calculate monthly average fuel temperatures, the DMS conducted a survey from April 2007 to March 2008.[34] During this survey, county sealers collected gasoline and diesel temperature data from retail fuel establishments. This data collection effort was voluntary, and 24 out of 58 California counties participated. Staff defines "participation" as a county that reported 6 or more months of temperature data to DMS for the 12-month study period.

As shown in Figure 4, three types of temperature measurements were collected from retail stations in counties that participated: (A) storage tank temperature, (B) prover temperature (temperature coming out of the fuel nozzle and measured upon introduction into a "prover," the vessel used by Weights and Measures inspectors to verify dispenser accuracy), and (C) ambient air temperature.

Figure 4: DMS Temperature Survey Sample Points

[34] A link to the fuel temperature survey information may be viewed at the following DMS site: [http://www.cdfa.ca.gov/dms/fueltempsurvey/FuelTempReports.pdf].



Source: NCWM graphic amended by Energy Commission staff.

No fuel temperatures were obtained from tanker trucks delivering to retail stations. Since county sealers were collecting temperature data during their routine inspections, the presence of a delivery truck would be a coincidence. For the prover temperature, the fuel temperature was normally taken after an initial five gallons of fuel was pumped from the dispenser. Fuel temperatures consisted of regular and premium grades of gasoline, along with diesel fuel (if available). No fuel temperature samples were obtained for mid-grade gasoline since this fuel is normally "created" at the dispenser by combining equal parts of regular and premium grades of gasoline as the motorist fills their fuel tank. As such, there are a limited number of storage tanks for mid-grade gasoline available at retail stations to take temperature samples.[35]

Incomplete Temperature Data for Certain Counties

County sealers collected temperature data for gasoline in the counties listed as participants for at least six months (Table 1). Many of these counties had temperature data for some but not all months of the April 2007 to March 2008 study period. While those participating are a minority of counties, they account for approximately 85 percent of California total gasoline sales and 78 percent of total diesel fuel sales.

[35] Energy Commission staff estimate that less than 10 percent of California's retail stations have a dedicated storage tank for mid-grade gasoline.

Table 1: California Counties With Temperature Data

County Name	Participated	County Name	Participated
Alameda	Yes	Orange	Yes
Alpine	No	Placer	Yes
Amador	Yes	Plumas	No
Butte	Yes	Riverside	Yes
Calaveras	No	Sacramento	Yes
Colusa	No	San Benito	No
Contra Costa	Yes	San Bernardino	Yes
Del Norte	No	San Diego	Yes
El Dorado	No	San Francisco	Yes
Fresno	Yes	San Joaquin	Yes
Glenn	No	San Luis Obispo	Yes
Humboldt	No	San Mateo	Yes
Imperial	No	Santa Barbara	No
Inyo	No	Santa Clara	Yes
Kern	No	Santa Cruz	Yes
Kings	No	Shasta	No
Lake	No	Sierra	No
Lassen	No	Siskiyou	No
Los Angeles	Yes	Solano	Yes
Madera	No	Sonoma	No
Marin	No	Stanislaus	Yes
Mariposa	No	Sutter	Yes
Mendocino	No	Tehama	No
Merced	No	Trinity	No
Modoc	No	Tulare	Yes
Mono	No	Tuolumne	No
Monterey	Yes	Ventura	No
Napa	No	Yolo	No
Nevada	No	Yuba	Yes

Source: Energy Commission staff analysis of DMS temperature survey information.

To see if it would be possible to estimate fuel temperatures in the remaining counties, staff determined the relationship between ambient temperatures and fuel dispenser (prover) temperatures. Gasoline and diesel fuel sold at retail stations are delivered by tanker trucks that load the fuel from one of 53 distribution terminals located throughout the state. The fuel is held in aboveground storage tanks from a couple of days to a couple of weeks before being transferred to a tanker truck. It is believed that ambient temperatures can influence the fuel temperature in these storage tanks by either warming or cooling the fuel depending on the season. Further, it is believed that the fuel temperatures do not appreciably change (on average) from the tanker truck loading event and fueling of the motorists' vehicles.

To test this hypothesis of correlation to ambient temperatures, staff compared average monthly temperature data from the National Climactic Data Center (NCDC) to the fuel prover temperatures collected by county sealers.[36] The NCDC had temperature data for 275 weather stations in California for the period covered by the DMS Temperature Study. Some weather stations were in cities that did not have any fuel stations, and a number of fuel stations were in cities that did not have any weather stations. Data from these categories was not included in the temperature correlation calculation.

Each county's mean ambient retail fuel station air temperature was obtained by weighting each weather station's temperature by the number of fuel stations in the same city as the weather station. For cities containing more than one station, the mean of the weather stations' temperature recordings was taken. Weather stations missing four or more months of data were excluded from these calculations. Average ambient temperatures for all California counties throughout the study period are in Appendix B.

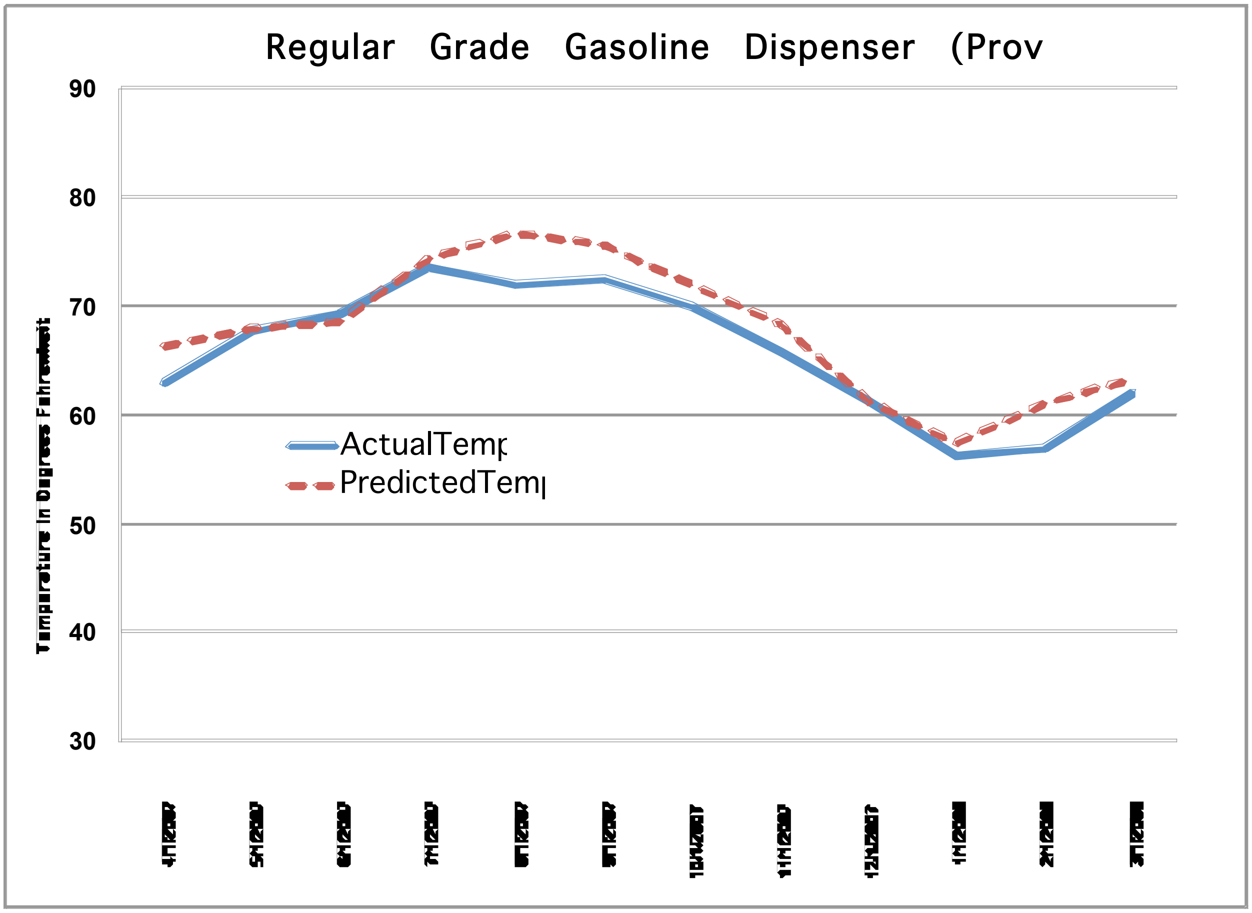
For April 2007 through February 2008, monthly mean temperature was taken. For March 2008, the median between each day's high and low temperature was taken. The mean of these medians was then calculated for each weather station. Counties that had only one weather station were assumed to have that temperature county wide. Alpine and Sutter counties lack ambient temperature data because they did not have any weather stations. Additionally, Mariposa County only has temperatures available for two months of 2007. Staff used temperatures in neighboring counties to estimate temperatures in these counties. The results and methods apply only to California, and temperatures that were measured from April 2007 to March 2008. These results should not be applied to other regions outside the state.

Results of Air and Fuel Temperature Correlation Analysis

Staff used the monthly ambient temperature data for counties that had sufficient fuel temperature data for gasoline and diesel fuel to assess the relationship between air and fuel temperatures. The results of statistical analysis consisting of regression equations indicated that the average air temperature and seasonal factors produced the strongest relationship for predicting fuel temperatures dispensed at retail stations. A more detailed description of the variables and regression equation specifics is found in Appendix C. A visual example of how well the regression equation "fits" the actual fuel temperature data is illustrated in the monthly comparison for Alameda County in Northern California (Figure 5) and Los Angeles County in Southern California (Figure 6).

Figure 5: Alameda County Gasoline Temperature – Actual vs. Predicted

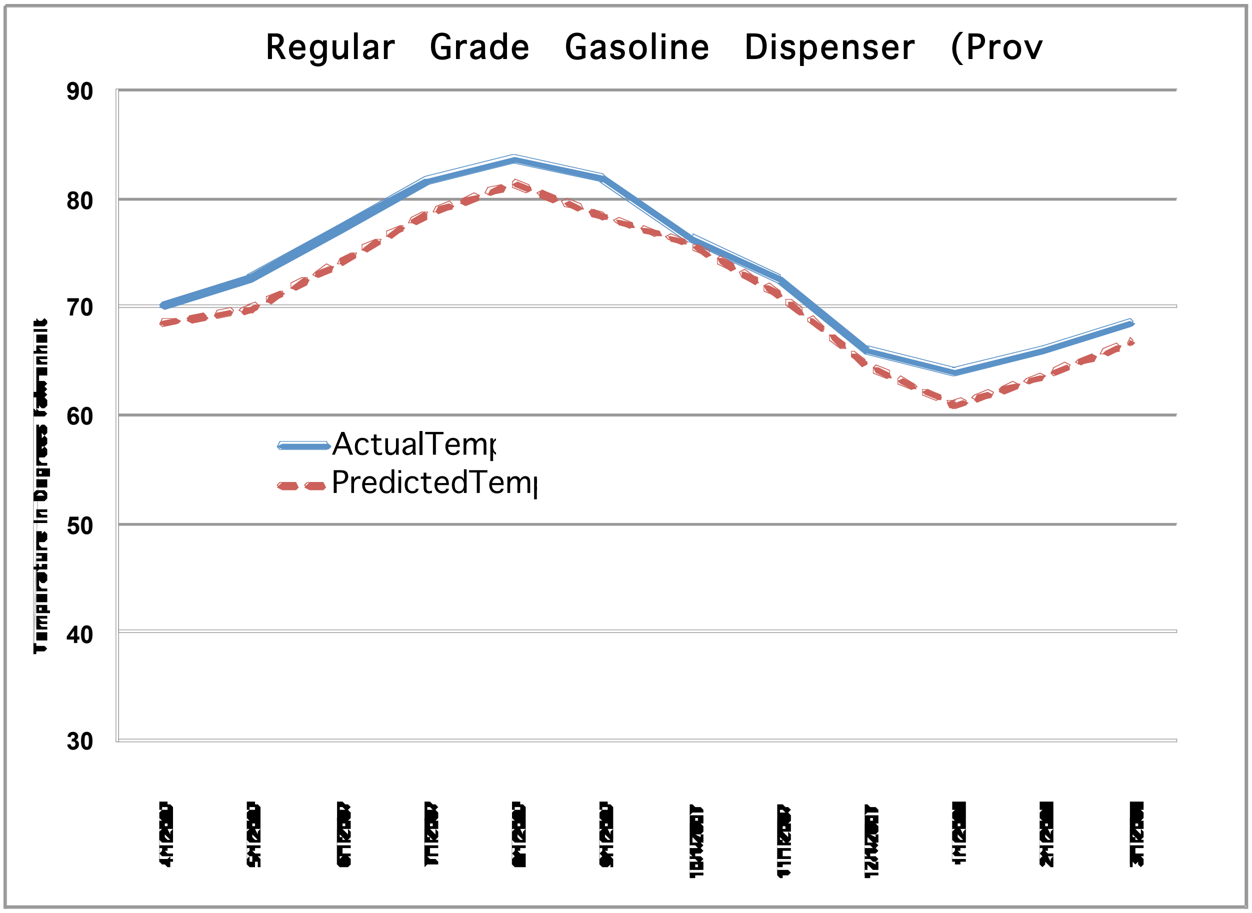
[36] National Climactic Data Center is a division of the National Oceanic and Atmospheric Administration. A link to their web site is at: [http://lwf.ncdc.noaa.gov/oa/climate/climatedata.html].



Source: Energy Commission staff analysis of DMS temperature survey information.

The coefficient of determination or R^2 number is a statistical measure of how closely the variables (in this case ambient temperature and season of the year) predict the actual fuel prover temperature. If the variables are a precise predictor for all of the monthly fuel temperatures, the R^2 number would be 1.0. Values of less than one usually imply that there are other factors influencing the fuel prover temperatures besides ambient temperature and season. The R^2 number for regular grade gasoline was 0.87, followed by 0.78 for premium grade gasoline, and 0.70 for diesel fuel. These values can be interpreted to mean that ambient temperature can explain between 76 and 87 percent of the fuel prover temperature throughout the year. However, the relationship falls short of precisely predicting fuel prover temperature.

Figure 6: Los Angeles County Gasoline Temperature – Actual vs. Predicted



Source: CEC staff analysis of DMS Temperature Survey information.

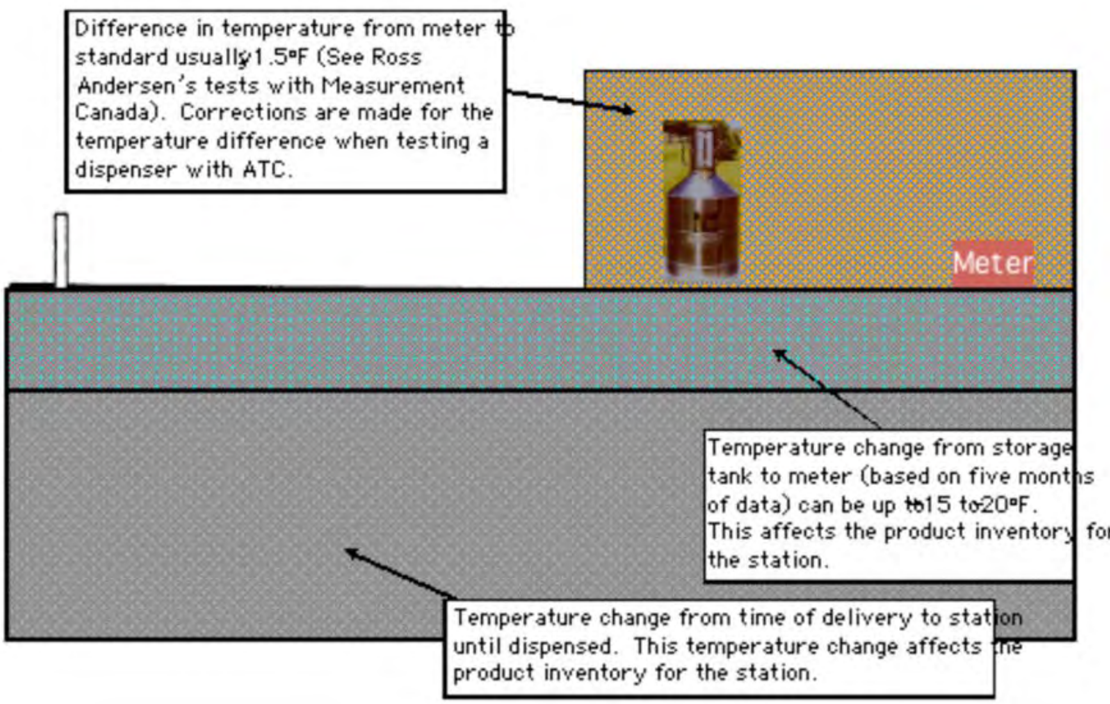
Actions to Modify Database

Besides estimating monthly prover temperatures for various California counties, staff also made slight modifications to the DMS temperature survey database. In one instance, an obviously incorrect fuel prover temperature was replaced with another value that staff assumed was the correct value. Six prover temperatures were excluded from the average temperature calculations, two for regular grade gasoline and four for diesel fuel. A combination of 23 prover and storage tank temperature "pairs" was excluded from the analysis used to create the histogram charts illustrating the average difference between the fuel dispenser (prover) and storage tank fuel temperatures. These excluded pairs consisted of five for regular grade gasoline, nine for premium grade gasoline, and nine for diesel fuel. Finally, any temperature data information from any dates outside the study period (April 2007 through March 2008) was excluded from any average temperature or differential analysis. All of the specific instances are detailed in Appendix D.

Other Factors Influencing Fuel Temperatures

Staff has not quantified other factors that could potentially influence the fuel dispenser temperatures, but is aware that gasoline and diesel fuel can be warmed or cooled as the fuel is distributed from storage tank to tanker truck to retail station underground storage tank (UST) to fuel dispenser and the motorist's fuel tank. The National Conference on Weights and Measures (NCWM) ATC Committee has analyzed temperature information from several states in order to better understand how these other factors could be influencing the temperature of fuel at the point of the dispenser.[37] Figure 7 illustrates some of the results from this analysis.

Figure 7: Other Factors Influencing Fuel Temperature

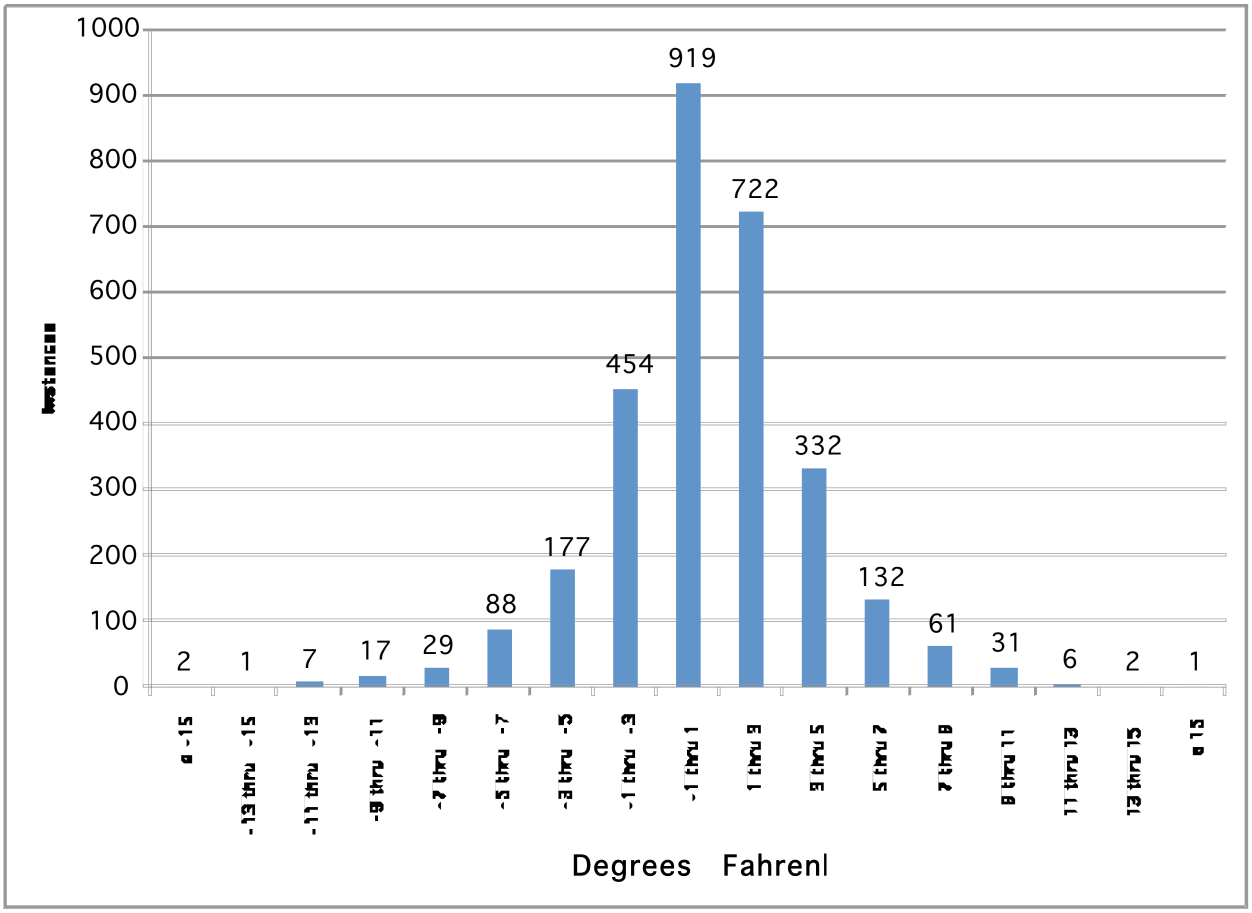


Source: NCWM presentation materials.

Analysis of information supplied by several states indicates that the temperature of the gasoline or diesel fuel can vary by as much as 15 to 20 degrees Fahrenheit warmer or cooler between the UST and the fuel dispenser. Although this temperature differential range appears large, the majority of the fuel temperatures are grouped in a much closer range. Energy Commission staff analyzed the data collected during the DMS temperature survey to assess the difference in temperatures between the UST and the fuel dispenser (prover) between April 2007 and March 2008. The distribution of these temperature differences is plotted in Figure 8 for regular grade gasoline.

Figure 8: California Regular Grade Gasoline – Prover Less UST Temperature

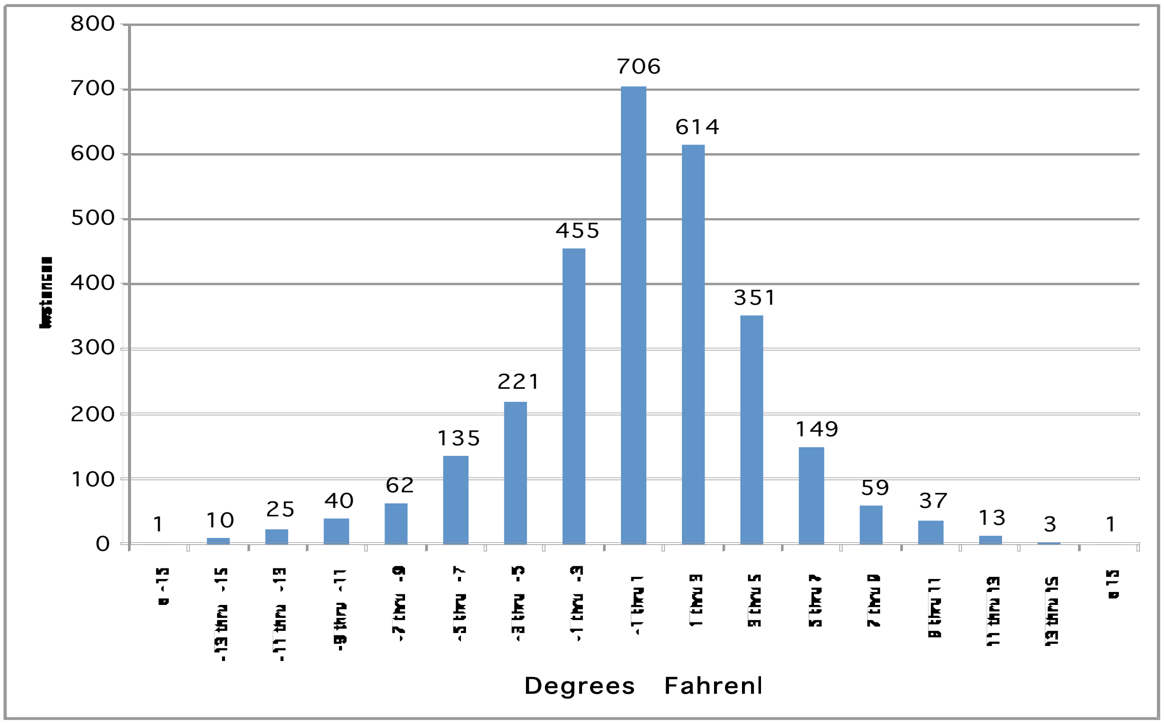
[37] Oppermann, Henry, *Temperature Data from Weights and Measures Programs*, presentation at NCWM annual meeting, July 15, 2008, [http://www.ncwm.net/events/annual2008/service_station_annual08.ppt].



Source: Energy Commission staff analysis of DMS temperature survey information.

The differential in fuel temperatures has a similar broad range compared to the NCWM results. The fairly even distribution appears to be slightly shifted to the positive side of zero, but only minimally. Figure 8 also shows how tightly grouped the differentials are with more than 70 percent of the data points within plus or minus 3 degrees Fahrenheit and 94.7 percent within plus or minus 7 degrees Fahrenheit. The distribution of temperature differentials for premium grade gasoline and diesel fuel are similar, but with a somewhat broader spread as indicated by Figure 9 and Figure 10. A measure of this flatter distribution is evident by the smaller percentage of data points within plus or minus 7 degrees Fahrenheit for premium grade gasoline (91.3 percent) and diesel fuel (85.4 percent).

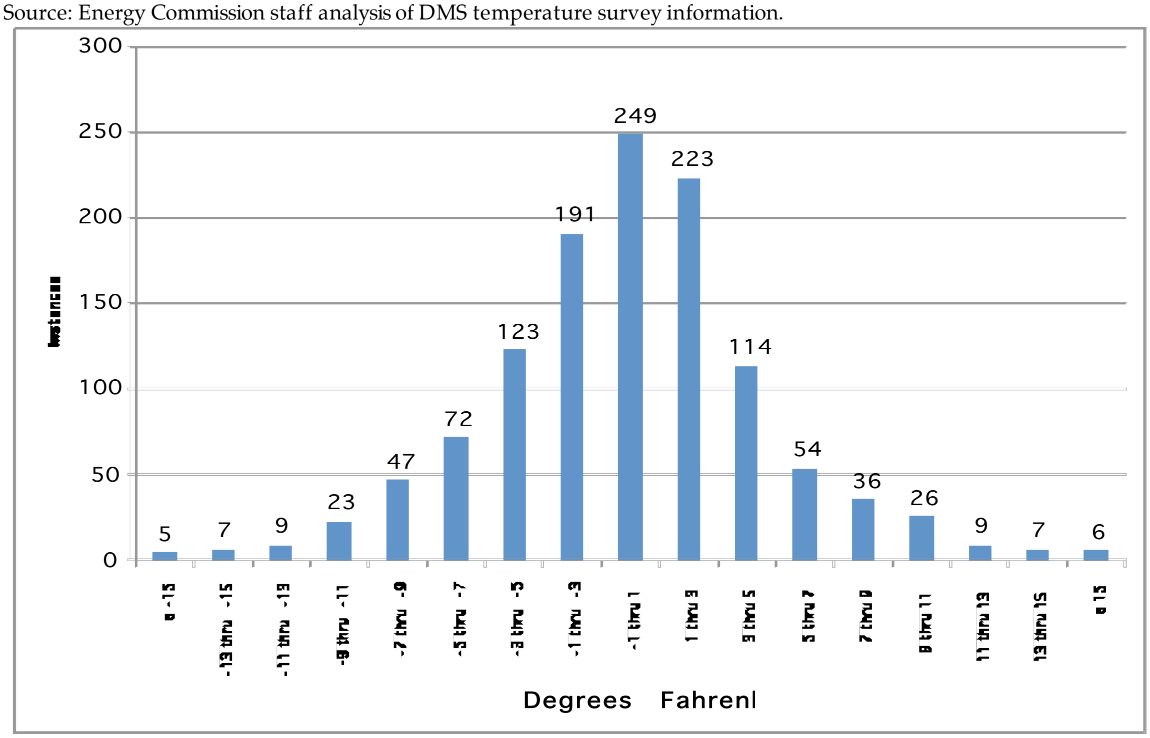
Figure 9: California Premium Grade Gasoline – Prover Less UST Temperature



Source: Energy Commission staff analysis of DMS temperature survey information.

Figure 10: California Diesel Fuel – Prover Less UST Temperature

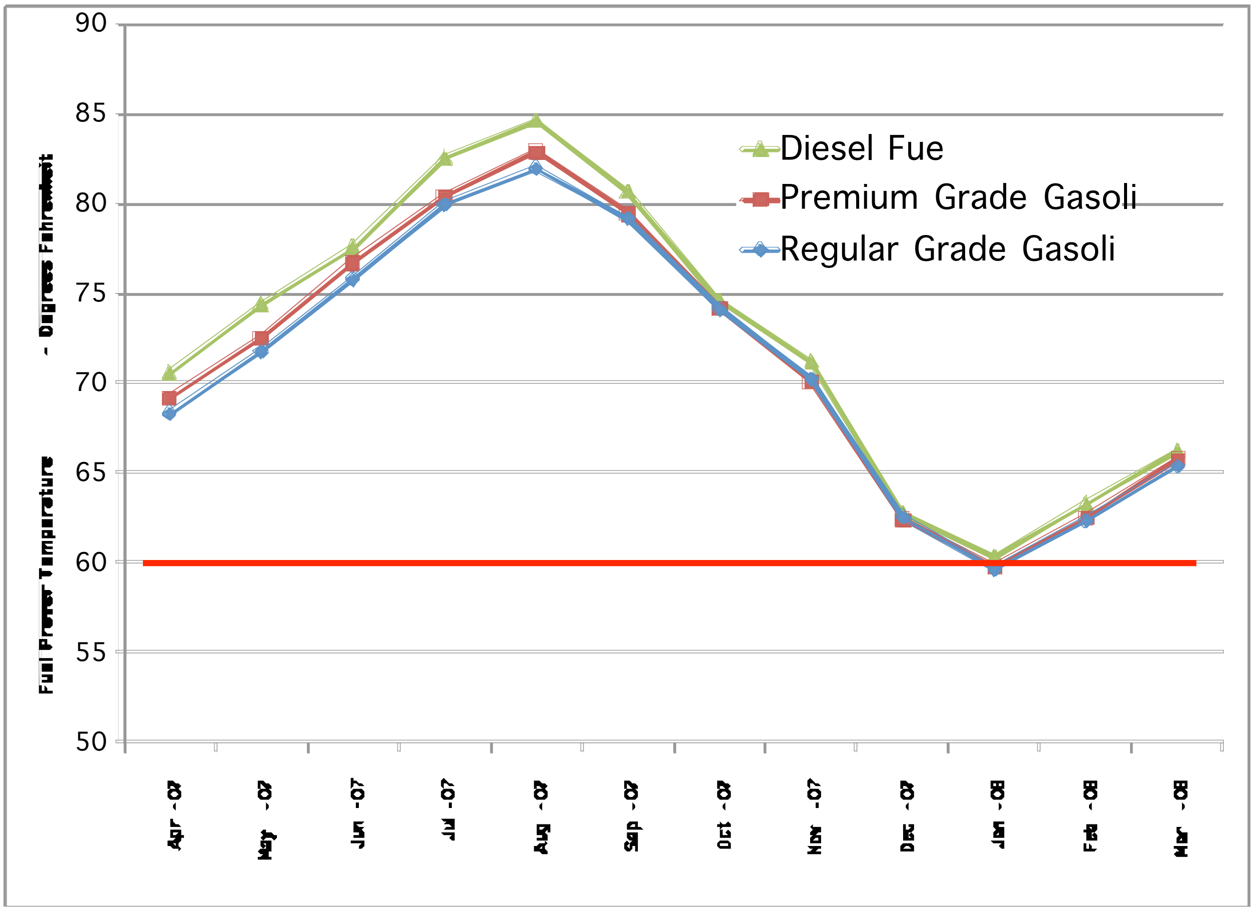
Source: Energy Commission staff analysis of DMS temperature survey information.



California Retail Station Fuel Temperature Results

The statewide monthly average prover temperatures for diesel fuel and gasoline ranged from the upper 50s to the mid 80s (degrees Fahrenheit). Diesel fuel normally had the warmest temperature in any month, followed by premium grade gasoline, then regular grade gasoline. Even with significant differences in density, all three fuel types are remarkably similar in temperature, regardless of winter or summer. The numbers in Figure 11 also show us that the monthly average temperatures are almost always above the reference standard of 60 degrees Fahrenheit, similar to the earlier NIST survey results.

Figure 11: California Monthly Average Prover Temperatures



Source: Energy Commission staff analysis of DMS temperature survey information.

The data presented in Figure 11 are a combination of the original DMS temperature survey data and the estimated fuel temperatures developed by Energy Commission staff based on the relationship between ambient and fuel temperatures. Staff then used annual fuel consumption estimates by county obtained from the California Department of Transportation to calculate volumetric-weighted average prover temperatures. Table 2 displays the statewide average results for the NIST, DMS, and the Energy Commission adjusted fuel temperature information.

Table 2: California Annual Average Prover Temperatures

	Regular Grade Gasoline Degrees F	Premium Grade Gasoline Degrees F	Diesel Fuel Degrees F
NIST Survey Results			
Statewide Average	74.7		
Statewide Minimum Monthly (Feb.)	64.3		
Statewide Maximum Monthly (Aug.)	83.0		
DMS Survey Results - Raw Data*			
Statewide Arithmetic Mean (Average)	71.5	72.0	72.5
DMS Survey Results - CEC Modified			
Statewide Weighted Average	71.1	71.5	72.9
Statewide Minimum Monthly (Jan.)	59.7	59.8	60.4
Statewide Maximum Monthly (Aug.)	82.0	82.9	84.6

* Selected data points modified or removed from calculated averages.

Although the statewide average fuel temperatures were almost always greater than 60 degrees Fahrenheit, there are several instances when specific counties diverged by a greater margin than indicated by the statewide maximum and minimum county averages. For example, the warmest average county fuel temperatures were:

- 89.6 degrees Fahrenheit – regular grade gasoline – Riverside County in July 2007
- 90.7 degrees Fahrenheit – premium grade gasoline – Tulare County in September 2007
- 92.0 degrees Fahrenheit – diesel fuel – Fresno County in August 2007

The coldest average county fuel temperatures over the study period were:

- 49.4 degrees Fahrenheit – premium grade gasoline – Lake County in January 2008
- 50.5 degrees Fahrenheit – regular grade gasoline – Butte County in January 2008
- 51.8 degrees Fahrenheit – diesel fuel – Butte County in January 2008

Fuel Density

Transportation fuel densities are a potentially important property relative to retail ATC due to differences in their thermal expansion and contraction properties, known as coefficient of expansion. Volume correction factors (VCFs) are developed for transportation fuels for purposes of determining conversions between gross and net gallons. The accuracy of applying industry standard VCF tables to determine expansion and contraction of transportation fuels can be reduced in two ways: variation of densities for the same types of transportation fuel, and increased use of fuels that have density values dissimilar to fuels in widespread use. This section of the report presents density information for traditional and alternative transportation fuels, estimates changes in use of alternative fuels and their potential impacts on densities, and outlines consequences of variable density values with regard to retail ATC.

Density Analysis and Findings for Gasoline and Diesel Fuel

Density of gasoline and diesel fuel varies due to differences in crude oil, refining processing, and seasonal specifications (for gasoline). Staff examined information from various sources to determine typical density values for transportation fuels and to what extent these values diverge from the average. Information was obtained from confidential refiner surveys conducted by the Energy Commission and other technical sources.

Gasoline Density – U.S. Variability

The petroleum industry generally uses a term known as American Petroleum Institute (API) gravity to compare various liquid petroleum products to one another using a formula that incorporates specific gravity or the ratio of a substance's density relative to water.[38] If one knows the API gravity designation for a particular transportation fuel, this information can be used to calculate the density of the petroleum product relative to water (specific gravity) using the following formula:

$$Degrees \quad API = \frac{141.5}{sp.gr. \ 60^\circ F / 60^\circ F} - 131.5$$

The API adopted this formula in 1922 and the equation is widely used by the industry. ASTM D 1250 Petroleum Measurement Tables are used by the industry to obtain the temperature VCF of transportation fuels. To use these tables, the density of the product must be known in order to obtain the corresponding VCF of the particular product. The assumed density of finished gasoline in Canada that is used for retail ATC calculations is 0.7302 grams per milliliter (g/ml).[39] A table listing the various density reference values by fuel type may be viewed in Appendix E.

A recent survey of retail gasoline in the United States by the Alliance of Automobile Manufacturers (AAM) yielded an average of 0.740 g/ml at 60 degrees Fahrenheit.[40] It should be noted that this value is a representation of retail gasoline from various locations throughout the United States and encompasses the seasonal period beginning in the summer of 2006 (July and August) through the winter of 2006/2007 (January and February). In addition, the gasoline samples included both regular and premium grades, as well as blends containing ethanol at 10 percent by volume concentrations and conventional gasoline without any ethanol. Figure 12 depicts the relative density distribution of retail gasoline during the summer of 2006, while Figure 13 depicts the relative density values for winter 2007.

On average, winter gasoline blends in the United States tend to be lower in density, a reflection of higher concentrations of lighter components such as butane. However, the main issue that must be addressed is how the gasoline densities in California differ from the typical industry values and what are the potential impacts on retail ATC accuracy?

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[38] The ratio of the density of a substance relative to water is usually calculated at a standard temperature and pressure. For purposes of using the API gravity formula, the assumed temperature is 60 degrees Fahrenheit and a pressure of one atmosphere. Water has a density of 1.00 g/ml.

[39] Automatic Temperature Compensation Steering Committee, "Progress Report," January 28, 2008, slide number 18, [http://www.ncwm.net/ppt/steering_committee_interim_report_2008.ppt].

[40] Oppermann, Henry, "Temperature Compensating Meters, the Concepts and Calculations for Testing ATC Meters," presentation at Western Weights and Measures Association Conference, September 11, 2007, [http://www.westernwma.org/presentations/2007%20Presentations/ATC%20slides%20for%20WWMA%209-11-07.pdf].

Figure 12: AAM Survey Results – Summer 2006

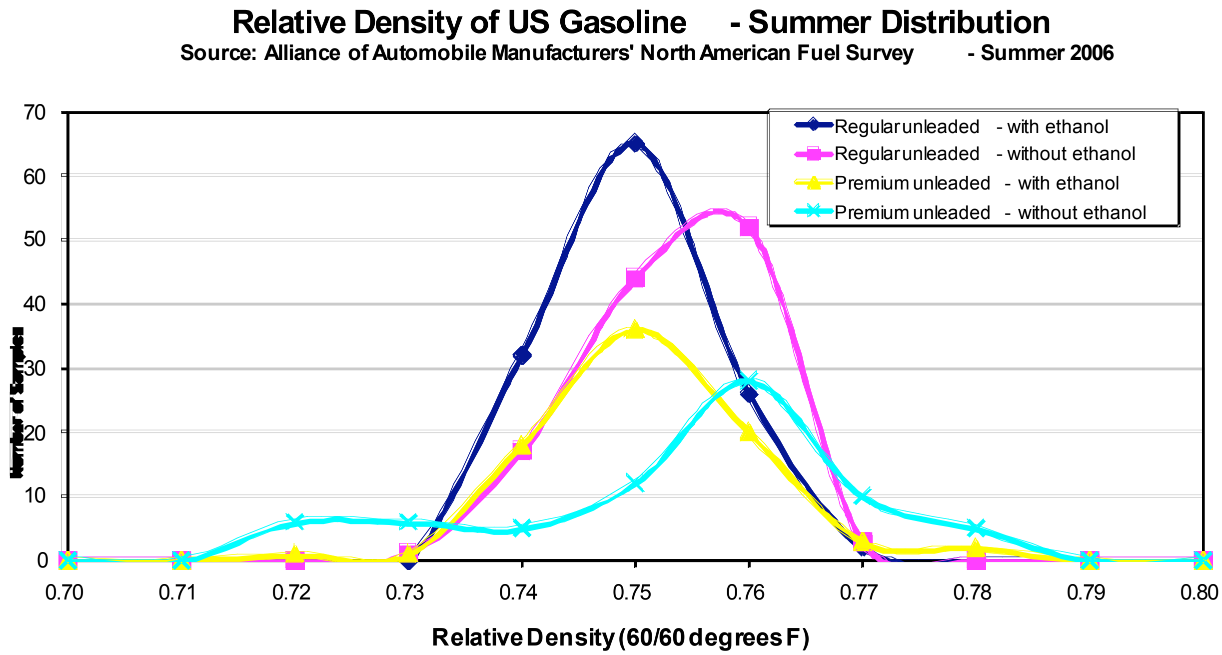
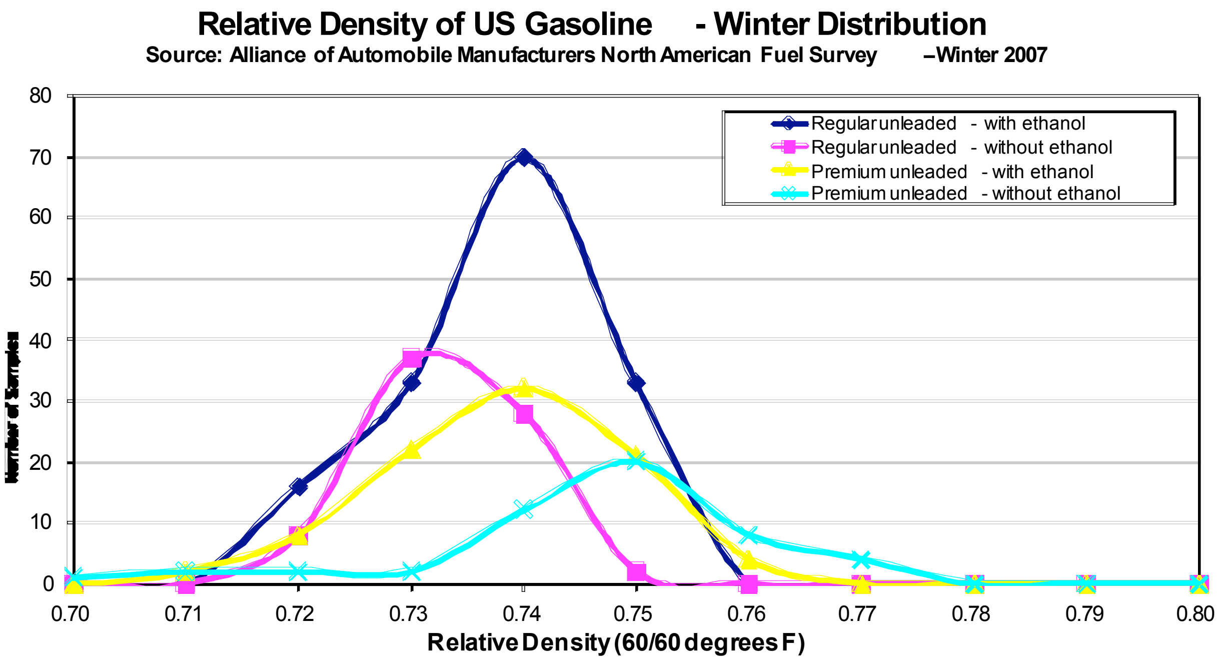


Figure 13: AAM Survey Results – Winter 2007



Gasoline Density – California Variability

The Energy Commission periodically conducts confidential surveys of the petroleum industry as part of their normal analytical activities. Information is collected under confidentiality provisions of the Petroleum Industry Information Reporting Act (PIIRA).[41] A recent survey of California refiners provided, in part, API gravity information for the base gasoline used to blend with ethanol at an average concentration of 5.7 volume percent. The survey obtained refinery-specific average gasoline properties for the summer blending season of 2006 that are presented in Table 3.[42]

The volume-weighted API gravity for regular California Reformulated Blendstock for Oxygenate Blending (CARBOB) was 59.3 (0.7416 g/ml), while premium grade CARBOB averaged 60.5 (0.7370 g/ml). Slightly higher API gravity values have an inverse correlation to relative density, meaning that higher API gravity numbers are less dense than lower API gravity numbers. However, the density of gasoline delivered to retail establishments was estimated by staff using a typical density value for fuel ethanol of 0.769 g/ml.[43]

Table 3: California Refinery Production Properties – Summer of 2006 Gasoline

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[41] [http://www.energy.ca.gov/piira/index.html].

[42] The summer season refers to the period June 1 through September 30, 2006 (122 calendar days).

[43] Staff assumed fuel ethanol has a specific gravity of 0.7690 g/ml. Source: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels Data Center, Table 2.4, [http://cta.ornl.gov/bedb/biofuels/ethanol/Fuel_Property_Comparison_for_Ethanol-Gasoline-No2Diesel.xls].

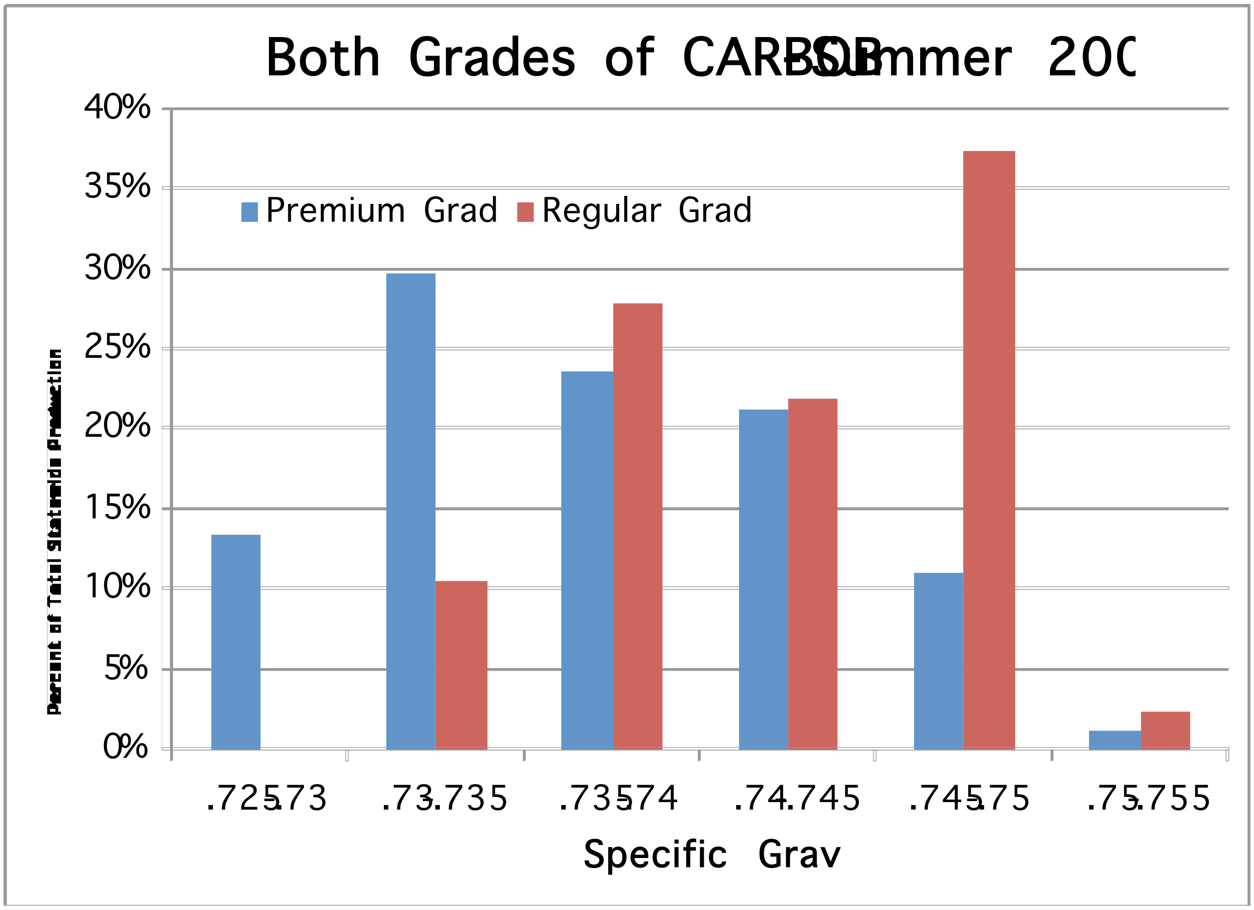
Volume/ Property	CARBOB Premium	CARBOB Regular	Arizona CBG Premium	Arizona CBG Regular	Conventional Premium	Conventional Regular	Other Premium	Other Regular
Volume (bbl/d)	160,520	723,644	700	53,039	15,195	76,290	5,471	39,755
Octane								
MON	85.6	81.8	88.2	83.0	86.4	82.8	86.9	83.3
RON	93.3	88.6	94.7	91.4	96.0	91.7	95.1	91.3
API Gravity	60.5	59.3	63.2	59.0	56.6	56.6	62.0	58.8
RVP (psi)	5.6	5.6	6.8	6.7	8.4	8.1	6.9	7.7
Oxygen (wt%)								
Aromatics (vol%)	23.7	24.8	22.3	25.8	33.8	32.7	20.5	27.5
Benzene (vol%)	0.5	0.6	0.4	0.7	0.5	0.7	0.3	0.6
Olefins (vol%)	6.1	5.9	2.2	11.1	6.7	7.5	6.6	5.5
Sulfur (ppm)	7.4	10.1	6.0	22.2	5.3	27.4	3.4	24.0
E200 (%)	39.9	41.9	34.7	41.7	34.8	40.6	44.3	42.7
E300 (%)	87.7	86.8	83.9	84.8	83.1	78.3	89.3	84.7
Distillation (°F)								
IBP	103.4	106.4	91.0	100.2	91.3	92.6	106.0	93.9
T10	150.9	148.7	152.0	142.0	132.5	128.2	142.3	132.6
T30	184.3	179.7	193.0	173.9	186.3	165.5	NA	138.2
T50	217.4	214.5	220.0	217.1	232.1	225.4	212.1	215.4
T70	248.7	252.4	254.0	255.3	268.1	277.3	NA	275.9
T90	309.4	311.7	321.0	320.6	320.3	338.2	300.5	321.0
FBP	384.2	381.2	390.0	400.0	391.3	403.8	374.0	396.8

Source: Energy Commission staff analysis of confidential PIIRA information.

Since the gasoline sold at retail during 2006 contained approximately between 5.7 and 6.0 percent ethanol by volume, staff calculated what the finished gasoline API gravity could have been assuming a linear density blending relationship between the base gasoline (CARBOB) and fuel ethanol (denatured ethanol). API gravity values for finished California gasoline were estimated at 58.5 (0.7447 g/ml) for regular grade and 59.6 (0.7403 g/ml) for premium grade gasoline, assuming an average ethanol concentration of 5.7 volume percent. Figure 14 illustrates the estimated specific gravities (relative densities) for regular and premium grades of finished California gasoline containing 5.7 percent ethanol and the distribution as a percentage of total production.

Figure 14 illustrates the density variation in gasoline produced at California's refineries during the summer of 2006. The national AAM survey yielded an average regular grade gasoline specific gravity of 0.7450 g/ml for blends containing 10 percent by volume ethanol compared to the estimated average 0.7447 g/ml for California gasoline with an average ethanol content if 5.7 percent by volume, a difference of 0.04 percent. For premium gasoline, the AAM survey value was 0.7460 g/ml compared to the California estimated average of 0.7403, less than 0.8 percent difference. The year-round Canadian gasoline density value of 0.7302 g/ml is within 2.0 percent of the California regular grade summer average and within 1.4 percent of the premium grade value.

Figure 14: California Refinery Gasoline – Relative Density Distribution



Source: Energy Commission staff analysis of confidential PIIRA information.

Not only does the California's average relative density value for gasoline differ from the accepted Canadian number used for ATC calculations, but the distribution of gasoline densities can vary by as much as 4.7 percent from the mean. The consequences of this variability are that VCFs used to program ATC software will not always be precise from one delivery to the next. However, this level of imprecision may not matter with regard to potential differences in volume correction factors.

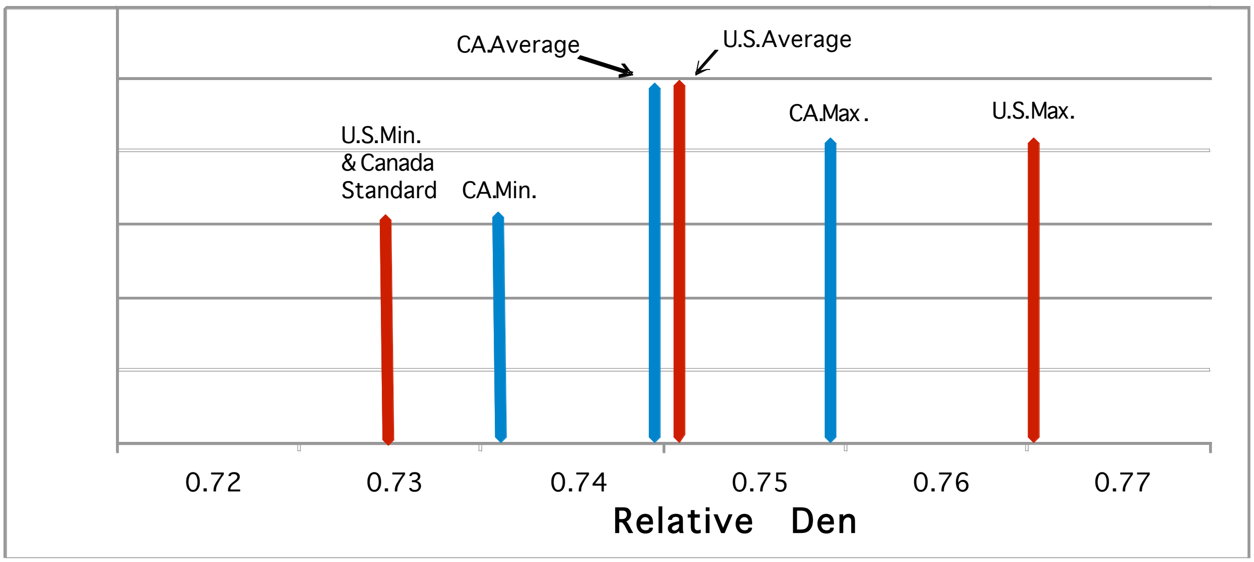
Since the refinery production information is not finished gasoline and the data is from the summer blending season of 2006, Energy Commission staff felt it was necessary to obtain additional information concerning API gravity properties of finished California gasoline. A confidential survey of California refiners was conducted to obtain API gravity information from their distribution terminals. The survey and associated questions used to obtain the confidential information from the petroleum marketing companies may be viewed in Appendix F.

ATC at wholesale involves a conversion of gross gallons to net gallons using the measured temperature of the fuel and the input density of the transportation fuel loaded into the tanker truck before delivery to a retail station. Refiners were requested to provide this information for the time period coinciding with the temperature survey, discussed earlier in this chapter. Analysis of the survey information indicates that the density of regular grade gasoline in California containing 5.7 volume percent ethanol during the study period is within the estimated range of the 2006 refinery data.

Gasoline Density – California and United States Versus Canada Standard

The variability in California and the United States gasoline density values is shown in Figure 15 compared to the accepted industry reference standard used in Canada to program ATC devices at retail stations. As indicated by the graphic, the Canadian standard density value for gasoline is at the lower range of both the California and United States density values for the summer period of 2006. However, the seasonal change in properties for gasoline will tend to decrease the density values closer to the Canadian standard.

Figure 15: Regular Grade Summer Gasoline Density – United States and California Comparison



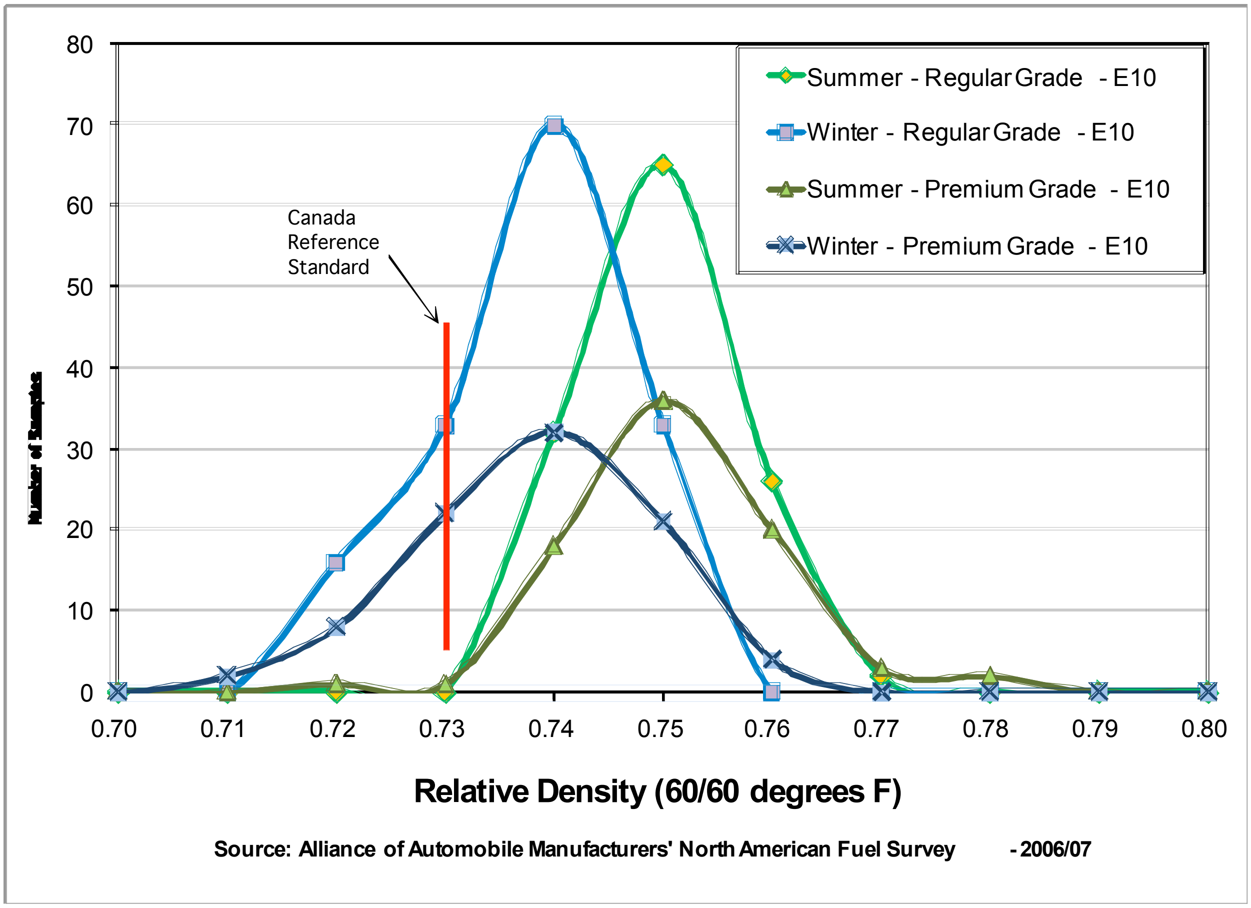
Source: Energy Commission staff analysis of AAM and PIIRA information.

Gasoline Density – Seasonal Variation

In addition to gasoline density differences between individual refineries, gasoline density can vary on a seasonal basis due to changes in gasoline specifications that govern volatility or Reid vapor pressure (Rvp). The transition from summer gasoline blends (with Rvp limits of 7.20 pounds per square inch volatility) to winter blends is accomplished by using gasoline blendstocks with higher volatility, such as butane. Rvp levels can more than double to 15 psi in certain geographic regions of the state.[44] The seasonal gasoline density variation from the 2006/07 NIST survey, depicted in Figure 16, indicates that winter blends tend to be less dense compared to the summer blends of gasoline with 10 percent ethanol (E10). This shift would be consistent with the use of a larger portion of lighter gasoline blendstocks.

[44] Winter Rvp upper limits are determined by ASTM D 4814 standards that include six classes of regions. California includes four of these geographic regions. In practice, the common carrier pipeline distribution system operated by Kinder Morgan has upper Rvp limits for CARBOB shipped through their pipelines and at their distribution terminal storage tanks. Kinder Morgan, *Pacific Operations Specification Manual*, Section 5.1 Rvp Terminal Compliance, "Maximum Terminal Rvp Specifications for Calendar Year 2008/2009," December 1, 2008, [http://www.kindermorgan.com/business/products_pipelines/sec5-1.pdf].

Figure 16: United States Gasoline – Seasonal Density Distribution



Results of the California terminal survey data for gasoline densities also show that winter blends containing 5.7 percent ethanol by volume are also shifted to the left (lower density), such that the average is closer to the Canadian value.

Gasoline Density Variability and Volume Correction Factor Impact

The variability of gasoline density in California that occurs from one refinery to the next and across seasons demonstrates that there are no static, accepted values for gasoline. This distribution of densities means that the use of a single density value for finished gasoline at retail will result in imprecise calculations of volume correction factors for ATC at retail the majority of the time. However, the magnitude of this potential inaccuracy may be somewhat small. For example, nearly 96 percent of the AAM gasoline density values are within 2.7 percent of the average of 0.740 g/ml. The volume correction factor for gasoline at 75 degrees Fahrenheit using this average density would be 0.98992. However, if the actual density of the gasoline was 0.720 g/ml, the correct VCF would be 0.98950, a difference of 0.042 percent.[45] In other words, the use of a single gasoline density value close to the annual average will yield a

[45] VCF value obtained by using the API's *Temperature and Pressure Volume Correction Factor for Generalized Crude Oils, Refined Products, and Lubricating Oils* CD and software program.

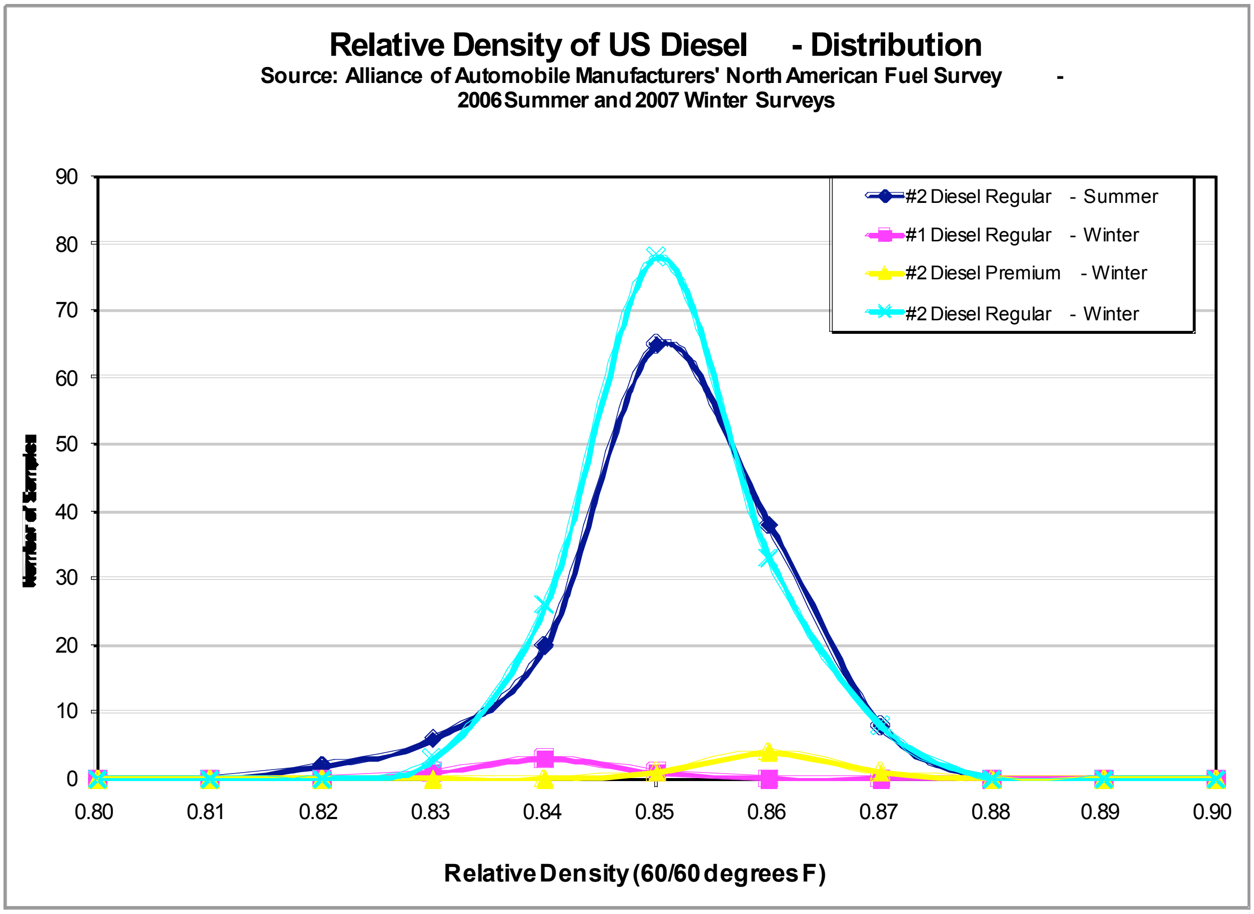
VCF at 75 degrees Fahrenheit that is within plus or minus 0.04 percent of the actual, true value 96 percent of the time.

Improving upon this level of precision by altering the accepted density value on a seasonal or per-delivery basis would be costly, problematic, and only decrease the potential error by an almost imperceptible measure. Therefore, staff believes that a single density value would be optimal for use in California for gasoline if ATC was to be mandated at retail stations. Keep in mind that the selection of a density reference standard for gasoline at retail in California is more important during the summer months, when the fuel temperatures divert the most from the 60 degree Fahrenheit level. During the winter months, when retail gasoline temperatures are much closer to 60 degrees Fahrenheit, the accuracy of the gasoline density reference standard would be less important. The actual California value selected may differ from that of the Canadian standard of 0.730 g/ml since that number appears to be at the lower range of gasoline densities observed for California gasoline. The final value should be one that is at or near the summer, rather than annual, California gasoline density value as determined by DMS in consultation with industry and appropriate state agencies.

Diesel Fuel Density – United States Variability

Diesel fuel density issues are somewhat similar to those of gasoline, but with fewer differences compared to California and the Canadian reference standard. As was the case with gasoline, the AAM also collected diesel fuel density property information during the summer of 2006 and the winter of 2006/07. The average density for diesel fuel was 0.846 g/ml for the combined data set, with no difference from summer to winter for #2 diesel fuel. However, as is the case with gasoline, density values do have variability caused by variations in crude oil properties and refining techniques. The AAM survey yielded density values ranging from a low of 0.819 g/ml to a high of 0.863 g/ml. Figure 17 shows the distribution of the AAM survey results.

Figure 17: AAM Survey Results – Diesel Fuel



Unlike the gasoline density variability, diesel fuel density values do not vary on a seasonal basis since the specifications remain unchanged from summer to winter. Used primarily for certain fleets of city transit buses, #1 diesel fuel is a lighter version of #2 highway diesel.[46]

Diesel Fuel Density – California Variability

As is the case with gasoline, California uses a type of diesel fuel that includes a specification for aromatic content that differentiates the fuel from the U.S. Environmental Protection Agency (EPA) on-highway ultra low sulfur diesel (ULSD) specifications.[47] To compare the AAM results to those of California, staff examined data related to the PIIRA survey of California refinery production from the summer of 2006. The API gravity for California diesel fuel averaged 38.5 or 0.832 g/ml specific gravity. California refiners also produce diesel fuel for export to Arizona and Nevada. The density of that EPA ULSD was 0.841 g/ml or an API gravity of 36.8, slightly higher in density compared to the California type of diesel fuel. Table 4 contains information for the API gravity and other properties for all distillate fuels, including jet fuel.

[46] Energy Information Administration, "Definitions, Sources and Explanatory Notes," [http://tonto.eia.doe.gov/dnav/pet/TblDefs/pet_cons_821use_tbldef2.asp].
[47] California Air Resources Board, *The California Diesel Fuel Regulations*, August 14, 2004, [http://www.arb.ca.gov/fuels/diesel/081404dslregs.pdf]. Also see U.S. EPA diesel fuel programs at [http://www.epa.gov/OMS/regs/fuels/diesel/diesel.htm].

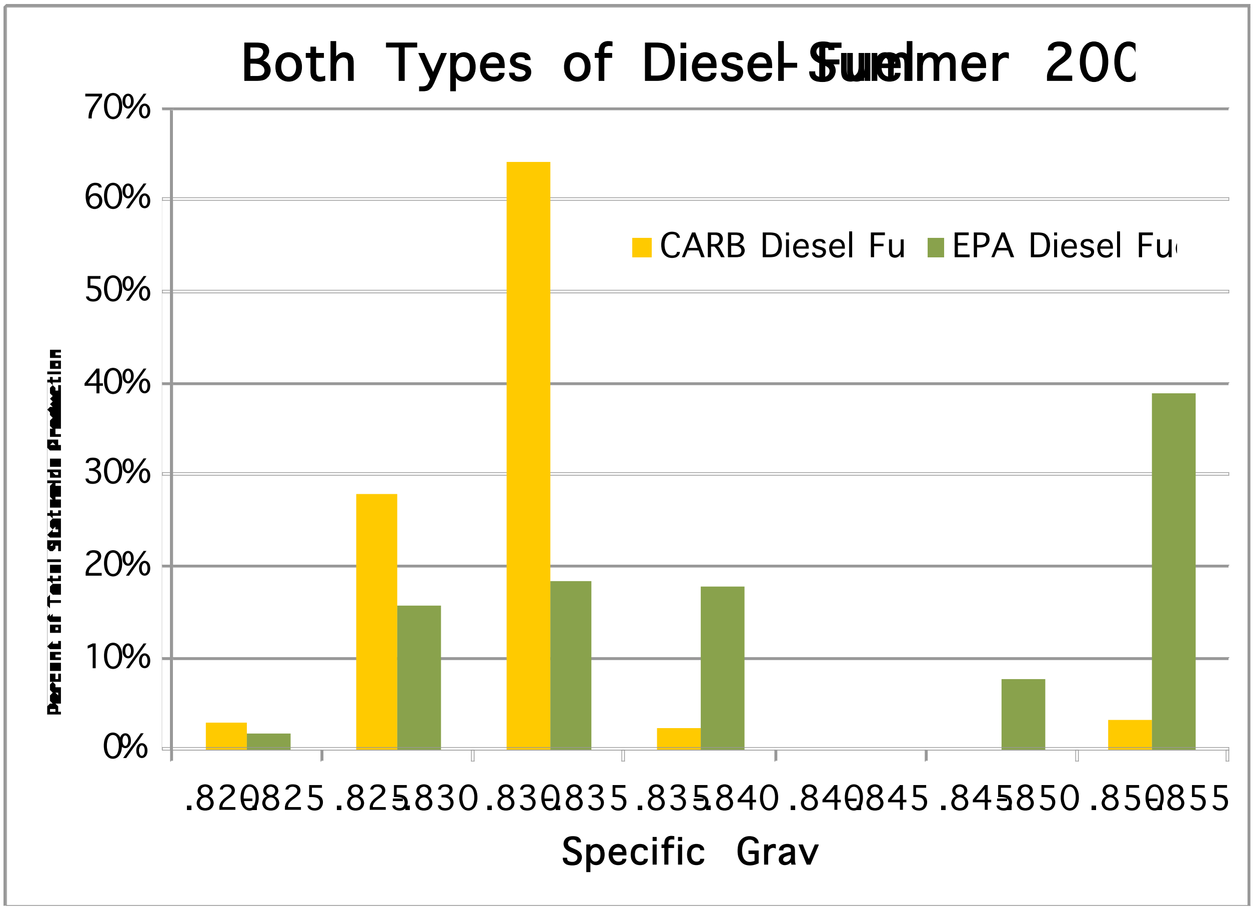
Table 4: California Refinery Production Properties – Summer of 2006 Distillate

Volume/ Property	Jet Fuel	Diesel Fuel CARB ULSD	EPA ULSD	Diesel Other	Residual Fuel Oil
Volume (bbl/d)	247,495	269,737	74,505	37,555	50,267
API Gravity	42.1	38.5	36.8	33.9	7.0
Sulfur (ppm)	654.0	4.4	4.6	234.5	22,501.8
Nitrogen (ppm)		56.6	25.6	NA	
Freeze Point (°F)	-60.3				
Smoke Point (mm)	20.2				
Naphthalenes (vol%)	1.2				
Aromatics (vol%)	20.1	17.6	30.9	31.5	
Polynuclear Aromatics (vol%)	NA	2.2	2.4	NA	
Cetane Number (clear)					
Cetane Improver (ppm)					
Cetane Number (additized)					
Pour Point (°F unadditized)		0.9	-5.3	-14.9	
Pour Point Depressant (ppm)		No Use of Pour Depressant			
Distillation (°F)					
IBP	320.1	341.8	355.7	405.4	
T10	349.5	390.6	397.3	454.1	
T30	382.4	426.9	432.2	487.6	
T50	402.0	479.3	476.3	514.5	
T70	431.9	524.1	520.7	544.2	
T90	465.1	605.8	596.9	590.2	
FBP	504.5	659.2	657.7	629.6	

Source: Energy Commission staff analysis of confidential PIIRA information.

The variability or distribution of California diesel fuel is illustrated in Figure 18. As indicated by the chart, nearly 97 percent of the California refinery output during the summer of 2006 was within 1.2 percent of the average density value, with only 3 percent outside the primary distribution range.

Figure 18: California Refinery Diesel Fuel – Relative Density Distribution



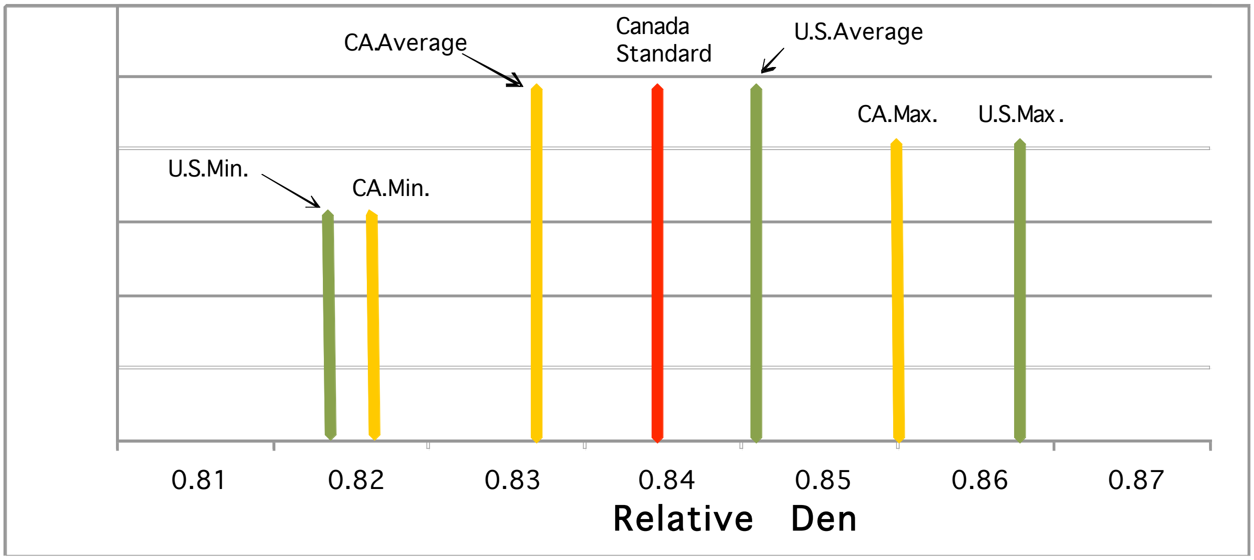
Source: Energy Commission staff analysis of confidential PIIRA information.

Diesel Fuel Density – California and United States Versus Canada Standard

The variability in the United States and California diesel fuel density values is shown in Figure 19 compared to the accepted industry reference standard used in Canada to program ATC devices at retail stations. As indicated by the graphic, the Canadian standard density value for diesel fuel is nearly midway between the average California and AAM survey results for the summer of 2006, rather than on the lower end of the distribution range as was the case with gasoline density values.

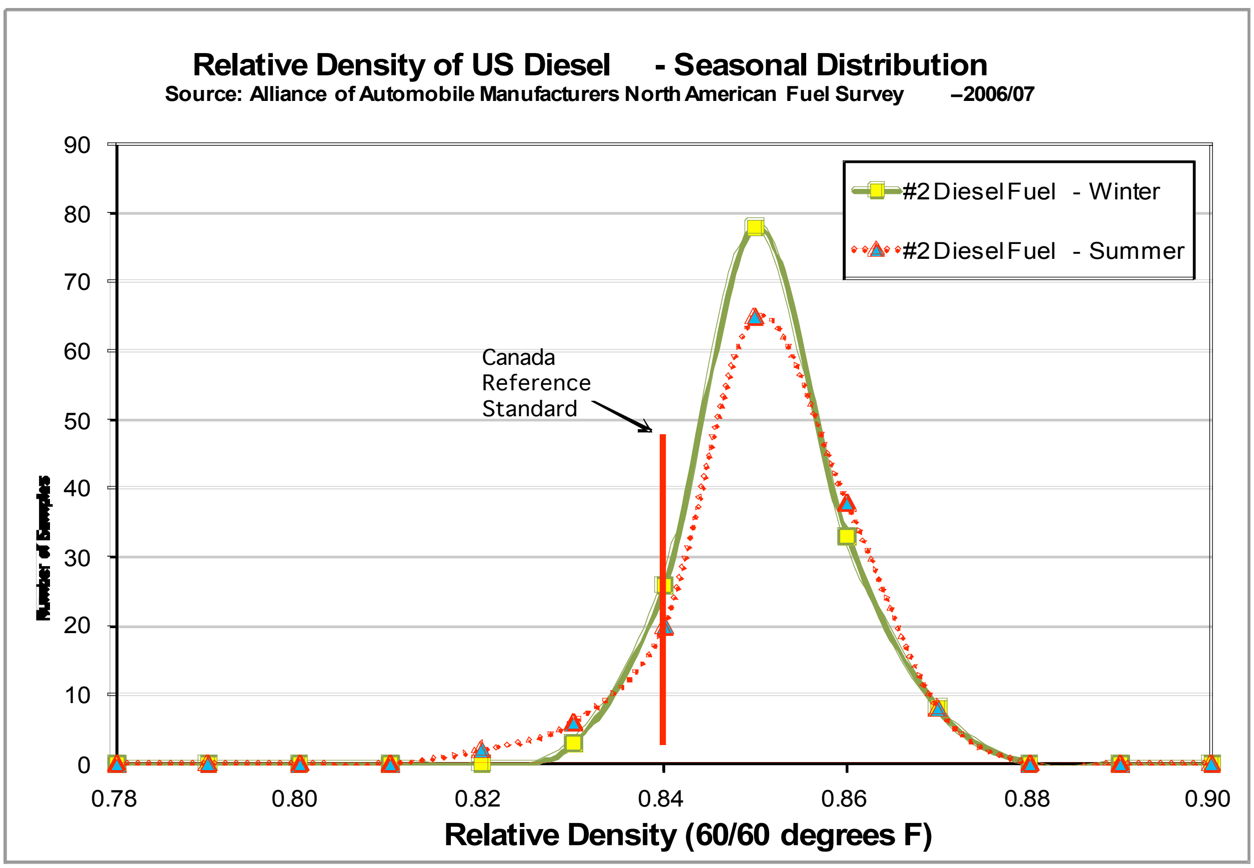
As was the case with California gasoline density distribution, the range is within that of the United States values. This is not a surprise in light of the greater variation in refinery configurations that exist outside of California.

Figure 19: Summer Diesel Fuel Density – United States and California Comparison



Source: Energy Commission staff analysis of AAM and PIIRA information.

Figure 20: United States Diesel Fuel – Seasonal Density Distribution



Diesel Fuel Density – Seasonal Variation

The distribution range of diesel fuel density values does not vary from summer to winter, a marked difference compared to the seasonal swing of gasoline. Figure 20 shows the summer and winter density distribution from the AAM diesel fuel survey compared to the Canadian reference standard of .840 g/ml used to program the volume correction factors for ATC devices installed at retail stations. You will notice that there is an absence of seasonal variation and that the Canadian reference standard is within 0.7 percent of the AAM average of 0.846 g/ml. Results of the California terminal survey data analysis for diesel fuel densities show that the distribution of values are within the upper and lower limits illustrated above in Figure 20.

Diesel Density Variability and Volume Correction Factor Impact

The variability of diesel fuel density in California is consistent with AAM values and a distribution within plus or minus 1.5 percent of the Canadian reference value of 0.840 g/ml. This tight grouping of diesel fuel densities means that if ATC were mandated in California for use at retail stations, the overwhelming majority of diesel fuel transactions would likely be within 0.02 percent of the true VCF for diesel fuel at 75 degrees Fahrenheit. Obviously, the use of variable density values at retail stations would be problematic, as is the conclusion regarding gasoline. However, unlike gasoline, the Canadian reference density value of 0.840 g/ml for diesel fuel is probably acceptable for use in California, if ATC was to be mandated at retail stations.

Potential Implications of Renewable Fuel Standard and Low Carbon Fuel Standard for Retail ATC

Typical alternative based transportation fuels in California currently consist of low-level blends of ethanol and biodiesel. Although other types of alternative transportation fuels can include methanol, compressed natural gas (CNG), and liquefied petroleum gas (LPG),[48] these fuel types will not be addressed in this report. Methanol is only used in limited application, primarily as a transit fuel not subject to retail transaction. Regarding the latter fuels, CNG is sold by weight, and temperature compensation of LPG is voluntary at retail in California through regulations administered by DMS.[49]

AB 868 directs the Energy Commission to, among other things, "evaluate how different reference temperatures or temperature correction devices apply to alternative fuels and low-carbon fuel standards." Energy Commission staff interprets this portion of the legislation to include analysis of how the varying types of alternative fuels would be addressed in a retail ATC environment.
Staff elected to identify the different discrete types of alternative fuels that are currently used in California and how their use may change as a consequence of the yet-to-be-defined Low Carbon Fuels Standard (LCFS) being developed by the California Air Resources Board (ARB).[50] Both of these regulations are expected to increase the use of ethanol and biodiesel that is used in retail transportation fuels for the state over the mid to longer term time period.

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[48] Propane used in transportation is referred to as automotive propane or HD5 propane. This grade of heavy duty propane is a specification that limits the propylene content to a maximum of 5 percent by volume and butanes (and heavier hydrocarbons) to maximum of 2.5 percent by volume.

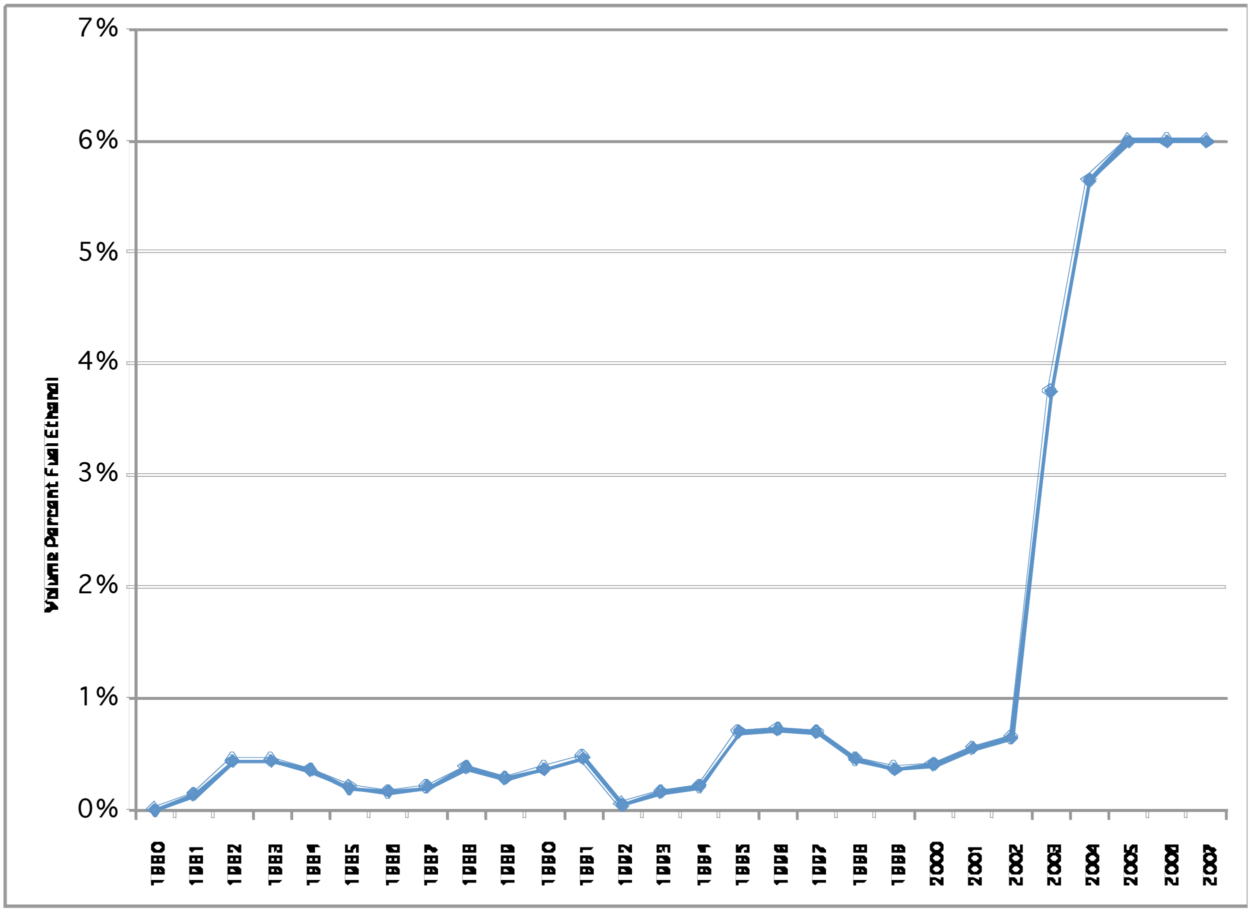
[49] Title 4 CCR 4000 NIST Handbook 44, Section 3.32 U.R.2.4.

[50] For further details concerning the LCFS regulatory process staff and development, please refer to the California Air Resources Board's web site at [http://www.arb.ca.gov/fuels/lcfs/lcfs.htm].

Ethanol

Ethanol is primarily used in California's gasoline in low concentrations; averaging about 6 percent by volume during 2007, and amounting to nearly 950 million gallons (see Figure 21).[51]

Figure 21: California Ethanol Use in Gasoline – 1980 through 2007



Source: Energy Commission staff analysis of FHA and BOE information.

The increased use of this alcohol as a blending component was driven by federal reformulated gasoline provisions mandating the use of a minimum quantity of oxygen in gasoline on a year-round basis and the phase-out of the competing blendstock methyl tertiary-butyl ether (MTBE) beginning in 2003. The promulgation of LCFS regulations are anticipated sometime during 2009. These regulations are designed to decrease the carbon intensity of transportation fuels over time. Alternative fuels such as ethanol and biodiesel normally have lower carbon intensities, but the average values that will be ultimately adopted into regulation are uncertain at this time. There is a general recognition that ethanol developed from corn has a greater carbon intensity when compared to ethanol produced from other cereal crops or sugar cane. Regardless, the final values adopted are presumed to be lower than gasoline and will likely result in greater use of ethanol in California. However, there is also a federal regulation that is expected to spur

[51] Information obtained from the Department of Transportation's Federal Highway Administration (FHA), the California State Board of Equalization (BOE), and PIIRA. A link to the FHA historical data is at: [http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubsarc.cfm].

greater use of ethanol and other biofuels in the United States, including California, referred to as the Renewable Fuel Standard (RFS).[52]

Due to these state and federal renewable fuel regulations, staff assumed that California's gasoline will contain an average of 10 percent ethanol (E10) by volume as early as 2009, but no later than 2010. For purposes of this analysis, therefore, staff assumed that the typical gasoline in use will be E10 before any retail ATC regulations take effect in California. Increased ethanol use will alter the density of finished gasoline (gasoline sold at retail stations) and could alter the expansion and contraction properties of the new transportation fuels sufficient to render the standard VCF values for gasoline to be less accurate for use in California.

Staff assumed the LCFS and RFS will also require even greater use of ethanol in California over the mid to longer term. This could be accomplished by (1) increased sales of E85 (a mixture of 15 percent gasoline and 85 percent ethanol), or (2) adoption of new upper limits for low-level ethanol blends in excess of the current E10 standard. Experts generally recognize that there are potential vehicle operability and emission issues that need to be addressed before the low-level cap on ethanol blends in gasoline can be increased to levels greater than 10 percent.

Original Engine Manufacturers (OEMs) generally have vehicle warranties that are voided if the owner uses gasoline with more than 10 percent by volume ethanol. OEMs are concerned about potential harm to the catalyst in their vehicles. A recent study conducted on behalf of the University of Minnesota, however, yielded information that suggests existing vehicles could operate at slightly higher ethanol concentrations without undue operational or emissions problems.[53] The U.S. Department of Energy (U.S. DOE) is also conducting vehicle testing of intermediate ethanol blends (E15 and E20) to quantify effects on vehicle emissions, catalysts, and engine durability. This group has recently released a preliminary report that did not identify any significantly detrimental issues.[54] The use of intermediate ethanol blends in California may require new VCFs for both E15 and E20.

Measurement Canada specifies that the assumed standard density of gasoline containing ethanol at up to 15 percent by volume be identical to that of gasoline, 730 kg/m^3 at 15 degrees Celsius, when such blends are used in retail fuel dispensers equipped with ATC devices.[55]

E85

There is also a very limited quantity of ethanol sold in higher concentrations to some owners of flexible fuel vehicles (FFVs) in California. FFVs can operate on gasoline or E85. Over time, staff expects that the quantity of E85 sold in California will increase in response to the federal RFS and the state LCFS. If retail ATC was mandated in California, stations with E85 dispensers would require software that was programmed with a density and associated VCF equation

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[52] Energy Independence and Security Act of 2007, *Title II – Energy Security Through Increased Production of Biofuels*, Subtitle A – Renewable Fuel Standard, Section 202 – Renewable Fuel Standard, December 2007, [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf].

[53] University of Minnesota, Department of Mechanical Engineering, *Demonstration and Driveability Project to Determine the Feasibility of Using E20 as a Motor Fuel,* November 4, 2008, [http://www.mda.state.mn.us/news/publications/renewable/ethanol/e20drivability.pdf].

[54] Oak Ridge National Laboratory, *Effects of Intermediate Ethanol Blends on Legacy Vehicles and Small Non-Road Engines, Report 1*, publication number ORNL/TM-2008/117, October 2008, [http://feerc.ornl.gov/publications/Int_blends_Rpt_1.pdf].

[55] Measurement Canada, *Selection of Volume Correction Factor Tables and Standard Density Values for Some Common Products*, Bulletin V-18 (rev. 5), April 1, 2008, [http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00116.html].

specific to E85. Although average density values could be calculated for E85 using API gravity values for each fuel in the correct proportions, it is possible that the resultant mixture may exhibit other characteristics sufficiently dissimilar to gasoline to render the VCF equations less useful. Therefore, staff believes that it would be optimal that laboratory testing be performed by DMS to determine expansion and contraction values for E85 before the introduction of ATC.

Biodiesel

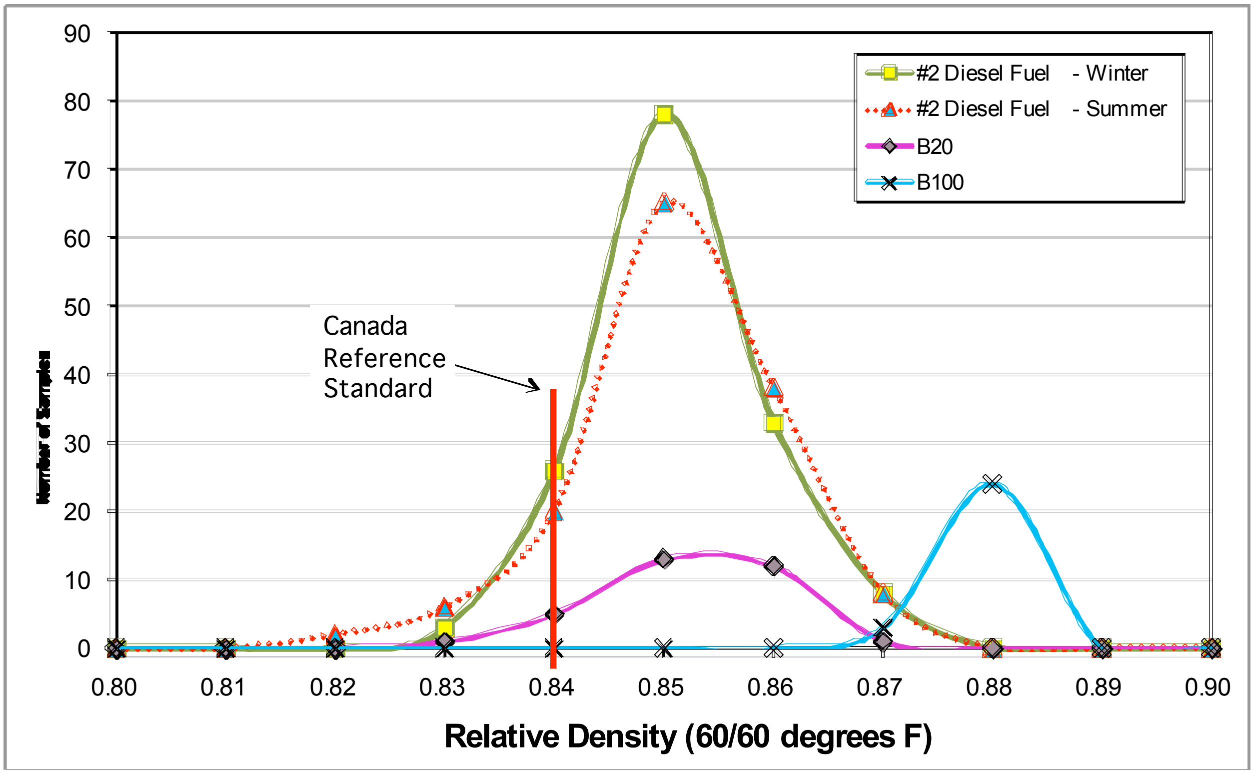
Biodiesel is a general term used to describe mixtures of diesel fuel with varying concentrations (between 2 and 20 percent) of biomass-based distillate. Retail sales of biodiesel in California are quite modest at this time, but will likely increase for the same reason as ethanol (the state LCFS and the federal RFS). If retail ATC was mandated in California, accuracy of biodiesel fuel dispensers may be less when compared to gasoline and traditional diesel fuel, because of variable densities for different types of biodiesel and imprecise biodiesel concentrations at retail locations. The potential level of inaccuracy is related to the degree to which biodiesel densities differ from traditional diesel fuel. If the differences are small, the VCF for traditional diesel fuels should be sufficient for purposes of ATC application at retail.

Blenders of biodiesel are permitted to vary the concentration in diesel fuel depending on which standard is adhered to for the final blend. Low level biodiesel blends can range from 2 to 5 percent of B100 mixed with the conventional diesel fuel to meet ASTM specification D975. Higher blends of B100 between the range of 6 and 20 percent by volume must meet ASTM specification D7467.[56] Density values for the pure biodiesel (B100) can vary due to the feedstock used or the type of process employed. A survey of biodiesel producers in the United States was conducted in 2004 to identify the properties of both B100 and B20.[57]

Among the findings was that the density values for the B100 samples averaged 0.883 g/ml, with a low value of 0.875 g/ml and a high value of 0.889 g/ml. Samples were also analyzed during the survey for low level blends of biodiesel. The density of all of the samples with biodiesel concentrations between 18 and 22 volume percent averaged 0.857 g/ml, with a low of 0.836 g/ml and a high of 0.870 g/ml. A table with the accompanying density values for B100 can be found in Appendix G, while the table containing the low level biodiesel blend properties (including density) is located in Appendix H of this document. Figure 22 shows the distribution of these density values in relation to the diesel fuel density distribution from the AAM 2006 survey.

Figure 22: Diesel Fuel and Biodiesel – Density Distribution

[56] National Renewable Energy Laboratory, *Biodiesel Handling and Use Guide*, fourth edition, publication number NREL/TP-540-43672, September 2008, page 23, [http://www.nrel.gov/docs/fy08osti/43672.pdf].
[57] National Renewable Energy Laboratory, *Survey of the Quality and Stability of Biodiesel and Biodiesel Blends in the United States in 2004*, publication number NREL/TP-540-38836, October 2004, pages 18, 49 and 50, [http://www.nrel.gov/docs/fy06osti/38836.pdf].



Source: Energy Commission staff analysis of AAM and NREL information.

The varying nature of low-level biodiesel blends should not pose an accuracy problem if retail ATC was mandated in California, since the variation of density appears to be within the normal distribution for regular diesel fuel. However, pure or neat biodiesel (B100) density is outside the normal distribution variability and should merit consideration for a separate reference standard density value if sold at ATC retail. Measurement Canada acknowledges that "bio-diesel and bio-diesel blends do not expand and contract in the same manner as petroleum diesel of the same density."[58] The ability of a retailer to know the actual density of the biodiesel blends delivered to the service station is quite limited. Therefore, Measurement Canada requires ATC at retail to use the same standard density as diesel fuel, 840 kg/m^3 at 15 degrees Celsius.[59]

Density Conclusions

If ATC is mandated at retail fuel stations in California, the following conclusions regarding fuel density are offered:

- Density reference values used to program retail ATC software should not be altered on a seasonal or per-load basis due to the impractical and problematic consequences of such an approach.

- A single reference density value for finished gasoline should be selected and be representative of the summer blending season, since the highest divergence from the 60 degree Fahrenheit reference standard exists at that time of year in California. Slightly less

[58] Measurement Canada, *Selection of Volume Correction Factor Tables and Standard Density Values for Some Common Products*, Bulletin V-18 (rev. 5), April 1, 2008, [http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00116.html].
[59] Ibid, Table 1.

accurate density representation during the winter blending season is more acceptable because the fuel temperatures during that time of year are much closer to the reference temperature of 60 degrees Fahrenheit.

- The Canadian reference value of 0.730 g/ml is outside the lower range of California gasoline density values and should not be used as the reference density standard in this state for ATC at retail.

- The final value should be one that is at or near the summer average, rather than annual, California retail gasoline density value as determined by DMS in consultation with industry and appropriate state agencies. For purposes of this conclusion, the summer period includes May 1 through September 30.

- The ethanol concentration in retail gasoline should be assumed to be 10 percent by volume for purposes of determining a reference density standard.

- Retail sales of E85 at ATC retail stations should use a density reference standard other than the one selected for California retail gasoline containing 10 percent ethanol. DMS should conduct laboratory work to determine the appropriate density value of E85 in consultation with industry and appropriate state agencies.

- The Canadian reference density standard of 0.840 g/ml for diesel fuel would be acceptable for use in California since that value is at or near the average retail density properties for retail diesel fuel in this state.

- ATC retail sales of diesel fuel that contains biodiesel at concentrations up to 20 percent by volume should use the Canadian reference diesel density standard of 0.840 g/ml.

- The Canadian reference value of 0.840 g/ml is outside the lower range of B100 density values and should not be used as the reference density standard in this state for ATC at retail. Rather, DMS should conduct laboratory work to determine the reference standard density value for B100 in consultation with industry and appropriate state agencies.

CHAPTER 4: ATC Retrofit Option

This chapter of the report includes details associated with the quantification of Automatic Temperature Compensation (ATC) retrofit costs, options to decrease costs for some retail outlets, potential consumer and retailer benefits, cost-benefit comparison, and trends in the retail gasoline business relevant to the analysis.

Cost-Benefit Analysis Approach and Methodology

A cost-benefit analysis (CBA) of a particular option (in this case an ATC retrofit of California's retail stations) sums all of the monetized benefits resulting from an option and subtracts all associated monetized costs over 10 or 15 years. The CBA results of this ATC option can then be compared against other ATC options, such as the new reference temperature option discussed in Chapter 5.

The methodology used in the ATC retrofit option was to identify and quantify the associated costs and benefits over time to determine if benefits outweighed costs. Costs examined included the expense of the ATC retrofit equipment, labor to install the devices, and incremental time to certify the new devices. These initial costs are considered to occur only once under an assumption that all of the retail stations would be retrofitted initially. Energy Commission staff also identified and quantified additional expenses that were assumed to recur annually. These recurring costs included increased device registration fees, ATC equipment for new or refurbished stations, and periodic maintenance to service ATC devices. One final aspect of the ATC retrofit cost valuation methodology was to include an additional expense for financing the money required to pay for the initial retrofit of the retail stations.

On the benefit side of the ledger, staff performed analysis to monetize the expected benefits society might realize from the ATC retrofit option. In this context, "society" would include all California consumers who purchase gasoline and diesel fuel at retail stations within the state and owners of retail stations. The two types of potential benefits that were analyzed as part of this option included expected benefits for retail motorists that might be derived from changes in the method by which retail fuel was sold at the retail station and potential economic benefit to society of improved information regarding transparency of California retail fuel prices. Accuracy and reliability in measurement standards is critical to the maintenance of a fair marketplace and to facilitate value comparison, benefiting consumers and competitors alike.

Since the ATC equipment would operate in such a fashion as to dispense slightly larger gallons of variable size (in cubic inches) in a warmer fuel temperature state such as California, the expected benefit to consumers is perceived by various stakeholders to be the value of the decreased quantity of gallons that would have been purchased if ATC equipment had been installed at retail stations, referred to as net gallons.

Improved transparency concerning retail price information is the other expected benefit for California retail motorists associated with ATC retrofit and involves the elimination of temperature variation from the retail station transaction. California retail motorists are able to examine and compare prices of gasoline or diesel fuel at various potential fueling destinations by examining retail prices posted on large signs as they drive. However, this comparison of retail fuel prices is not completely accurate because variations in fuel temperatures can alter the effective size of the net gallons that would be received at any given retail station available to an individual motorist who is seeking to obtain transportation fuel at the lowest price. If the retail stations had ATC dispensers, the variability of fuel temperature (and corresponding impacts on net gallon size) would be corrected and retail motorists would be able to more accurately compare gasoline and diesel fuel prices posted at various potential fueling destinations.

In economic terms, this imperfect market condition resulting from less transparent retail fuel prices is referred to as dead-weight loss (DWL). Installing ATC at retail stations in California would improve retail fuel price transparency by increasing consumer information, thus eliminating the dead-weight loss to the California retail fuel market. Although small in magnitude, the quantification of this impact was included in the consumer benefit analysis.

Costs (Equipment, Labor and Inspection)

If ATC was mandated for use at retail stations in California, the operators of these fueling facilities would need to retrofit their existing fuel dispensers to comply with such a requirement. As part of the ATC retrofit option analysis, Energy Commission staff quantified the following ATC-related costs: new equipment for fueling dispensers, labor to install and calibrate the devices, and fee increases by inspectors to verify correct calibration of ATC equipment during regularly scheduled certification inspections.

Energy Commission staff used data from a variety of different sources in order to estimate attributes of retail fueling sites, such as the total number of retail fuel dispensers, number of fuel products per dispenser and which retail fuel establishments blend their midgrade gasoline as a mixture of regular and premium grade gasoline. These sources include the Energy Commission's California Retail Fuel Outlet Annual Report (A15 report),[60] data collected from County Agricultural Commissioners/Sealers of Weights and Measures (county sealers), data from various air quality management districts, survey responses from the petroleum industry, and information provided by ATC equipment manufacturers.

[60] California Retail Fuel Outlet Annual Report, CEC Form A15. A blank A15 form may be viewed at: [http://www.energy.ca.gov/piira/forms_instructions/CEC_A15_RetailSurvey_Dec07_Rev.pdf].

Costs – ATC Retrofit Equipment Overview

There are roughly 9,700 retail fuel establishments in California containing about 42,050 active fuel dispensers, with the majority (91 percent) of these devices being electronic. Energy Commission staff used approximately 5,100 completed A15 forms to obtain data on what fuel types each retail fuel establishment dispenses and whether that particular site blends fuels to produce its midgrade gasoline. This data focused mainly on retail sites that sell gasoline and diesel fuel, rather than other fuels such as propane and natural gas.

Data was collected from county sealers, on the total number of meters per retail site. In this context, total meters means the total number of product delivery streams available to customers. For example, if a retail fuel establishment has three dispensers, each of which dispenses six product delivery streams (three per side), then there are 18 total meters at that site. The meter data alone was used to help estimate costs for approximately 3,000 retail fueling sites.

The Energy Commission contacted the majority of Air Quality Management Districts (AQMDs) in California and also visited one to obtain dispenser data for retail fuel establishments. Most retail establishment operators are required to submit an application for a Gasoline Dispensing Facility (GDF) permit on an annual basis. Most of the AQMDs that use GDF permits require specific data to be submitted that includes: the make and model of retail dispensers, the number of dispensers, and the number of nozzles each dispenser has. In theory, the information provided in the GDF permits would be ideal for use in the cost estimation. In practice, however, the GDF information was either unavailable electronically, outdated, or incomplete. As a result, the AQMD resource was of limited use to staff.

Lastly, a dispenser survey was sent out to retail fuel sites in counties that did not require GDFs to report dispenser make and model information. A copy of the survey may be viewed in Appendix I. The survey was also sent to many of the major oil companies and retailers in California. The purpose of this survey was to collect the same type of GDF data that is required to be filed by the majority of retail outlets applying for their AQMD permits. Additional questions were included in the survey regarding whether the dispensers are electronic or mechanical. This survey generated nearly 600 responses; some of the responses were from retail sites that had data from the A15 report and from the county sealers.

ATC Retrofit Cost Methodology

Energy Commission staff initially pursued make and model information for retail fuel dispensers since retrofit kits were designed and priced for specific brands of dispensers. During the course of our analysis, a change in business practice occurred for ATC manufacturers that resulted in the pursuit of "universal" ATC retrofit kits designed to be compatible with most fuel dispenser makes and models.[61] This development simplified the cost quantification task for Energy Commission staff and shifted the emphasis of the retail station attributes to the number of dispensers, fuel types, and mid-grade gasoline blending capability.

Universal Automatic Temperature Compensation (ATC) kits are priced based on how many fuel products are delivered from a dispenser. On the low end are one-product dispensers that would require an ATC retrofit kit costing $1,700. On the upper end are four-product dispensers (non-blending) that would cost about $2,426. Blending for midgrade reduces the kit cost and was also considered in the analysis. Other aspects that staff included are whether dispensers

[61] Conversations with Krause Global representatives concerning their recent ATC retrofit plans and activities in Belgium.

are mechanical or electronic. Mechanical dispensers are more expensive to retrofit (between $3,200 and $4,000) with an ATC kit because, in addition to installing the kit, some equipment on the dispenser needs to be replaced with electronic components. Table 5 lists the various ATC retrofit kits and their associated costs.

Table 5: ATC Retrofit Kit Costs by Dispenser Attributes

Number of Fuel Types	Mid-Grade Blending Capability	Electronic or Mechanical	Nozzles	Estimated Equipment Costs
One	No	Electronic	NA	$1,422
Two	No	Electronic	NA	$1,700
Three	No	Electronic	NA	$2,042
Three	Yes	Electronic	NA	$1,700
Four	Yes	Electronic	NA	$2,426
One	No	Mechanical	One	$3,183
Two	No	Mechanical	Two	$3,997

Source: Energy Commission staff research and analysis.

In the process of collecting data, staff received information from different sources to gather as much data as possible. For retail fuel stations, staff needed different techniques to calculate the number of dispensers and products per dispenser. For 40 percent of all retail stations in California, staff obtained data from the A15 report and meter information from the county sealers. This allowed staff to determine the number of dispensers based on the number of products per dispenser from the A15 data and the number of meters per location. For 28 percent of the retail stations, staff has only meter data, which is a good indication of the dispenser count. To determine the number of fuel products per dispenser, staff used the average number of fuel products per dispenser from the retail dispenser survey; the average used is by county. For 12 percent of the stations, staff has only A15 data, which indicates the number of fuel products, and whether the retail station in question blends midgrade gasoline.

To calculate the number of dispensers, staff used the average number of dispensers, by county, from the retail dispenser survey. For retail stations in Los Angeles and Monterey counties however, the respective air quality management district provided data used to calculate the average number of dispensers. For only 8 percent of the stations, Energy Commission staff did not have any dispenser information. Again, the staff took averages by county for the number of fuel products and dispenser count except for Los Angeles and Monterey Counties, which have their own averages. Staff has full dispenser information for 12 percent of the stations in California, which required the most information gathering and data compilation. Staff was able to calculate a cost for each retail station with this information without using averages.

From the retail dispenser survey, which included 12 percent of all retail stations, staff determined which stations have electronic or mechanical dispensers. For retail stations where staff does not have dispenser survey information, staff took an average cost difference between mechanical and electronic dispensers and took into account that most stations have electronic dispensers. From the dispenser survey, only 9 percent of stations have mechanical dispensers.

Using the retail dispenser survey and A15 data, which included 52 percent of all retail stations, staff knew which stations blend midgrade and which do not. For stations without that information, staff took an average cost difference between a blended dispenser and non-blended dispenser for all stations. Through the retail dispenser survey and A15 report, staff found that about 70 percent of stations blend for midgrade and took this into consideration when calculating dispenser costs.

Costs – ATC Retrofit Equipment Totals

Statewide costs for ATC retrofit kits are estimated by staff to amount to approximately $84 million or $8,682 per retail station. Highest per-station county average was $10,474 in Orange County, while the lowest per-station cost average was estimated at $2,212 for Alpine County. Retail outlets in the urban areas tended to have higher per-station ATC retrofit costs due to a greater number of dispensers and fuel types, when compared to counties that are rural in nature. Appendix J provides a county-specific breakdown of the ATC retrofit kit equipment costs.

Costs – Labor to Install ATC Retrofit Equipment

Energy Commission staff calculated an estimate for labor expenses to install ATC retrofit kits at all of California's retail stations of between $9.0 million and $27.9 million. Staff assumed that the ATC installation work would require two technicians working between one and a half to four hours to install ATC kits for each dispenser.[62] The labor rate per technician was estimated to be between $60 and $70 per hour.[63] These hourly wage rates are assumed to be "fully loaded," meaning that the rates are sufficient to cover the salary of the worker, benefits, and sufficient overhead for the company to maintain a profit.

Staff took the number of dispensers in each retail station used initially in the equipment costs and multiplied the number of dispensers by the hours required per dispenser, technicians, and labor rate to calculate a labor cost per station. Installation costs for retail stations located greater distances from large metropolitan areas were increased to account for time spent away from the business's headquarters. These additional costs included: fuel allowance, hotel stay and per diem overhead. Staff considered counties "rural" if they are far enough from a major metropolitan center to necessitate overnight stays. Examples of counties that are considered metropolitan areas are Fresno County (due to the city of Fresno) and Kern County (due to Bakersfield). Counties in the greater San Francisco Bay Area, Los Angeles basin and San Diego regions were designated as "urban" with no adjustments made for additional labor costs. The large eastern geographic extent of San Bernardino and Riverside counties was also designated "rural" in terms of calculating higher labor costs.

Installation costs were adjusted to take into account the additional time required for technicians to drive to their retail station destinations, assuming clients were being charged when the technician departed their place of business.[64] Staff assumed that California cities with populations of greater than 200,000 would have technicians certified to install ATC retrofit devices. Calculations for additional technician driving time for each county used the nearest technician "home base" to estimate additional labor expenses. This approach yielded an additional labor cost component of between $1.1 million and $3.8 million. The lower estimate

[62] Energy Commission staff labor time estimate based on discussions with industry representatives.
[63] California wage rates of workers in Standard Occupational Classification (SOC) code 49-2094 (designated for electrical and electronics repairers, commercial and industrial equipment) averaged $25.67 per hour during May 2007 with a 90th percentile wage rate of $38.28. A link to the state SOC data is at: [ftp://ftp.bls.gov/pub/special.requests/oes/oesm07st.zip]. Due to the specialized nature of fuel dispenser technician work, it would be reasonable to assume their hourly wages are closer to the 90th percentile level in California. Further, fully-loaded wage rates in the $60 to $70 per hour range would appear sufficient to cover all fully loaded company expenses.
[64] Based on comments received during the December 9, 2008, Committee Workshop.

assumes two technicians each charging $60 per hour. The higher estimate used a wage rate of $70 per hour.

Costs – ATC Retrofit Labor Totals

Statewide costs for ATC retrofit kit installation labor are estimated by staff to amount to between $9.0 million and $27.9 million or from $925 to $2,879 per retail station. The low labor estimate assumes a $60 per hour wage rate (fully loaded) and one and a half hours worked by two technicians on each dispenser. Under these assumptions, the highest per-station labor cost average was $1,241 in Del Norte County, while the lowest per-station labor cost average was estimated at $521 for Trinity County. The high labor estimate assumes a $70 per hour wage rate (fully loaded) and four hours worked by two technicians on each dispenser. Under these assumptions, the highest per-station labor cost average was $3,647 in Riverside County, while the lowest per-station labor cost average was estimated at $1,312 for Alpine County. Counties with the higher averages were a mixture of both urban and rural locations. Urban areas with higher than average number of dispensers per location would push up the labor costs, while rural locations with average numbers of dispensers but more distant locations also had some higher labor costs. Appendix K provides a county-specific breakdown of the ATC retrofit kit labor costs.

Costs – Increased Inspection and Certification Fees

Retail stations in California are normally visited every 12 to 18 months by county weights and measures inspectors for purposes of verifying accuracy of measurement devices, which would include retail fuel dispensers. Currently, these inspectors check and verify the accuracy of fuel dispensers to ensure that the correct quantity of fuel (in cubic inches) is within specified measurement tolerances. If the fuel dispenser is within acceptable measurement tolerances, the devices receive a weights and measures seal. Over the last couple of years, initial inspections of retail motor fuel metering devices have resulted in approved certification 93 percent of the time.[65] If the fuel dispenser is not within acceptable range of accuracy, the inspector shall require the fuel dispenser to be properly calibrated.

The time required to perform these field calibration tests varies by individual site according to the number of dispensers, the number of fuel types (different grades of gasoline and the presence of diesel fuel), and the percentage of dispensers that dispense mid-grade gasoline by combining equal portions of regular and premium grades of gasoline (referred to as "blenders"). County Weights and Measures Departments charge a device registration fee to offset the cost of this inspection and certification service that will usually vary as a reflection of the time required to perform the field work. Currently, in Sacramento County, the fee for service stations is $100 for the location and $20 per meter. The $20 per meter fee is based on an average of 12 minutes inspection time per meter. If the time was doubled, the fee would theoretically need to be increased to $40 per meter,[66] as the fees are designed to recapture the expenses incurred by each county to perform this inspection service. The registration fee that can be charged by county sealers, though, is currently capped by statute to no more than $1,000 per business location.[67]

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[65] California Division of Measurement Standards, County Monthly Report (CMR) summaries for period July 1, 2006 through June 30, 2008.
[66] Telephone conversation with David Lazier of Sacramento County Weights and Measures.
[67] California Business and Professions Code, Section 12240, subdivision (n). A link to this provision is at: [http://www.leginfo.ca.gov/calaw.html].

Energy Commission staff estimated the time needed to inspect and certify retail fuel dispensers will increase between 10 and 20 percent if ATC is mandated for use at retail stations in California. As such, the corresponding costs incurred by each county will rise and fees will need to be increased to compensate for the additional expenses (such as the hiring of additional weights and measures inspectors). However, there may be some instances when the fee in some counties or locations already being charged is at or near the upper limit imposed by Section 12240 of the California Business and Professions Code. If ATC is mandated in California at retail stations, the maximum limit stipulated in subdivision (n), Section 12240, California Business and Professions Code should be increased to at least $1,200 to ensure that counties will be able to recover all of their additional costs of performing inspections and certifications. The maximum permissible limit on inspection fees does not mean that county weights and measures departments can automatically set their inspection fees at the upper limit. Rather, these agencies must demonstrate that the fees being charged to retail station operators reflect the actual costs being incurred by the county sealers and no more. Approval for inspection fee increases typically must be approved by each respective county's board of supervisors.

Equipment costs for county weights and measures sealers are expected to increase if ATC was to be mandatorily implemented, but only slightly. Based on analysis performed by the NCWM, inspectors are expected to use an electronic device to measure fuel temperature during the dispenser testing and certification process, referred to as a digital thermistor thermometer (including the probe). Staff estimates that each inspector will probably require one such temperature measuring device, with one additional device to use as a back-up while in the field. Total cost for each device (including flexible probe) is not expected to exceed $450.[68] Certification costs of these additional standards will be borne by DMS. Costs to each county will vary and will be directly related to the number of inspectors that would be required in a post-ATC scenario. The number of county inspectors involved with testing retail motor fuel (RMF) meters is estimated by staff to be between 129 and 156 statewide.[69] Total statewide costs for the thermistor thermometers, therefore, are estimated to range between $77,000 and $140,000. Individual county totals are located in Appendix L. Assuming that these devices would be sufficiently durable to last several years, initial costs to each county could be recovered as part of the increased registration fee. Costs for other equipment (such as VCF look-up charts, calculators, and so on) should be minor.

For purposes of this portion of the total cost estimate, Energy Commission staff assumed that registration fees are at the maximum upper limit of $1,000 per retail station location and that these fees will need to increase by 10 to 20 percent if ATC is mandated at retail stations in California. As such, the costs to retail station operators is estimated to increase between $100 to $200 per year per location to cover the increased time required to perform testing and certification of fuel dispensers by county sealers or certified technicians. On a statewide basis,

[68] The cost estimate range will vary by quality of the handheld thermistor thermometer as reflected by level of accuracy and data recording and housing capability. For example, two models of Digi-Sense Thermistor Thermometers (models 60010-70 and 60010-75) retail for $174 and $315, respectively. Each device would also require the use of a flexible thermistor probe that would cost approximately $120 (stainless steel model) [http://www.novatech-usa.com/Products/RTD-Thermistor-Temperature-Meters]. Also see Digi-Sense product catalogue, [http://www.digi-sense.com/digi-sense-brochure-r2.pdf].

[69] Based on information from Los Angeles County, there are 14 full-time inspectors for over 1,900 retail stations. Applying this ratio to the rest of the state, staff estimates that 82 inspectors would be required (on a full-time basis) for about 9,700 retail outlets. Not all counties have inspectors dedicated solely to retail motor fuel (RMF) meter testing. The low estimate assumes all counties can inspect 100 RMF locations per year per sealer. All calculated values were rounded up to the next whole number. The high estimate assumes all counties with under 200 retail outlets inspect 50 RMF locations per year per sealer.

that fee increase would amount to between $970,000 and $1.94 million per year. This registration fee increase is expected to cover all additional expenses including new equipment that may be required to test accuracy of ATC- modified or equipped retail fuel dispensers. It should be noted that this would be an upper limit estimate for increased registration fees since there are likely several counties that are below the $1,000 limit. In those circumstances, the increased per-station inspection fees would be less than those used in the staff estimate.

Summary of Initial ATC Retrofit Costs

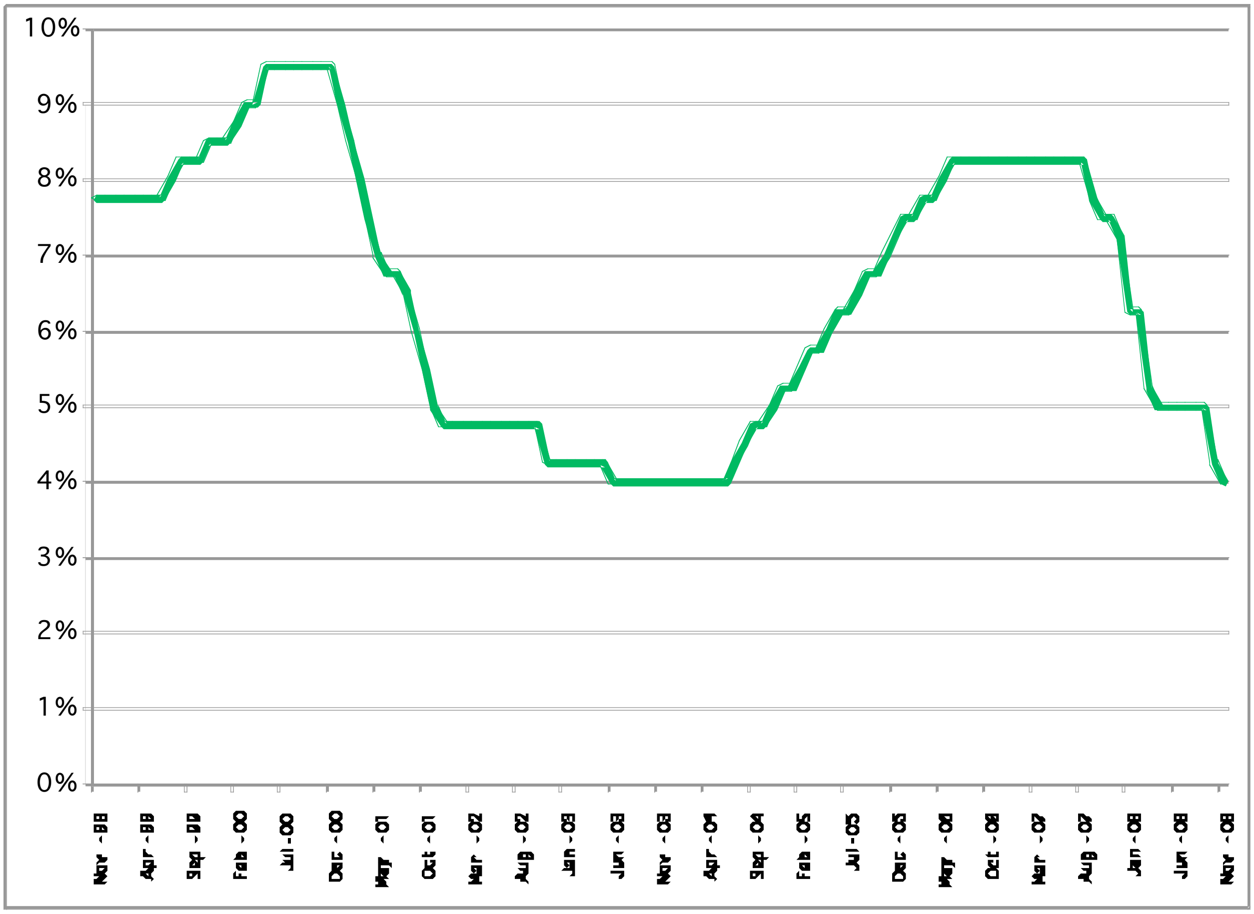
If ATC is mandated for use at retail stations in California, total initial costs to retail station owners are estimated to amount to between $94.1 million and $114.0 million or a per-station initial total cost of between $9,707 and $11,761. Alpine County had the lowest total initial cost estimate of between $2,848 and $3,724 per station, while Orange County was estimated to have the highest costs at between $11,533 and $13,647 per station. All of the county-specific costs are located in Appendix M.

Energy Commission staff assumed that the cost to pay for the ATC retrofit equipment (including installation) would be accomplished through the use of business loans that would be either secured (by real estate property and other assets) or unsecured. Although some retail station owners may elect to pay the retrofit costs with cash or other liquid assets, for purposes of calculating per-gallon total costs on a statewide basis, staff used two different interest rates and payback periods to bracket the upper and lower bounds of the total expenditures. The higher per-gallon ATC retrofit case assumes the cost to install the ATC retrofit kits (including labor and slightly higher inspection fee) are financed through loans at the highest prime rate experienced over the last decade and paid off within one year. The lower per-gallon ATC retrofit case assumes a loan at the lowest prime rate paid off over three years. The Prime Rate (as published by the Wall Street Journal) is an aggregate of the lending rates of the top 75 percent of the nation's banks. Over the last ten years, this rate has fluctuated between 4 and 9.5 percent as depicted in Figure 23.

Based on the high case borrowing assumptions discussed in the previous paragraph, staff estimated that the statewide financing expenses (interest and various loan fees) for ATC retrofit costs would amount to $13.3 million and be paid back over a period of one year at an average interest rate of 9.5 percent.[70] As such, the additional financing expenses would increase the statewide costs to a new total of $127.4 million or an average of $13,136 per retail station. Refer to Appendix N for county-specific results of the higher financing expense scenario. Staff assumed that retail station owners will attempt to recover these costs by raising prices on products that are sold at retail stations, both fuel and non-fuel commodities. It is uncertain as to how these price increases would be apportioned between the two classes of consumer goods, but the industry as a whole is expected to be successful in passing all of these expenses through to consumers over the long run.

Figure 23: Historical Prime Rate

[70] For purposes of this analysis, staff assumed that loan fees (points and other expenses) amounted to 2 percent of the loan amount.



Source: Wall Street Journal

If one assumes that these costs will only be passed through to consumers by raising the price of gasoline and diesel fuel over the useful lifetime of the fuel dispenser (10 years for the high estimate and 15 years for the low estimate), then the incremental retail price would increase by nearly seven hundredths (7/100) of a cent per gallon.

If the ATC retrofit expenses are financed through borrowing over a longer period of time (3 years) and at a lower interest rate (4 percent), the statewide financing cost would amount to $9.7 million and paid back by the retail station owners over 3 years. Total statewide initial costs (including equipment, labor, and financing) for ATC retrofit at retail would be approximately $103.8 million or an average of $10,704 per station. Assuming that these initial costs are completely passed through to consumers over 15 years by only increasing fuel prices, the price increase for gasoline and diesel fuel would be less at around four hundredths (4/100) of a cent per gallon. Refer to Appendix O for county-specific results of the lower financing expense scenario. Regardless of the financing and payback period assumptions, the temporary cost to consumers to retrofit retail stations with ATC devices would be extremely modest.

Recurring Annual Costs

If ATC is mandated for use at retail stations in California, there would be some level of recurring costs for such items as increased device registration fees, ATC equipment for new or refurbished stations, and periodic maintenance to service ATC devices.

The estimated inspection cost increase of $100 to $200 per station would be an incremental cost for retail station owners that would continue indefinitely. That increased expense would equate to between five thousandths (5/1000) and one hundredth (1/100) of a cent per gallon, an insignificant value.

Another type of recurring cost related to ATC would be for slightly more expensive fuel dispensers that are ATC capable that would be required to be installed at all new retail stations or refurbished stations after ATC regulations became effective. ATC-ready fuel dispensers are estimated to reflect the additional electronics and other components that are already part of an ATC retrofit kit. The additional expense of labor to install the devices in the field would not be included in the estimated incremental expense because that work would already have been performed in the factory.

Staff assumed that between 2,100 and 4,200 new dispensers would be installed throughout California each year.[71] All of the fuel dispensers are assumed to be electronic and capable of blending mid-grade gasoline within the dispenser. Approximately 85 percent of these dispensers would deliver 3 grades of gasoline, while 15 percent are estimated to also dispense diesel fuel.[72] As such, the incremental expenses for these types of dispensers are estimated to average $1,810 each. The statewide incremental costs for these more expensive fuel dispensers would amount to between $3.8 million and $7.6 million per year or between two hundredths (2/100) and four hundredths (4/100) of a cent per gallon.

A final category of recurring ATC costs is periodic maintenance. Energy Commission staff has learned that, if an ATC unit detects an error or "bad pulse," it will abort any active transactions, will show an error on the dispenser display, and would remain in that condition until the ATC unit is power-cycled.[73] The ATC software in dispensers will notify the operator if there is a current malfunction with the dispenser. These malfunctions would include the incorrect pulsation of the device or the device not working. Uncertainty does exist on the timeliness and the incentives for retailers in a warm state to quickly fix the problem. Over time, it is expected that some percentage of ATC retrofit components will fail to operate properly, necessitating an in-field adjustment or replacement by a certified technician.

Staff is not aware of any field repair statistics available from Canada that could shed light on this portion of the cost estimate, but understand that the overwhelming majority of new fuel dispensers have warranties of at least 12 to 24 months. It is reasonable to assume that the ATC retrofit kit components (pictured in Figure 24) are a combination of electronic, electrical, and solid-state probes. The lack of moving parts decreases the probability of significant failure rates. In addition, if failure rates were significant, the companies that manufacture these kits

[71] Energy Commission staff analyzed CMR Summary data for new retail motor fuel devices (or meters) obtained from the Division of Measurement Standards. There were 6,671 new meters inspected at retail stations over the last couple of years. Assuming that 85 percent of new fuel dispensers are designed for 3 fuel types and the remaining 15 percent designed for 4 different fuel types, there would be an average of 6.3 meters per new fuel dispenser. That means that there were an average of 529 new fuel dispensers installed each of the last 2 years with a low of 509 and a high of 550. Based on comments received from various stakeholders as part of the December 9, 2008, Committee Workshop proceedings, staff modified the estimate of new fuel dispensers installed to a higher range of between 2,100 and 4,200 per year. The lower figure assumes that all fuel dispensers would be replaced every 20 years, while the higher figure assumes replacement every 10 years.

[72] Staff estimate based on the ratio of diesel fuel availability at existing California retail stations per the CEC A15 Retail Outlet Survey from 2007.

[73] Evaluation Certificate Number TC7167, Project Number 800337. Issued by NMi Certin B.V.; Hugo de Grootplein 1; 3314 EG Dordrecht, The Netherlands.

would be motivated to improve the ruggedness and field lifetime expectancy of the components to reduce the expense incurred to service ATC-ready dispensers still under warranty.

Figure 24: ATC Retrofit Kit

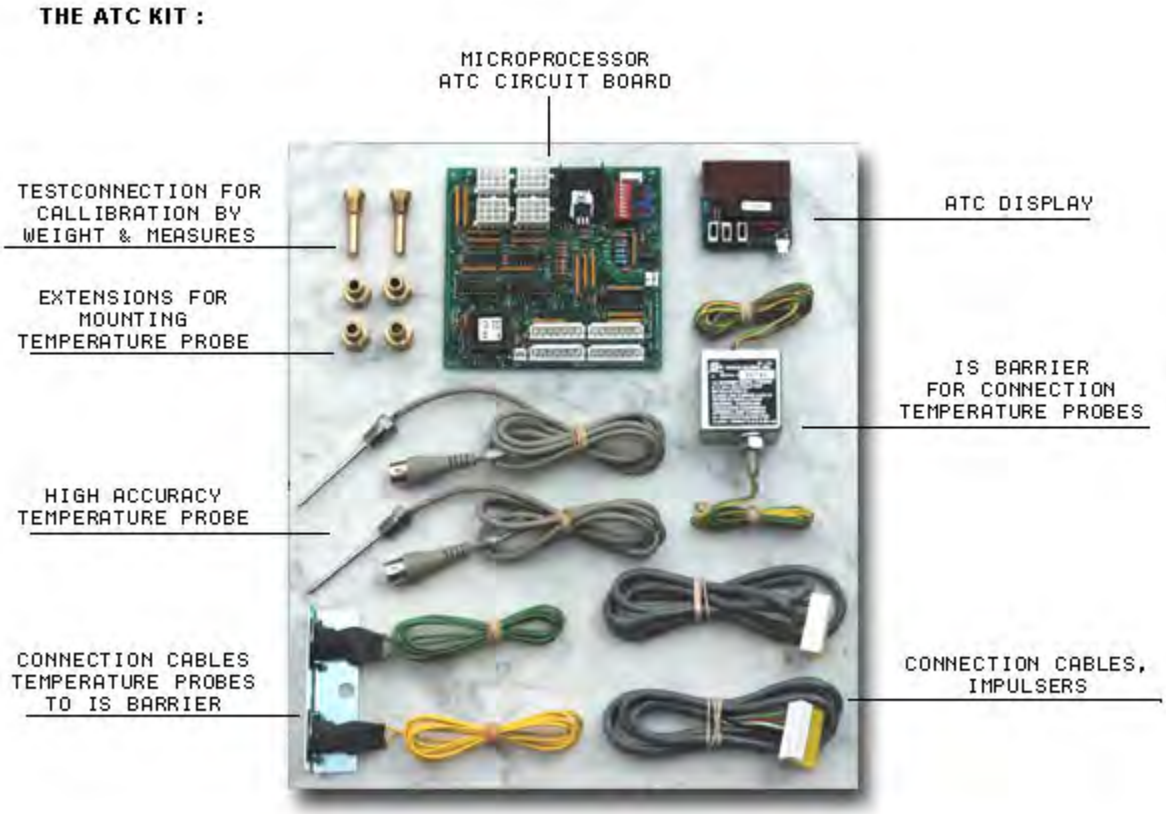


Photo Credit: Pump Service Automatic NV, http://www.pumpservice.be/engels/en_atc.htm.

Over the typical service life of a fuel dispenser, it is likely some degree of maintenance or repair would be necessary that is directly related to the ATC components. Therefore, staff assumed that some portion of the existing retail station locations will require some degree of ATC-related maintenance before the normal replacement cycle of the fuel dispensers. The low end of the annual maintenance estimate assumes that 10 percent of all retail stations will require a service technician to spend 8 hours of field time (at $60 per hour) and replace 25 percent of the initial cost of the ATC components at the retail location. The labor costs were increased by approximately 20 percent to allow for the increased expenses incurred for overnight stays in rural locations and the travel time for the technician to the retail station. This set of assumptions would amount to a recurring average statewide cost of $2.7 million, equivalent to 14 thousandths (14/1000) of a cent per gallon if applied to all gallons of gasoline and diesel fuel sold at retail stations.[74] The low maintenance scenario implies an average failure rate of 2.5 percent per year for ATC-related equipment.

[74] The actual per-gallon cost valuation for a station owner who incurs the additional maintenance cost on any given year will vary and be greater than the statewide valuation of 0.014 cents per gallon. Assuming an average per-station fuel sales volume, the maintenance cost for only those stations incurring the additional expense could be up to 14 hundredths (14/100) of a cent per gallon for the low maintenance cost estimate and up to 29 hundredths (29/100) of a cent per gallon for the high maintenance cost estimate. However, this valuation is for illustrative purposes as retail station owners are expected to try to pass along these incremental maintenance expenses by raising prices of fuel and non-fuel commodities that they sell.

The higher maintenance scenario assumes that 20 percent of all retail stations will require a service technician to spend 16 hours of field time (at $70 per hour) and replace 50 percent of the initial cost of the ATC components at the retail location. This set of assumptions would amount to a recurring average statewide cost of $11.0 million, equivalent to six hundredths (6/100) of a cent per gallon. The high maintenance scenario implies an average failure rate of 10 percent per year for ATC-related equipment.

ATC Retrofit Costs – Summary

ATC-related costs are summarized in Table 6 for both the low and high estimates expressed in total dollars and monetized in terms of cents per gallon of retail transportation fuel.

Table 6: ATC Retrofit Costs Summary

	Low Cost Estimate		High Cost Estimate	
	Statewide Total	Cents Per Gallon	Statewide Total	Cents Per Gallon
Initial Retrofit Costs				
Equipment	$84,180,731	0.0300	$84,180,731	0.0451
Labor & Increased Inspection Fee	$9,938,300	0.0035	$29,853,925	0.0160
Financing	$9,662,874	0.0034	$13,330,651	0.0071
Subtotal	$103,781,905	0.0370	$127,365,308	0.0682
Recurring ATC-Related Costs				
Inspection Fees	$969,600	0.0052	$1,939,200	0.0104
New Dispenser Incremental Costs	$3,801,000	0.0203	$7,602,000	0.0407
ATC-Related Maintenance	$2,663,008	0.0143	$11,024,358	0.0590
Subtotal	$7,433,608	0.0398	$20,565,558	0.1101

Source: Energy Commission staff analysis.
Note: Initial costs recovered over 15 years (low estimate) or over 10 years (high estimate).

Recovery of Expenses

Most retail station owners in California operate in a highly competitive business environment that can, at times, create temporary difficulties and challenges with regard to recovering increased expenses. This sphere of competition can consist of a single busy intersection that has four retail stations, a short stretch of road where two to three stations and their retail fuel prices are visually evident to motorists, or a single outlet in a small community. Each of these examples highlights varying degrees of competition for any retail station operator and can factor in his or her ability to pass through any and all incremental expenses to their customers. However, in all of these situations, staff believes that retail station owners (in aggregate) may be able to successfully pass along increased expenses over the long run, regardless of the type.

But this staff assumption, although plausible, is not a certainty considering the fact that the convenience store industry profitability has declined between 2005 and 2007.[75] Over this period of time, expenses for the industry have been increasing at a faster rate than the industry's

[75] National Association of Convenience Stores, *State of the Industry Report of 2007 Industry Data*, 2008, page 20. Convenience store industry pre-tax profits were $5.9 billion in 2005, but declined to $4.8 billion in 2006, and then dropped further to $3.4 billion in 2007.

collective ability to pass 100 percent of increased expenses through to customers. Increased expenses can include, but not be limited to, such items as higher wages, more expensive rents, utilities, rising credit card fees, new regulatory requirements (such as enhanced vapor recovery), and ATC. Increasingly higher charges by credit card companies for convenience store owners have been especially challenging to recover having reached a total of $7.6 billion in 2007, more than double the size of total pre-tax profits for the industry.[76] It is recognized, though, that even if the industry is able to eventually recover these increased expenses there could be some retail establishments that will go out of business while new stations will emerge.

For any given retail station owner, there are also other variables that can affect the ability to completely recover increased business expenses or the speed at which those costs can be recovered. One such example is the types of revenue streams available at the retail stations. For example, retail stations that sell both fuel and non-fuel commodities (such as convenience stores) have increased flexibility to attempt incremental expense recovery by increasing prices for multiple goods (gasoline and foodstuffs) and/or services (car washes). A retail station that only sells transportation fuels, however, has less flexibility and can only attempt to pass along increased expenses by raising the price of fuel they sell. These types of retail stations are estimated to account for less than 20 percent of the gasoline and diesel fuel sales.[77] Based on information obtained through the Energy Commission's A15 Retail Outlet Annual Survey, 76 percent of the retail outlets in California are categorized as convenience stores.

Another factor that will help determine how successfully or quickly a retail station owner can recover increased expenses is the average monthly or annual fuel sales. Obviously, retail stations that have a higher-than-average throughput of retail fuel sales can distribute increased expenses over a greater quantity of gallons, lessening the extent to which retail margins would need to be increased relative to their competitors. The converse is also true, retail stations that sell quantities of gasoline and diesel fuel that are below the California average of 160,550 gallons per month, would need to increase fuel prices to a higher level compared to a competitor with higher monthly fuel sales volumes in order to recover an identical level of expenses over the same period of time. The highest average retail fuel sales volumes in the state were in San Bernardino County at an estimated 210,761 gallons per month, while the lowest average was 54,569 gallons per month in Plumas County during the period April 2007 through March 2008. A listing of each county and the average fuel sales is located in Appendix P.

Agency Costs

If ATC is mandated for use at retail stations in California, DMS would need to craft regulations and conduct public workshops as part of a series of proceedings designed to culminate in new rules for businesses and inspection procedures for county sealers. This regulation development is assumed to be handled by DMS technical staff and management as part of their normal activities and should not require additional funding or positions.

Evaluation testing of ATC retrofit kits, as well as ATC-capable fuel dispensers, to ensure accurate performance, durability, and ability to maintain calibration is known as "type-evaluation." Applicants in this program are charged fees designed to cover related expenses incurred by DMS. This portion of ATC-related activity would be self- funding, as those fees are paid by the manufacturers of the devices. It is uncertain whether any additional staffing positions would be necessary for this type of work, but it should be noted as a possibility.

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[76] Ibid, page 22.

[77] National Association of Convenience Stores, *The Convenience and Petroleum Retailing Industry*, February 1, 2008, [http://www.nacsonline.com/NACS/News/FactSheets/Pages/TheIndustry.aspx].

Potential Impacts on Fuel Availability for Isolated Locations

If ATC is mandated at retail stations in California, it is possible that the expense to comply with the regulation could be onerous for some station owners. Further, some of these station owners may be unable to obtain adequate financing and could possibly shutter their business. Under such circumstances, this development could result in the loss of retail fuel supplies for consumers. Usually the closure of a retail station in an urban area does not result in the unavailability of retail fuel for motorists that normally frequent the retail establishment, as long as there are alternative retail stations within reasonable proximity to the station that had to go out of business. There can be other circumstances, though, when the retail station may be either the sole source or one of only two sources of retail fuel for a community.

If ATC is required in California, there should be provisions to ensure that retail stations serving isolated California communities receive special consideration for financial assistance. Criteria should be developed to identify candidate retail stations and revenue sources developed to fund ATC retrofit installations. One potential source of additional revenue would be to assess a special fee on gasoline and diesel fuel for a period of six months. As an example, a fee of two hundredths (2/100) of a cent per gallon would generate approximately $1.9 million. Staff has estimated that ATC retrofit costs for approximately 200 locations (2 percent of all retail outlets) could be fully financed through this 6-month temporary fee structure.[78]

ATC Retrofit Cost Conclusions

If ATC is mandated for use at retail stations in California:

- The maximum limit stipulated in subdivision (n), Section 12240, California Business and Professions Code would need to be increased to at least $1,200 to ensure that counties will be able to recover all of their additional costs of performing inspections and certifications.

- There should be provisions to ensure that retail stations serving isolated California communities receive special consideration for financial assistance. One such example would be the assessment of a special fee of two hundredths (2/100) of a cent per gallon on all gasoline and diesel fuel wholesale transactions for a period of six months to cover the expenses incurred for ATC retrofit for retail stations that meet all of the criteria established by the DMS in consultation with appropriate state agencies.

Potential Consumer Benefits Resulting From ATC Retrofit

Mandating the use of ATC at retail stations in California has been proposed by certain stakeholders because the anticipated consumer benefits are expected to outweigh the costs. "Consumers," in this context, refers to California motorists who purchase gasoline and diesel fuel at retail stations. This section of the report details the staff efforts to properly characterize and quantify these potential benefits. "Consumer benefits" have been denoted as the monetary value of the additional transportation fuel that California motorists would have received if ATC devices had been in place during the study period. The additional fuel would be in slightly

[78] Energy Commission staff estimates that there are currently 150 communities in the state that have either one or two sources of retail fuel, with the next alternative source of retail fuel supply a minimum of 10 miles driving distance (one way) from the community. The number of retail stations that currently meet the above criteria is estimated at 182 locations. Appendix Q contains a list of the number of retail stations by county and the estimated costs to retrofit those locations. Additional costs of technician travel time and cost of overnight stays has been factored in to these expense estimates.

larger size gallons as measured in cubic inches that would occur under circumstances in which retail fuel temperatures are warmer than 60 degrees Fahrenheit. Retail transactions transitioning from gross to net gallons will not alter the total demand for fuel consumed over the study period, but rather result in variable size gallons depending on temperature. The main question to address is whether consumers would retain the additional cubic inches dispensed from ATC fuel dispensers during warmer period of the year without any attempt by retail station owners to raise the price of the fuel to compensate for selling slightly larger-sized "gallons".

Quantification of Potential Consumer Benefits

Various stakeholders claim that retail station owners are receiving higher profits during the summer months and that a conversion to ATC at retail stations will benefit motorists by providing them with slightly larger-sized gallons, but with no or little adjustment to the retail price of the fuel. Although consumers would receive slightly larger-sized gallons as measured in terms of cubic inches, the actual units sold by the retail station owners would decline as a result of a conversion from gross to net gallons at retail. The more important point that has direct bearing on potential benefits for motorists has to do with the expected reaction by retail station owners to ATC at retail. Is it reasonable to assume that retail station owners will not increase their fuel prices if the cost of their fuel remains unchanged (wholesale purchase of net gallons) and the expected number of units sold declines? Staff assumes that the industry of retail station owners and operators will continue to grow and remain profitable.

The conclusion, therefore, is that retail station owners will in fact raise their fuel prices to compensate for selling fewer units, all other things being equal.[79] It should be noted, however, that various stakeholders are in disagreement with the report's conclusions regarding retail fuel price adjustment and the ability of retail owners to completely pass through incremental expenses. These contrary positions are described in the work of Dr. Jeffrey Leitzinger submitted to the docket on January 5, 2009. [80] Dr. Leitzinger and others assert that it is unclear whether, and the degree to which, retail station owners will be able to raise motor fuel prices depending on market conditions and other factors. Further, these stakeholders also maintain that it is unclear whether retail station owners will be able to completely recover ATC-related costs, even over the long-term. The Energy Commission acknowledges uncertainty in this regard but finds that the balance of evidence points to complete or near-complete pass-through of ATC-related costs from retail station owners to consumers. The quantification of the reduced number of units and a valuation of their worth during the study period are presented in the following paragraphs only to illustrate the magnitude of the anticipated retail price adjustment.

Energy Commission staff used retail fuel temperature, volume correction factor (VCF) equations, and retail fuel prices to quantify the net change in cubic inches that would have been dispensed if retail stations had been selling gasoline and diesel fuel as net gallons instead of gross gallons. It is recognized that the total volume of fuel sold during the study period would have remained unchanged. However, the primary difference would have manifested itself in the

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[79] The outlook for convenience stores (that sell transportation fuels) in the United States appears to be one of growth. According to statistics developed by Willard Bishop, convenience store numbers are forecast to increase from 120,740 in 2007 to 142,026 by 2012. Annual sales of non-fuel goods (groceries and consumables) are also expected to rise from a per-store average of $1.03 million in 2007 to $1.18 million by 2012. Bishop, Willard, *The Future of Food Retailing*, June 2008, [http://www.willardbishop.com/filebin/200806FFR.pdf].

[80] **California Energy Commission, Docket No. 07-HFS-01, AB 868 Fuel Delivery Temperature Study, Written Comments of Jeffrey J. Leitzinger, Ph.D.,** Econ One Research, Inc., January 5, 2009. [http://www.energy.ca.gov/transportation/fuel_delivery_temperature_study/documents/2008-12-09_workshop/comments/Jeff_Leitzinger_Econ_One_TN-49602.PDF].

decreased quantity of "gallons" as measured on a net basis. For example, during the study period there were 15.625 billion gross gallons sold at retail that equated to 3,609.375 billion cubic inches. If ATC had been in effect at retail during the same period of time, the quantity of net gallons of gasoline sold would have been approximately 15.508 billion or about 117 million gallons less compared to status quo (no ATC at retail) because the fuel was warmer (71.1 degrees Fahrenheit) than the 60 degree Fahrenheit reference standard. Under the ATC scenario, the quantity of net gallons of diesel fuel sold would have been approximately 3.037 billion or about 19 million gallons less compared to status quo (no ATC at retail) of 3.056 billion because the fuel was also warmer (72.9 degrees Fahrenheit) than the 60 degree Fahrenheit reference standard.

The next step in the analysis was to match these decreased quantities of gallons with the retail prices of the fuel during the study period. Doing so, staff calculated that the decreased quantities of gasoline gallons were valued at about $376.4 million and diesel fuel at about $61.1 million. Appendix R details the county-specific valuation. This amount of money is the representative value of the reduced quantity of gallons for which consumers would not have purchased if ATC had been in place at retail stations in California during the study period. However, this potential benefit to consumers perceived by some stakeholders is not expected to materialize. Rather, the retail station owners are expected to adjust the price of the new units to a slightly higher level to try and maintain similar levels of profitability in a post ATC scenario.

Quantification of Increased Price Transparency Benefits

Energy Commission staff acknowledges that having no knowledge of fuel temperature at the time of a transaction creates a problem because retail fuel consumers cannot adequately compare the benefits or value of fuel prices advertised by two competing retail stations. If consumers seek the lowest priced fuel and if temperature variation is not taken into account in the advertised price per gallon, a consumer could potentially buy a higher priced gallon when they could have received a better value if they had knowledge of the net price of that gallon. For example, a 15 degree Fahrenheit difference in temperature would produce an approximate one percent expansion or contraction of actual volume of fuel delivered, translating to a three cent per gallon variance in value received if the fuel were advertised at $3.00 per gallon. If the competing stations' respective advertised prices vary by only 2 cents per gallon, value comparison is not facilitated.

A mandated implementation of ATC will remove the effects of temperature variance and would remove information asymmetry as it involves the temperature of the fuel. This would force retailers to price gasoline and diesel products in net gallons, which would allow consumers to more accurately compare the prices among retail stations and retail station owners to more competitively price their fuel. By improving the retail price transparency for retail motorists and station owners, an inefficiency in the marketplace is corrected resulting in a monetary benefit for society, albeit quite small. In economics, this consumer benefit is described as elimination of deadweight loss. Staff had originally calculated this value to be approximately $3.2 million per year. However, additional information provided during the December 9, 2008, Committee Workshop and documents submitted to the docket during January 2009 provided new analytical insight that allowed staff to modify the earlier work and to take into account other factors not addressed in the earlier analysis (discussed in greater detail in Appendix S). As a consequence of these adjustments, the revised societal benefit of increased price transparency or removal of deadweight loss is now estimated at a little more than $250,000 per year.

The assumed net benefit to society, including business operators and consumers, would come through the ability of consumers to perform accurate value comparison in shopping among competing fuel retailers, as advertised per-gallon prices would reflect gallons of the same size under equivalent conditions (i.e., adjusted automatically to a 60 degree Fahrenheit reference standard). Station operators would benefit from the facilitation of fair competition achieved by such clarification. Any uncertainty regarding whether or not temperature influences had been factored into the advertised per-gallon price would be removed and the consumer's selection of the lowest priced fuel would consistently result in an actual savings to the consumer.

Measurement Canada, the governmental organization that oversees ATC in that country, describes consumer benefits in terms of more accurate retail transactions and increased consumer fairness. The following language is taken from their information bulletin dated January 1, 2008:

> **"What are the benefits of using ATC for the purchase and sale of gasoline?**
> Automatic temperature compensation is a more accurate and equitable method of measuring gasoline as it removes the effect of temperature on the volume of gasoline. The purchase and sale of gasoline based on a common reference temperature allows gasoline retailers to sell product on the same basis as it was purchased (facilitating accurate product inventories and early detection of product loss). The use of gasoline pumps equipped with automatic temperature compensation benefits consumers by removing the effects of temperature when purchasing gasoline."[81]

Quantification of Fairness

The concept of increased fairness for motorists has been raised by some stakeholders as a type of benefit that has not been accounted for in the cost-benefit-analysis. Some stakeholders believe that the collective benefits for motorists that would result from a conversion to ATC at retail stations could amount to hundreds of millions of dollars per year in California. Although no quantification of "fairness" has been attempted as part of these proceedings due to the variable nature of this possible consumer benefit, there are some research survey techniques and methodologies that could be used to provide some valuable insight into this possible and variable consumer benefit.

[81] Measurement Canada, *Selection of Volume Correction Factor Tables and Standard Density Values for Some Common Products*, Bulletin V-18 (rev. 5), April 1, 2008, [http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00116.html].

ATC Retrofit Cost-Benefit Analysis Results for Society

The following tables depict the results of ATC at retail stations under three scenarios: retrofit of existing stations (low estimate), retrofit of existing stations (high estimate), and gradual phase-in of ATC devices at retail stations. Assuming that the transition from gross gallons to net gallon at retail results in a corresponding price increase by retail station owners, the only benefit for society of ATC at retail would be the value of increased price transparency or elimination of deadweight loss. If retail station owners are completely successful in recovering their initial expenses (equipment, labor, and financing) by raising prices of fuel and non-fuel commodities at a commensurate and offsetting rate over the payback period, then theoretically the implementation of ATC at retail stations in California will result in a net cost to consumers, albeit extremely small.

The cost-benefit analysis results for the lower estimate of ATC retrofit for all retail stations are presented in Table 7. Net costs to society amount to approximately $245 million and range between four hundredths (4/100) and seven hundredths (7/100) of a cent per gallon over a 20-year period. After applying a discount rate of 5 percent over the 20-year time period to obtain a single unit of measure of net present value (since $100 today is more valuable to a person than $100 ten years from now), the net present value of costs amounts to about $165 million. The assumptions used to create this estimate are that demand and price for transportation fuels remain fixed over the next two decades. All of the retrofits are completed within the first couple of years and their associated expenses are completely recovered by retail station owners over a 15-year period of time. Increased transparency benefits do not begin until the ATC devices are activated in the third year.

Table 7: ATC Retrofit – CBA Low Cost Summary

	A	B	C	(A+B)-C		
Year	Initial Industry Costs Dollars	Recurring Industry Costs Dollars	Increased Transparency Benefits Dollars	Net Costs Dollars	Net Costs CPG	Present Value of Net Costs Dollars
	$103,781,905	$7,433,608	$257,729			
1	$6,918,794	$6,464,008	$0	$13,382,802	0.0716	$13,382,80
2	$6,918,794	$6,464,008	$0	$13,382,802	0.0716	$12,713,6
3	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$12,720,44
4	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$12,084,4
5	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$11,480,1
6	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$10,906,1
7	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$10,360,8
8	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$9,842,83
9	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$9,350,69
10	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$8,883,15
11	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$8,439,00
12	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$8,017,05
13	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$7,616,19
14	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$7,235,38
15	$6,918,794	$7,433,608	$257,729	$14,094,673	0.0755	$6,873,61
16	$0	$7,433,608	$257,729	$7,175,879	0.0384	$3,324,52
17	$0	$7,433,608	$257,729	$7,175,879	0.0384	$3,158,29
18	$0	$7,433,608	$257,729	$7,175,879	0.0384	$3,000,38
19	$0	$7,433,608	$257,729	$7,175,879	0.0384	$2,850,36
20	$0	$7,433,608	$257,729	$7,175,879	0.0384	$2,707,84
Totals	$103,781,905	$146,732,958	$4,639,122	$245,875,740		$164,947,9

Source: Energy Commission staff analysis.
Discount rate of 5 percent used to calculate net pr

Table 8 presents the ATC retrofit cost and benefit results of the higher estimate. Payback period of the equipment, labor and financing is spread out over a shorter period of time, 10 years. Net costs to society of this scenario amount to approximately $530 million and range between 11 hundredths (11/100) and 18 hundredths (18/100) of a cent per gallon over a 20-year period. After applying a discount rate of 3 percent, the net present value of costs amounts to about $417 million.

Table 8: ATC Retrofit – CBA High Cost Summary

	A	B	C	(A+B)-C		
Year	Initial Industry Costs Dollars	Recurring Industry Costs Dollars	Increased Transparency Benefits Dollars	Net Costs Dollars	Net Costs CPG	Present Value of Net Costs Dollars
	$127,365,308	$20,565,558	$257,729			
1	$12,736,531	$18,626,358	$0	$31,362,889	0.1679	$31,362,8
2	$12,736,531	$18,626,358	$0	$31,362,889	0.1679	$30,422,0
3	$12,736,531	$20,565,558	$257,729	$33,044,360	0.1769	$31,091,4
4	$12,736,531	$20,565,558	$257,729	$33,044,360	0.1769	$30,158,6
5	$12,736,531	$20,565,558	$257,729	$33,044,360	0.1769	$29,253,9
6	$12,736,531	$20,565,558	$257,729	$33,044,360	0.1769	$28,376,3
7	$12,736,531	$20,565,558	$257,729	$33,044,360	0.1769	$27,525,0
8	$12,736,531	$20,565,558	$257,729	$33,044,360	0.1769	$26,699,2
9	$12,736,531	$20,565,558	$257,729	$33,044,360	0.1769	$25,898,2
10	$12,736,531	$20,565,558	$257,729	$33,044,360	0.1769	$25,121,3
11	$0	$20,565,558	$257,729	$20,307,829	0.1087	$14,975,4
12	$0	$20,565,558	$257,729	$20,307,829	0.1087	$14,526,2
13	$0	$20,565,558	$257,729	$20,307,829	0.1087	$14,090,4
14	$0	$20,565,558	$257,729	$20,307,829	0.1087	$13,667,7
15	$0	$20,565,558	$257,729	$20,307,829	0.1087	$13,257,6
16	$0	$20,565,558	$257,729	$20,307,829	0.1087	$12,859,9
17	$0	$20,565,558	$257,729	$20,307,829	0.1087	$12,474,1
18	$0	$20,565,558	$257,729	$20,307,829	0.1087	$12,099,9
19	$0	$20,565,558	$257,729	$20,307,829	0.1087	$11,736,9
20	$0	$20,565,558	$257,729	$20,307,829	0.1087	$11,384,8
Totals	$127,365,308	$407,432,758	$4,639,122	$530,158,944		$416,982,5

Source: Energy Commission staff analysis.
Discount rate of 3 percent used to calculate net p

Table 9 presents the cost and benefit results of gradually phasing in ATC equipment at retail stations. Under this scenario, all fuel dispensers installed at new or refurbished retail stations would need to be ATC-ready, but not activated. It is estimated that nearly 50 percent of the fuel dispensers in California could be replaced through this natural form of replacement over five years, negating the additional expense for labor to retrofit an existing fuel dispensers in the field. The remaining portion of the fuel dispensers would then be retrofitted during the fifth year. That portion of the work would also include the additional expenses associated with installation labor, travel costs, and financing. Net costs to society of this scenario amount to approximately $205 million and range between one hundredth (1/100) and nine hundredths (9/100) of a cent per gallon over a 20-year period. After applying a discount rate of 5 percent, the net present value of costs amounts to about $127 million.

Table 9: Gradual ATC Phase-in – CBA Cost Summary

Year	A Initial Industry Costs Dollars	B Recurring Industry Costs Dollars	C Increased Transparency Benefits Dollars	(A+B)-C Net Costs Dollars	Net Costs CPG	Present Value of Net Costs Dollars
	$84,180,731	$7,433,608	$257,729			
1	$841,807	$266,301	$0	$1,108,108	0.0059	$1,108,10
2	$1,683,615	$532,602	$0	$2,216,216	0.0119	$2,105,40
3	$2,525,422	$798,902	$0	$3,324,324	0.0178	$3,000,20
4	$3,367,229	$1,065,203	$0	$4,432,432	0.0237	$3,800,25
5	$9,398,132	$1,331,504	$0	$10,729,636	0.0574	$8,739,35
6	$9,398,132	$6,464,008	$257,729	$15,604,411	0.0835	$12,074,3
7	$9,398,132	$7,433,608	$257,729	$16,574,011	0.0887	$12,183,4
8	$9,398,132	$7,433,608	$257,729	$16,574,011	0.0887	$11,574,2
9	$9,398,132	$7,433,608	$257,729	$16,574,011	0.0887	$10,995,5
10	$9,398,132	$7,433,608	$257,729	$16,574,011	0.0887	$10,445,7
11	$8,556,324	$7,433,608	$257,729	$15,732,203	0.0842	$9,419,45
12	$7,714,517	$7,433,608	$257,729	$14,890,396	0.0797	$8,469,65
13	$6,872,710	$7,433,608	$257,729	$14,048,589	0.0752	$7,591,29
14	$6,030,903	$7,433,608	$257,729	$13,206,781	0.0707	$6,779,59
15	$0	$7,433,608	$257,729	$7,175,879	0.0384	$3,499,49
16	$0	$7,433,608	$257,729	$7,175,879	0.0384	$3,324,52
17	$0	$7,433,608	$257,729	$7,175,879	0.0384	$3,158,29
18	$0	$7,433,608	$257,729	$7,175,879	0.0384	$3,000,38
19	$0	$7,433,608	$257,729	$7,175,879	0.0384	$2,850,36
20	$0	$7,433,608	$257,729	$7,175,879	0.0384	$2,707,84
Totals	$93,981,318	$114,529,030	$3,865,935	$204,644,413		$126,827,5

Source: Energy Commission staff analysis.
Discount rate of 5 percent used to calculate net pi

Although the total cost of the ATC-ready dispensers would be lower under this scenario, it should also be noted that the relative economic burden to the retail station owner would be lessened as well. The reason is that the cost of the incremental costs of the ATC-ready dispensers of between $8,000 and $12,000 per retail station are quite small when compared to the total costs for a new retail station that are estimated by the National Association of Convenience Stores (NACS) to range between $2.5 and $3.2 million per site. This means that the additional expense amounted to roughly 0.3 to 0.4 percent of the total business expense. For remodeled retail stations, the relative percentage of the incremental costs for ATC-ready dispensers is greater (about 4 percent) because the expense of a remodeled retail station is much less, roughly $312,000 during 2007.[82] However, the relative costs for the owner of an existing retail station are much greater, $8,000 to $12,000 versus zero (assuming no remodeling plans for the facility). This is why the option of a gradual phase-in of ATC devices at retail stations is the more favorable compliance pathway if ATC was to be mandated at retail stations in California.

[82] NACS State of the Industry Report, 2007 data.

A final point pertaining to the total costs for these various ATC retail options involves a comparison to expected expenditures for transportation fuels by consumers and business owners over the 20-year period. Although the total net costs to society of between $127 million and $417 million (expressed in terms of present value) appear to be quite large, it should be recognized that these values are very small when compared to the expected expenditures for transportation fuels in California over the same period of between $700 billion and $1.4 trillion.[83]

ATC Retrofit – Potential Net Benefit to Consumers Under Certain Circumstances

In the previous version of this report, staff noted that it was "plausible that some motorists could realize a net benefit from ATC at retail stations in California under certain circumstances, while at the same time the net cost to society is slightly negative."[84] After revisions to the increased price transparency benefits revealed that the value was far less than initially calculated, circumstances by which some motorists could realize a small net benefit are now quite unlikely. For such a scenario to be possible, over 97 percent of the equipment, labor, and financing expenses would have to be recovered by convenience store owners by raising the price of their non-fuel commodities. Although likely that a portion of the capital costs will be recovered by retail station owners raising non-fuel commodity prices, it is improbable that the apportionment will be significantly skewed to non-fuel items. As such, it is unlikely that there are any plausible circumstances whereby some consumers could realize a small net benefit of ATC at retail in California.

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[83] Assumes nearly 18.7 billion gallons of gasoline and diesel fuel are purchased each year at an average cost of $3 per gallon. The lower present value estimate assumes a discount rate of 5 percent, while the higher fuel expenditure present value estimate assumes a discount rate of 3 percent.

[84] In this context, the "motorists" who may have benefited were those people who purchased their transportation fuel at a convenience store, but did not purchase any non-fuel items during their fueling event. Information from the Convenience Store News indicates that a new analytical approach employed by Homescan allowed them to determine that 9 of the 23 household trips to convenience stores during 2007 were gas trips only. This information implies that about 39 percent of household trips to convenience stores were for purposes of purchasing gasoline only, significantly higher than the 10 percent average estimate assumed by Energy Commission staff. Convenience Store News, *2008 Extended Industry Report*, May 2008, page 7.

Retail Station Characteristics and Trends

Retail fueling stations in the United States have evolved from facilities that, in the early years of automobile development, sold fuel, lubricants, and provided repairs to motorists. A number of stations in more remote portions of the nation's roadways also provided lodging. However, the days of helpful attendants (as depicted in Figure 25) and garage repair services are all but a memory.

Like most types of businesses, selling transportation fuel to the motoring public has undergone significant change. Gasoline stations have been transformed into fueling locations that offer a plethora of non-fuel goods and services designed to enhance revenue streams and increase profitability. The early roots of the convenience store chain can be traced back to the late 1920s when the Southland Ice Company of Dallas, Texas, started selling everyday fresh goods such as eggs, milk, and bread from their ice docks. That company, now referred to as 7-Eleven, has transformed into a business with more than 18,000 convenience stores located in 18 countries around the world.[85]

Figure 25: Service Station of the Past - 1936

From the Eastman's Originals Collection, Department of Special Collections, General Library, University of California, Davis. The collection is property of the Regents of the University of California; no part may be reproduced or used without permission of the Department of Special Collections.

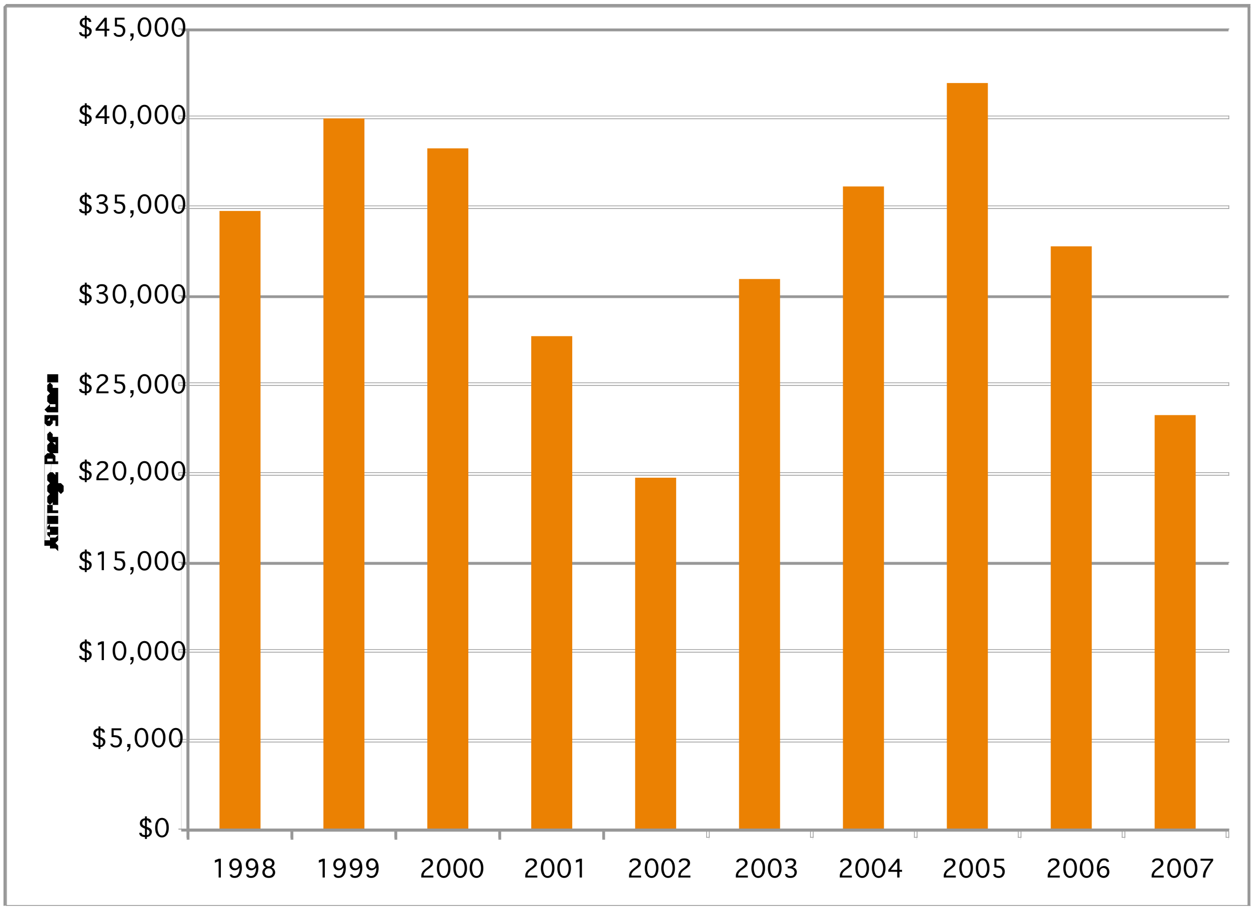
Source: Online Archive of California, [http://oac.cdlib.org/].

During 2007, more than 80 percent of the gasoline sold to the public nationwide was through convenience stores.[86] These places of business have continued to be profitable over the last

[85] Funding Universe, Company Perspectives, *7-Eleven, Inc.*, [http://www.fundinguniverse.com/company-histories/7Eleven-Inc-Company-History.html].
[86] National Association of Convenience Stores, *The Convenience and Petroleum Retailing Industry*, February 1, 2008, [http://www.nacsonline.com/NACS/News/FactSheets/Pages/TheIndustry.aspx].

decade, averaging nearly $33,000 per store pre-tax profits between 1998 and 2007. Figure 26 shows that these profits are not steady, but can fluctuate over time.

Figure 26: United States Convenience Store Pre-Tax Profits

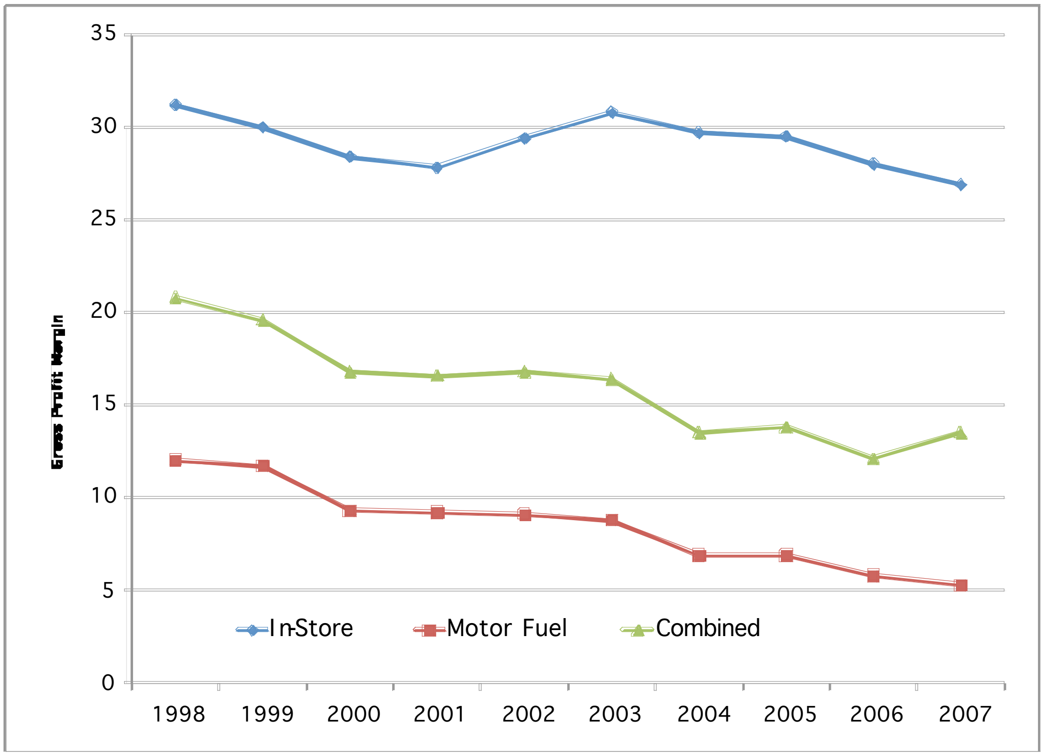


Source: NACS State of the Industry Report data.

Profit margins for convenience stores across the United States show that in-store sales (non-fuel) have a consistently higher and steadier profit margin, relative to that of the steadily declining profit margins for fuel sales as depicted in Figure 27.

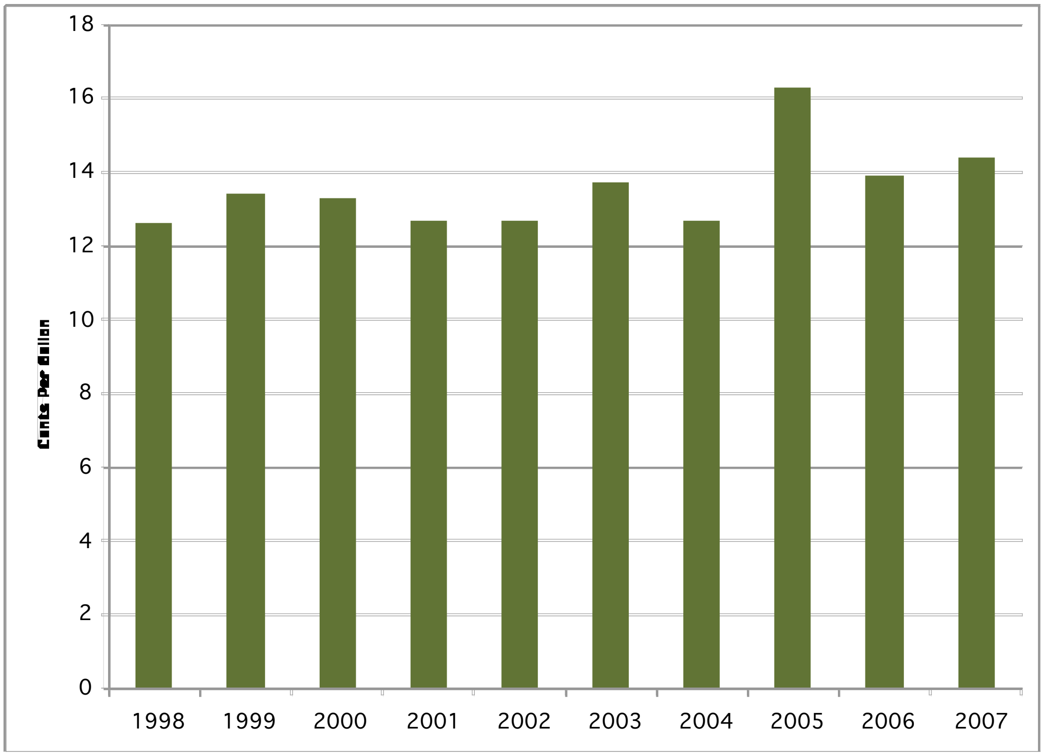
Declining gross profit margins for convenience store motor fuel sales can be interpreted to indicate that retail store operators are having to price their retail gasoline and diesel fuel at increasingly competitive prices and lower profit margins (as a percent of total price), to continue attracting a sufficient number of in-store customers purchasing non-fuel commodities to help sustain overall profitability. Declining profit margins for motor fuel sales, however, does not necessarily mean that the per-gallon margin for motor fuel is also declining. Fluctuations in average annual retail fuel prices for the United States in combination with declining profit margins have actually resulted in a rather steady margin for motor fuel sales at convenience stores as evidenced by the values in Figure 28. Staff interprets these stable per-gallon margins as an indication that the ability of convenience store owners to pass through increased expenses by increasing the price of their gasoline and diesel fuel only is not reflected in the overall trend. Therefore, retail station owners will likely have to recapture a portion of the revenue shift by raising prices of non-fuel commodities.

Figure 27: United States Convenience Store Financial Trends



Source: NACS State of the Industry Report data.

Figure 28: United States Convenience Store Per-Gallon Margins



Source: NACS State of the Industry Report data.

CHAPTER 5: New Reference Temperature Option

This chapter includes details associated with an option similar to the approach taken in Hawaii, adjusting the retail fuel dispensers to distribute an additional quantity of fuel (as measured in cubic inches). The purpose of the adjustment was to increase the total number of cubic inches contained in each "gallon" sold to a quantity that would represent the expanded volume that would result from warming a standard gallon of fuel from 60 degrees Fahrenheit to a higher temperature that is intended to represent the average annual fuel temperature. In the case of Hawaii, it was ultimately decided that the average target temperature would be 80 degrees Fahrenheit.

The new reference temperature approach for California would work in a similar fashion, the retail fuel dispensers would be modified to distribute an additional quantity of fuel that would reflect how much an individual standard gallon would have expanded if the gasoline was warmed from 60 degrees Fahrenheit to 71.7 degrees Fahrenheit (average temperature of regular grade gasoline during the study period).

It should be noted that the resulting non-standard gallons dispensed in a new reference temperature scenario would always be the same size (as measured in cubic inches) regardless of the actual fuel temperature. The dispensed gasoline gallon would only be accurate in terms of "temperature adjustment" at precisely 80 degrees Fahrenheit for Hawaii and 71.7 degrees Fahrenheit for California.

Overview

Requiring new reference temperatures for gasoline and diesel fuel (that are higher than the current standard or temperature-assigned gallon of 60 degrees Fahrenheit) would involve adjusting each retail fuel dispenser in California to provide more than 231 cubic inches to consumers for each gallon they purchase. How much larger these new "California gallons" would be depends on the statewide average annual temperature of gasoline and diesel fuel in conjunction with their assumed density values.

The new size of these non-standard gallons will be determined using volume correction formulas based on Energy Commission's collected density and fuel temperature data analysis. Using this methodology, the new California gallon capacity would increase from 231 cubic inches to 232.7 cubic inches for gasoline and to 232.4 cubic inches for diesel fuel. Therefore, retail gasoline dispensers would need to be modified such that an additional 1.7 cubic inches would be distributed for each non-standard gallon (231 cubic inches at any temperature) sold to the consumer such that the resulting volume would amount to 232.7 cubic inches. These new size California gallons would be dispensed to retail fuel consumers each and every instance, regardless of different temperatures on a regional or seasonal basis in California.

The new values were calculated by using the API Table 6B VCF software and assuming the gasoline in the very near future will contain 10 percent ethanol (E10). The average density of E10 will be 57.9 API gravity, while the volume correction factor (VCF) at 71.1 degrees would be 0.99261. This means that the new statewide, year-round "California gasoline gallon" would equate to 232.72 cubic inches, rather than 231.0 cubic inches for the current non-standard or gross retail gallon.

For diesel fuel with an assumed API gravity of 38.5 and an average statewide, year-round temperature of 72.9, the VCF (per the software) is 0.99391. The new "California diesel gallon" would be 232.42 cubic inches.

The Division of Measurement Standards (DMS) informed Energy Commission staff that the alternative option of regional reference temperatures should be omitted from the cost-benefit analysis. The existence of different regional reference temperatures would create regulatory confusion along with confusion in the industry. An example of one of the difficulties that regional reference temperatures could create is the use of multiple calibration and certification protocols that would be necessary to create several different regions throughout the state that have varying size California gallons as measured in terms of cubic inches. Development of such variable inspection and certification procedures in conjunction with the creation of multiple new jurisdictions that cross county boundaries could create difficulties for enforcement officials. Staff believes, therefore, that a regional reference temperature approach may create too many difficulties and should not be considered as an option to pursue in California.

Costs

Energy Commission staff assumed that no new equipment or labor costs to install devices will occur under the statewide reference temperature option. The only cost will be a one-time calibration adjustment of the fuel dispenser so that each gallon sold to retail fuel consumers meets the new size definitions. Although this adjustment, in theory, could probably be accomplished by county sealers during their normal inspection and certification visit, staff assumed that a certified technician would need to make the fuel dispenser modifications. Further, staff assumed that no new parts would be necessary.

For purposes of quantifying labor costs associated with a new statewide reference temperature standard, staff assumed that the estimated range of labor costs identified as part of the ATC retrofit option would also be used in this option's cost calculation. Staff recognized that the per-dispenser labor hours could be less, but took a more conservative approach to help compensate for any additional unforeseen costs that would be necessary beyond minor adjustments to electronic and mechanical dispensers. Therefore, the estimated costs of a new reference temperature and associated larger gallon size (in cubic inches) could amount to between $9.0 million and $27.9 million or from $925 to $2,879 per retail station. On a per-gallon basis these additional expenses incurred by retail station owners would equate to between five hundredths (5/100) and 15 hundredths (15/100) of a cent per gallon for only one year. If the expenses incurred by retail station owners were recovered over a longer period of time, the per-gallon costs would decline significantly, but be present for a longer period of time. For example, the costs would amount to between 5 thousandths (5/1000) and 15 thousandths (15/1000) of a cent per gallon if completely recovered over a period of 10 years. After the modifications were completed, there would be no additional recurring costs.

Benefits

The new statewide reference temperature will not eliminate variability of fuel temperatures, but would set the standard such that the additional volume received by retail consumers (as measured in cubic inches) would be the same (in theory) as they would have received prior to modifying the dispensers. Since the size of the California gallon will be fixed at a permanently larger size, this type of change could be viewed as similar to transitioning from U.S. gallons to the metric system. As a direct consequence, the number of California gallons sold in a particular year would be less when compared to the number of U.S. gallons that would have been sold at 231 cubic inches in size.

Staff believes that the retail station owners will realize that the new reference standard option will decrease the number of "gallons" sold and will compensate by raising retail prices to avoid any potential permanent decrease in revenues. In other words, the potential expected benefits for retail fuel consumers would therefore be zero.

Unlike the ATC retrofit option, there will be no uncertainty by retail station owners concerning the day-to-day size of each gallon due to variability in temperatures because the size of the new California gasoline gallon will always be 232.7 cubic inches, regardless of fuel temperature.

Potential Net Costs or Benefits

Staff calculated the statewide reference temperature option to have a net cost in the first year of between five hundredths (5/100) and 15 hundredths (15/100) of a cent per gallon, followed by a zero net cost/benefit in the following years.

Compliance Schedule

If a statewide reference temperature option was mandated for use at California retail stations, the implementation schedule is less complex than that of the ATC retrofit option. In this case, adjustments by certified technicians to retail fuel dispensers could be accomplished over several months. Only one visit would be required to complete the work without the use of any new equipment or components. It would be optimal for the conversion of the dispensers to take place during the time of year when fuel temperatures are anticipated to be close to the current reference standard of 60 degrees Fahrenheit. This approach would be consistent with the optimal conversion timing discussed for the ATC retrofit option. Prior to any adjustments to existing fuel dispensers, though, authority would need to be granted to DMS through enactment of new legislation, and regulations would need to be developed by DMS to clarify procedures that would have to be adhered to by certified technicians and county sealers. These procedural steps could take between 18 and 24 months to complete.

CHAPTER 6: Related Issues

An assessment of automatic temperature compensation (ATC) entails more than a quantification of potential benefits and costs. There are several other issues that need to be addressed to better understand ATC in a broader context and conclusions regarding procedures that should be considered if such regulations were to be mandated for use in California.

Permissive vs. Mandatory ATC at Retail Stations

Permissive (voluntary) use of automatic temperature compensation (ATC) devices at California retail stations in connection with retail transactions of gasoline and diesel fuel is an issue that may be in dispute according to opposing viewpoints expressed by various stakeholders during the Committee Workshop convened on December 9, 2008.

Although there are no ATC retrofit kits approved for use in California that could be used by retailers interested in implementing ATC on a voluntary basis, there is one model series ATC-ready fuel dispenser that has been approved for use in commerce in California by the California Department of Food and Agriculture, Division of Measurement and Standards.[87] Before commencement of this study, it was reported at the NCWM interim meeting in New Mexico that a retailer in California was considering installing new fuel dispensers with ATC capability but would defer that decision until after the Energy Commission had completed its analysis.

Although no retail station operator has elected to install ATC-ready dispensers in California, if such a business decision was made, there could be some difficulties with such a scenario due to lack of operational and enforcement standards, inspection procedures, and labeling provisions. These points, as well as others, were raised by the California Independent Oil Marketers Association (CIOMA) during February 2008.[88]

The near-absence of any ATC regulatory framework in California means that there are currently no provisions regarding when the temperature compensation capability of a dispenser would be activated, either upon installation or later at the discretion of the retail station operator. DMS regulations do, though, specify that, if ATC is operated at retail, it must remain active for 12 consecutive months at a time. This requirement precludes the selective use of ATC at retail to solely benefit the station operator on a seasonal basis (such as operating the device when the fuel is colder than the 60 degree Fahrenheit reference temperature and disabling the ATC function when fuel temperatures rise above 60 degrees Fahrenheit).

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[87] The Gilbarco Model Nxx series was approved with electronic Automatic Temperature Compensation capability that became effective on May 17, 2007. Department of Food and Agriculture, Division of Management Standards, California Type Evaluation Program, "Certificate of Approval for Weighing and Measuring Devices," Certificate Number 5510(a)-07, [http://www.cdfa.ca.gov/dms/programs/ctep/CTEPApprovals/PDF2007/5510a-07.pdf].

[88] CIOMA issued a letter to DMS requesting adoption of emergency regulations to prevent any retail station operators from installing ATC-ready fuel dispensers. The request was denied by DMS on grounds that the agency did not have authority to promulgate such a regulatory modification without legislative directive. McKeeman, Jay, "Letter From CIOMA Regarding Temperature Compensating Devices," February 15, 2008, [http://www.energy.ca.gov/transportation/fuel_delivery_temperature_study/documents/index.html].

Even the ability to activate an approved ATC-ready fuel dispenser would be difficult without any established procedures for properly assessing the calibration of the device. It would be these same sets of protocols that would need to be followed by a county sealer during an inspection and fuel dispenser recertification visit.

The fact that there are no regulatory guidance standards for labeling of fuel dispensers or large signs could lead to consumer confusion at the initial stages of permissive ATC use at retail stations. Over time, consumers would become more knowledgeable of circumstances that could be beneficial to them in a permissive ATC environment, namely electing to fill-up at stations advertising ATC during the warmer months, while avoiding ATC stations during the coldest months (assuming non-ATC stations are readily available options). Adequate labeling requirements would be necessary to empower consumers with sufficient information so as to make a better informed decision. Permissive ATC without adequate regulatory structure does not ensure that sufficient labeling standards would be adhered to by an ATC fuel retailer.

Lastly, there would be the possibility that permissive ATC retail fuel dispenser use could be viewed as a marketing advantage, especially during the warmer months of the year. To succeed, this scenario would require that the retailer advertise the fact that he or she has ATC fuel dispensers on the large sign, thereby enticing the consumer into the station, and consumers would have to understand the beneficial significance. Since temperature compensation has been a media issue in California for several months, it is likely that motorists understand the benefits of going to an ATC station during the summer months. It is also highly probable that a permissive ATC retailer would realize the potential for increased numbers of customers that could be attracted assuming other retail stations within their immediate sphere of competition do not also have ATC fuel dispensers. A permissive ATC environment with partial adoption in a state with generally warmer fuel temperatures could result in a marketing disadvantage to those retailers who did not have ATC fuel dispensers.

In order to diminish or eliminate any potential disagreements or misinterpretations involving permissive use of ATC at retail stations in California, it is recommended that the California Legislature consider clarifying the use of ATC at retail stations. If the Legislature chooses not to mandate the use of ATC at retail stations, the Legislature may wish to clarify whether the current intent of the existing statutes is to permit or prohibit voluntary ATC at retail outlets for gasoline and diesel fuel. If the Legislature chooses to permit or mandate ATC at retail, they should direct the California Division of Measurement Standards to develop standards addressing equipment approval, certification testing, compliance enforcement, and consumer labeling provisions for ATC at retail stations.

Labeling

Temperature compensation, if recommended for application at retail, should include regulations that help to ensure that consumers will be provided with information sufficient to alert a motorist to the presence of ATC at the service station. There are several options to consider for conveying ATC information, such as labels on the fuel dispenser, large retail station display signs, and printed sales receipts.

Fuel Dispenser Labels

Fuel dispensers could be labeled with a brief notation indicating the use of ATC. It would be most advantageous if the message was mandatory, consistent at all stations, and brief. Canada has taken the approach to label the fuel dispensers with “Volume corrected to 15° C” (see

Figure 29).[89] A similar labeling approach could be used in California that would require a brief message on the fuel dispenser, such as: "Corrected to 60 degrees Fahrenheit."

In California, the Division of Measurement Standards (DMS) has existing legal authority regarding labeling of fuel dispensers and has developed specific regulations stipulating requirements for such labeling.[90] It is possible that this portion of the regulations could be amended to include ATC fuel dispenser labeling requirements.

The cost of fuel dispenser labels is estimated to be modest, amounting to no more than $20 per dispenser. Most small pump decals used in the retail fuel industry cost less than $5, such as the sticker sold by one retail company that reads "Contains 10% or less ethanol."[91]

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[89] Measurement Canada is the government agency responsible for setting the rules of the marketplace with respect to trade measurement. This agency requires labeling of any meter that is equipped with an automatic temperature compensator. See Section 21 of the Weights and Measures Regulations (C.R.C., c.1605), [http://laws.justice.gc.ca/en/ShowDoc/cr/C.R.C.-c.1605///en?page=1].

[90] State of California, California Code of Regulations, Title 4 (Business Regulations), Division 9. Also California Business and Professions Code, Chapter 14, Article 8, Sections 13470 through 13477. Extracts for both codes can be found at: [http://www.cdfa.ca.gov/dms/publications.html].

[91] Allied Electronics with headquarters in Chicago, Illinois, prices these types of decals at $1 each. Octane decals are even less expensive [http://www.alliedelectronics.com/miscellaneous-decals.html].

Figure 29: Example of Fuel Dispenser Label

Fuel dispenser in Waterton, Alberta (Canada) displays temperature correction labeling in French and English.
Photo Credit: Gordon Schremp, California Energy Commission.

Retail Station Display Signs

Another option involving labeling would be a requirement for the large display signs at the service stations to contain an indication that ATC is present or in use at the site. Such a requirement would be unnecessary if ATC is mandatory for all retail establishments. In a mandatory setting, sufficient information could be conveyed to consumers using appropriate fuel dispenser decals. If ATC at retail was voluntary, on the other hand, consumers would not be able to determine which retail stations had ATC equipment until they pulled up to the fuel dispenser and searched for the presence of an “ATC-ready” decal.

Obviously, consumers would be better served in a permissive setting if retail stations that had installed ATC equipment were to display that information as prominently as their posted fuel prices. This type of approach would provide consumers with sufficient information allowing them to make a more informed decision on where they should fuel their vehicle. A logical location for indicating the presence of ATC at retail in a voluntary environment would be the large display or street signs that are normally mounted on poles in an elevated position readily visible and easily legible by consumers driving by a retail site.

DMS also has the regulatory authority regarding retail station street sign advertising (referred to as price sign advertising).[92] It is possible that this portion of the regulations could be amended to include ATC street sign labeling requirements for retail establishments. It should be noted that Measurement Canada has no such requirement in their voluntary retail application of ATC.

If the message indicating ATC is limited to an acronym of two or three letters and a height no greater than six inches (similar to the street sign price number requirement), expenses for the retail station operator can be kept to a modest amount of approximately $50 to $100 per retail establishment, assuming that there is spare space on the existing big display signs to place these three letters.[93] The message should be limited to a recognizable acronym such as "ATC" for automatic temperature compensation or "TC" for temperature compensation. The size, limited number of letters, and placement of the message should be such that existing signs would not have to be modified or replaced to accommodate ATC labeling.

There may be some styles of retail street signage that have limited space available for the placement of letters that are six inches in height. As an alternative, it may be possible to place an ATC placard on top of the main display sign for a cost of $400 to $600 per retail establishment. Any message, though, that is more extensive and larger in size could result in significantly greater expenses being incurred by a retail establishment operator.

In those circumstances, a retail station operator may be required to retrofit an existing display sign to allow an additional row that would be used to include the ATC message. If so, the expense of this work could be considerably more than several letters placed on the street signs. Staff estimates that costs for retrofitting existing retail street signs could amount to $1,600 to $5,000 per retail station.[94] Local planning ordinances may limit the ability of stations to extend the size of the street sign resulting in a complete redesign of the signs, in which case the cost could be even greater.

Printed Sales Receipts

A final ATC labeling option involves requiring some form of information to be included with consumers' printed receipts indicating that the retail transaction has included an adjustment that compensates for variations in fuel temperature. One example of information that could be included on the receipt is a simple message, such as "retail transaction has been compensated for temperature." Most retail establishments in California use electronic fuel dispensers that distribute a printed receipt after each pump transaction. Station operators are able to program a message to be included at the bottom of each receipt through the Point of Sale (POS) register

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[92] California Business and Professions Code, Division 5, Chapter 14, Article 12, Sections 13530 through 13536, [http://www.cdfa.ca.gov/dms/publications.html].

[93] Staff estimated costs for gasoline sign lettering by viewing various signage options offered by Alphabet Signs [http://www.alphabetsigns.com/c/CL25/?gclid=CPm4p76G-pUCFQ0xawod9FWGFA]. Gas price numbers that are six inches in height are priced in a package of 48 pieces at less than $3 each. Staff assumed that letters of identical height would be priced at a slightly higher value for orders involving smaller quantities. Retail station operators would be expected to purchase up to six letters per street sign (up to three for each side) and have up to two street signs per retail establishment. For purposes of this estimate, staff included an additional cost of $20 per street sign for shipping and handling.

[94] Sign Resource of Maywood, California, and McCale Signs of Redding, California.

and associated software. A typical example would be a "Thank You" phrase. Including an additional, brief message would require little effort and essentially no expense.

Any attempts to increase the level of information to include net and gross gallons would pose some difficult and problematic issues. Although the ATC retrofit kits possess electronics and software designed to monitor fuel temperature and adjust the volume dispensed to consumers, there is no current capability for this system to convey the two different forms of measurement to the cash register or POS equipment. It is possible that, over time, POS and ATC retrofit manufacturers could collaborate to enable this exchange of data, but the initial expense of this software and some electronic modifications is unknown.

Measurement Canada does not appear to require acknowledgment of ATC on the printed consumer receipt, as long as the fuel dispenser is appropriately labeled.[95]

Timing of Requirement

Any requirement for ATC labeling would also involve the correct "timing" of the message. ATC labeling regulations should stipulate when signage would be present at a retail site. One example is to require that signage be present when the ATC equipment is activated. That step could occur when installation of an ATC retrofit kit has been completed or at a later date when the ATC equipment is activated by a certified installer/inspector.

Labeling Conclusions

If ATC is required at retail fuel stations, DMS should develop amended regulatory language for labeling fuel dispensers that includes guidance for:

- Wording of the ATC message (such as "Corrected to 60°F").
- Font size (similar to existing standards).
- Location of the decal.
- Timing of the requirement (when ATC equipment is activated).
- Authority to affix the decal (certified equipment installers and inspectors).

If voluntary use of ATC at the retail level is clarified by the State's Legislature to be permissible, DMS should develop amended regulatory language for the large price display signs that includes guidance for:

- Wording of the ATC message (such as the notation of "ATC" or "TC").
- Font size (similar to existing standards for the prices).
- Location of the message.
- Timing of the requirement (when ATC equipment is activated).
- Authority to affix the message (retail station operators).

Retail station operators should be required to include a message on the printed consumer receipt that fuel is corrected to 60 degrees Fahrenheit, but not be required to include any additional information such as fuel temperature or net and gross gallons. Over time, it should be possible for ATC equipment and point-of-sale manufacturers to design the software to communicate between measurement software and printer software to enable the registration of both net and

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[95] Measurement Canada, *Printer Requirements for Volumetric Liquid Meters Equipped with Automatic Temperature Compensation (ATC)*, Bulletin V-20 (rev. 1), April 1, 2008, [http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00116.html].

gross gallons. Such a program could be phased in over time, but should not be permanently ruled out if ATC were to be mandated at retail in California.

Authority to Activate Retail ATC

Access to retail ATC devices in fuel dispensers is usually limited to only those entities that have a need to make repairs or modifications to the devices in the field. To reduce the possibility of illegal manipulation of software settings or operation, ATC devices in Canada are required to have tamper-proof seals in place that must be removed or damaged if someone were to attempt unauthorized access.[96] There can also be audit software programs that track access to the devices or alterations to any of the settings. This type of software can be employed to determine how long a device has been out of calibration.

In Canada, access to retail ATC devices is limited to authorized technicians or inspectors. If retail ATC was mandated in California, it would be appropriate for a similar class of authorized individuals to have sole access to the devices. In a scenario in which retail ATC has been mandated, these technicians or certified inspectors would need to make an additional visit to a retail establishment whenever an idle ATC device needed to be activated. This assumes that existing retail fuel dispensers have been retrofitted with ATC devices before some compliance deadline period. A permissive retail ATC market, such as Canada, does not require a return visit by a technician because the devices are activated at the time of installation. No waiting period exists in Canada. However, in a mandatory setting, activation of retail ATC devices would have to be delayed until all of the existing stations had time to modify their dispensers (refer to Timeline section of this chapter), necessitating an additional technician visit. In California, DMS already has regulations and other provisions in place to handle this aspect of ATC if temperature compensation was mandated for use throughout the state.

Implementation Timeline Options for Retail ATC

If ATC was mandated for use in California at retail stations, how much time would be required to develop regulations, what would be an optimal sequence of steps, and how should compliance deadline be structured?

Questions like those listed above have been grappled with during the national debate of ATC at retail stations for several years. Most recently, though, the National Conference on Weights and Measures (NCWM) Steering Committee on ATC has devoted a great deal of thought to the various elements associated with timing of ATC regulations and a number of options that could be pursued on a national level. A schematic of these potential implementation timelines is illustrated in Figure 30.[97]

Development of Regulations and Standards

To ensure adequate guidance for businesses, consumers, and enforcement officials, regulations should be developed before ATC is adopted for widespread use at retail stations in California. The minimum steps associated with regulatory development include:

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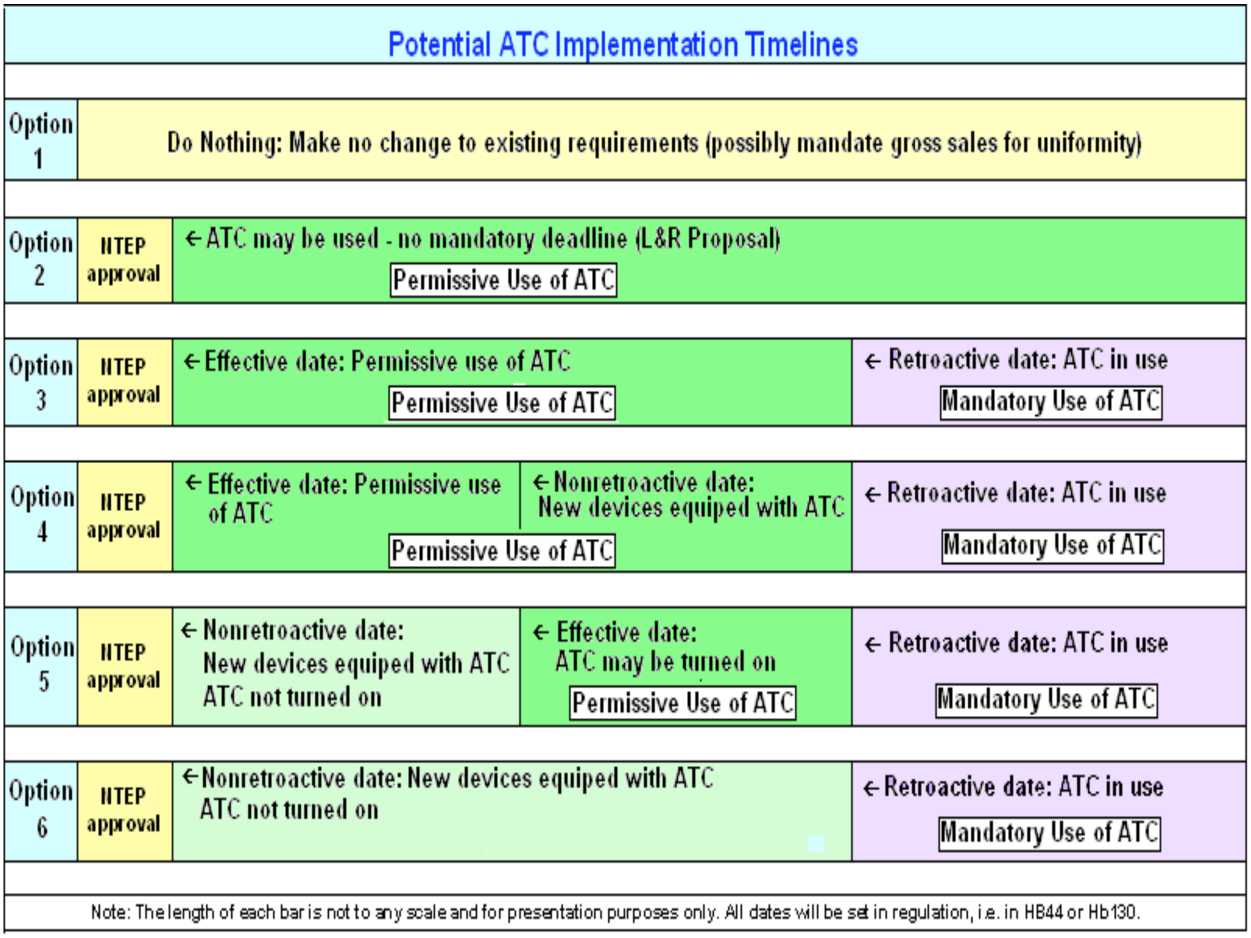
[96] Measurement Canada, *Metering Assemblies Incorporating Electronic ATCs Specifications* (SI/90-155), [http://laws.justice.gc.ca/en/Showdoc/cr/SI-90-155///en?page=1].

[97] Automatic Temperature Compensation Steering Committee, "Progress Report," presentation at National Conference of Weights and Measures, Albuquerque, New Mexico, January 28, 2008, [http://www.ncwm.net/ppt/steering_committee_interim_report_2008.ppt].

- Legislation granting authority for oversight and regulation development for appropriate agency or agencies.
- Development and adoption of regulations through rule-making procedures.
- Revision of guidance documents and handbooks.

Before mandatory retail ATC could happen in California, the Legislature would have to approve and the Governor sign a new bill requiring ATC at retail stations. DMS would then initiate a rule-making process that includes the development of draft standards, public consultations and comment periods, and ultimately adoption of new regulations. A final set of steps would involve the updating of various guidance documents that are used by enforcement officials as an inspection procedure reference as well as by business owners to better

Figure 30: Potential ATC Implementation Options – NCWM



Source: Automatic Temperature Compensation Steering Committee presentation, January 28, 2008, slide 33.

understand compliance rules and timelines. A primary example of such a reference document is the DMS Field Reference Manual.[98] Examples of informational resources that could be revised would be the Petroleum Products Program Information Guides for both businesses and consumers.[99]

Staff estimates that the time required to complete all of these discrete regulatory steps could take between 18 and 24 months from the date an approved piece of legislation is signed into law.

Certification of ATC Equipment

If ATC was mandated for use at retail stations in California, retail station operators would need to have available to them a sufficient selection of ATC retrofit kits certified for use in

[98] California Department of Food and Agriculture, Division of Measurement Standards, *Field Reference Manual – Division 9*, 2008, [http://www.cdfa.ca.gov/dms/programs/general/CCR2007.pdf].
[99] California Department of Food and Agriculture, Division of Measurement Standards, *Petroleum Products Program Information Guide (Businesses)*, 2008, [http://www.cdfa.ca.gov/dms/programs/petroleum/petInfoGuideBusiness.pdf]. A link to the consumer guide is at: [http://www.cdfa.ca.gov/dms/programs/petroleum/petInfoGuideConsumer.pdf].

California that would encompass the majority of fuel dispensers in use at retail stations throughout the state. The process for receiving approval for ATC-related equipment has two pathways, the California Type Evaluation Program (CTEP) and the National Type Evaluation Program (NTEP).

The CTEP certification process involves an application process that takes between three and six months, followed by a testing and evaluation step of between two and three months. Any deficiencies identified during the evaluation step would require corrective measures by the applicant and could extend this step by several months.[100]

The NTEP certification process is a national program administered by the NCWM. California has the authority to "approve" devices separately from NTEP for in-state use.[101] An ATC device from one manufacturer has been evaluated and approved for use in California. All devices submitted under this program must meet all applicable regulations outlined in the National Institute of Standards and Technology (NIST) Handbook 44 (*Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*). California has the authority to adopt exceptions to Handbook 44 and would need to do so if ATC was to be used in the state.

Applicants are required to submit a completed application and associated fees to NTEP. Their application will then be assigned to a certified testing laboratory where the actual certification testing will occur. Actual testing of the equipment could take between 40 and 200 hours, the lengthier time period if field testing is deemed necessary. The total time to receive an NTEP certification will range from two to seven months and cost upwards of $20,000.[102] Any manufacturer of ATC-related equipment or fuel dispensers who obtains an NTEP certificate may use the approved device in California, unless expressly denied by DMS.

Staff estimates that a minimum period of 11 to 15 months would be required for manufacturers of ATC retrofit kits and ATC-ready dispensers to obtain certification from DMS from the date ATC regulations are adopted and published by DMS. This time frame assumes that ATC manufacturers would initially submit for certification retrofit kits and some ATC-ready dispensers already in use in other countries (such as Canada and Belgium). It is likely that some additional time would be necessary for equipment manufacturers to develop additional kits and modified ATC-ready dispensers, on the order of six months.

Existing Retail Stations and ATC Compliance

If ATC was mandated at retail stations in California, compliance could either exclude or include existing retail establishments. Exclusion of existing retail stations from compliance would create a pseudo-permissive market. Such a development would be undesirable for reasons described in the "permissive" section of this chapter. Therefore, staff concludes that it would be optimal that all retail stations should comply under any mandated ATC regulation scenario. However, the timing for installing the ATC retrofit kits would be somewhat discretionary for the retail station operator, as long as the modifications were completed before the full compliance deadline. The risk of waiting too long to schedule the work could result in some retail stations not fully complying by the deadline. To avoid stations being out of

[100] California Department of Food and Agriculture, Division of Measurement Standards, California Type Evaluation Program, 2008, [http://www.cdfa.ca.gov/dms/programs/ctep/CTEPInfoGuide.pdf].
[101] A list of newer California certificates of approval going back to 2000 appears on the DMS website at [http://www.cdfa.ca.gov/dms/programs/ctep/ctep.html].
[102] Additional details associated with the NTEP certification process may be viewed at the following link: [http://www.ncwm.net/ntep/index.cfm?fuseaction=faq].

compliance and unable to legally dispense fuel, staff concludes that it would be optimal that there be a process to enable some retail station operators additional time to comply conditioned on a "showing" that the ATC retrofit work or installation of ATC-ready dispensers was already under contract for that retail location, but the work was not yet completed.

Activation of ATC Devices

Activation of ATC devices can occur in either of two scenarios: at the time of installation or by some prescribed deadline for full compliance. If ATC devices were allowed to be activated at the time a retrofit kit or ATC-ready dispenser was installed, inspection costs for the retail station operator could be decreased by avoiding one additional inspection visit. The assumption is that a licensed service agent would have the capability to approve operation of the fuel dispenser after modification or installation under authority of law.

Optimal Compliance Schedule Conclusion

After reviewing the various steps necessary for converting California's retail stations to ATC capability, staff is proposing three compliance schedules if ATC was to be mandated for use at retail stations in the state. The shorter compliance timeline is five years and three months in duration, while the lengthier schedule requires six years and three months to complete. The main difference in schedule length is due to varying estimates of time required to complete the regulatory and certification steps. The final phase of each respective compliance schedule occurs during an identical time of the year designed to coincide with fuel temperatures that are closer to the 60 degree Fahrenheit reference standard (October through March). Staff believes that the longer compliance schedule would be more reasonable and have a higher likelihood of success.

Table 10: Mandatory ATC Compliance Schedule Options

Phase	Description	Option 1	Option 2	Option 3
1	Legislation Signed Into Law	January 1, 2010	January 1, 2010	January 1, 201
2	DMS Regulations Adopted and Guidance Documents Revised	July 11, 2011 (18 months)	January 1, 2012 (24 months)	July 11, 2011 (18 months)
3	CTEP/NTEP Certification Completed by Majority of Equipment Manufacturers	June 1, 2012 (11 months)	April 1, 2013 (15 months)	June 1, 2012 (11 months)
4	ATC Compliance - Initial Installation	November 1, 2012	November 1, 2013	November 1, 20
5	ATC Compliance - Final Installation	October 1, 2014	October 1, 2015	October 1, 201
6	ATC Compliance - Activation	April 1, 2015	April 1, 2016	April 1, 2018

Phases 1 through 3 consist of the time needed to develop regulations, guidance documents, and certifications. At Phase 4, initial ATC compliance would begin:

- New retail stations required to install ATC-ready fuel dispensers.
- All existing retail station operators may begin to install ATC retrofit kits or ATC-ready fuel dispensers.
- ATC set to "inactive" mode.

At Phase 5 compliance continues:

- All existing retail station operators required to have completed installation of ATC retrofit kits or ATC-ready fuel dispensers
- ATC set to "inactive" mode.
- Limited number of existing stations with temporary exemptions allowed additional six months to comply.
- Temporary exemption granted with "proof of work contract."

At Phase 6, activation would commence:

- ATC set to "active" mode at all existing stations.
- All new ATC-ready dispensers installed activated at time of installation.
- All existing retail stations that received temporary exemptions required to complete installation of ATC retrofit kits or ATC-ready fuel dispensers and set to "active" mode upon completion of the work.
- All retail stations that have not fully complied by the final deadline will be prohibited from dispensing transportation fuels until full ATC compliance is achieved.

The optimal compliance schedule from the perspective of most consumers would likely be as quickly as feasible. Consumer advocacy groups, such as the Foundation for Taxpayer and Consumer Rights, believe that mandatory ATC at retail is long overdue. However, an unreasonably short compliance deadline could create problems for regulators, retail station operators, equipment manufacturers, and inspectors. Staff believes that the three schedules would be best characterized as optimistic, especially when contrasted with the recommended timeline of 10 years suggested by the NCWM ATC Steering Committee.[103]

ATC and Other Liquid Transportation Fuels

[103] Automatic Temperature Compensation Steering Committee, "Progress Report," slide 35, presentation at National Conference of Weights and Measures, Albuquerque, New Mexico, January 28, 2008, [http://www.ncwm.net/ppt/steering_committee_interim_report_2008.ppt].

Temperature compensation (TC) application at retail for transportation fuels other than gasoline and diesel fuel is also addressed in this report for aviation fuels. For purposes of this report, it is assumed that bunker fuels used in marine vessels would not be subject to any retail ATC program since these fuels are primarily sold through wholesale, rather than retail transactions.

Energy Commission staff conclude that other traditional petroleum-based aviation transportation fuels are not initially considered for inclusion in any ATC program due to the limited use of these fuel types and the greater expense that would be incurred by airport-based retail fuel operators. The rationale is that these fuels, such as aviation gasoline and jet fuel for private airplanes are significantly smaller in total sales compared to gasoline.[104] Jet fuel sold for use in private planes is normally a retail transaction at a private or public airport. The vast majority of jet fuel used in California is done so in conjunction with the operation of commercial aircraft. These sales transactions are not considered a retail taxation event and would, therefore, not be subject to any retail ATC regulation.

Further, it is believed that the retail fuel dispensers used at the majority of California's private airports are usually mechanical, rather than electronic. Consequently, the expense for retrofitting these devices would be more than double compared to typical retail gasoline station fuel dispensers. Finally, the average annual sales volume for retail aviation fuel providers is significantly lower compared to their counterparts at a typical service station, roughly 90 percent less per fueling establishment.[105] Higher retrofit costs in conjunction with lower average sales volumes could result in significantly greater per-gallon recovery cost increases if the aviation fuel provider elected to pass along all of the additional costs solely by raising their fuel prices.

Other Liquid Transportation Fuels Conclusions

The following aviation transportation fuels should be initially excluded from any retail ATC standards:

- Aviation gasoline (100 LL)
- Commercial jet fuel (Jet A)
- Military grade jet fuel (JP-5 and JP-8)

If ATC was mandated at retail in California, application at airports for private aircraft could still be reconsidered in some delayed form, such as a phase-in as aviation fuel dispensers are replaced.

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[104] Total aviation gasoline sales amounted to 27.8 million gallons in 2007, approximately 0.2 percent of total gasoline sales. California State Board of Equalization, *Taxable Aviation Gasoline Gallons 10 Year Report*, November 21, 2008, [http://www.boe.ca.gov/sptaxprog/reports/AVGAS_10_Year_Report.pdf]. Jet fuel sales for private planes amounted to 155.4 million gallons in 2007, approximately 4 percent of total jet fuel sales in California. Military jet fuel is excluded from these totals. California State Board of Equalization, *Taxable Jet Fuel Gallons 10 Year Report*, November 21, 2008, [http://www.boe.ca.gov/sptaxprog/reports /Jet_Fuel_10_Year_Report.pdf].

[105] Staff estimates that there are about 185 locations throughout the state that offer aviation gasoline (100 LL) or jet fuel (Jet A) for retail sales. Based on 2007 retail aviation gasoline sales, the average annual throughput per airport amounted to roughly 92,000 gallons. By comparison, there are nearly 10,000 retail stations in California that sell retail gasoline and diesel fuel, averaging more than 1.5 million gallons of gasoline per location in 2007.

Leak Detection – Potential Benefit

One reported potential benefit of automatic temperature compensation is enhanced inventory tracking and leak detection. If inventory tracking is used to detect leaks in storage tanks (loss of fuel into surrounding soil or into the space between inner and outer walls of double-walled tanks), automatic temperature compensation improves this process because the expansion or contraction of temperature compensated gallons is known with inventory tracking systems and only estimated when gross gallons are measured. If more precise measurement methods are already in place, automatic temperature compensation will not confer any additional leakage detection benefit.

Energy Commission staff investigated current leak detection standards. Staff contacted the state Water Resources Control Board and obtained the following information:[106]

- Current underground storage tank leak detection sensitivity requirements depend upon the time when the tank was installed and upon whether the tanks are single-walled or double-walled.
- Approximately 88 percent of California underground storage tanks are double walled. These tanks are required to have leak detection sensors within the retaining area between the two tanks. Those tanks built since 2003 must be initially certified to leak no more than .005 gallons per hour (gph) gasoline liquid and vapor combined. Tanks built earlier, and those built recently that are renewing their certification, must use third-party certified leak detection sensors.
- Approximately 4 to 5 percent of California underground storage tanks are single walled, built before 1984, and within 1000 feet of a water source. These tanks are required to detect leaks (via vacuum pressure) of .005 gph via an enhanced leak detection test every 36 months. The rest of the time, the system is required to be tested to detect 0.1 or 0.2 gph leaks.
- The remaining 6 to 7 percent of California underground storage tanks are single walled storage tanks built before 1984 and not within 1000 feet of a water source. These tanks are required to detect 0.1 or 0.2 gph leaks. Their piping systems are required to detect 0.1, 0.2, or 3.0 gph of leaks.[107]

The above information indicates that inventory tracking is not currently being used as a primary method of leak detection, and most California underground storage tanks are either double walled or subject to a .005 gph vacuum pressure test. Inventory tracking alone does not detect leaks to the standard that most stations are presently required to meet. Energy Commission staff concluded, therefore, that ATC implementation would not significantly affect underground storage tank leak detection in California because stronger leak detection requirements are already in place.

Applicability of Findings to Other Regions of the United States

[106] Per email from John Elkins, UST Leak Prevention Unit, State Water Resources Control Board.

[107] Statutes of Chapter 6.7, Health and Safety Code, Underground Storage of Hazardous Substances, Sections 25281 and 25292, January 1, 2006, [http://www.waterboards.ca.gov/ust/regulatory/docs/hs_chp7_w_additions.pdf].

A great deal of debate has occurred over the last couple of years as various stakeholders and governmental organizations strive to objectively address the primary question: Should temperature compensation be used for retail transportation fuel transactions throughout the United States? If so, should ATC be mandatory or permissive?

The Energy Commission staff work embodied in this report was directed at addressing ATC for California. Some portions of the methodology, assumptions, findings, and conclusions contained in this report may be directly transferrable to other states or regions of the United States. It is likely that the analysis of the costs, potential agency impacts, labeling, and timing issues could be germane to the discussion of ATC in other areas outside of California. However, issues of quantifying potential net benefits and value of increased accuracy for retail transactions (fairness) are possibly less useful when applied to ATC in the United States as a whole.

Although there are a number of other states that have annual fuel temperature profiles that are similar to those in California (such as Texas, Arizona, and Florida), there are also some states in the Union that have temperature profiles considerably cooler than this state and below the 60 degree Fahrenheit reference standard (such as Alaska, Minnesota, and Wyoming).[108] In addition, there likely exist examples of states that normally have wholesale transactions on a gross, rather than net, basis (such as New York). These types of differences between individual states or regions of the United States could render comparisons to all of the findings and conclusions in this report less meaningful to areas outside of California, especially with regard to the net benefit assessment portion of the analysis.

The state and regional differences may be of such significance that a national consensus is neither achievable nor prudent. A more sensible approach would be for national standards and guidelines to be adopted through the NCWM ATC steering committee structure that could be referenced and adhered to by individual states that elected to promulgate retail ATC regulations. Such standards could include field test procedures and equipment used for certification of ATC fuel dispensers, minimum labeling recommendations, and possibly standardized densities for various types of transportation fuel.[109] It may be preferable that individual states retain the flexibility and autonomy regarding any decision to adopt ATC at retail stations within their own state boundaries.

[108] National Conference of Weights and Measures, "State Charts for Temperature of Gasoline in Filling Station Holding Tanks," presentation at ATC Meeting, Chicago, Illinois, August 2007, [http://www.ncwm.net/events/atc2007/item9_avg_temp_states.pdf].

[109] An expanded discussion on these other standards can be found in "Report of ATC Steering Committee Meeting," presented at the NCWM ATC meeting, Chicago, Illinois, August 2007, [http://www.ncwm.net/events/atc2007/ATC_Meeting_Report_8_07.doc].

CHAPTER 7: Findings and Recommendations

This chapter highlights the main findings and recommendations concerning the implementation of automatic temperature compensation (ATC) at retail stations in California.

Findings (Sequential Order)

Chapter 1 Findings

Background

- Liquids expand and contract in volume due to changing temperatures. Gasoline and diesel fuel are no exception.
- Gasoline warmed from 60 degrees Fahrenheit to 75 degrees Fahrenheit will expand by approximately 1 percent. The volume of gasoline will expand from 231.0 cubic inches to 233.3 cubic inches.
- If the 233.3 cubic inches of gasoline is cooled back down to 60 degrees Fahrenheit, the liquid will occupy a space of 231.0 cubic inches (assuming no losses from evaporation).
- The majority of wholesale transactions of gasoline and diesel fuel at California's 53 distribution terminals are normally consummated using a volumetric measurement referred to as a standard or net gallon that can be expressed as 231 cubic inches at 60 degrees Fahrenheit.
- The final temperature compensated price paid by wholesale fuel customers is the calculated standard or net gallon quantity multiplied by the posted wholesale price in net gallon.
- Retail fuel sale transactions are conducted in non-standard or gross gallons, represented by 231.0 cubic inches, regardless of fuel temperature.
- Currently, no retail station owner has chosen to install and operate ATC-ready dispensers in California. Whether California law currently permits the voluntary installation and activation of ATC devices by retail station owners for retail sales transactions of gasoline and diesel fuel has been disputed by stakeholders.

Chapter 2 Findings

Hawaii

- Fuel temperatures in Hawaii have minor seasonal fluctuations and can average near 80 degrees Fahrenheit on an annual basis.

- In the early 1970s the majority of Hawaii's retail fuel dispensers were modified to distribute an additional quantity of fuel (as measured in cubic inches) to compensate for the fact that the fuel sold is warmer.

- Hawaii's retail sales unit of gasoline is now 233.8 cubic inches, roughly equivalent to how much a standard gallon of gasoline would expand when warmed from 60 to 80 degrees Fahrenheit.

- Retail diesel fuel dispensed in Hawaii now contains 233.3 cubic inches for each unit of sale.

- Energy Commission staff believes that a reference temperature is a more viable option in Hawaii because there is very little seasonal volatility in climate temperatures throughout the year, as well as very small geographic differences in temperature in areas dispensing gasoline on any given day. California, on the other hand, has many climate zones that have large variations in seasonal temperatures throughout the year. The existence of the diversity and range of temperatures at any given time in California would also make the reference temperature option not as preferable as it is in Hawaii.

Canada

- Canada has adopted ATC at retail on a voluntary basis, beginning back in the early 1990s.

- Today, more than 90 percent of Canadian fuel retailers sell temperature-compensated fuel.

- Fuel temperatures in Canada are cooler than the reference standard of 15 degrees Celsius, resulting in the distribution of liters that are slightly smaller in size (in cubic centimeters).

- The fuel temperature circumstances in Canada (cooler fuel) are opposite of those in California (warmer fuel).

Chapter 3 Findings

Fuel Demand

- Approximately 23 billion gallons of gasoline, diesel and jet fuel were consumed by California motorists and businesses during 2007.

- For the study period (April 2007 through March 2008), taxable gasoline sales in California were 15.62 billion gallons, reflecting a slightly lower demand due to historically high retail prices. Taxable diesel fuel sales amounted to 3.06 billion gallons over the same period.

- Demand for gasoline is greatest in Los Angeles County, accounting for 24.1 percent of statewide consumption.

Retail Fuel Prices

- During the study period, the statewide average retail price for regular grade gasoline in California was $3.29 per gallon, while diesel fuel averaged $3.41 per gallon.
- The Oil Price Information Service (OPIS) was used as the source of retail fuel prices that were available for all 58 California counties.
- County-specific retail fuel prices were obtained from OPIS and California American Automobile Association (AAA) sources for 34 of California's 58 counties. These counties collectively represented a total of 93 percent of California's diesel consumption. The remaining counties were estimated by staff using gasoline price differentials calculated from the OPIS data.

Fuel Temperatures

- County sealers collected temperature data for retail gasoline and diesel fuel from some but not all months of the study period. While those counties account for a minority of counties, they account for approximately 85 percent of California gasoline sales and 78 percent of total statewide diesel fuel sales.
- Energy Commission staff determined that there is a statistically significant correlation between ambient average temperatures and the temperature of fuel dispensed from retail stations. These ambient temperatures can explain between 76 and 87 percent of the fuel prover temperature throughout the year. This statistical relationship was used to estimate fuel temperatures in the remaining counties.
- Fuel temperatures can fluctuate between the underground storage tanks (UST) and the dispenser on any given day by as much as 15 to 20 degrees Fahrenheit. Large differentials are unusual since more than 70 percent of these temperature differences are within plus or minus 3 degrees Fahrenheit and 94.7 percent of the temperatures are within plus or minus 7 degrees Fahrenheit.
- Gasoline and diesel fuel temperatures dispensed at California's retail stations during the study period were warmer than the reference standard of 60 degrees Fahrenheit.
- Regular grade gasoline averaged 71.1 degrees Fahrenheit, premium grade gasoline averaged 71.5 degrees Fahrenheit, and diesel fuel averaged 72.9 degrees Fahrenheit.
- Fuel temperatures fluctuate on a seasonal basis with the highest monthly averages recorded in August and coldest monthly averages occurring during January.
- Highest statewide fuel temperature (in August) for regular grade gasoline averaged 82.0 degrees Fahrenheit, premium grade gasoline averaged 82.9 degrees Fahrenheit, and diesel fuel averaged 84.6 degrees Fahrenheit.
- Lowest statewide fuel temperature (in January) for regular grade gasoline averaged 59.7 degrees Fahrenheit, premium grade gasoline averaged 59.8 degrees Fahrenheit, and diesel fuel averaged 60.4 degrees Fahrenheit.
- Individual county extremes during the study period were as follows:
    - 89.6 degrees Fahrenheit – regular grade gasoline - Riverside County in July 2007

- 90.7 degrees Fahrenheit – premium grade gasoline - Tulare County in September 2007
- 92.0 degrees Fahrenheit – diesel fuel - Fresno County in August 2007
- 49.4 degrees Fahrenheit – premium grade gasoline - Lake County in January 2008
- 50.5 degrees Fahrenheit – regular grade gasoline - Butte County in January 2008
- 51.8 degrees Fahrenheit – diesel fuel - Butte County in January 2008

- Fuel temperature survey results were similar to the earlier NIST work from April 2002 through February 2004 that determined regular grade retail gasoline averaged 74.7 degrees Fahrenheit.

Fuel Density - General

- Transportation fuel densities are a potentially important property relative to retail ATC due to differences in their thermal expansion and contraction properties, known as coefficient of expansion.

Gasoline Density

- The assumed density of finished gasoline in Canada that is used for retail ATC calculations is 0.7302 grams per milliliter (g/ml).

- Density of gasoline and diesel fuel varies due to differences in crude oil, refining processing, and seasonal specifications (for gasoline).

- The Canadian standard density value for gasoline is at the lower range of both the California and United States density values for the summer period of 2006.

- The use of a single gasoline density value in California that is close to the annual average will yield a volume correction factor (VCF) at 75 degrees Fahrenheit that is within plus or minus 0.04 percent of the actual, true value 96 percent of the time.

- Improving upon this level of precision by altering the accepted density value on a seasonal or per-delivery basis would be costly, problematic, and only decrease the potential error by an almost imperceptible measure.

Diesel Fuel Density

- Diesel fuel density does not vary on a seasonal basis in California or the United States.

- The Canadian standard density value for diesel fuel of 0.840 g/ml is nearly midway between the average California and AAM survey results for the summer of 2006, rather than on the lower end of the distribution range as was the case with gasoline density values.

- If ATC was mandated in California for use at retail stations, the overwhelming majority of diesel fuel transactions would likely be within plus or minus 0.02 percent of the true volume correction factor (VCF) for diesel fuel at 75 degrees Fahrenheit.

- The Canadian reference density value of 0.840 g/ml for diesel fuel is probably acceptable for use in California, if ATC was mandated at retail stations.

Renewable Fuels

- Due to development of the state's Low Carbon Fuel Standard and federal requirements of the Renewable Fuel Standard, staff assumed that California's gasoline will contain an average of 10 percent ethanol by volume as early as 2009, but no later than 2010.

- If retail ATC was mandated in California, stations with E85 (a mixture of 85 percent ethanol and 15 percent gasoline) dispensers would require software that was programmed with a density and VCF equation specific to E85.

- The varying nature of low-level biodiesel blends should not pose an accuracy problem if retail ATC was mandated in California, since the variation of density appears to be within the normal distribution for regular diesel fuel.

Chapter 4 Findings

Initial ATC Retrofit Costs

- Statewide costs for ATC retrofit kits are estimated by staff to amount to approximately $85 million or $8,763 per retail station. The highest per-station county average was $10,474 in Orange County, while the lowest per-station cost average was estimated at $2,212 for Alpine County.

- Statewide costs for ATC retrofit kit installation labor are estimated by staff to amount to between $9.0 million and $27.9 million or from $925 to $2,879 per retail station. The highest per-station labor cost average was $3,647 in Riverside County, while the lowest per-station labor cost average was estimated at $1,312 for Alpine County

- Energy Commission staff estimated that the time required to inspect and certify retail fuel dispensers will increase between 10 and 20 percent if ATC is mandated for use at retail stations in California.

- The number of county inspectors involved with testing and certifying retail motor fuel meters are estimated by staff to be between 129 and 156 statewide. Total statewide costs for the new equipment (specialized thermometers) they will need to verify the accuracy of ATC dispensers is estimated to range between $77,000 and $140,000.

- Staff assumed that the cost to pay for the ATC retrofit equipment (including installation) would be accomplished through the use of business loans that were either secured (by real estate property and other assets) or unsecured. Total financing costs of these loans is estimated to be between $9.7 million and $13.3 million.

- If one assumes that the total initial costs of retrofitting all of California's retail stations will only be passed through to consumers by raising the price of gasoline and diesel fuel, then the incremental retail price would increase by four hundredths (4/100) to seven hundredths (7/100) of a cent per gallon.

- These estimates assume that the lower cost is recovered over 15 years, while the higher estimate assumes retrofit costs are recovered over 10 years.

Recurring ATC-Related Costs

- The estimated inspection cost increase of $100 to $200 per station would be an incremental cost for retail station owners that would continue indefinitely. On a statewide basis, that fee increase would amount to between $970,000 and $1.94 million per year. That increased expense would equate to between five thousandths (5/1000) and one hundredth (1/100) of a cent per gallon.

- After ATC retrofit was completed, all new dispensers installed in the state after that time would be required to have ATC capability. The statewide incremental costs for these more expensive fuel dispensers would amount to between $3.8 million and $7.6 million per year or between two hundredths (2/100) and four hundredths (4/100) of a cent per gallon.

- Staff estimated that between 10 and 20 percent of existing retail stations will require some degree of ATC-related maintenance before the normal replacement cycle of the fuel dispensers. Maintenance could add between $2.7 million and $11.0 million per year to ongoing expenses. This cost is equivalent to between 14 thousandths (14/1,000) and 59 thousandths (59/1000) of a cent per gallon.

- Total recurring ATC-related costs are estimated to amount to between four hundredths (4/100) and 11 hundredths (11/100) of a cent per gallon.

Potential Impacts on Fuel Availability for Isolated Locations

- If ATC was to be mandated at retail stations in California, it is possible that the expense to comply with the regulation could be onerous for some station owners. Some of these station owners may be unable to obtain adequate financing and could possibly close their business.

- The closure of a retail station that was either the sole or one of only two sources of retail fuel for a community could create a local fuel supply availability problem.

Quantification of Potential Consumer Benefits

- If ATC had been in effect at retail during the study period, the quantity of net gallons of gasoline sold would have been approximately 15.508 billion gallons. This is about 117 million gallons less compared to status quo (no ATC at retail) because the fuel was warmer (71.1 degrees Fahrenheit) than the 60 degree Fahrenheit reference standard.

- Under the ATC scenario, the quantity of net or petroleum gallons of diesel fuel sold would have been approximately 3.037 billion gallons. This is about 19 million gallons less compared to status quo (no ATC at retail) of 3.056 billion gallons because the fuel was also warmer (72.9 degrees Fahrenheit) than the 60 degree Fahrenheit reference standard.

- The representative value of the reduced quantity of "gallons" that consumers would not have purchased if ATC had been in place at retail stations in California during the study period was calculated at about $376.4 million for gasoline and about $61.1 million for diesel fuel.

- But the perception by various stakeholders that the price of the retail fuel would not be raised to compensate for the selling of slightly larger-sized "gallons" is unrealistic if retail station owners are expected to maintain a similar level of profitability before and after a conversion to mandated ATC. Staff assumes that since the industry of retail station owners and operators will continue to grow and remain profitable. The conclusion is that retail station owners will in fact raise their fuel prices to compensate for selling fewer units, all other things being equal.

- Dr. Leitzinger and others assert that it is unclear whether, and the degree to which, retail station owners will be able to raise motor fuel prices depending on market conditions and other factors. Further, these stakeholders also maintain that it is unclear whether retail station owners will be able to completely recover ATC-related costs, even over the long-term. The Energy Commission acknowledges uncertainty in this regard but finds that the balance of evidence points to complete or near-complete pass-through of ATC-related costs from retail station owners to consumers.

Quantification of Increased Price Transparency Benefits for Society

- A mandated implementation of ATC will remove the effects of temperature variance and would remove information asymmetry as it involves the temperature of the fuel. This would force retailers to price gasoline and diesel products in net gallons, which would allow consumers to more accurately compare the prices among retail stations and retail station owners to more competitively price their fuel.

- The revised societal benefit of increased price transparency or removal of deadweight loss is now estimated at a little more than $250,000 per year.

Quantification of Fairness

- The concept of increased fairness for motorists has been raised by some stakeholders as a type of benefit that has not been accounted for in the cost-benefit-analysis.

- Some stakeholders believe that the collective benefits for motorists that would result from a conversion to ATC at retail station could amount to hundreds of millions of dollars per year in California.

- Although no quantification of "fairness" has been attempted as part of these proceedings due to the variable nature of this possible consumer benefit, there are some research survey techniques and methodologies that could be used to provide some valuable insight into this variable consumer benefit.

ATC Retrofit Cost-Benefit Analysis Results for Society

- The cost-benefit analysis results for the lower estimate of ATC retrofit for all retail stations are presented in Table 7. Net costs to society amount to approximately $245 million and range between four hundredths (4/100) and seven hundredths (7/100) of a cent per gallon over a 20-year period. The net present value of costs amounts to about $165 million.

- The higher estimate scenario amounts to approximately $530 million and range between 11 hundredths (11/100) and 18 hundredths (18/100) of a cent per gallon over a 20-year period. The net present value of costs amounts to about $417 million.

- Gradually phasing in ATC equipment at retail stations minimizes the expense for retail station owners because most of the expenses associated with installation labor can be avoided. Net costs to society of this scenario amount to approximately $205 million and range between one hundredth (1/100) and nine hundredths (9/100) of a cent per gallon over a 20-year period. The net present value of costs amounts to about $127 million.

ATC Retrofit – Potential Net Benefit to Consumers under Certain Circumstances

- Although likely that a portion of the capital costs will be recovered by retail station owners raising non-fuel commodity prices, it is improbable that the apportionment will be significantly skewed to non-fuel items. As such, it is unlikely that there are any plausible circumstances whereby some consumers could realize a small net benefit of ATC at retail in California.

Retail Station Characteristics and Trends

- Today, more than 80 percent of the gasoline sold to the public nationwide is through convenience stores.
- These places of business have continued to be profitable over the last decade, averaging nearly $34,000 per store pre-tax profits between 1998 and 2006.
- Profit margins for convenience stores across the United States show that in-store sales (non-fuel) have a consistently higher and steadier profit margin, relative to that of the steadily declining profit margins for fuel sales.
- On a per-gallon basis, the average margin of motor fuel sales at a typical convenience store has remained fairly steady between 2000 and 2006, averaging 10.5 cents per gallon.
- Staff interprets these stable per-gallon margins as an indication that the ability of convenience store owners to pass through increased expenses by increasing the price of their gasoline and diesel fuel only is not reflected in the overall trend.
- As such, retail station owners will likely have to recapture a portion of the revenue shift by raising prices of non-fuel commodities.

Chapter 5 Findings

Initial Reference Temperature Costs

- The estimated costs of a new reference temperature and associated larger gallon size (in cubic inches) could amount to between $9.0 million and $27.9 million or from $925 to $2,879 per retail station. On a per-gallon basis these additional expenses incurred by retail station owners would equate to between five hundredths (5/100) and 15 hundredths (15/100) of a cent per gallon for only one year. After the modifications were completed, there would be no additional recurring costs for businesses or consumers.

Regional Reference Temperature

- Development of such variable inspection and certification procedures in conjunction with the creation of multiple new jurisdictions that cross county boundaries could create difficulties for enforcement officials. Staff believes, therefore, that a regional reference temperature approach may create too many difficulties and should not be considered as an option to pursue in California.

Chapter 6 Findings

Permissive vs. Mandatory ATC at Retail Stations

- The status of permissive (voluntary) use of ATC devices at California retail stations is currently in dispute by various stakeholders.

Labeling

- Canada requires all fuel dispensers equipped with ATC to be labeled with the message: “Volume corrected to 15°C”.

- If ATC was mandated for use at California retail stations, the cost of fuel dispenser labels is estimated to be modest, amounting to no more than $20 per dispenser.

- Canada does not require the large price signs to contain any message that the station has ATC capability.

- If ATC was mandated for use at California retail stations, the cost of displaying an ATC message on the large price sign could range from as little as $50 to nearly $5,000 if a complete large sign replacement was necessary.

- Canada does not require that printed receipts for retail customers have any ATC-related message or notation of net and gross quantities.

- Any attempts to increase the level of information on printed receipts at retail stations to include net and gross gallons would pose some difficult and problematic issues due to software limitations between the dispenser ATC equipment and the electronic cash register or Point of Sale (POS).

- It is possible that, over time, POS and ATC retrofit manufacturers could collaborate to enable this exchange of data, but the initial expense of this software and some electronic modifications is unknown.

Authority to Activate Retail ATC

- Access to retail ATC devices in fuel dispensers is usually limited to only those entities that have a need to make repairs or modifications to the devices in the field.

- To reduce the possibility of illegal manipulation of software settings or operation, ATC devices in Canada are required to have tamper-proof seals in place that must be removed or damaged if someone were to attempt unauthorized access.

- The Division of Measurement Standards (DMS) already has regulations concerning authority to activate ATC devices (for such fuel as LPG) and a stipulation that the ATC device must remain active for at least 12 consecutive months, once it is activated.

- This DMS regulation is to help ensure that a retail station operator could not selectively operate the device when it was only a benefit to the owner.

Implementation Timeline Options for Retail ATC

- Before mandatory retail ATC could happen in California, the Legislature would have to approve and the Governor sign a new bill requiring ATC at retail stations.

- The Division of Measurement Standards would then initiate a rule-making process that includes the development of draft standards, public consultations and comment periods, and ultimately adoption of new regulations.

- A final set of steps would involve the updating of various guidance documents that are used by enforcement officials as an inspection procedure reference as well as by business owners to better understand compliance rules and timelines.

- The optimal compliance schedule from the perspective of most consumers would likely be as quickly as feasible. However, an unreasonably short compliance deadline could create problems for regulators, retail station operators, equipment manufacturers, and inspectors.

- If ATC was mandated for use at retail stations in California, the optimal timeline to phase in the new standard would be five to eight years from the date legislation requiring retail ATC was signed into law. If the bill signing were to take place during January 2010, activation of the ATC devices could begin as early as October 2014.

Leak Detection

- ATC implementation would not significantly affect underground storage tank leak detection in California because stronger leak detection requirements are already in place.

Recommendations

Primary

- If the ***only criterion*** for assessing the merit of mandatory ATC installations for use at California retail stations is a net benefit to consumers, the Transportation Committee (Committee) of the California Energy Commission concludes that ATCs should not be required since the results of the cost-benefit analysis show a net cost for consumers.

- However, the Committee recommends that the Legislature also consider whether the possible value of increased fairness, accuracy, and consistency of fuel measurement, in addition to the benefits quantified in the cost-benefit analysis, justify mandating ATC at California retail stations.

- If the Legislature chooses to mandate the use of ATC at retail stations, two options are available: (1) require all retail stations to retrofit their fuel dispensers over a two-year period, or (2) a more gradual phase-in approach, requiring new and refurbished stations to install, ***but not activate***, ATC devices over a five-year period. The remainder of retail stations would be required to install ATC devices during the fifth year, and all stations would activate their devices at the end of that year. Such a phase-in approach is the least-cost option for mandatory ATC, although it would still result in a net cost to society.

- If the Legislature chooses not to mandate the use of ATC at retail stations, they should clarify if the current intent of the existing statutes is to permit or prohibit voluntary ATC at retail outlets for gasoline and diesel fuel.

- If the Legislature chooses to permit or mandate ATC at retail, they should direct the California Division of Measurement Standards to develop standards addressing equipment approval, certification testing, compliance enforcement, and consumer labeling provisions for ATC at retail stations.

- Based on the report analysis, the Committee concludes that establishing a new statewide reference temperature, or different regional reference temperatures for the state, would not successfully address temperature compensation at the retail level and therefore does not recommend this approach.

Fuel Density

If ATC was mandated for use at retail stations in California:

- Density reference values used to program retail ATC software should not be altered on a seasonal or per-load basis due to the impractical and problematic consequences of such an approach.

- A single reference density value for finished gasoline should be selected and be representative of the summer blending season, since the highest divergence from the 60 degree Fahrenheit reference standard exists at that time of year in California. Slightly less accurate density representation during the winter blending season is more acceptable because the fuel temperatures during that time of year are much closer to the reference temperature of 60 degrees Fahrenheit.

- The Canadian reference value of 0.730 g/ml is outside the lower range of California gasoline density values and should not be used as the reference density standard in this state for ATC at retail.

- The final value should be one at or near the summer average, rather than annual, California retail gasoline density value as determined by DMS in consultation with industry and appropriate state agencies. For purposes of this conclusion, the summer period is May 1 through September 30.

- The ethanol concentration in retail gasoline should be assumed to be 10 percent by volume for purposes of determining a reference density standard.

- Retail sales of E85 at ATC retail stations should use a density reference standard other than the one selected for California retail gasoline containing 10 percent ethanol. DMS should conduct laboratory work to determine the appropriate density value of E85 in consultation with industry and appropriate state agencies.

- The Canadian reference density standard of 0.840 g/ml for diesel fuel would be acceptable for use in California since that value is at or near the average retail density properties for retail diesel fuel in this state.

- ATC retail sales of diesel fuel that contains biodiesel at concentrations up to 20 percent by volume should use the Canadian reference diesel density standard of 0.840 g/ml.

- The Canadian reference value of 0.840 g/ml is outside the lower range of B100 density values and should not be used as the reference density standard in this state for ATC at retail. Rather, DMS should conduct laboratory work to determine the reference standard density value for B100 in consultation with industry and appropriate state agencies.

ATC Retrofit Costs

If ATC was mandated for use at retail stations in California:

- The maximum limit stipulated in subdivision (n), Section 12240, California Business and Professions Code should be increased to at least $1,200 to ensure that counties will be able to recover all of their additional costs of performing inspections and certifications.

- There should be provisions put in place to ensure that retail stations that serve isolated California communities should receive special consideration for financial assistance. One such example would be the assessment of a special fee of two hundredths (2/100) of a cent per gallon on all gasoline and diesel fuel wholesale transactions for a period of six months to cover the expenses incurred for ATC retrofit for retail stations that meet all of the criteria established by the DMS in consultation with appropriate state agencies.

Permissive vs. Mandatory ATC at Retail Stations

- The status of permissive (voluntary) use of ATC devices at California retail stations is currently in dispute by various stakeholders.

- If the Legislature chooses not to mandate the use of ATC at retail stations, the Legislature may wish to clarify whether the current intent of the existing statutes is to permit or prohibit voluntary ATC at retail outlets for gasoline and diesel fuel.

- If the Legislature chooses to permit or mandate ATC at retail, they should direct the California Division of Measurement Standards to develop standards addressing equipment approval, certification testing, compliance enforcement, and consumer labeling provisions for ATC at retail stations.

Labeling

- If ATC is required at retail fuel stations, DMS should develop amended regulatory language for labeling fuel dispensers that includes guidance for:

  - Wording of the ATC message (such as “Corrected to 60°F”).
  - Font size (similar to existing standards).
  - Location of the decal.
  - Timing of the requirement (when ATC equipment is activated).
  - Authority to affix the decal (certified equipment installers and inspectors).

- If voluntary use of ATC at the retail level is clarified by the State’s Legislature to be permissible, DMS should develop amended regulatory language for the large price display signs that includes guidance for:

  - Wording of the ATC message (such as the notation of “ATC” or “TC”).
  - Font size (similar to existing standards for the prices).
  - Location of the message.
  - Timing of the requirement (when ATC equipment is activated).
  - Authority to affix the message (retail station operators).

- Retail station operators should be given the option to include a message on the printed consumer receipt, but not be required to include any additional information such as fuel temperature, net and gross gallons.

Optimal Compliance Schedule

- If ATC is mandated for use at California retail stations, the longer schedule (option 3) would be optimal to minimize costs to businesses and allow adequate lead-time for a final compliance deadline of April 1, 2018.

Other Liquid Transportation Fuels

- The following aviation transportation fuels should initially be excluded from any retail ATC standards:
    - Aviation gasoline (100 LL)
    - Commercial jet fuel (Jet A)
    - Military grade jet fuel (JP-5 and JP-8)

Applicability of Findings to Other Regions of the United States

- National standards and guidelines should be adopted through the National Conference of Weights and Measures (NCWM) committee structure that could be referenced and adhered to by individual states that elected to promulgate retail ATC regulations.

GLOSSARY OF ACRONYMS

°C	Degrees Celsius
°F	Degrees Fahrenheit
100 LL	Low-lead aviation gasoline designation with minimum 100 octane
AAA	American Automobile Association
AAM	Alliance of Automobile Manufacturers
AB	Assembly Bill
API	American Petroleum Institute
AQMD	Air Quality Management District
ARB	California Air Resources Board
AST	Aboveground Storage Tank
ATC	Automatic Temperature Compensation
ASTM	American Society for Testing and Materials
B100	Biomass-based diesel fuel
B5	Diesel fuel containing up to 5 percent biomass-based diesel by volume
B6-20	Diesel fuel containing from 6 to 20 percent biomass-based diesel by volume
bbl/d	Barrels per Day
BOE	California State Board of Equalization
CARBOB	California Reformulated Blendstock for Oxygenate Blending
CBG	Cleaner Burning Gasoline
CBA	Cost-Benefit Analysis
C.C.R.	California Code of Regulations
CIOMA	California Independent Oil Marketers Association
CMR	County Monthly Reports
CNG	Compressed Natural Gas
CTEP	California Type Evaluation Program
DFA	Department of Food and Agriculture
DMS	Division of Measurement Standards
E10	Finished gasoline containing 10 percent fuel ethanol by volume
E15	Finished gasoline containing 15 percent fuel ethanol by volume
E20	Finished gasoline containing 20 percent fuel ethanol by volume
E200	The percentage of fuel evaporated at 200 degrees Fahrenheit
E300	The percentage of fuel evaporated at 300 degrees Fahrenheit
E85	Finished gasoline containing 85 percent fuel ethanol by volume
EIA	Energy Information Administration
EPA	Environmental Protection Agency (U.S.)
FBP	Final Boiling Point
FFV	Flexible Fuel Vehicles
FHA	Federal Highway Administration
g/ml	grams per milliliter
GAO	Government Accountability Office
GDF	Gasoline Dispensing Facility
gph	gallons per hour
Gross gallon	Non-standard or unit gallon (231 cubic inches at any temperature)
IBP	Initial Boiling Point
HD-5	Heavy Duty propane specification for automotive fuel use
IP	Institute of Petroleum
Jet A	Kerosene grade of fuel suitable for most turbine engine aircraft meeting ASTM D1655 specification
JP-5	Military jet fuel designed for use in aircraft stationed aboard aircraft carriers, meeting the MIL-DTL-5624U specification

JP-8	Military jet fuel meeting the MIL-DTL-83133E specification
Kg/m^3	Kilograms per cubic meter
LCFS	Low Carbon Fuel Standard
mm	millimeters
MON	Motor Octane Number
MTBE	Methyl Tertiary Butyl Ether
MVSTAFF	Motor Vehicle Stock, Travel, and Fuel Forecast
NA	Not Available or Not Applicable
NACS	National Association of Convenience Stores
NCDC	National Climactic Data Center
NCWM	National Conference on Weights and Measures
NEL	National Engineering Laboratory
Net gallon	Standard or temperature-assigned gallon (231 cubic inches at 60 degrees Fahrenheit)
NIST	National Institute of Standards and Technology
Non-standard gallon	Gross or unit gallon (231 cubic inches at any temperature)
NREL	National Renewable Energy Laboratory
NTEP	National Type Evaluation Program
NWML	National Weights and Measures Laboratory (United Kingdom)
OAC	Online Archive of California
OEM	Original Engine Manufacturer
OPIS	Oil Price Information Service
PIIRA	Petroleum Industry Information and Reporting Act
POS	Point of Sale
ppm	parts per million
psi	pounds per square inch
RFS	Renewable Fuel Standard
RIS	Regulatory Impact Statement
RMF	Retail Motor Fuel
RON	Research Octane Number
Rvp	Reid vapor pressure
SOC	Standard Occupational Classification
Sp.Gr.	Specific Gravity
Standard gallon	Net or temperature-assigned gallon (231 cubic inches at 60 degrees Fahrenheit)
T10	Temperature on the fuel distillation curve at which 10 percent of the fuel has distillated or transitioned from a liquid to vapor state
T30	Temperature on the fuel distillation curve at which 30 percent of the fuel has distillated or transitioned from a liquid to vapor state
T50	Temperature on the fuel distillation curve at which 50 percent of the fuel has distillated or transitioned from a liquid to vapor state
T70	Temperature on the fuel distillation curve at which 70 percent of the fuel has distillated or transitioned from a liquid to vapor state
T90	Temperature on the fuel distillation curve at which 90 percent of the fuel has distillated or transitioned from a liquid to vapor state
TC	Temperature Compensation
Temperature-assigned gallon	Net or standard gallon (231 cubic inches at 60 degrees Fahrenheit)
UATC	Universal Automatic Temperature Compensation
ULSD	Ultra Low Sulfur Diesel
Unit gallon	Gross or non-standard gallon (231 cubic inches at any temperature)
U.S.	United States
UST	Underground Storage Tank
VCF	Volume Correction Factor

vol.	volume
wt.	weight

Appendix A: County Demand and Percentages

COUNTY	April '07 to March '08 Gasoline MM Gallons	2007 CalTrans Percent of Total	April '07 to March '08 Diesel Fuel MM Gallons	2007 CalTrans Percent of Total	April '07 to March '08 Total Fuel MM Gallons
ALAMEDA	680.114	4.35%	105.200	3.44%	785.314
ALPINE	3.127	0.02%	0.467	0.02%	3.594
AMADOR	20.633	0.13%	3.477	0.11%	24.109
BUTTE	83.453	0.53%	14.669	0.48%	98.123
CALAVERAS	20.191	0.13%	3.038	0.10%	23.229
COLUSA	29.156	0.19%	15.067	0.49%	44.223
CONTRA COSTA	399.901	2.56%	52.187	1.71%	452.088
DEL NORTE	12.054	0.08%	2.324	0.08%	14.379
EL DORADO	80.899	0.52%	12.359	0.40%	93.257
FRESNO	383.935	2.46%	103.024	3.37%	486.959
GLENN	24.019	0.15%	11.147	0.36%	35.167
HUMBOLDT	62.062	0.40%	13.790	0.45%	75.852
IMPERIAL	92.672	0.59%	29.167	0.95%	121.840
INYO	25.552	0.16%	5.918	0.19%	31.470
KERN	387.380	2.48%	177.920	5.82%	565.299
KINGS	64.047	0.41%	24.994	0.82%	89.041
LAKE	28.440	0.18%	5.442	0.18%	33.882
LASSEN	24.835	0.16%	8.137	0.27%	32.972
LOS ANGELES	3,760.363	24.07%	627.652	20.54%	4,388.016
MADERA	73.808	0.47%	29.156	0.95%	102.964
MARIN	138.536	0.89%	14.243	0.47%	152.779
MARIPOSA	12.235	0.08%	1.367	0.04%	13.602
MENDOCINO	55.089	0.35%	10.866	0.36%	65.955
MERCED	124.149	0.79%	48.685	1.59%	172.835
MODOC	9.712	0.06%	2.851	0.09%	12.563
MONO	15.068	0.10%	3.224	0.11%	18.292
MONTEREY	171.437	1.10%	40.105	1.31%	211.542
NAPA	54.475	0.35%	7.864	0.26%	62.339
NEVADA	56.808	0.36%	13.596	0.44%	70.404
ORANGE	1,240.410	7.94%	175.801	5.75%	1,416.211
PLACER	164.846	1.06%	36.340	1.19%	201.186
PLUMAS	16.205	0.10%	3.440	0.11%	19.645
RIVERSIDE	918.030	5.88%	230.182	7.53%	1,148.212
SACRAMENTO	566.573	3.63%	96.226	3.15%	662.798
SAN BENITO	25.650	0.16%	7.765	0.25%	33.415
SAN BERNARDINO	1,027.588	6.58%	282.499	9.24%	1,310.088
SAN DIEGO	1,342.201	8.59%	187.456	6.13%	1,529.657
SAN FRANCISCO	163.297	1.05%	14.620	0.48%	177.917
SAN JOAQUIN	318.576	2.04%	100.852	3.30%	419.429
SAN LUIS OBISPO	139.252	0.89%	28.796	0.94%	168.048
SAN MATEO	315.937	2.02%	33.097	1.08%	349.035
SANTA BARBARA	174.842	1.12%	28.561	0.93%	203.402
SANTA CLARA	729.457	4.67%	88.179	2.89%	817.636
SANTA CRUZ	95.865	0.61%	11.131	0.36%	106.997
SHASTA	93.991	0.60%	28.411	0.93%	122.402
SIERRA	5.197	0.03%	1.666	0.05%	6.862
SISKIYOU	44.100	0.28%	19.469	0.64%	63.570
SOLANO	219.586	1.41%	35.105	1.15%	254.691
SONOMA	183.588	1.17%	28.111	0.92%	211.700
STANISLAUS	194.687	1.25%	55.542	1.82%	250.229
SUTTER	42.092	0.27%	7.210	0.24%	49.302
TEHAMA	45.645	0.29%	16.785	0.55%	62.430
TRINITY	8.407	0.05%	2.033	0.07%	10.440
TULARE	168.441	1.08%	60.959	1.99%	229.400
TUOLUMNE	30.664	0.20%	4.479	0.15%	35.142
VENTURA	321.816	2.06%	46.058	1.51%	367.874
YOLO	100.726	0.64%	28.811	0.94%	129.537
YUBA	32.751	0.21%	8.192	0.27%	40.943
TOTAL	15,624.571		3,055.714		18,680.285

Source: CalTrans MVStaff 2007
http://www.dot.ca.gov/hq/tsip/smb/documents/mvstaff/mvstaff07.pdf

Appendix B: NCDC Average Ambient Temperatures

County	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08
ALAMEDA	57.709	60.905	63.672	66.434	67.206	65.667	60.685	56.751	49.122	48.772	52.057	54.533
Alpine	43.510	52.500	59.920	67.790	64.970	53.970	46.550	37.371	27.100	23.980	23.350	35.875
AMADOR	56.900	64.800	72.700	76.900	77.700	67.000	61.600	57.200	42.000	43.900	47.700	54.080
BUTTE	58.683	66.879	73.690	78.525	78.600	70.126	64.794	57.725	45.671	45.062	48.262	54.492
CALAVERAS	48.540	57.640	63.840	70.040	69.820	59.920	52.720	49.700	35.700	34.880	38.300	43.028
COLUSA	60.500	68.600	73.500	74.000	75.500	68.700	60.200	55.700	45.200	44.900	50.800	55.060
CONTRA COSTA	59.540	64.161	68.857	71.315	71.502	67.417	61.321	56.204	47.504	46.825	51.072	55.101
Del Norte	49.900	52.500	54.700	61.700	60.100	56.200	53.300	48.200	43.400	43.300	45.200	44.940
El Dorado	48.590	56.316	55.667	71.895	69.587	58.790	50.726	45.806	34.419	32.939	36.797	42.809
FRESNO	63.004	71.401	77.415	82.091	82.286	74.174	65.656	58.148	45.368	46.953	51.280	57.992
GLENN	61.416	69.105	74.242	77.174	76.689	70.489	61.895	57.468	46.768	44.984	50.237	54.789
HUMBOLDT	50.886	53.024	56.515	61.687	59.993	57.318	53.878	50.267	44.698	44.717	45.676	47.343
IMPERIAL	72.300	79.800	87.400	93.100	93.700	85.400	75.300	66.500	52.100	53.400	58.900	65.400
INYO	62.275	71.100	79.375	86.400	82.825	72.275	60.925	52.525	38.550	39.975	59.400	48.290
KERN	63.924	72.709	78.770	83.509	82.989	74.044	64.402	57.536	45.996	48.694	52.384	57.939
KINGS	61.387	70.069	75.978	80.404	80.349	71.909	62.016	54.553	43.067	45.189	48.221	55.086
LAKE	54.300	62.200	67.800	73.300	72.600	64.900	55.000	50.000	42.500	43.500	46.200	49.000
LASSEN	48.327	56.307	63.193	71.667	69.107	58.600	48.400	41.300	31.000	27.400	33.373	41.042
LOS ANGELES	60.976	63.929	67.583	72.891	74.231	69.839	66.478	61.130	54.219	54.201	56.014	59.985
MADERA	60.800	68.700	74.900	79.200	79.600	71.400	61.000	53.800	43.500	45.500	48.400	54.290
MARIN	56.932	60.444	64.248	67.148	67.816	65.052	59.588	55.176	47.392	46.488	51.076	53.642
MARIPOSA	60.800	68.700	74.900	79.200	79.600	71.400	61.000	53.800	43.500	45.500	48.400	54.290
MENDOCINO	52.091	58.642	60.949	66.509	65.749	61.531	52.365	50.446	42.351	42.931	46.353	43.890
MERCED	61.457	69.663	75.026	78.987	79.170	72.028	62.707	56.224	45.439	46.100	49.809	55.655
Modoc	46.150	53.833	58.683	68.783	69.550	58.900	43.200	37.450	28.783	24.683	27.767	37.555
MONO	43.510	52.500	59.920	67.790	64.970	53.970	46.550	37.371	27.100	23.980	23.350	35.875
MONTEREY	54.587	57.015	59.251	62.319	63.090	62.771	59.105	55.308	47.946	48.563	50.676	52.283
NAPA	55.845	61.494	65.697	68.636	68.709	65.688	58.709	52.288	44.964	45.964	48.752	51.298
NEVADA	47.015	58.307	64.055	68.200	69.672	63.314	50.883	47.397	35.038	35.414	38.097	43.492
ORANGE	62.388	65.683	68.369	73.776	76.249	71.554	68.492	63.119	55.881	56.977	58.590	62.652
PLACER	54.012	62.318	69.362	73.647	67.991	65.735	56.576	52.297	40.729	39.362	43.959	39.005
PLUMA	47.833	55.605	62.038	69.210	66.781	58.014	47.771	41.481	32.367	30.348	33.705	40.445
RIVERSIDE	64.167	69.507	75.258	80.766	82.558	73.738	70.797	62.119	51.424	51.580	54.986	62.960
SACRAMENT	61.200	67.300	72.850	76.350	76.650	69.550	62.100	56.100	46.400	46.700	50.300	55.470
SAN BENITO	57.300	61.000	65.000	68.100	68.300	65.200	60.300	55.200	46.100	46.800	49.200	52.560
SAN BERNARDINO	64.016	71.560	79.084	85.441	85.126	75.575	65.585	58.693	45.855	45.807	53.442	59.767
SAN DIEGO	59.768	62.989	65.183	70.031	73.472	69.753	66.696	61.217	54.058	54.240	55.545	58.743
SAN FRANCISCO	54.150	55.650	57.200	60.100	60.500	63.400	59.150	57.050	50.800	49.900	53.200	54.480
SAN JOAQUIN	62.224	68.753	73.874	77.209	77.334	70.510	62.846	56.220	45.648	46.090	49.743	54.404
SAN LUIS OBISPO	57.052	61.369	65.931	69.969	70.492	65.815	60.788	56.752	44.179	45.610	49.383	53.834
SAN MATEO	56.266	59.698	63.338	65.860	66.216	64.285	59.647	55.644	49.289	48.372	51.186	52.210
SANTA BARBARA	59.063	59.829	61.984	65.439	66.327	65.539	62.552	58.148	50.637	52.364	54.387	54.041
SANTA CLARA	58.611	62.910	66.540	69.533	69.834	67.311	61.445	56.466	46.651	46.862	50.316	54.200
SANTA CRUZ	55.812	58.319	61.421	64.465	64.216	62.956	59.047	55.098	47.756	47.756	50.691	52.879
SHASTA	58.992	68.823	76.449	81.164	79.142	70.619	59.760	55.100	44.291	43.158	48.658	52.992
SIERRA	52.200	55.242	61.331	68.021	66.282	60.800	49.124	47.100	35.400	34.500	38.200	44.600
SISKIYOU	50.217	58.517	64.817	72.533	71.620	62.067	48.933	42.283	32.950	30.550	36.200	40.885
SOLANO	60.732	67.132	71.768	75.460	75.414	70.283	62.440	57.152	47.300	45.948	50.648	55.711
SONOMA	57.410	61.315	65.982	68.758	68.967	65.910	59.729	54.488	46.696	46.104	49.673	52.699
STANISLAUS	63.172	70.209	75.837	80.094	80.390	72.279	64.099	57.152	46.992	47.581	51.302	57.016
SUTTER	60.500	68.600	73.500	74.000	75.500	68.700	60.200	55.700	45.200	44.900	50.800	55.060
TEHAMA	60.500	69.900	76.700	82.000	79.500	71.100	61.300	56.000	45.400	44.200	50.100	54.400
TRINITY	52.900	61.300	66.800	74.200	72.000	64.500	52.400	47.800	37.600	36.300	41.500	45.810
TULARE	61.823	70.026	75.655	81.484	80.616	72.668	62.181	56.530	44.838	46.893	50.658	55.961
TUOLUMNE	49.800	59.800	66.400	71.200	71.500	62.700	53.200	48.700	36.600	37.500	41.900	46.260
VENTURA	58.172	60.515	64.384	69.273	69.645	66.669	64.597	58.822	53.100	53.657	54.710	58.304
YOLO	62.416	68.720	73.523	76.732	76.532	70.768	62.820	56.484	46.986	45.714	50.127	55.773
YUBA	55.700	63.400	68.600	74.700	74.900	65.400	61.877	53.400	42.800	42.400	46.000	51.290

Source: Energy Commission staff analysis of NCDC ambient temperature

Appendix C: Fuel Temperature Regression Results

The regression equations look at fuel prover (fuel from the dispenser nozzle) temperature as a function of ambient air temperature and other variables. The data used are monthly observations for each California county for April 2007 through March 2008. Four different specifications were estimated for regular and premium grade gasoline along with diesel fuel. Regression Equation 1 has fuel temperature as a function of only ambient air temperature; Equation 2 uses ambient air temperature and four regional variables; Equation 3 uses ambient air temperature and month dummy variables; while Equation 4 uses ambient air temperature, the regional variables and the month variables. The variables in Equation 3 have the highest significance among all the equations. Also, Equation 3 appears to fit the data the best when graphed. Thus, Equation 3 will be used to estimate the temperatures from missing counties.

The regression variables are defined as follows: Air temperature is the median monthly air temperature collected from NCDC. The month variables, Feb-Dec, are dummy variables equal to one for that month and zero otherwise. For example, in March, the March variable would equal one while all the other month variables equal zero. Also, there is no variable for January as all the month variables are relative to January. The F Statistic is a measure of overall fit of the equation. Generally, an F Statistic of 4 or more is significant at the 1 percent level. The # of observations is just the number of data points used for that equation. R sq measures how well the independent variables (month variables, regional variables, air temperature) can explain the dependant variable (fuel temperature).

In all the specifications, ambient air temperature is significant at the 1 percent level for explaining fuel prover temperature. In the two specifications which include the month dummy variables, most of the months are positive and significant. The regional dummy variables are negative, but only about half are significant. Specification 3 was chosen over Specification 4 as adding the regional dummy variables to Specification 3 did not change the fit of the equation.

The variables: Central, North, Sierra, and South are dummy variables that represent various regions in California.

The three tables below show the regression results for regular grade gasoline, premium grade gasoline, and diesel fuel.

Regression Results for Regular Grade Gasoline

Variable	Equation 1	Equation 2	Equation 3	Equation 4
Constant	20.30*	21.55*	24.65*	27.9*
	[1.27]	[1.31]	[2.03]	[2.14]
Air Temperature	0.81*	0.80*	0.67*	0.62*
	[0.02]	[0.02]	[0.04]	[0.04]
February			1.47	1.63***
			[0.93]	[0.90]
March			1.98**	2.24
			[0.92]	[0.91]
April			2.99*	3.54*
			[1.02]	[1.01]
May			2.36**	3.15*
			[1.12]	[1.13]
June			4.14*	5.12*
			[1.25]	[1.26]
July			5.09*	6.12*
			[1.38]	[1.38]
August			6.99*	8.17*
			[1.42]	[1.41]
September			6.90*	7.92*
			[1.25]	[1.26]
October			6.60*	7.20*
			[1.11]	[1.08]
November			5.59*	5.89*
			[1.01]	[0.98]
December			3.65*	3.52*
			[0.96]	[0.93]
Central		-2.14*		-1.31**
		[0.49]		[0.46]
North		-2.14*		-2.51*
		[0.49]		[0.45]
Sierra		-0.38		-1.54
		[1.39]		[1.29]
South		-2.57**		-1.67
		[1.18]		[1.05]
F Statistic	1536	329	165	137
# of Observations	307	307	307	307
R sq	0.83	0.84	0.87	0.87

*, **, *** represent significance at the 1%, 5%, and 10% levels respectively. Standard errors in parentheses.

Regression Results for Premium Grade Gasoline

Variable	Equation 1	Equation 2	Equation 3	Equation 4
Constant	18.99*	20.3	25.54*	30.31*
	[1.65]	[1.68]	[2.82]	[2.98]
Air Temperature	0.83*	0.83*	0.66*	0.59*

	[0.02]	[0.02]	[0.05]	[0.06]
February			1.54	1.8
			[1.30]	[1.26]
March			2.32***	2.99**
			[1.31]	[1.27]
April			4.94*	5.94*
			[1.43]	[1.41]
May			3.77**	5.27*
			[1.56]	[1.58]
June			5.08*	6.81*
			[1.73]	[1.74]
July			4.86*	6.64*
			[1.86]	[1.89]
August			9.52*	11.64*
			[1.95]	[1.99]
September			6.52*	8.31*
			[1.72]	[1.75]
October			3.91**	4.97*
			[1.50]	[1.49]
November			3.81*	4.44*
			[1.38]	[1.36]
December			2.83**	2.71**
			[1.33]	[1.29]
Central		-1.50**		-1.53**
		[0.67]		[0.63]
North		-2.14*		-2.87*
		[0.64]		[0.62]
Sierra		-1.68		-4.19**
		[1.89]		[1.87]
South		-3.02**		-2.14
		[1.50]		[1.42]
F Statistic	979	205	91	75
# of Observations	293	293	293	293
R sq	0.77	0.77	0.78	0.80

*, **, *** represent significance at the 1%, 5%, and 10% levels respectively. Standard errors in parentheses.

Regression Results for Diesel Fuel

Variable	Equation 1	Equation 2	Equation 3	Equation 4
Constant	22.59* [2.43]	23.81* [2.52]	30.91* [4.15]	38.07* [4.68]
Air Temperature	0.78* [0.04]	0.78* [0.39]	0.54* [0.08]	0.41* [0.09]
February			3.23 [2.16]	3.95*** [2.13]
March			4.31*** [2.21]	5.62** [2.23]
April			6.00** [2.39]	7.89* [2.46]
May			9.42* [2.60]	11.61* [2.75]
June			7.82* [2.78]	10.57* [2.95]
July			6.96** [3.09]	10.33* [3.36]
August			14.34* [3.31]	18.64* [3.65]
September			9.93* [2.88]	13.30* [3.15]
October			6.35** [2.54]	8.02* [2.62]
November			7.24* [2.32]	8.31* [2.34]
December			4.34** [2.08]	3.73*** [2.05]
Central		-1.81*** [0.94]		-1.65*** [0.89]
North		-1.21 [1.09]		-2.94* [1.08]
Sierra		-2.53 [2.55]		-6.37** [2.54]
South		-2.88 [2.30]		-0.37 [2.20]
F Statistic	396	80	40	32
# of Observations	151	151	151	151
R sq	0.72	0.72	0.76	0.77

*, **, *** represent significance at the 1%, 5%, and 10% levels respectively. Standard errors in parentheses.

Appendix D: Modified DMS Temperature Survey Data

Date	County	Temp. Type	Original Data Point Degrees F	Action Taken
March 2007	Merced	All	NA	Temperature data outside study period, excluded from analysis.
4/26/2007	Siskiyou	Dsl-P	77	Temperature excluded from prover average & differential calculations.
8/7/2007	Los Angeles	Dsl-ST	103.5	Temperature excluded from differential calculation.
9/22/2007	Los Angeles	87-P	96.5	Temperature excluded from prover average & differential calculations.
9/25/2007	Stanislaus	91-ST	54.3	Temperature excluded from differential calculation.
10/17/2007	Inyo/Mono	Dsl-ST	45.4	Temperature excluded from differential calculation.
11/5/2007	Butte	Dsl-ST	85.4	Temperature excluded from differential calculation.
11/8/2007	San Bernardino	Dsl-P	61.4	Temperature excluded from prover average & differential calculations.
11/20/2007	San Bernardino	Dsl-P	101	Temperature excluded from prover average & differential calculations.
11/20/2007	San Bernardino	Dsl-ST	112.3	Temperature excluded from prover average & differential calculations.
11/21/2007	Los Angeles	87-ST	91	Temperature excluded from differential calculation.
12/6/2007	Riverside	Dsl-P	14.9	Original data point changed to 74.9 & included in calculations.
12/13/2007	San Bernardino	87-ST	97.8	Temperature excluded from differential calculation.
12/14/2007	Los Angeles	91-ST	90.6	Temperature excluded from differential calculation.
12/15/2007	Fresno	Dsl-ST	37.3	Temperature excluded from differential calculation.
1/8/2008	Los Angeles	91-ST	90.3	Temperature excluded from differential calculation.
1/8/2008	Los Angeles	91-ST	90.3	Temperature excluded from differential calculation.
1/22/2008	Los Angeles	91-ST	72.9	Temperature excluded from differential calculation.
1/30/2008	Butte	91-ST	67.3	Temperature excluded from differential calculation.
2/7/2008	Santa Barbara	87-ST	6237	Temperature excluded from differential calculation.
2/25/2008	San Bernardino	87-P	86.8	Temperature excluded from prover average & differential calculations.
2/28/2008	San Bernardino	91-ST	95	Temperature excluded from differential calculation.
3/6/2008	San Bernardino	Dsl-ST	94.1	Temperature excluded from differential calculation.
3/14/2008	Los Angeles	91-ST	91.1	Temperature excluded from differential calculation.
3/21/2008	Los Angeles	91-ST	85.8	Temperature excluded from differential calculation.
4/2/2008	Lake	All	NA	Temperature data outside study period, excluded from analysis.
April 2008	Alameda	All	NA	Temperature data outside study period, excluded from analysis.

Source: Energy Commission staff analysis of DMS Temperature study data set.

87-P Temperature of regular grade gasoline from prover.
87-ST Temperature of regular grade gasoline from storage tank.
91-P Temperature of premium grade gasoline from prover.
91-ST Temperature of premium grade gasoline from storage tank.
Dsl-P Temperature of diesel fuel from prover.
Dsl-ST Temperature of diesel fuel from storage tank.

Appendix E: Canada Fuel Density Values

TABLE 1: Selection of Volume Correction Factor Table for Some Common Products

Product Name Note: This list is not exhaustive.	Standard Density (kg/m^3) @ 15°C	Density Range (kg/m^3) @ 15°C	Volume Correction Factor Reference Table
LPGs Propane Butane	 510 580	 495-520 564-585	ASTM-IP, Table 54
Gasoline Premium Gasoline Clear Gasoline Unleaded Gasoline Low Lead Gas	730	640-780	API Chapter 11.1, Table 54B
Gasoline: Alcohol Blends (15% alcohol max)	730	653-780	
Aviation Fuels - (Kerosine based) Jet A, A1, Jet Kerosine Turbine Fuel	800	780-840	
Aviation Gasoline	710	654-727	
Diesel Fuels Fuel Oils Stove Oils	840	780-1074 830- 900	
Bio-diesel[1] (B100) and all blends with petroleum diesel	840	860-900[2]	
Stoddard Solvent	790	780-800	
Bunker fuel oils	n/a	800 - 990	
Jet B (Naptha based)	760	750-770	API Chapter 11.1, Table 54A
Lubricating Oils (SAE Grades)	880	850-905	API Chapter 11.1, Table 54D
Alcohols Methanol Ethanol Isopropyl Alcohol Hexylene Glycol	Refer to bulletin V10 for coefficients of expansion and specific tables.		API Chapter 11.1, Table 54C
Acetone Methyl Ethyl Ketone Methyl Isobutyl Carbinol	Refer to bulletin V10 for coefficients of expansion and specific tables		
Anhydrous Ammonia	617.7	-	Refer to Bulletin V10 for specific tables
Toluene Xylene	870 870	869-873 865-875	Refer to Bulletin V10 for specific tables

Source: Measurement Canada

Appendix F: Distribution Terminal Survey

AB 868 - Distribution Terminal Questions – August 22, 2008

Please address Questions 1 through 3 for each of the terminals that you control or operate. For example, private companies would not address these questions for Kinder Morgan distribution terminals, but they would answer these questions for their own proprietary distribution terminals.

1. Are your truck-loading facilities equipped with meters having automatic temperature compensation capability?

2. If so, what is the nature of the fuel-loading event with regard to temperature compensation? For example, is fuel loaded into the tanker truck measured in gross gallons (U.S. gallons) and then converted to net gallons (petroleum gallons) using temperature measurement and assumed fuel density properties? Please confirm or specify.

3. How long are temperature and/or API gravity (or density) data records retained for the distribution terminal? Is the historical backlog of information in electronic format?

   If the data is available, please provide the following information for the time period April 1, 2007 through March 31, 2008:

   - Daily average fuel temperature by type (CaRFG and CARB diesel) differentiating between difference ethanol concentrations, if appropriate.
   - Daily average density values by fuel type.
   - Daily distribution volumes associated with the aforementioned data.

   If the information is readily available in a "per loading event" format, the data can be submitted as such without aggregating to a daily level. Whichever method is easier for the survey respondent would be acceptable.

Please address Questions 4 through 6 for each of the distribution terminals from which you conduct wholesale transactions. These questions should apply to business conducted at both proprietary and common carrier distribution terminals. Operators of common carrier distribution terminals would not respond to these questions.

4. Are unbranded wholesale fuel prices posted and/or quoted for your terminal in units of net gallons or gross gallons? For purposes of this question, a net gallon is 231 cubic inches at 60 degrees Fahrenheit. A gross gallon is 231 cubic inches, regardless of temperature.

5. What portion, approximately, of your customers purchase their fuel on a net gallon vs. gross gallon basis?

6. Which of the following information is normally displayed on a Bill of Lading (BOL) issued for individual transactions? Please indicate all that apply.

   - Net gallons quantity
   - Gross gallons quantity
   - Temperature of fuel (degrees Fahrenheit)

- API gravity of the fuel

Appendix G: Biodiesel Density

Table 4. Results of Additional Analyses Performed on B100 Samples
Results of additional analyses performed on B100 samples
(a measured value of 0 indicates below detection limit).

Sample ID	Calcium	Copper	Iron	Magnesium	Potassium	Sodium	Zinc	Density
	ICP D4951 ppm	ICP D4951 ppm	ICP D4951 ppm	ICP D4951 ppm	ICP D4951 ppm	ICP D4951 ppm	ICP D4951 ppm	D4052 @ 60 °F (g/mL)
A	2	0	1	0	0	3	6	0.8826
B	4	0	1	0	0	2	4	0.8826
C	0	0	1	0	0	1	1	0.8845
D	35	0	1	7	0	2	38	0.8862
E	6	0	1	0	0	1	4	0.8845
F	0	0	2	0	0	0	1	0.8835
G	0	2	1	0	0	2	0	0.8888
H	1	0	1	0	0	0	0	0.8847
I	0	0	3	0	0	0	0	0.8838
J	2	2	1	1	0	1	2	0.8850
K	0	1	12	0	0	2	2	0.8852
L	0	0	1	0	0	0	0	0.8837
N	1	5	1	0	0	2	2	0.8847
O	0	0	1	0	0	3	0	0.8846
P	0	0	1	0	0	0	0	0.8836
Q	5	0	2	0	0	0	1	0.8839
R	0	1	1	0	0	0	0	0.8838
S	0	0	1	0	0	0	0	0.8833
T	1	0	9	1	0	37	0	0.8826
U	0	0	1	0	0	1	0	0.8827
V	0	0	1	0	0	1	5	0.8798
W	2	1	4	0	0	0	1	0.8838
X	2	0	2	0	0	2	8	0.8831
Y	1	0	1	0	0	0	0	0.8751
Z	1	1	1	0	0	1	1	0.8823
AA	1	0	1	0	0	0	0	0.8768
BB	0	1	3	0	0	0	2	0.8817

Source: NREL/TP-540-38836, October 2005, Table 4, page 18.

Appendix H: B20 Density

Sample ID	D2709 Water and Sediment (% vol)	D4176 Haze Rating	WLS 102 Field Acid Number	D445 Kinematic Viscosity@ 40°C (cSt)	MAS001 Silver Strip Test	D3703 Peroxide Number (ppm)	D524 Carbon Residue (% mass)	D5773 Cloud Point (°F)	GM EXT pH	GM EXT (µS/cm)	GM EXT Water Recovered (mL)	D4052 Density (g/mL@ 60°F)	D5453 Sulfur Content (ppm)	D2622 Sulfur Content (ppm)	Biodiesel Content (% vol)	D86 90% Recov
04070862	NA	1	0.08	2.749	0	35.6	<0.010	4	6.8	51.6	39	0.8571	302	N/A	7.25	628.5
04070863	NA	1	0.11	3.001	0	27.7	0.017	12	5.5	60.6	40	0.8587	272	N/A	13.29	636.5
04070864	NA	1	0.06	2.218	0	12.2	<0.010	10	7.2	22.4	37	0.8335	56	N/A	14.04	631.6
04070865	NA	1	0.14	2.739	0	12.3	0.022	10	7.3	14.5	31	0.8589	287	N/A	14.41	633.9
04070866	NA	1	0.11	2.838	0	11.3	0.017	4	6.1	42.7	28	0.8632	350	N/A	14.86	619.9
04070867	NA	1	0.11	2.966	0	46.9	0.021	-6	6.8	56.1	38	0.8497	217	N/A	15.28	627.5
04070868	NA	1	0.75	2.524	0	12.9	0.018	10	4.4	81.5	33	0.8473	34	N/A	15.39	634.1
04070869	NA	1	0.08	2.841	0	21.4	0.016	12	7.2	42.8	30	0.8534	266	N/A	15.77	635.0
04070870	NA	1	0.11	2.154	0	3.8	<0.010	8	5.0	189	38	0.8393	226	N/A	16.08	634.1
04070871	NA	1	0.03	2.731	0	4.1	0.018	4	6.9	15.2	33	0.8602	259	N/A	17.27	633.6
04070872	NA	1	0.03	2.774	0	156.0	0.033	2	6.9	57.2	20	0.8610	242	N/A	17.56	631.3
04070873	NA	1	0.17	2.697	0	199.1	<0.01	14	4.8	115	33	0.8464	90	N/A	18.27	635.9
04070874	NA	1	0.15	2.603	0	74.9	0.013	-6	5.7	39.7	37	0.8559	150	N/A	18.32	629.3
04070875	NA	1	0.08	3.330	0	72.3	0.041	4	5.1	53.3	17	0.8683	325	N/A	18.34	637.7
04070876	NA	1	0.06	2.838	0	33.9	<0.01	10	5.7	27.8	35	0.8593	258	N/A	18.40	630.1
04070877	NA	1	0.06	3.040	0	241.0	0.018	14	5.5	123	38	0.8621	245	N/A	18.48	737.4
04070878	Trace	4	0.14	2.739	0	23.5	0.030	2	5.4	24.7	15	0.8560	186	N/A	18.49	634.2
04070879	NA	1	0.06	2.979	0	67.9	0.016	10	4.6	69.8	30	0.8596	248	N/A	18.51	640.4
04070880	NA	1	0.06	2.59	0.00	13.0	<0.010	8	6.85	23.4	35	0.8523	155	N/A	18.59	631.8
04070881	NA	1	0.08	2.900	0	24.0	0.024	-2	6.7	23.3	34	0.8705	318	N/A	18.64	641.2
04070882	NA	1	0.08	2.745	0	106.1	0.016	8	5.3	150	39	0.8654	301	N/A	18.67	637.3
04070892	NA	1	0.06	2.684	0	41.8	<0.010	6	7.3	57.3	39	0.8531	239	N/A	18.72	635.2
04070893	NA	1	0.17	2.299	0	32.5	<0.010	2	6.4	62.5	38	0.8442	199	N/A	18.74	629.5
04070894	NA	1	0.11	2.857	0	67.6	<0.010	2	5.7	63.4	31	0.8650	201	N/A	18.77	625.0
04070895	NA	1	0.20	2.945	0	31.3	0.015	16	6.7	19.3	27	0.8542	298	N/A	18.84	644.8
04070897	NA	1	0.11	3.095	0	29.5	0.015	14	6.2	54.7	39	0.8610	199	N/A	18.85	638.5
04070898	NA	1	0.06	2.849	0	126.4	<0.01	8	5.1	57.9	40	0.8584	268	N/A	18.85	634.0
04070910	NA	1	0.11	3.629	0	16.4	<0.01	42	6.4	25.8	39	0.8359	155	N/A	18.86	--
04070911	NA	1	0.06	2.852	0	47.9	0.103	10	7.3	45.2	26	0.8572	218	N/A	18.88	632.9
04070912	NA	1	0.11	2.750	0	8.5	0.018	-2	6.9	42.0	33	0.8654	269	N/A	18.90	632.2
04070913	NA	1	0.14	2.161	0	16.1	<0.010	4	6.1	42.3	40	0.8366	214	N/A	18.91	633.8
04070914	NA	1	0.28	2.666	0	43.6	0.013	8	5.7	69.2	17	0.8570	266	N/A	19.13	635.9
04070915	NA	1	0.16	2.491	0	22.4	<0.010	34	6.9	24.6	34	0.8422	3	N/A	19.19	631.8
04070917	NA	1	0.06	2.547	0	39.0	<0.010	6	6.8	19.1	33	0.8424	3	N/A	19.28	630.0
04070918	NA	1	0.03	3.042	0	145.6	0.033	12	7.3	32.5	28	0.8688	293	N/A	19.29	642.2
04070919	NA	1	0.06	2.798	0	1.1	<0.010	8	7.4	28.8	35	0.8598	194	N/A	19.30	635.3
04070920	NA	1	0.06	3.080	0	76.7	0.016	12	6.6	57.1	33	0.8655	268	N/A	19.36	638.6
04070921	NA	1	0.11	2.713	0	48.7	<0.010	8	6.6	45.8	33	0.8487	45	N/A	19.38	638.3
04070922	NA	1	0.06	2.808	0	87.1	0.041	8	4.5	105	39	0.8610	258	N/A	19.41	634.7
04070923	NA	1	0.08	2.957	0	334.2	0.016	10	4.6	158	40	0.8572	262	N/A	19.91	640.2
04070960	NA	1	0.11	2.985	0	<1.0	<0.010	10	6.6	45.5	39	0.8637	200	N/A	20.36	636.3
04070961	NA	1	0.14	2.841	0	<1.0	0.021	12	5.9	48.7	30	0.8632	N/A	2868	20.40	636.1
04070963	NA	1	0.22	2.882	0	3.1	<0.01	14	7.6	40.7	26	0.8570	240	N/A	20.75	640.2
04071007	NA	1	0.19	2.883	0	39.1	0.031	8	6.0	22.3	39	0.8662	264	N/A	21.29	637.7
04071046	NA	1	0.06	2.474	0	203.4	<0.010	2	4.9	106	40	0.8535	190	N/A	25.36	635.5
04071052	NA	1	0.28	2.308	0	<1.0	0.015	12	7.1	45.3	40	0.8622	N/A	2386	28.17	643.0
04071072	NA	1	0.68	2.697	0	29.0	0.014	20	4.4	60.7	24	0.8665	168	N/A	36.91	608.1
04071073	NA	1	0.03	3.126	0	73.7	<0.010	14	7.3	21.1	39	0.8706	190	N/A	42.01	641.0
04071074	NA	1	0.34	3.568	0	46.9	<0.010	28	5.8	96.0	38	0.8627	119	N/A	56.69	645.8
04080015	NA	1	0.08	4.113	0	141.4	<0.010	32	6.3	128	35	0.8842	10	N/A	96.41	--
04080628	NA	1	0.42	4.858	0	55.1	0.024	40	3.9	215	35	0.8801	7	N/A	98.80	--

Source: NREL/TP-540-38836, October 2005, Appendix E, pp 49-50.

Appendix I: Fuel Dispenser Survey

California Energy Commission Ph. 916-654-4868, Fax 916-654-4753 E-mail: piira@energy.state.ca.us	Facility Name:	Phone Number:
	Address:	
	City and Zip code:	County:

	Dispenser type 1	Dispenser type 2	Dispenser type 3
1. Is this retail fuel dispenser **Electronic** or **Mechanical** ?	☐ Electronic ☐ Mechanical	☐ Electronic ☐ Mechanical	☐ Electronic ☐ Mechanical
2. What is the make of each type of dispenser you use to sell fuel at your retail establishment?	☐ Gilbarco ☐ Dresser Wayne ☐ Tolkheim ☐ Gasboy ☐ Other*	☐ Gilbarco ☐ Dresser Wayne ☐ Tolkheim ☐ Gasboy ☐ Other*	☐ Gilbarco ☐ Dresser Wayne ☐ Tolkheim ☐ Gasboy ☐ Other*
3. If "Other", please indicate the make*	*	*	*
4. Please indicate the name of the dispenser:			
5. Please list the model # of the dispenser:			
6. How many fuel products does the dispenser have?	☐ 1 ☐ 2 ☐ 3 ☐ 4	☐ 1 ☐ 2 ☐ 3 ☐ 4	☐ 1 ☐ 2 ☐ 3 ☐ 4
7. How many fuel nozzles does the dispenser have? (include both sides of dispenser)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8
8. How many dispensers of this type does your facility have?	☐ Dispensers of this type	☐ Dispensers of this type	☐ Dispensers of this type
9. Does the dispenser sell regular gasoline?	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO
10. Does the dispenser sell midgrade gasoline?	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO
11. Does the dispenser blend midgrade at the pump?	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO
12. Does the dispenser sell premium gasoline?	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO
13. Does the dispenser sell diesel fuel?	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO
14. How many fueling points are there in total for this type of dispenser?	☐ Fueling points	☐ Fueling points	☐ Fueling points

Appendix J: ATC Retrofit Kit Equipment Costs

COUNTY	Number Retail Stations	ATC Retrofit Kit Cost	Per Station Averag
ALAMEDA	349	$3,355,984	$9,616
ALPINE	5	$11,059	$2,212
AMADOR	28	$134,419	$4,801
BUTTE	95	$640,799	$6,745
CALAVERAS	34	$170,884	$5,026
COLUSA	19	$113,529	$5,975
CONTRA COSTA	292	$2,632,966	$9,017
DEL NORTE	11	$77,298	$7,027
EL DORADO	67	$501,914	$7,491
FRESNO	355	$2,694,660	$7,591
GLENN	22	$133,340	$6,061
HUMBOLDT	70	$453,528	$6,479
IMPERIAL	70	$630,275	$9,004
INYO	19	$112,071	$5,898
KERN	327	$2,695,184	$8,242
KINGS	60	$401,238	$6,687
LAKE	40	$220,428	$5,511
LASSEN	24	$100,799	$4,200
LOS ANGELES	1942	$18,161,351	$9,352
MADERA	69	$486,799	$7,055
MARIN	65	$586,965	$9,030
MARIPOSA	20	$80,610	$4,030
MENDOCINO	55	$331,248	$6,023
MERCED	91	$591,650	$6,502
MODOC	7	$30,993	$4,428
MONO	13	$64,900	$4,992
MONTEREY	130	$886,616	$6,820
NAPA	33	$257,693	$7,809
NEVADA	36	$249,563	$6,932
ORANGE	596	$6,242,527	$10,474
PLACER	118	$917,297	$7,774
PLUMA	30	$101,991	$3,400
RIVERSIDE	462	$4,609,029	$9,976
SACRAMENT	367	$3,172,562	$8,645
SAN BENITO	16	$106,671	$6,667
SAN BERNARDINO	518	$4,920,281	$9,499
SAN DIEGO	747	$6,915,025	$9,257
SAN FRANCISCO	111	$814,559	$7,338
SAN JOAQUIN	204	$1,744,715	$8,553
SAN LUIS OBISPO	109	$783,302	$7,186
SAN MATEO	200	$1,687,073	$8,435
SANTA BARBARA	117	$900,579	$7,697
SANTA CLARA	375	$3,759,259	$10,025
SANTA CRUZ	70	$513,570	$7,337
SHASTA	130	$859,220	$6,609
SIERRA	6	$15,138	$2,523
SISKIYOU	40	$240,320	$6,008
SOLANO	146	$1,362,472	$9,332
SONOMA	154	$1,399,546	$9,088
STANISLAUS	193	$1,587,863	$8,227
SUTTER	40	$218,053	$5,451
TEHAMA	34	$279,006	$8,206
TRINITY	10	$25,619	$2,562
TULARE	233	$1,552,707	$6,664
TUOLUMNE	37	$210,205	$5,681
VENTURA	188	$1,772,007	$9,426
YOLO	60	$465,725	$7,762
YUBA	37	$195,648	$5,288
TOTAL	9,696	$84,180,731	$8,682

Source: Energy Commission staff analysis.

Appendix K: ATC Retrofit Kit Labor Costs

COUNTY	Number of Retail Stations	Low Est. Labor Cost	High Est. Labor Cost	Low Per Station Cost	High Per Station Cost
ALAMEDA	349	$310,320	$961,520	$889	$2,755
ALPINE	5	$2,680	$6,560	$536	$1,312
AMADOR	28	$17,940	$62,627	$641	$2,237
BUTTE	95	$87,303	$261,397	$919	$2,752
CALAVERAS	34	$23,291	$68,027	$685	$2,001
COLUSA	19	$15,684	$45,983	$825	$2,420
CONTRA COSTA	292	$270,926	$812,593	$928	$2,783
DEL NORTE	11	$13,648	$37,756	$1,241	$3,432
EL DORADO	67	$53,229	$159,487	$794	$2,380
FRESNO	355	$256,755	$795,597	$723	$2,241
GLENN	22	$17,473	$51,671	$794	$2,349
HUMBOLDT	70	$72,284	$218,008	$1,033	$3,114
IMPERIAL	70	$74,201	$221,920	$1,060	$3,170
INYO	19	$17,480	$52,060	$920	$2,740
KERN	327	$277,674	$832,840	$849	$2,547
KINGS	60	$46,247	$157,810	$771	$2,630
LAKE	40	$31,331	$93,833	$783	$2,346
LASSEN	24	$16,421	$47,103	$684	$1,963
LOS ANGELES	1942	$1,970,096	$5,903,227	$1,014	$3,040
MADERA	69	$51,506	$154,313	$746	$2,236
MARIN	65	$62,049	$186,133	$955	$2,864
MARIPOSA	20	$12,006	$34,767	$600	$1,738
MENDOCINO	55	$45,976	$136,080	$836	$2,474
MERCED	91	$65,083	$222,640	$715	$2,447
MODOC	7	$5,467	$16,620	$781	$2,374
MONO	13	$11,060	$32,353	$851	$2,489
MONTEREY	130	$112,582	$393,467	$866	$3,027
NAPA	33	$31,984	$111,360	$969	$3,375
NEVADA	36	$30,707	$107,480	$853	$2,986
ORANGE	596	$571,731	$1,771,697	$959	$2,973
PLACER	118	$100,297	$300,696	$850	$2,548
PLUMAS	30	$17,919	$51,100	$597	$1,703
RIVERSIDE	462	$528,463	$1,685,063	$1,144	$3,647
SACRAMENTO	367	$296,405	$918,509	$808	$2,503
SAN BENITO	16	$13,200	$46,013	$825	$2,876
SAN BERNARDINO	518	$497,658	$1,507,387	$961	$2,910
SAN DIEGO	747	$746,747	$2,555,333	$1,000	$3,421
SAN FRANCISCO	111	$87,510	$271,040	$788	$2,442
SAN JOAQUIN	204	$162,771	$504,347	$798	$2,472
SAN LUIS OBISPO	109	$108,800	$325,447	$998	$2,986
SAN MATEO	200	$174,579	$523,720	$873	$2,619
SANTA BARBARA	117	$112,440	$335,607	$961	$2,868
SANTA CLARA	375	$375,351	$1,126,040	$1,001	$3,003
SANTA CRUZ	70	$58,834	$200,890	$840	$2,870
SHASTA	130	$114,798	$343,595	$883	$2,643
SIERRA	6	$3,240	$8,063	$540	$1,344
SISKIYOU	40	$34,683	$101,893	$867	$2,547
SOLANO	146	$148,899	$509,300	$1,020	$3,488
SONOMA	154	$160,230	$560,840	$1,040	$3,642
STANISLAUS	193	$146,966	$455,290	$761	$2,359
SUTTER	40	$29,100	$101,267	$728	$2,532
TEHAMA	34	$35,581	$106,540	$1,046	$3,134
TRINITY	10	$5,210	$14,333	$521	$1,433
TULARE	233	$173,128	$592,030	$743	$2,541
TUOLUMNE	37	$29,843	$88,206	$807	$2,384
VENTURA	188	$160,260	$496,673	$852	$2,642
YOLO	60	$45,913	$142,280	$765	$2,371
YUBA	37	$24,643	$86,093	$666	$2,327
TOTAL	9,696	$8,968,600	$27,914,525	$925	$2,879

Source: Energy Commission staff analysis.

Appendix L: County Sealers and Equipment Costs

COUNTY	Number of Retail Stations	Low Est. County Sealers	High Est. County Sealers	Low Equipment Cost	High Equipment Cost
ALAMEDA	349	4	5	$2,400	$4,500
ALPINE	5	1	1	$600	$900
AMADOR	28	1	1	$600	$900
BUTTE	95	1	2	$600	$1,800
CALAVERAS	34	1	1	$600	$900
COLUSA	19	1	1	$600	$900
CONTRA COSTA	292	3	3	$1,800	$2,700
DEL NORTE	11	1	1	$600	$900
EL DORADO	67	1	2	$600	$1,800
FRESNO	355	4	4	$2,400	$3,600
GLENN	22	1	1	$600	$900
HUMBOLDT	70	1	2	$600	$1,800
IMPERIAL	70	1	2	$600	$1,800
INYO	19	1	1	$600	$900
KERN	327	4	4	$2,400	$3,600
KINGS	60	1	2	$600	$1,800
LAKE	40	1	1	$600	$900
LASSEN	24	1	1	$600	$900
LOS ANGELES	1942	20	20	$12,000	$18,000
MADERA	69	1	2	$600	$1,800
MARIN	65	1	2	$600	$1,800
MARIPOSA	20	1	1	$600	$900
MENDOCINO	55	1	2	$600	$1,800
MERCED	91	1	2	$600	$1,800
MODOC	7	1	1	$600	$900
MONO	13	1	1	$600	$900
MONTEREY	130	2	3	$1,200	$2,700
NAPA	33	1	1	$600	$900
NEVADA	36	1	1	$600	$900
ORANGE	596	6	6	$3,600	$5,400
PLACER	118	2	3	$1,200	$2,700
PLUMAS	30	1	1	$600	$900
RIVERSIDE	462	5	5	$3,000	$4,500
SACRAMENTO	367	4	4	$2,400	$3,600
SAN BENITO	16	1	1	$600	$900
SAN BERNARDINO	518	6	6	$3,600	$5,400
SAN DIEGO	747	8	8	$4,800	$7,200
SAN FRANCISCO	111	2	3	$1,200	$2,700
SAN JOAQUIN	204	2	3	$1,200	$2,700
SAN LUIS OBISPO	109	2	3	$1,200	$2,700
SAN MATEO	200	2	3	$1,200	$2,700
SANTA BARBARA	117	2	3	$1,200	$2,700
SANTA CLARA	375	4	4	$2,400	$3,600
SANTA CRUZ	70	1	2	$600	$1,800
SHASTA	130	2	3	$1,200	$2,700
SIERRA	6	1	1	$600	$900
SISKIYOU	40	1	1	$600	$900
SOLANO	146	2	3	$1,200	$2,700
SONOMA	154	2	4	$1,200	$3,600
STANISLAUS	193	2	4	$1,200	$3,600
SUTTER	40	1	1	$600	$900
TEHAMA	34	1	1	$600	$900
TRINITY	10	1	1	$600	$900
TULARE	233	3	3	$1,800	$2,700
TUOLUMNE	37	1	1	$600	$900
VENTURA	188	2	4	$1,200	$3,600
YOLO	60	1	2	$600	$1,800
YUBA	37	1	1	$600	$900
TOTAL	9,696	129	156	$77,400	$140,400

Source: Energy Commission staff analysis.

Appendix M: ATC Retrofit Total Costs

COUNTY	Number of Retail Stations	ATC Retrofit Kit Cost	Low Est. Labor Cost*	High Est. Labor Cost*	Low Est. Total Cost*	High Est. Total Cost*	Low Per Station Cost*	High Per Station Cost*
ALAMEDA	349	$3,355,984	$345,220	$1,031,320	$3,701,204	$4,387,304	$10,605	$12,571
ALPINE	5	$11,059	$3,180	$7,560	$14,239	$18,619	$2,848	$3,724
AMADOR	28	$134,419	$20,740	$68,227	$155,159	$202,645	$5,541	$7,237
BUTTE	95	$640,799	$96,803	$280,397	$737,602	$921,197	$7,764	$9,697
CALAVERAS	34	$170,884	$26,691	$74,827	$197,576	$245,711	$5,811	$7,227
COLUSA	19	$113,529	$17,584	$49,783	$131,114	$163,313	$6,901	$8,595
CONTRA COSTA	292	$2,632,966	$300,126	$870,993	$2,933,092	$3,503,959	$10,045	$12,000
DEL NORTE	11	$77,298	$14,748	$39,956	$92,046	$117,254	$8,368	$10,659
EL DORADO	67	$501,914	$59,929	$172,887	$561,843	$674,801	$8,386	$10,072
FRESNO	355	$2,694,660	$292,255	$866,597	$2,986,915	$3,561,257	$8,414	$10,032
GLENN	22	$133,340	$19,673	$56,071	$153,012	$189,410	$6,955	$8,610
HUMBOLDT	70	$453,528	$79,284	$232,008	$532,812	$685,536	$7,612	$9,793
IMPERIAL	70	$630,275	$81,201	$235,920	$711,476	$866,195	$10,164	$12,374
INYO	19	$112,071	$19,380	$55,860	$131,451	$167,931	$6,918	$8,838
KERN	327	$2,695,184	$310,374	$898,240	$3,005,557	$3,593,424	$9,191	$10,989
KINGS	60	$401,238	$52,247	$169,810	$453,485	$571,048	$7,558	$9,517
LAKE	40	$220,428	$35,331	$101,833	$255,759	$322,262	$6,394	$8,057
LASSEN	24	$100,799	$18,821	$51,903	$119,619	$152,702	$4,984	$6,363
LOS ANGELES	1942	$18,161,351	$2,164,296	$6,291,627	$20,325,647	$24,452,978	$10,466	$12,592
MADERA	69	$486,799	$58,406	$168,113	$545,205	$654,913	$7,902	$9,491
MARIN	65	$586,965	$68,549	$199,133	$655,513	$786,098	$10,085	$12,094
MARIPOSA	20	$80,610	$14,006	$38,767	$94,616	$119,377	$4,731	$5,969
MENDOCINO	55	$331,248	$51,476	$147,080	$382,724	$478,328	$6,959	$8,697
MERCED	91	$591,650	$74,183	$240,840	$665,833	$832,490	$7,317	$9,148
MODOC	7	$30,993	$6,167	$18,020	$37,160	$49,013	$5,309	$7,002
MONO	13	$64,900	$12,360	$34,953	$77,260	$99,853	$5,943	$7,681
MONTEREY	130	$886,616	$125,582	$419,467	$1,012,198	$1,306,083	$7,786	$10,047
NAPA	33	$257,693	$35,284	$117,960	$292,978	$375,653	$8,878	$11,383
NEVADA	36	$249,563	$34,307	$114,680	$283,870	$364,243	$7,885	$10,118
ORANGE	596	$6,242,527	$631,331	$1,890,897	$6,873,859	$8,133,424	$11,533	$13,647
PLACER	118	$917,297	$112,097	$324,296	$1,029,394	$1,241,593	$8,724	$10,522
PLUMAS	30	$101,991	$20,919	$57,100	$122,910	$159,091	$4,097	$5,303
RIVERSIDE	462	$4,609,029	$574,663	$1,777,463	$5,183,691	$6,386,492	$11,220	$13,824
SACRAMENTO	367	$3,172,562	$333,105	$991,909	$3,505,668	$4,164,472	$9,552	$11,347
SAN BENITO	16	$106,671	$14,800	$49,213	$121,471	$155,884	$7,592	$9,743
SAN BERNARDINO	518	$4,920,281	$549,458	$1,610,987	$5,469,739	$6,531,267	$10,559	$12,609
SAN DIEGO	747	$6,915,025	$821,447	$2,704,733	$7,736,472	$9,619,758	$10,357	$12,878
SAN FRANCISCO	111	$814,559	$98,610	$293,240	$913,169	$1,107,799	$8,227	$9,980
SAN JOAQUIN	204	$1,744,715	$183,171	$545,147	$1,927,886	$2,289,862	$9,450	$11,225
SAN LUIS OBISPO	109	$783,302	$119,700	$347,247	$903,002	$1,130,549	$8,284	$10,372
SAN MATEO	200	$1,687,073	$194,679	$563,920	$1,881,751	$2,250,993	$9,409	$11,255
SANTA BARBARA	117	$900,579	$124,140	$359,007	$1,024,719	$1,259,586	$8,758	$10,766
SANTA CLARA	375	$3,759,259	$412,851	$1,201,040	$4,172,110	$4,960,299	$11,126	$13,227
SANTA CRUZ	70	$513,570	$65,834	$214,890	$579,404	$728,460	$8,277	$10,407
SHASTA	130	$859,220	$127,798	$369,595	$987,018	$1,228,815	$7,592	$9,452
SIERRA	6	$15,138	$3,840	$9,263	$18,978	$24,401	$3,163	$4,067
SISKIYOU	40	$240,320	$38,683	$109,893	$279,003	$350,214	$6,975	$8,755
SOLANO	146	$1,362,472	$163,499	$538,500	$1,525,970	$1,900,972	$10,452	$13,020
SONOMA	154	$1,399,546	$175,630	$591,640	$1,575,176	$1,991,186	$10,228	$12,930
STANISLAUS	193	$1,587,863	$166,266	$493,890	$1,754,128	$2,081,753	$9,089	$10,786
SUTTER	40	$218,053	$33,100	$109,267	$251,153	$327,319	$6,279	$8,183
TEHAMA	34	$279,006	$38,981	$113,340	$317,987	$392,346	$9,353	$11,540
TRINITY	10	$25,619	$6,210	$16,333	$31,829	$41,952	$3,183	$4,195
TULARE	233	$1,552,707	$196,428	$638,630	$1,749,134	$2,191,337	$7,507	$9,405
TUOLUMNE	37	$210,205	$33,543	$95,606	$243,748	$305,811	$6,588	$8,265
VENTURA	188	$1,772,007	$179,060	$534,273	$1,951,067	$2,306,281	$10,378	$12,267
YOLO	60	$465,725	$51,913	$154,280	$517,638	$620,005	$8,627	$10,333
YUBA	37	$195,648	$28,343	$93,493	$223,991	$289,141	$6,054	$7,815
TOTAL	9,696	$84,180,731	$9,938,300	$29,853,925	$94,119,031	$114,034,656	$9,707	$11,761

Source: Energy Commission staff analysis.

Note: * Includes incremental inspection fee cost.

Appendix N: High Case Financing Costs

COUNTY	Number of Retail Stations	High Estimate Total Cost*	Repayment Total Cost	Per Station Total Cost
ALAMEDA	349	$4,387,304	$4,900,180	$14,041
ALPINE	5	$18,619	$20,795	$4,159
AMADOR	28	$202,645	$226,335	$8,083
BUTTE	95	$921,197	$1,028,884	$10,830
CALAVERAS	34	$245,711	$274,435	$8,072
COLUSA	19	$163,313	$182,404	$9,600
CONTRA COSTA	292	$3,503,959	$3,913,572	$13,403
DEL NORTE	11	$117,254	$130,961	$11,906
EL DORADO	67	$674,801	$753,685	$11,249
FRESNO	355	$3,561,257	$3,977,567	$11,204
GLENN	22	$189,410	$211,552	$9,616
HUMBOLDT	70	$685,536	$765,675	$10,938
IMPERIAL	70	$866,195	$967,453	$13,821
INYO	19	$167,931	$187,562	$9,872
KERN	327	$3,593,424	$4,013,495	$12,274
KINGS	60	$571,048	$637,803	$10,630
LAKE	40	$322,262	$359,934	$8,998
LASSEN	24	$152,702	$170,553	$7,106
LOS ANGELES	1942	$24,452,978	$27,311,531	$14,064
MADERA	69	$654,913	$731,472	$10,601
MARIN	65	$786,098	$877,993	$13,508
MARIPOSA	20	$119,377	$133,332	$6,667
MENDOCINO	55	$478,328	$534,245	$9,714
MERCED	91	$832,490	$929,808	$10,218
MODOC	7	$49,013	$54,742	$7,820
MONO	13	$99,853	$111,526	$8,579
MONTEREY	130	$1,306,083	$1,458,764	$11,221
NAPA	33	$375,653	$419,567	$12,714
NEVADA	36	$364,243	$406,823	$11,301
ORANGE	596	$8,133,424	$9,084,221	$15,242
PLACER	118	$1,241,593	$1,386,735	$11,752
PLUMAS	30	$159,091	$177,689	$5,923
RIVERSIDE	462	$6,386,492	$7,133,073	$15,440
SACRAMENTO	367	$4,164,472	$4,651,299	$12,674
SAN BENITO	16	$155,884	$174,107	$10,882
SAN BERNARDINO	518	$6,531,267	$7,294,773	$14,083
SAN DIEGO	747	$9,619,758	$10,744,308	$14,383
SAN FRANCISCO	111	$1,107,799	$1,237,301	$11,147
SAN JOAQUIN	204	$2,289,862	$2,557,546	$12,537
SAN LUIS OBISPO	109	$1,130,549	$1,262,710	$11,584
SAN MATEO	200	$2,250,993	$2,514,134	$12,571
SANTA BARBARA	117	$1,259,586	$1,406,831	$12,024
SANTA CLARA	375	$4,960,299	$5,540,158	$14,774
SANTA CRUZ	70	$728,460	$813,617	$11,623
SHASTA	130	$1,228,815	$1,372,463	$10,557
SIERRA	6	$24,401	$27,254	$4,542
SISKIYOU	40	$350,214	$391,154	$9,779
SOLANO	146	$1,900,972	$2,123,195	$14,542
SONOMA	154	$1,991,186	$2,223,956	$14,441
STANISLAUS	193	$2,081,753	$2,325,110	$12,047
SUTTER	40	$327,319	$365,583	$9,140
TEHAMA	34	$392,346	$438,211	$12,889
TRINITY	10	$41,952	$46,856	$4,686
TULARE	233	$2,191,337	$2,447,504	$10,504
TUOLUMNE	37	$305,811	$341,561	$9,231
VENTURA	188	$2,306,281	$2,575,885	$13,702
YOLO	60	$620,005	$692,483	$11,541
YUBA	37	$289,141	$322,942	$8,728
TOTAL	9,696	$114,034,656	$127,365,308	$13,136

Source: Energy Commission staff analysis. Note: * Includes incremental inspection fee cost.

Interst Rate:	9.50%	Payback Period:	1	Year

Appendix O: Low Case Financing Costs

COUNTY	Number of Retail Stations	Low Estimate Total Cost*	Repayment Total Cost	Per Station Total Cost
ALAMEDA	349	$3,701,204	$4,081,194	$11,694
ALPINE	5	$14,239	$15,700	$3,140
AMADOR	28	$155,159	$171,088	$6,110
BUTTE	95	$737,602	$813,329	$8,561
CALAVERAS	34	$197,576	$217,860	$6,408
COLUSA	19	$131,114	$144,575	$7,609
CONTRA COSTA	292	$2,933,092	$3,234,222	$11,076
DEL NORTE	11	$92,046	$101,496	$9,227
EL DORADO	67	$561,843	$619,525	$9,247
FRESNO	355	$2,986,915	$3,293,571	$9,278
GLENN	22	$153,012	$168,722	$7,669
HUMBOLDT	70	$532,812	$587,514	$8,393
IMPERIAL	70	$711,476	$784,521	$11,207
INYO	19	$131,451	$144,946	$7,629
KERN	327	$3,005,557	$3,314,127	$10,135
KINGS	60	$453,485	$500,043	$8,334
LAKE	40	$255,759	$282,017	$7,050
LASSEN	24	$119,619	$131,900	$5,496
LOS ANGELES	1942	$20,325,647	$22,412,411	$11,541
MADERA	69	$545,205	$601,179	$8,713
MARIN	65	$655,513	$722,813	$11,120
MARIPOSA	20	$94,616	$104,330	$5,216
MENDOCINO	55	$382,724	$422,017	$7,673
MERCED	91	$665,833	$734,192	$8,068
MODOC	7	$37,160	$40,975	$5,854
MONO	13	$77,260	$85,192	$6,553
MONTEREY	130	$1,012,198	$1,116,116	$8,586
NAPA	33	$292,978	$323,057	$9,790
NEVADA	36	$283,870	$313,014	$8,695
ORANGE	596	$6,873,859	$7,579,574	$12,717
PLACER	118	$1,029,394	$1,135,079	$9,619
PLUMAS	30	$122,910	$135,528	$4,518
RIVERSIDE	462	$5,183,691	$5,715,883	$12,372
SACRAMENTO	367	$3,505,668	$3,865,582	$10,533
SAN BENITO	16	$121,471	$133,942	$8,371
SAN BERNARDINO	518	$5,469,739	$6,031,298	$11,643
SAN DIEGO	747	$7,736,472	$8,530,749	$11,420
SAN FRANCISCO	111	$913,169	$1,006,921	$9,071
SAN JOAQUIN	204	$1,927,886	$2,125,816	$10,421
SAN LUIS OBISPO	109	$903,002	$995,710	$9,135
SAN MATEO	200	$1,881,751	$2,074,944	$10,375
SANTA BARBARA	117	$1,024,719	$1,129,923	$9,657
SANTA CLARA	375	$4,172,110	$4,600,447	$12,268
SANTA CRUZ	70	$579,404	$638,889	$9,127
SHASTA	130	$987,018	$1,088,352	$8,372
SIERRA	6	$18,978	$20,926	$3,488
SISKIYOU	40	$279,003	$307,647	$7,691
SOLANO	146	$1,525,970	$1,682,636	$11,525
SONOMA	154	$1,575,176	$1,736,894	$11,279
STANISLAUS	193	$1,754,128	$1,934,219	$10,022
SUTTER	40	$251,153	$276,938	$6,923
TEHAMA	34	$317,987	$350,633	$10,313
TRINITY	10	$31,829	$35,096	$3,510
TULARE	233	$1,749,134	$1,928,712	$8,278
TUOLUMNE	37	$243,748	$268,773	$7,264
VENTURA	188	$1,951,067	$2,151,377	$11,443
YOLO	60	$517,638	$570,782	$9,513
YUBA	37	$223,991	$246,987	$6,675
TOTAL	9,696	$94,119,031	$103,781,905	$10,704

Source: Energy Commission staff analysis. Note: * Includes incremental inspection fee cost.

Interst Rate:	4.00%	Payback Period:	3	Years

Appendix P: Retail Station Average Fuel Sales

COUNTY	Number Retail Stations	Apr.07 to Mar.08 Fuel Sales Millions of Gallons	Fuel Sales Per Station Monthly Gallons
ALAMEDA	349	785.314	187,515
ALPINE	5	3.594	59,896
AMADOR	28	24.109	71,754
BUTTE	95	98.123	86,072
CALAVERAS	34	23.229	56,933
COLUSA	19	44.223	193,959
CONTRA COSTA	292	452.088	129,020
DEL NORTE	11	14.379	108,929
EL DORADO	67	93.257	115,992
FRESNO	355	486.959	114,310
GLENN	22	35.167	133,208
HUMBOLDT	70	75.852	90,300
IMPERIAL	70	121.840	145,047
INYO	19	31.470	138,026
KERN	327	565.299	144,062
KINGS	60	89.041	123,668
LAKE	40	33.882	70,588
LASSEN	24	32.972	114,487
LOS ANGELES	1,942	4,388.016	188,295
MADERA	69	102.964	124,353
MARIN	65	152.779	195,871
MARIPOSA	20	13.602	56,673
MENDOCINO	55	65.955	99,932
MERCED	91	172.835	158,274
MODOC	7	12.563	149,555
MONO	13	18.292	117,253
MONTEREY	130	211.542	135,604
NAPA	33	62.339	157,422
NEVADA	36	70.404	162,973
ORANGE	596	1,416.211	198,016
PLACER	118	201.186	142,080
PLUMA	30	19.645	54,569
RIVERSIDE	462	1,148.212	207,109
SACRAMENT	367	662.798	150,499
SAN BENITO	16	33.415	174,037
SAN BERNARDINO	518	1,310.088	210,761
SAN DIEGO	747	1,529.657	170,644
SAN FRANCISCO	111	177.917	133,571
SAN JOAQUIN	204	419.429	171,335
SAN LUIS OBISPO	109	168.048	128,477
SAN MATEO	200	349.035	145,431
SANTA BARBARA	117	203.402	144,874
SANTA CLARA	375	817.636	181,697
SANTA CRUZ	70	106.997	127,377
SHASTA	130	122.402	78,463
SIERRA	6	6.862	95,312
SISKIYOU	40	63.570	132,437
SOLANO	146	254.691	145,372
SONOMA	154	211.700	114,556
STANISLAUS	193	250.229	108,044
SUTTER	40	49.302	102,713
TEHAMA	34	62.430	153,016
TRINITY	10	10.440	86,997
TULARE	233	229.400	82,046
TUOLUMNE	37	35.142	79,149
VENTURA	188	367.874	163,065
YOLO	60	129.537	179,913
YUBA	37	40.943	92,213
TOTAL	9,696	18,680.285	160,550

Source: Energy Commission staff analysis.

Appendix Q: At Risk Retail Station Costs

COUNTY	Number of Retail Stations	ATC Retrofit Cost
ALPINE	5	$20,419
BUTTE	4	$26,021
CALAVERAS	2	$12,762
COLUSA	6	$35,784
DEL NORTE	2	$18,969
EL DORADO	3	$22,723
FRESNO	11	$58,679
GLENN	1	$3,718
HUMBOLDT	8	$61,085
IMPERIAL	6	$42,251
INYO	5	$35,931
KERN	2	$10,633
LASSEN	8	$49,968
MADERA	2	$11,670
MARIN	1	$3,058
MARIPOSA	7	$44,124
MENDOCINO	8	$52,593
MERCED	2	$14,366
MODOC	2	$9,037
MONO	5	$38,082
MONTEREY	2	$19,709
NEVADA	2	$11,413
PLACER	7	$56,533
PLUMAS	8	$43,609
RIVERSIDE	3	$24,000
SACRAMENTO	3	$24,950
SAN BERNARDINO	6	$42,796
SAN DIEGO	8	$50,941
SAN JOAQUIN	1	$19,994
SAN LUIS OBISPO	1	$6,549
SAN MATEO	2	$18,582
SANTA BARBARA	4	$24,906
SANTA CLARA	1	$16,246
SHASTA	7	$46,371
SIERRA	6	$27,135
SISKIYOU	13	$105,242
SONOMA	1	$3,623
SUTTER	1	$6,054
TRINITY	6	$25,940
TULARE	1	$2,955
TUOLUMNE	2	$12,422
YOLO	1	$2,882
YUBA	6	$22,908
TOTAL	182	$1,187,631

Source: Energy Commission staff analysis.

Appendix R: Valuation of Reduced “Gallons” Sold

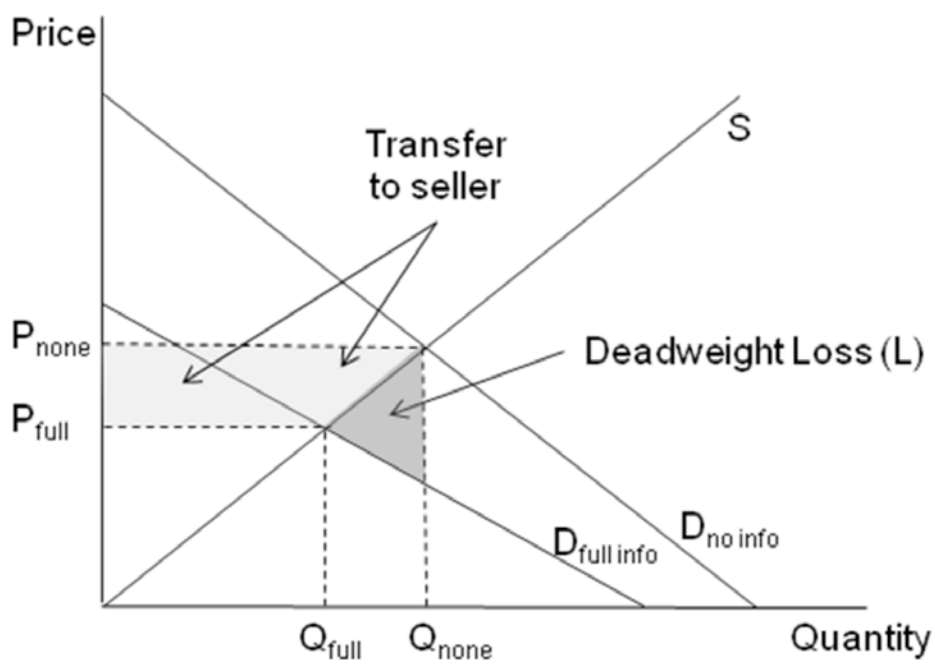
COUNTY	Regular Gasoline	Mid-Grade Gasoline	Premium Gasoline	Diesel Fuel	All Fuels
ALAMEDA	$6,725,220	$933,288	$1,399,909	$1,466,294	$10,524,711
ALPINE	-$9,184	-$926	-$910	$1,470	-$9,550
AMADOR	$252,802	$35,722	$54,453	$57,350	$400,328
BUTTE	$1,081,140	$157,622	$246,999	$236,791	$1,722,552
CALAVERAS	$118,179	$19,090	$32,392	$30,106	$199,767
COLUSA	$458,988	$63,727	$95,622	$265,180	$883,517
CONTRA COSTA	$5,406,818	$693,746	$961,185	$879,622	$7,941,372
DEL NORTE	$45,153	$7,073	$11,727	$16,800	$80,753
EL DORADO	$256,856	$41,643	$70,714	$96,418	$465,631
FRESNO	$7,315,386	$1,037,089	$1,585,825	$2,134,299	$12,072,599
GLENN	$393,558	$54,549	$81,713	$200,324	$730,145
HUMBOLDT	$368,526	$50,009	$73,400	$109,791	$601,726
IMPERIAL	$2,763,628	$376,257	$554,191	$784,185	$4,478,261
INYO	$449,708	$62,229	$93,056	$112,653	$717,646
KERN	$7,687,905	$1,058,765	$1,576,379	$3,606,642	$13,929,691
KINGS	$988,418	$135,364	$200,458	$382,350	$1,706,590
LAKE	$334,150	$46,171	$68,955	$83,818	$533,094
LASSEN	$54,604	$9,641	$17,294	$55,907	$137,446
LOS ANGELES	$82,279,504	$11,142,317	$16,325,934	$14,089,409	$123,837,163
MADERA	$1,351,778	$187,196	$280,163	$530,940	$2,350,077
MARIN	$1,661,608	$233,949	$355,566	$206,889	$2,458,012
MARIPOSA	$209,279	$28,993	$43,413	$25,200	$306,884
MENDOCINO	$391,440	$57,241	$89,889	$111,995	$650,564
MERCED	$2,145,664	$296,067	$441,619	$928,100	$3,811,450
MODOC	-$9,398	-$307	$911	$12,714	$3,921
MONO	-$47,738	-$4,888	-$4,945	$9,857	-$47,714
MONTEREY	$2,085,393	$301,807	$470,030	$570,419	$3,427,650
NAPA	$738,693	$104,323	$159,019	$140,365	$1,142,400
NEVADA	$273,102	$41,633	$67,575	$125,737	$508,046
ORANGE	$24,253,341	$3,307,540	$4,879,715	$3,909,243	$36,349,839
PLACER	$2,066,142	$280,464	$411,690	$591,514	$3,349,810
PLUMA	$24,284	$4,718	$8,934	$21,820	$59,757
RIVERSIDE	$23,660,103	$3,240,870	$4,801,021	$6,414,998	$38,116,992
SACRAMENT	$7,252,716	$1,051,163	$1,638,593	$1,581,851	$11,524,323
SAN BENITO	$302,870	$42,671	$64,887	$109,546	$519,974
SAN BERNARDINO	$21,927,792	$2,951,351	$4,297,853	$6,512,949	$35,689,946
SAN DIEGO	$26,044,708	$3,612,828	$5,417,058	$3,928,630	$39,003,224
SAN FRANCISCO	$518,970	$70,215	$102,765	$159,987	$851,939
SAN JOAQUIN	$5,446,135	$735,356	$1,074,137	$1,628,052	$8,883,680
SAN LUIS OBISPO	$1,810,023	$244,633	$357,713	$408,828	$2,821,198
SAN MATEO	$3,830,430	$512,422	$741,920	$409,849	$5,494,621
SANTA BARBARA	$2,431,908	$354,378	$555,194	$446,806	$3,788,286
SANTA CLARA	$11,174,377	$1,465,443	$2,078,700	$1,428,914	$16,147,434
SANTA CRUZ	$1,236,563	$168,684	$248,862	$153,712	$1,807,821
SHASTA	$1,478,967	$209,447	$319,940	$484,083	$2,492,438
SIERRA	$23,011	$3,570	$5,874	$15,081	$47,537
SISKIYOU	$181,267	$24,682	$36,273	$117,492	$359,714
SOLANO	$2,588,538	$354,504	$524,977	$467,549	$3,935,568
SONOMA	$2,040,990	$285,937	$432,573	$352,628	$3,112,129
STANISLAUS	$3,680,778	$491,374	$709,642	$1,107,094	$5,988,888
SUTTER	$729,135	$104,132	$160,293	$132,072	$1,125,632
TEHAMA	$767,399	$104,339	$153,436	$285,493	$1,310,667
TRINITY	$76,169	$10,436	$15,449	$23,146	$125,200
TULARE	$4,062,805	$557,629	$827,636	$1,689,837	$7,137,907
TUOLUMNE	$222,558	$32,493	$50,941	$48,287	$354,278
VENTURA	$5,626,278	$755,184	$1,096,921	$827,889	$8,306,272
YOLO	$1,493,643	$203,358	$299,404	$442,198	$2,438,602
YUBA	$510,523	$65,959	$92,024	$136,322	$804,828
TOTAL	$281,233,602	$38,415,174	$56,756,964	$61,107,496	$437,513,236

Source: Energy Commission staff analysis.

Appendix S: Information Asymmetry

Information asymmetry exists in the retail fuels market as it pertains to fuel temperature which implies that the knowledge of the temperature is not equal between the motorists and retail stations. In the case of retail fuels market, sellers have more knowledge of the temperature of the fuel than motorists. Absent this temperature information consumers may over-value or under-value fuel depending on the temperature of fuel. Sellers do not have any information signals to specify their fuel temperature or temperature differences with other retail stations, so government intervention through the mandating of automatic temperature compensation (ATC) equipment would be required to remove this information asymmetry since retailer will not have the incentive to do so on their own.

Figure 1 – Information Asymmetry Model[110]



Economists distinguish three types of products: search goods, experience goods, and post-experience goods[111]. The Energy Commission considers transportation fuels as a post-experience good since consumption does not necessarily reveal the temperature or quality of the fuel. Fuel is unique in that it is a product that consumers never observe but only experience.

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[110] Figure 1 Assumption: Retailers price fuel on a net gallon basis and then sell the fuel on a gross gallon basis. This is illustrated by Q_{none} indicating gross gallons sold, and P_{none} as net price posted. Q_{full} then indicates net gallons sold and P_{full} indicates gross price posted.

[111] Boardman, Anthony, et al. Cost Benefit Analysis: Concepts and Practice. Third Edition. Prentice Hall. New Jersey: Upper Saddle River, 2001. Search goods are products with characteristics that consumers can learn about by examining them prior to consumption. Experience goods are products where consumers can obtain full knowledge only after purchasing and consuming them. Post-experience goods are products where consumption does not necessarily reveal information to consumers.

Economics provides a methodology for analyzing costs to society from the distortion of the market from temperature variation over time and across retailers. In Figure 1, with no information the market outcome is price P_{none} and quantity gallons consumed Q_{none}. With full information the demand would be lower resulting in a price of P_{full} and a quantity consumed of Q_{full}. These two outcomes in Figure 1 illustrate the two effects of information asymmetry. The first effect is the increase in price and quantity demand of the good purchased, creating a transfer of wealth from the buyer to the seller. The second impact is the increased amount of goods sold relative to the full information scenario which is a deadweight loss which is shown by the triangle. The deadweight loss is the cost to society due to the inefficiency that information asymmetry creates. The first effect of a transfer wealth does not represent a decrease in social welfare and therefore is not relevant in determining the costs from the inefficiency created by misinformation, but may have relevance in the question of fairness.[112]

The perception is that consumers in warmer states, such as California, are not receiving their "fair share" of transportation fuels since consumers are not receiving the larger gallon as they would at the wholesale level. The inefficiency occurs when consumers over-value fuel in warm weather or fuel sold by retailers offering warmer fuel, purchasing more than they if they had full information on temperature. The opposite is also true where consumers may undervalue fuel in colder weather or when retailers offer colder fuel, purchasing less than they would have if they had known the temperature of the fuel.

Deadweight loss calculations:
In the November 2008 Fuel Delivery Temperature Study Staff Report Appendix R, the calculation of the deadweight loss was a simplistic geometric exercise measuring the area of the deadweight loss triangle. Applying the average fuel temperature difference from the reference temperature to Figure 1 yielded the calculations of total annual deadweight loss for all grades of gasoline and diesel equal $3.22 million, $2.84 million for gasoline and $380,000 for diesel. The revised calculation of total annual deadweight loss for all grades of gasoline and diesel is $257,729.

Since the release of the November staff report, a white paper written by University of Chicago Professors Kevin M. Murphy and Robert H. Topel provided a more technical econometric methodology for measuring the costs of information asymmetry.[113] A similar figure is used as Figure 1 and they included the deadweight loss formula that includes economic components like own-price elasticity of demand, pass-thru rate, and variability of information effects. Their "best case" calculation of $200,000 for the gain in increased transparency for gasoline is much smaller than the original $3.2 million dollar value primarily due to the inclusion of a 0.2 own-price elasticity of demand for gasoline.

The formula for calculating the deadweight loss or the overall social cost of the purchasing decisions that are distorted by information asymmetry is:

(1)
$$L = \frac{1}{2} X \eta_D R \alpha^2 \left(1 + R \frac{\alpha}{1-\alpha}\right)$$

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[112] Vining, Aidan R. and Weimer, David L. "Information asymmetry favoring sellers: a policy framework." *Policy Sciences* 21: 281-303, 1988.

[113] Murphy, Kevin M., Topel, Robert H. White Paper: "Comments on the California Energy Commission's Fuel Delivery Temperature Study." University of Chicago. [http://www.energy.ca.gov/transportation/fuel_delivery_temperature_study/documents/2008-12-09_workshop/comments/] White paper provides further discussion of deadweight loss methodology.

In the deadweight loss formula in equation (1), $X = P_{none}$ x Q_{none} is total market expenditure on gasoline during the period, $□_D$ represents the own-price elasticity of demand for gasoline, □ represents the percentage reduction of the effective energy content of warmer fuel from the average temperature, and R represents the pass-thru rate. The formula for equation (1) is both used to estimate the total social costs of fuel temperature differences over time and across regions.

After performing some algebra, equation (2) incorporates the variance of □ and is used as the formula calculate the final deadweight loss for seasonal and across retailers differentials.[114]

(2)

$$E(L_C) = \frac{1}{2}\eta_D R^2 E\left(\frac{\alpha^2}{1-\alpha}\right) \approx \frac{1}{2}\eta_D R^2 \operatorname{var}(\alpha)$$

Given a pass-thru rate, R=1.0 (an upper bound value), a short-run own-price elasticity for gasoline and diesel, $□_D$=0.23[115], and values X and □ estimated from the report, the total annual gain for both gasoline and diesel from increased price transparency from ATC is $257,729. The reduction of seasonal variation for gasoline gives an annual gain of $108,876 and $14,622 for diesel. The reduction of variation across retailers results in an annual gain of $111,756 for gasoline and $22,475 for diesel.[116]

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[114] Equation (2) is derived in the Murphy and Topel white paper cited in the above footnote.

[115] Espey, Molly. "Gasoline demand revisited: an international meta-analysis of elasticities." Energy Economics 20: 273-295, 1998. Molly Epsey examined 101 studies and found a median price elasticity ($□_D$) for gasoline of 0.23. For simplicity we used the same price elasticity for both diesel and gasoline.

[116] Actual consumption (Q_{none}) of gasoline during the 12th-month study period was 15,624,571,016 gallons with an average volume-weighted price (P_{none}) of $3.284. Actual consumption (Q_{none}) of diesel during the 12th-month study period was 3,055,713,800 gallons and average volume-weighted price (P_{none}) of $3.377. The estimated seasonal value for □ is 0.00744 for gasoline and 0.00608 for diesel, the variance of □ *is* (0.00744^2)/3 for gasoline and (0.00608)/3 for diesel. For costs associated from variation across retailers the values of $□_D$=30, R=0.2, and □=0.00333 were used for all fuels.