DEPARTMENT OF FOOD AND AGRICULTURE
PROPOSED AMENDMENT OF THE REGULATIONS

Title 4, Division 9, Chapter 6, Article 9
Specifications for Dimethyl Ether Used In
Compression-Ignition Engines

INITIAL STATEMENT OF REASONS

Background

The overall mission of weights and measures is to preserve and maintain the standards of measurement essential in providing a basis of value comparison for the consumer and fair competition for industry.

The California Oil Substitution Act was enacted in 1931 (Stats 1931, Chapter 609). The provisions of that legislation are found in the Business and Professions Code (BPC), Division 5, Chapters 14 (Petroleum), 14.5 (Service Stations) and 15 (Automotive Products). The Department of Food and Agriculture (Department) Division of Measurement Standards (Division) was given the responsibility for establishing and enforcing the quality standards for spark and compression-ignition engine fuels sold in California. These include gasoline, diesel fuel, and other fuels such as biodiesel and hydrogen.

The principle task of the Division's Petroleum Products Program (Program) is to regulate and enforce quality specifications for engine fuels, motor oils, engine coolants, and brake fluids. These products are sampled and tested in the Program's laboratories to verify that they meet the minimum quality, performance, and drivability standards. The Program also ensures that the products are correctly labeled and all advertising meets State requirements.

The broad objective of the proposed regulation is to ensure that motor vehicle fuels offered for sale to Californians meet minimum quality standards. BPC Section 13450 requires the Department to adopt by reference the latest standards for a compression-ignition engine fuel developed by a recognized consensus organization such as ASTM International (ASTM) or SAE International. Dimethyl Ether (DME) is a compression-ignition fuel that previously had no fuel quality standard. ASTM International completed and published its ASTM D7901-14 "Standard Specification for Dimethyl Ether for Fuel Purposes" in March 2014. BPC Section 13451 declares that it is unlawful to sell any product as "compression-ignition engine fuel" unless it conforms to the specifications of Chapter 14, Article 6 of the BPC.

Description of the Public Problem, Administrative Requirements, or Other Conditions or Circumstances the Regulations are Intended to Address

The Department is authorized by BPC Section 12027 to make regulations necessary to carry out the provisions of Division 5. In addition, under BPC Section 13450, the Department is required to take regulatory action to adopt by reference the latest standards for a compression-ignition engine fuel established by a recognized consensus organization such as ASTM International or SAE International. Since ASTM has published D7901-14 "Standard Specification for Dimethyl Ether for Fuel Purposes", the Department is obliged to adopt this new standard in order for DME to be sold commercially.

The State of California has determined that greenhouse gas emissions (GHG) are a primary contributor to climate change. According to the California Air Resources Board (CARB), the transportation sector is responsible for 40 percent of California's GHG emissions. Accordingly, the State of California is actively pursuing strategies to reduce GHG produced from fuels:

- The Global Warming Solutions Act, AB 32 (Nuñez, Chapter 488, Statutes of 2006), required CARB to establish a comprehensive program to reduce GHG from all sources throughout the state.

- Executive Order S-3-05 established GHG emission reduction targets for California: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; by 2050, reduce GHG emissions to 80 percent below 1990 levels.

- Executive Order S-06-06 directed the state to produce 40 percent of biofuels from California resources by 2020 and 75 percent by 2050.

- Executive Order S-01-07 established California's Low Carbon Fuel Standard (LCFS), which is designed to reduce GHG emissions by reducing the carbon intensity of transportation fuels used in California.

According to Energy Almanac of the California Energy Commission (CEC), an average of nearly 2.8 billion gallons of diesel fuel has been sold in California each year since 2005. Each year, diesel fuel contributes 37 million metric tons of CO_2 equivalent (CO_2e) to California's GHG emissions. Currently, California requires that diesel fuel meet quality specifications and have a baseline average carbon intensity value of 98.03 g CO_2/MJ. Under the CARB's LCFS, the average carbon intensity of the State's fuel supply must be reduced 10 percent by 2020.

Benefits of the Regulation

DME can replace petroleum diesel in modified compression-ignition vehicles if it meets established fuel quality specifications. As noted above, ASTM has published a quality specification for DME as a compression-ignition fuel, D7901-14. BPC Section 13450 requires the Department to adopt this standard.

When new fuel quality specifications are published and adopted into Title 4, Division 9 of the California Code of Regulations (CCR), the Department is able to continue its marketplace oversight. This ensures that engine fuels will not damage motor vehicles, resulting in costly repairs to consumers. Therefore, immediate beneficiaries of the proposed regulation will be Californians with vehicles using DME as a compression-ignition engine fuel. Positive experiences with new fuels will result in increased purchases of alternative fuel vehicles and greater acceptance of alternative fuels in general.

Vehicle exhaust from petroleum-based fuels is also associated with adverse effects on human health. The California Office of Environmental Health Hazard Assessment (OEHHA) reviewed the health impacts of petroleum diesel exhaust. Both acute and chronic exposure to diesel emissions of particulates and nitrogen oxides (NOx) are found to have serious adverse effects on human health. These include asthma, other respiratory illnesses and cancer. An OEHHA fact sheet states “long-term exposure to diesel exhaust particles poses the highest cancer risk of any toxic air contaminant evaluated by OEHHA” and that both diesel particulates and NOx emissions can cause respiratory illness and aggravate asthma.

CARB has identified diesel exhaust as a major source of fine particulate matter pollution (PM2.5, also called black carbon) in California. PM2.5 has a wide range of negative effects on the environment and human health. It is also recognized as a major contributor to global warming. A 2011 fact sheet from the U.S. EPA, *Black Carbon Research and Future Strategies*, summarizes the adverse impacts of PM2.5, citing its association to asthma and other respiratory diseases, cardiovascular disease, cancer, and birth defects.

CARB has identified diesel exhaust as a major source of fine particulate matter pollution (PM2.5) in California. PM2.5 consists of respirable particles smaller than 2.5 microns containing both organic and inorganic carbon. These extremely small particles can lodge deep in the lungs, leading to serious human health impacts. PM2.5 has a wide range of negative effects on the environment and human health. It is also recognized as a major contributor to global warming.

One component of PM2.5 is black carbon which consists of fine particles of pure carbon. Black carbon is known to cause serious human health impacts. These have been summarized in a 2011 fact sheet from the U.S. EPA, *Black Carbon Research and Future Strategies,* that associates black carbon with asthma and

other respiratory diseases, cardiovascular disease, cancer, and birth defects. Black carbon is an efficient absorber of solar energy, and so is a significant contributor to global warming. The fact sheet, *What is Black Carbon?*, from the Center for Climate and Energy Solutions describes the environmental and climate impacts of black carbon.

Some mitigation of the adverse health and environmental impacts of diesel fuel has occurred through improvements in compression-ignition engine design and new diesel emissions control technology. According to the Diesel Technology Forum, an industry educational organization, these technologies ~~can significantly~~ reduce emissions of particulates and NOx. However, there is a significant cost to these new technologies, which also reduces the efficiency of diesel engines. Many older trucks still on the road in California as well as other types of diesel-powered equipment do not have the latest improvements installed. Emissions control equipment must be properly maintained to ensure that it functions as designed.

The combustion of DME does not produce particulate emissions because its chemical structure does not have the carbon-carbon bonds that can condense to form black carbon, or soot. The DME molecule also has a high ratio of oxygen to carbon atoms, which promotes cleaner burning. In contrast, the major components of diesel fuel do not contain oxygen. They consist of chains of carbon-carbon bonds that lead to the formation of soot particles during combustion.

By displacing petroleum diesel, DME can mitigate these negative health impacts, resulting in improvements in both environmental and public health throughout California.

It is the policy of the State to reduce its GHG emissions. One measure of GHG emissions from fuels is carbon intensity, expressed in CO_2 equivalent. Diesel fuel contributes 37 million metric tons of CO_2 equivalent (CO_2e) to California's GHG emissions each year. DME is a low carbon fuel that meets the requirements of the LCFS. While CARB has not yet certified a carbon intensity for DME, it has greatly reduced GHG emissions compared to diesel fuel. DME can make a significant contribution towards California's LCFS and AB 32 goals and so can mitigate the contribution of the transportation sector to global warming.

In a 2003 joint report *Reducing California's Petroleum Dependence*, the CEC and the CARB set goals for the reduction of petroleum fuel use to 15 percent below 2003 levels by 2020 and increased use of alternative fuels to 26 percent of all fuel consumed by 2022. The replacement of petroleum diesel with DME provides California with a reliable and stable transportation fuel whose cost is not linked to crude oil prices and availability. The use of DME will reduce the state's

dependence on petroleum, helping to meet the goal of the CEC and CARB of a 15 percent reduction below 2003 levels by 2020.

DME can be manufactured from a wide range of feedstock, including natural gas, dairy digester biogas, and other biomass sources. The production of DME is scalable and small production units can be located near dairies or other feedstock sources. The use of agricultural waste for DME production could also reduce agriculture's 6 percent contribution to the state's GHG emissions. In addition, biomass-based DME may even have *net* negative carbon content.

According to a 2010 University of Minnesota study, DME has the highest well-to-wheel energy efficiency, 25 percent better than synthetic diesel fuel, and the lowest GHG emissions of any biomass-based fuel. Production of DME in California would contribute to the goal of Executive Order S-06-06 to shift to state resources to produce biofuels.

According to an October 2000 report prepared by Dupont for the U.S. EPA, DME has no known carcinogenic, mutagenic, or reproductive toxicity effects. Its very low toxicity combined with its non-ozone depleting properties has supported wide use of DME as a propellant in cosmetic and pharmaceutical products. DME, a gas under ambient conditions, also poses no known threat of polluting soil or water. DME degrades rapidly in the atmosphere through photochemical reactions. If DME is released into surface waters, it will volatilize rapidly out of the water, and then break down in the air. Unlike petroleum diesel fuel, DME has very low toxicity to aquatic invertebrates, fish, and wildlife.

DME's physical and combustion properties are very similar to those of propane. Therefore, DME may be handled using the same equipment, distribution, infrastructure, and dispensers used for liquefied propane gas (LPG). The safety procedures used with LPG can be used for handling DME.

Economic Impact Assessment/Results

Currently, DME is not sold at retail as a motor vehicle fuel in California. It has limited use in vehicles as a demonstration fuel by Oberon Fuels, a California producer of DME. Since DME production is so low at this time, it does not compete with conventional fuels. DME is not expected to have any negative impact on the businesses that currently sell petroleum diesel. If demand and production increase, existing fuel retailers will have the opportunity to expand into this market. The Department has made an initial determination that the proposed regulations will not have a negative statewide impact on existing businesses. The Department anticipates no elimination of jobs or existing businesses within the State of California as a result of the proposed regulations.

The Department has made an initial determination that adoption of the proposed regulations will not have a significant statewide adverse economic impact on

businesses that produce DME and must adhere to the fuel quality specifications. Oberon Fuels, a current producer of this fuel in California and a driver for the adoption of the ASTM specifications, has requested that the Department move forward with the adoption of the proposed regulations, even though widespread production and use of DME does not currently exist.

The extent of market acceptance and commercialization of DME cannot be predicted at this time, but expanded DME utilization will provide opportunities for other business types. Fuel distributors can use existing LPG technology and infrastructure for the distribution of DME. There could be job creation or expansion in California for the approximately 200 registered service agencies (RSAs) that install, repair, and maintain commercial fuel dispensers. Most of these are small businesses, averaging fewer than ten employees. Therefore, the Department has determined that this regulation could have a positive effect on existing small businesses by expanding the variety of commercial devices available for service.

Diesel mechanics would be needed to perform the vehicle conversions to accept DME fuel, and provide maintenance on heavy-duty trucks. Businesses wishing to purchase and use DME fuel in their vehicles will have certain upfront expenses, but these will likely be offset by the benefits associated with the fuel. According to Oberon Fuels, the price of DME is expected to be competitive with that of diesel. DME will meet or exceed CARB's latest emissions standards. A DME-modified vehicle is expected to have reduced maintenance costs because of the simpler fuel injection and emissions control systems.

To reduce particulate and NOx pollution from diesel fuel, in 2008 CARB adopted truck and bus regulations that require upgrades to most diesel engines. By 2023, most diesel vehicles must have engines from model year 2010 or later. These requirements will be phased in starting in 2015 for the oldest engines (pre-1994). Fleet owners that add alternative fuel trucks will have flexibility in meeting the requirements. Availability of DME as a motor vehicle fuel would offer a new and cost-effective method of addressing the CARB mandate. Oberon Fuels states that by 2015 California's fleet operators will be able to purchase heavy-duty trucks with compression-ignition engines specially designed to run on DME instead of diesel.

Type evaluation is the examination of weighing or measuring devices for the legal purpose of certifying that its design and performance complies with all applicable weights and measures requirements such as accuracy and reliability. Retail sale of DME as a motor vehicle fuel would require type evaluation of the dispenser(s) by the Department (BPC Section 12500.5). Once a commercial device type has been successfully evaluated by the Department, that make and model may be mass-produced for commercial purposes. Manufacturers choosing to sell DME dispensers would incur one-time costs of up to $20,000 for type evaluation.

RSAs that install, repair, and provide maintenance service for conventional fuel dispensers could choose to expand their operations to include DME dispensers. Established RSAs would not incur additional fees or expenses unless they needed to buy new test equipment. RSAs currently servicing LPG dispensers can likely use existing equipment. The Department estimates that new equipment may cost up to $25,000, should a business decide to expand into this arena.

The Department concludes that the proposed regulations: (1) may create new jobs within California; (2) may create new businesses within California; (3) may affect the expansion of businesses currently doing business within California. The Department estimates that between 1 and 10 new businesses in the RSA and diesel mechanics sectors could be created as a result of DME commercialization. These new businesses could add between 10 and 100 new jobs; and (4) are unlikely to eliminate any jobs or existing businesses.

Estimated Cost or Savings to Public Agencies or Affected Private Individuals or Entities

There is no immediate cost or savings to the Department associated with the adoption of these fuel specifications since there are no commercial stations selling DME at this time. Adoption of these specifications is precedent to fuel quality enforcement which will only occur with commercialization of DME.

If the fuel becomes popular and its use becomes widespread, the Department will be responsible for the following activities:

- Development of field fuel sampling protocols and field sampling. For conventional fuels, this activity is funded by industry fees (BPC Sections 13430 – 13434, CCR Chapter 8). A funding source for DME sampling and testing would need to be established.
- Type evaluation of DME dispensers. Type evaluations of new commercial devices are funded by manufacturers who pay for this service (BPC Section 12500.9, CCR Chapter 1, Article 1).
- Training and oversight of county officials who test fuel dispensers for accuracy. State training and oversight of county officials is funded by an administrative fee collected by counties at the time of annual device registration (BPC Section 12241, CCR Chapter 3, Article 3); county inspection costs are funded by annual device registration fees established by ordinance (BPC Section 12240).

All fuels sold at retail in California must meet ASTM or SAE International specifications. In order for the Department to verify compliance, fuel quality analysis will become necessary. The Department does not currently have the instrumentation required. Therefore, initial testing of up to five samples a year would likely be performed by a private laboratory at an estimated cost of $1,000

per sample. Because the Department cannot predict the extent and rate of market adoption of DME fuel, the long-term fiscal impact to the Department is unknown.

The Department has initially determined that the proposed regulations do not impose a mandate on local agencies or school districts. The Department has also determined that no cost or savings to any other state agency, no reimbursable costs or savings under Part 7 (commencing with Section 17500) of Division 4 of the Government Code to local agencies or school districts, no nondiscretionary costs or savings to local agencies or school districts, and no cost or savings in federal funding to the state will result from the proposed action.

The Department has made an initial determination that the action will not have a significant statewide adverse economic impact on housing costs or California businesses, including the ability of California businesses to compete with businesses in other states.

The Department is not aware of any cost impacts that a representative private person or business would necessarily incur in reasonable compliance with the proposed action.

Federal Regulations

The proposed regulations are not in conflict with any federal regulations contained in the Code of Federal Regulations. Moreover, the proposed regulations are not mandated by federal law or regulation.

Specific Purpose of the Regulation

Necessity

Existing law, BPC Section 13450, requires the Department to adopt by reference the latest standards for a compression-ignition engine fuel developed by a recognized consensus organization such as ASTM International or SAE International. ASTM International completed and published D7901 “Standard Specification for Dimethyl Ether for Fuel Purposes” in March 2014. Accordingly, the Department must update its regulations through the adoption by reference of this specification.

Specific Purpose – By Section

Chapter 6, Article 9. Specifications for Dimethyl Ether Used as a Motor Vehicle Fuel

This regulation proposes to define Dimethyl Ether and adopt fuel quality specifications for its use as a motor vehicle fuel. Adoption of ASTM International D7901-14 makes the fuel quality requirements clear and specific.

4190. Definitions Used in This Article

Dimethyl Ether – The Department proposes to add a definition of dimethyl ether as a motor vehicle fuel. It makes clear and specific that this definition only applies to DME used in surface vehicles.

4191. Specifications- Dimethyl Ether for use as an Engine Fuel

The BPC requires that the specifications for fuels for use in compression-ignition engines be adopted by reference from a consensus standards organization such as ASTM International or SAE International. Currently, the only specification available is ASTM Standard D7901-14, "Dimethyl Ether for use as an Engine Fuel" which was finalized in March 2014. This section specifies that the DME used as a motor vehicle fuel must meet the requirements of the most recent version of this specification.

Alternatives Considered

The Department has determined that no reasonable alternative it considered or that has otherwise been identified would be more effective in carrying out the purpose for which the action is proposed. In addition, the Department has determined that no reasonable alternative would be as effective as or less burdensome to affected private persons than the proposed action, or would be more cost-effective to affected private persons and equally effective in implementing the statutory policy or other provision of law.

If the Department chooses to do nothing, it would be in violation of BPC Section 13450, which requires the adoption of a standard promulgated by a consensus organization establishing fuel quality specifications for compression-ignition fuel for use in internal combustion engines.

Through promulgation of regulations, the Department can adopt by reference the latest specification published by ASTM International. Doing so allows the Department to stay abreast of best practices and standards for the industry. The Department believes that this is the best and only solution.

Technical, Theoretical, and/or Empirical Study, Reports or Documents

The Division of Measurement Standards relied on the following documents in drafting the regulatory language of this proposal:

- *ASTM International D7901-14*, published March 2014
- The Global Warming Solutions Act, AB 32 (Nuñez, Chapter 488, Statutes of 2006)
- Governor's Executive Order S-3-05 http://gov.ca.gov/news.php?id=1861
- Governor's Executive Order S-06-06 http://gov.ca.gov/news.php?id=183

- Governor's Executive Order S-1-07 http://gov.ca.gov/news.php?id=5172
- California Energy Commission *Energy Almanac: Retail Fuel Report and Data for California,* website accessed 6/4/2014. http://energyalmanac.ca.gov/gasoline/piira_retail_survey.html
- CalEPA OEHHA Fact Sheet *Health Effects of Diesel Exhaust*, http://oehha.ca.gov/public_info/facts/dieselfacts.html
- U.S. EPA fact sheet *Black Carbon Research and Future Strategies*, October 2011. http://www2.epa.gov/sites/production/files/2013-12/documents/black-carbon-fact-sheet_0.pdf
- Center for Climate and Energy Solutions fact sheet, *What is Black Carbon?*, April 2010 http://www.c2es.org/publications/black-carbon-climate-change
- Diesel Technology Forum fact sheet *Sustainably Powering Our Economy with Clean Diesel Technology*, http://www.dieselforum.org/energy-and-environment/clean-diesel-technology-and-sustainability
- California Energy Commission and California Air Resources Board joint report *Reducing California's Petroleum Dependence*, #P600-03-005F, August 2003.
- D. Kittleson et al, University of Minnesota, Department of Mechanical Engineering, presentation at the 2010 IREE E3 Conference "*Performance and Emissions of a Second Generation Biofuel – DME*", November 30, 2010. http://www.me.umn.edu/centers/cdr/cdr_dme.html
- E. I. du Pont de Nemours and Company, Robust Data Summary and Test Plan for Dimethyl Ether, prepared for U.S. EPA High Production Volume Challenge Program, October 11, 2000.
- DuPont Dimethyl Ether Product Safety Summary Sheet, revision of September 25, 2012. http://www2.dupont.com/inclusive-innovations/en-us/sites/default/files/Dimethyl%20Ether%20Product%20Safety%20Summary.pdf
- Sigma-Aldrich Dimethyl ether Material Data Safety Sheet, Version 4.4 revised 04/09/2013. http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=US&language=en&productNumber=295299&brand=ALDRICH&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fproduct%2Faldrich%2F295299%3Flang%3Denhttp://www.epa.gov/hpv/pubs/summaries/dimethr/c12794rs.pdf
- Letter dated April 17, 2012, submitted to the California Energy Commission, referenced as Docket 11-ALT-1; Author: Rebecca Boudreaux Breitenkamp, Ph.D., President, Oberon Fuels.
- Oberon Response to Rule Making Questions, received via email April 4, 2014; Author: Brittany Applestein Syz, General Counsel and VP of Business Development, Oberon Fuels.
- California Air Resources Board *Truck and Bus Regulation Compliance Requirements Summary*, revision of 3/23/2011. http://www.arb.ca.gov/msprog/onrdiesel/documents/faqamend14.pdf

- California Air Resources Board *Truck and Bus Regulation Amendments* Approved in 2014, update of 5/8/2014. http://www.arb.ca.gov/msprog/onrdiesel/documents/faqamend14.pdf