Appendix C

Hydrogen Fuel Quality Standard

The California Air Resources Board (CARB) entered into an interagency agreement with the Department of Food and Agriculture (CDFA) for the development of "Specifications for Hydrogen Fuels for Use in Internal Combustion Engines and Fuel Cells in Motor Vehicles" by January 2008 as required by Chapter 91, Statutes 2005.

BACKGROUND

Hydrogen can be produced from many domestic sources of energy, including fossil fuels, such as natural gas and coal; and renewable resources such as solar radiation, wind, biomass, and nuclear energy. Due to this diversity of the sources of hydrogen fuel, it is imperative that quality standards for purity be put into place. Contaminants such as ammonia, carbon monoxide, carbon dioxide, formaldehyde, formic acid, hydrocarbons, sulfur compounds and water can harm catalyst-coated membranes inside the fuel cell reducing its efficiency, performance and reliability.

Hydrogen used for transportation is in its infancy stages and is developmental in nature. In addition, hydrogen fuel standards, sampling, and testing are new technologies that have not been narrowly defined. It is imperative that the marketplace be monitored for compliance so that the hydrogen fuel being produced and sold for transportation meets certain quality standards. Hydrogen fuel sold, absent continuous monitoring, may result in sales of substandard fuel that can cause damage to engines and fuel cells forcing the consumer to bear the expense of costly repairs.

CONTRACT REQUIREMENTS

The chemist is responsible for working with the American Society for Testing and Materials (ASTM) International, Society of Automotive Engineers (SAE) International or other American National Standards Institute (ANSI) accredited standards writing organizations, California Air Resources Board (CARB), and hydrogen fueled vehicle industry members to develop the performance and driveability specifications for hydrogen fuel for use in internal combustion engine and fuel cell motor vehicles within California. Laboratory equipment will be necessary for the research and development of hydrogen standards and sampling and testing protocols.

CONTRACT STATUS

The following is an update of Division of Measurement Standards activities relative to ARB/CDFA Agreement 05-612.

- The Chemist was hired in the second quarter of 2006, and contacts have been made with several fuel cell manufacturers. CDFA sent a letter out on June 7, 2006, requesting industry's input into the process development of the hydrogen standard. CDFA staff attended several meetings to discuss the process of the standard development with industry.

- CDFA staff sent out a letter with the proposed hydrogen fuel specification to industry and interested parties on September 6, 2006 requesting comments on the proposed draft regulations (attached). CDFA staff presented the draft proposal at 3 national meetings including the National Hydrogen Association; the National Hydrogen Fuel Cell Codes and Standards Coordinating Committee and the Society of Automotive Engineers in Detroit, MI. Comments were received from Ford Motor Company, American Petroleum Institute, Western States Petroleum Association, Ballard, DaimlerChrysler, General Motors, Nissan, United Technologies Company Power, Ballard, Hydrogenics, and United States Fuel Cell Council.

- CDFA plans to meet with members of the California Fuel Cell Partnership on December 7, 2006 to receive detailed input and comments on the proposed draft regulations.

- CDFA has met the requirements to submit the proposal to the Office of Administrative Law (OAL) and plans to submit the proposal to them OAL prior to June, 2007. This will begin a 45-day comment period. If significant comments and changes are necessary the proposal would be resubmitted with a second forty-five day comment period. If there are minor modifications, they could be handled with a fifteen day commenting period. The process is complete when CDFA staff has addressed all the comments and submitted the final statement of reasons to the Office of Administrative Law.

- CDFA is on track to have the "Specifications for Hydrogen Fuels for Use in Internal Combustion Engines and Fuel Cells in Motor Vehicles" in statute by January 2008.

- Initial equipment needs were evaluated and a purchase order was issued for a gas chromatotgraph – mass spectrophotometer and sampling equipment with expected arrival dates of next month. Sampling cylinders and ancillary equipment are still being evaluated. Additional equipment could be required to allow analyzes at the required level of resolution.

California Code of Regulations
Title 4, Division 9, Chapter 6

Article 8 Specifications for Hydrogen Used in Internal Combustion Engines and Fuel Cells

4180. Definitions Used in This Article

(a) "Fuel Cell" means an electrochemical device used to convert hydrogen and oxygen into electrical energy to power a motor vehicle.

(b) "Internal Combustion Engine" means a device used to ignite hydrogen in a confined space to create mechanical energy to power a motor vehicle.

(c) "Hydrogen Fuel" means a fuel composed of the chemical hydrogen intended for consumption in an internal combustion engine or fuel cell.

4181. Specifications – Hydrogen Fuel Used in Fuel Cells and Internal Combustion Engines. No person shall sell, offer for sale, supply or offer for supply hydrogen fuel that fails to comply with the following standards:

Specification	Value	Test Method [(a)]
Hydrogen Fuel Index (minimum, %)	99.99	(b)
Total Gases (maximum, ppm v/v)	100	(c)
Water (maximum, ppm v/v)	5	ASTM D 6348
Total Hydrocarbons (maximum, ppm v/v) [(d)]	2	ASTM D 1946
Oxygen (maximum, ppm v/v)	5	ASTM D 5466
Helium (maximum, ppm v/v)	100	ASTM D 1946
Nitrogen and Argon (maximum, ppm v/v)	100	ASTM D 5466
Carbon dioxide (maximum, ppm v/v)	2	ASTM D 5466
Carbon monoxide (maximum, ppm v/v)	0.2	ASTM D 5466
Total Sulfur Compounds (maximum, ppm v/v)	0.004	ASTM D 5504
Formaldehyde (maximum, ppm v/v)	0.01	ASTM D 1946
Formic acid (maximum, ppm v/v)	0.2	ASTM D 1946
Ammonia (maximum, ppm v/v)	0.1	ASTM D 5466
Total Halogenated Compounds (maximum, ppm v/v)	0.05	ASTM D 5466
Particulates Size (maximum, µm)	10	SCAQMD Method 301-91
Particulate Concentration (maximum, µg/L @ NTP)	1	Gravimetric Determination EPA IO 3.1

a. Modified or alternate test methods may be used provided they have been demonstrated to have a detection level and accuracy equal or better than the method specified.
b. The hydrogen fuel index is the value obtained with the value of total gases (%) is subtracted from 100%
c. Total Gases = Sum of all impurities listed on the table except particulates
d. Total Hydrocarbons may exceed 2 ppm v/v only due to the presence of methane, provided that the total gases do not exceed 100 ppm v/v.

4182. Sampling – Hydrogen Fuel. The containers and procedures used to obtain hydrogen fuel samples are not specified. However, the equipment and techniques used must have been demonstrated to provide representative samples. The effectiveness of cleaning procedures for sampling equipment and containers shall be confirmed by analyzing ultra high purity hydrogen. The determined concentration of each contaminate measured shall be equal or less than one fifth (1/5) of the specified limit in Section 4181.