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April 22, 2004

MANUFACTURERS ADVISORY CORRESPONDENCE (MAC) #04-02

TO: -ALL PASSENGER CAR MANUFACTURERS
-ALL LIGHT-DUTY TRUCK MANUFACTURERS
-ALL MEDIUM-DUTY VEHICLE MANUFACTURERS
-ALL HEAVY-DUTY VEHICLE MANUFACTURERS
-ALL OTHER INTERESTED PARTIES

SUBJECT: Evaporative Testing Requirements for Dual-Fuel Compressed Natural Gas (CNG)/Gasoline and Liquefied Petroleum Gas (LPG)/Gasoline Vehicles – Revision of MAC #99-01 To Allow Subtraction of Methane Emissions from CNG/Gasoline Dual-Fuel Vehicles (DFVs)

The attached MAC clarifies the Air Resources Board's procedures regarding evaporative emission testing of dual-fuel CNG/gasoline vehicles. This MAC revises and supersedes MAC #99-01 by allowing manufacturers to determine, report, and subtract methane emissions when a dual-fuel CNG/gasoline vehicle is tested for evaporative emissions. A related revision clarifies that for dual-fuel CNG/gasoline medium-duty vehicles, the applicable "LEV I" evaporative emission standards, which are dependent on the fuel tank capacity of the medium-duty vehicles, are determined solely on the fuel tank capacity of the gasoline fuel system.

If you have any questions or comments, please contact Mr. Steven Hada, Air Resources Engineer, On-Road Certification/Audit Section, at (626) 575-6641 or at shada@arb.ca.gov.

Sincerely,

/s/

Allen Lyons, Chief
Mobile Source Operations Division

Attachment

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Website: <http://www.arb.ca.gov>.

California Environmental Protection Agency

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SUBJECT: Evaporative Testing Requirements for Dual-Fuel Compressed Natural Gas (CNG)/Gasoline and Liquefied Petroleum Gas (LPG)/Gasoline Vehicles – Revision of MAC #99-01 To Allow Subtraction of Methane Emissions from CNG/Gasoline Dual-Fuel Vehicles (DFVs)

APPLICABILITY: 2003 and subsequent model-year (MY) dual-fuel CNG/gasoline and LPG/gasoline passenger cars (PCs), light-duty trucks (LDTs), medium-duty vehicles (MDVs) and heavy-duty vehicles (HDVs).

DEFINITIONS: For purposes of this MAC only, the following definitions apply.

Alternative Fuel: In this MAC, an alternative fuel is either compressed natural gas (CNG) or liquefied petroleum gas (LPG).

[Liquefied natural gas (LNG) fuel systems with their low pressure and temperature, venting characteristics, and special requirements for evaporative emission control, are outside the scope of this MAC.]

Dual-Fuel Vehicle(s) (DFV): A DFV is designed and engineered to separately operate on both gasoline and an alternative fuel. It has two separate on-board fuel systems, one for the alternative fuel and the other for gasoline. DFVs operate using only one fuel source at any given time, principally the alternative fuel; gasoline is used only when the alternative fuel system is inoperable or when the alternative fuel is low.

[For comparison, a "bi-fuel vehicle" is designed and engineered to operate on gasoline and an alternative fuel simultaneously in varying calibrated proportions. A bi-fuel vehicle also has two separate on-board fuel systems, one for the alternative fuel and the other for gasoline. A bi-fuel vehicle is subject to evaporative emission testing similar to that for gasoline vehicles, and is not a subject of this MAC.]

REFERENCES:

1. Title 13, California Code of Regulations, (13 CCR) Section 1976, "Standards and Test Procedures for Motor Vehicle Fuel Evaporative Emissions."

2. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," adopted August 5, 1999, and incorporated by reference in 13 CCR Section 1976(c). (The Evaporative Emission Test Procedures)
3. "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," as amended September 5, 2003, and incorporated by reference in 13 CCR Section 1961(d). (The Exhaust Emission Test Procedures)
4. MAC #99-01, "Evaporative Testing Requirements for Dual-Fuel CNG/Gasoline and LPG/Gasoline Vehicles"

BACKGROUND AND DISCUSSION:

13 CCR Section 1976(b)(1) provides that the California evaporative emission standards apply to "...1978 and subsequent model gasoline-fueled, 1983 and subsequent model liquefied petroleum gas-fueled, and 1993 and subsequent model alcohol-fueled motor vehicles and hybrid electric vehicles..., except petroleum-fueled diesel vehicles, compressed natural gas-fueled vehicles, hybrid electric vehicles that have sealed fuel systems which can be demonstrated to have no evaporative emissions, and motorcycles..." Based on the assumptions that CNG fuel systems are sealed, and the high-pressure CNG storage systems act as inherent and effective evaporative emission controls, ARB regulations exempt dedicated CNG vehicles from the evaporative emission standards.

The Evaporative Emission Test Procedures do not expressly address evaporative emission testing of DFVs. Since both gasoline and LPG vehicles are subject to the evaporative emission standards, it is clear that LPG/gasoline DFVs are subject to evaporative emissions testing when operated on LPG and gasoline. It is also clear that CNG/gasoline DFVs are subject to evaporative emissions testing when operated on gasoline because the evaporative emission standards apply to the gasoline fuel. As discussed below, it is necessary to determine the gasoline evaporative emissions of CNG/gasoline DFVs when operated on CNG in order to demonstrate compliance with the evaporative emission standards applicable to the gasoline fuel.

DFVs of other fuel types are also possible although none has yet been certified by ARB, e.g., CNG/alcohol, LPG/alcohol, where the secondary fuel (methanol and ethanol in the examples) is subject to the evaporative emission standards. For these DFVs, the discussion below and the policies provided in this MAC as applicable to gasoline also apply to these secondary fuels.

Due to the presence of the gasoline fuel system, evaporated gasoline emissions are always associated with DFV operation, whether running on CNG, LPG, or gasoline fuel. Most DFVs are certified to low emission standards (e.g., "LEV", "ULEV" or "SULEV") with more stringent non-methane organic gases (NMOG) exhaust emission standards for alternative fuel operation than for gasoline operation [Reference 3, Part I, Section E.1.3]. Because of different combustion characteristics and the need to meet different NMOG exhaust emission standards for the gasoline and alternative fuels, DFVs likely have different engine management calibrations and purge strategies for the different fuels. Therefore, demonstrating compliance with the evaporative emission standards when a DFV runs on gasoline does not provide sufficient assurance that the DFV also complies with the evaporative emission standards when running on the alternative fuel.

MAC #99-01 provided that DFVs undergo evaporative emission testing for both gasoline and the alternative fuel to ensure that the gasoline evaporative emission control system, in particular the purge strategy, is functioning properly when the vehicles operate on either fuel. The complete evaporative test procedure, including the 3-day and 2-day diurnal plus hot soak (3DHS and 2DHS, respectively) and running loss (R/L) tests, must be run for each fuel. The gasoline fuel fill and gasoline fuel tank R/L temperature profile for the evaporative emission testing of a DFV on the alternative fuel must follow the same procedures as when the DFV is being evaporative emission tested on gasoline. The specifications of the gasoline, LPG and CNG test fuels must conform to the requirements in the test procedures [Part III, Section F in Ref. 2 and/or Part II, Section A.100.3 in Ref. 3]. As the evaporative emission standards are specified in terms of total hydrocarbons, and again based on the expectation that CNG fuel systems are sealed, MAC #99-01 required that the measured total evaporative emissions be compared to the evaporative emission standards to determine compliance.

Recently, the California Natural Gas Vehicles Coalition (CNGVC) pointed out that under MAC #99-01, the gasoline fuel system of CNG/gasoline DFVs in effect would be subject to a more stringent level of emission control because the total evaporative gasoline and methane emissions from these vehicles must comply with the evaporative emission standards applicable to the gasoline fuel only. If evaporative emissions from the CNG fuel system are neither zero nor de minimus, the issue raised by the CNGVC seems valid. Specifically, manufacturers of dedicated CNG vehicles are not required to measure evaporative emissions, but under MAC #99-01, methane emissions from the CNG fuel system on DFVs are factored into evaporative emissions compliance. Staff's review of federal certification data indicates that the fuel systems of dedicated CNG vehicles may not in fact be completely sealed, and methane emissions from the diurnal and hot soak (DHS) test have in cases exceeded 50 percent of the applicable standards. Therefore, ARB staff concurs with the CNGVC that an unintended higher level of stringency currently exists in the application of evaporative emission standards to CNG/gasoline DFVs under the policy in MAC #99-01. To remedy this situation in the short term, the ARB is revising the policy of MAC #99-01 to allow manufacturers to determine, report, and subtract the methane emissions from the CNG fuel system of CNG/gasoline DFVs. The test procedure used by a manufacturer to determine the

evaporative methane emissions for this purpose must be approved in advance by the ARB. The precision and accuracy of the evaporative methane emissions determination must equal or exceed those for determining exhaust methane emissions as part of the NMOG test procedures applicable to the subject CNG/gasoline DFV.

For the longer term, the data reviewed in considering the issues raised by the CNGVC indicate that evaporative emissions from CNG fuel systems are significantly higher than previously realized by ARB staff. Therefore, staff plans to further review the appropriateness of the evaporative emission exemption for CNG vehicles under current ARB regulations.

A related issue is the determination of the applicable "LEV I" evaporative emission standards [13 CCR Section 1976(b)(1)(B) and (C)] for MDVs with a 6001-8500 pound gross vehicle weight rating (GVWR), as these standards are dependent on the fuel tank capacity of the vehicles. MAC #99-01 provided that the applicable "LEV I" 3DHS and 2DHS evaporative emission standards for 6001-8500 pound GVWR dual-fuel MDVs are determined based on the combined capacity of the gasoline and CNG or LPG fuel tanks. In view of the exclusion of the evaporative methane emissions permitted under this new MAC for CNG/gasoline DFVs, it is appropriate and consistent to modify Policy 3. in MAC #99-01 as follows: For dual-fuel CNG/gasoline MDVs in the 6001-8500 pound GVWR, the applicable "LEV I" 3DHS and 2DHS evaporative emission standards are based on the capacity of the gasoline fuel tank(s) only.

POLICY:

- 1.** For certification of 2003 and subsequent MY dual-fuel CNG/gasoline or LPG/gasoline PCs, LDTs, and chassis dynamometer-certified MDVs, the certification test vehicle shall undergo separate 3DHS, R/L and 2DHS evaporative emission tests when running on the gasoline and CNG or LPG test fuels. Exhaust emission data collected as part of the evaporative emission test sequence (Reference 2, Part III, Section D.6.) shall be reported in the application for certification of the DFV.
- 2.** For certification of 2003 and subsequent MY dual-fuel CNG/gasoline or LPG/gasoline HDVs or incomplete MDVs, manufacturers shall separately demonstrate that the certified vehicles comply with applicable evaporative emission standards when running on gasoline and CNG or LPG. The procedure in Reference 2, Part I, Section D.2. (i.e., by an engineering evaluation) may be used for these compliance demonstrations.
- 3.** When CNG/gasoline DFVs are tested on gasoline and CNG for evaporative emissions, manufacturers are permitted to determine the evaporative methane emissions from the CNG fuel system and subtract such methane emissions from the measured total evaporative emissions in order to determine the certification

emission levels before comparison to the evaporative emission standards. The excluded evaporative methane emissions shall be reported in the application for certification of the CNG/gasoline DFV. The manufacturer's test procedure to determine the evaporative methane emissions for this purpose must be approved in advance by the ARB. The precision and accuracy of the evaporative methane emissions determinations must equal or exceed those for determining exhaust methane emissions as part of the NMOG test procedures applicable to the subject CNG/gasoline DFV.

4. Optionally, manufacturers may demonstrate compliance with the evaporative emission standards for CNG/gasoline DFVs based on the total evaporative emissions (i.e., including the evaporative methane emissions). Under this option, it is not necessary to determine or report the evaporative methane emissions as required in Policy 3.
5. The gasoline fuel tank fill and gasoline fuel tank temperature profile for the evaporative emission testing of the DFV running on the alternative fuel shall be the same as those for the evaporative emission testing of the DFV running on gasoline.
6. For dual-fuel LPG/gasoline MDVs in the 6001-8500 pound GVWR certified to the "LEV I" evaporative emission standards [13 CCR Section 1976(b)(1)(B) and (C)], the applicable 3DHS and 2DHS evaporative emission standards are based on the combined capacity of the gasoline and LPG fuel tanks.
7. For dual-fuel CNG/gasoline MDVs in the 6001-8500 pound GVWR certified to the "LEV I" evaporative emission standards [13 CCR Section 1976(b)(1)(B) and (C)], the applicable 3DHS and 2DHS evaporative emission standards are based on the capacity of the gasoline fuel tank(s) only.