

***U.S. Department of Energy
FreedomCAR & Vehicle Technologies Program***

***CARB Executive Order Exemption Process for
a Hydrogen-fueled Internal Combustion Engine
Vehicle – Status Report***



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Prepared by Electric Transportation Applications

April 2008

***Idaho National Laboratory
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April 2008

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ABSTRACT

The CARB Executive Order Exemption Process for a Hydrogen-fueled Internal Combustion Engine Vehicle was undertaken to define the requirements to achieve a California Air Resource Board Executive Order for a hydrogen-fueled vehicle retrofit kit. A 2005 to 2006 General Motors Company Sierra/Chevrolet Silverado 1500HD pickup was assumed to be the build-from vehicle for the retrofit kit. The emissions demonstration was determined not to pose a significant hurdle due to the non-hydrocarbon-based fuel and lean-burn operation. However, significant work was determined to be necessary for Onboard Diagnostics Level II compliance. Therefore, it is recommended that an Experimental Permit be obtained from the California Air Resource Board to license and operate the vehicles for the durability of the demonstration in support of preparing a fully compliant and certifiable package that can be submitted.

CONTENTS

ABSTRACT.....	iii
1. INTRODUCTION.....	1
2. BASE TRUCK INFORMATION	1
3. EXECUTIVE ORDER CERTIFICATION REQUIREMENTS	1
4. TAILPIPE AND EVAPORATIVE EMISSIONS TESTING REQUIREMENTS.....	2
5. ONBOARD DIAGNOSTICS LEVEL II COMPLIANCE.....	3
5.1 Generic Scan Tool Use.....	4
5.2 Parameter Identifiers Monitoring	4
5.3 Onboard Diagnostics Level II Monitoring	4
6. EXPERIMENTAL PERMIT	5
Appendix A—Roush Correspondence with CARB	7
Appendix B—CARB Executive Order A-006-1340.....	21
Appendix C—Alternate Fuel Retrofit Systems Final CARB Regulatory Orders	23
Appendix D—CARB Correspondence Concerning Experimental Permit	104

Advanced Vehicle Testing Activity CARB Executive Order Exemption Process for a Hydrogen-fueled Internal Combustion Engine Vehicle – Status Report

1. INTRODUCTION

The CARB Executive Order Exemption Process for a Hydrogen-fueled Internal Combustion Engine (HICE) Vehicle work for the Advanced Vehicle Testing Activity (AVTA) was contracted with Roush Industries (Roush). Roush provides integrated automotive engineering services in disciplines ranging from body, chassis, and powertrain engineering through comprehensive testing, noise vibration harness engineering, and specialty manufacturing services. Roush assumed that the vehicle to be certified was the HICE pickup truck developed by ETEC in support of the U.S. Department of Energy's AVTA testing of HICE vehicles. California Air Resource Board (CARB) Executive Order personnel were consulted via correspondence presented in Appendix A. Using responses to this correspondence and incorporating Roush experience with vehicle certification and CARB Executive Order submissions (through Roush Performance Products division), the strategy for submission of a certification application presented in this report was developed by John Fleming, Roush Program Manager. This report describes the work performed to date to obtain CARB certification for the conversion of a gasoline engine base vehicle to a HICE vehicle.

2. BASE TRUCK INFORMATION

The base, build-from truck utilizes a General Motors factory KL5 CNG option 6.0L engine, which is heavy duty engine certified and engine dynamometer emissions tested instead of chassis roll emissions tested. The following list presents truck information for two trucks previously converted to hydrogen fuel use. These trucks were certified to Environmental Protection Agency (EPA) heavy duty engine standards and procedures.

2005 Chevrolet Silverado 1500HD

VIN Number: 1GCGC13U95F889816

Engine Family: 5GMXH06.0583

Evap Family: 5GMXR0223998

EPA Cert Number: GMX-CFF-LEV-05-03

2006 GMC Sierra 1500HD

VIN Number: 1GTGC13U06F160945

Engine Family: 6GMXH06.0583

Evap Family: 6GMXR0223998

EPA Cert Number: GMX-HDG-06-01

The 2005 truck was not original equipment manufacturer built with the KL5 option engine; it was updated with the KL5 option cylinder heads during conversion, which explains the different EPA Certification Number (i.e., EPA Cert Number).

3. EXECUTIVE ORDER CERTIFICATION REQUIREMENTS

CARB requires use of an original CARB-certified vehicle as the build-from vehicle to certify a retrofit system. The appropriate certified vehicle would fall under Executive Order A-006-1340 (see Appendix B) for 2006.

Currently, no formal CARB process is in place for certifying hydrogen-fueled vehicles. CARB has discussed grouping hydrogen with alternative fuel conversions. To date, no new vehicle manufacturer or retrofit company has received an Executive Order from CARB for hydrogen-fueled, on-road vehicles.

Specific CARB requirements applicable to alternate fuel retrofit systems are presented in Appendix C. In addition to all other standards and requirements, this Regulatory Order specifies the following:

- Use of a fuel lock-off valve to prevent fuel delivery while engine is shut off
- No drivability degradation from base vehicle
- Onboard diagnostics from base vehicle must not be impaired
- Creation of a supplemental emissions control information label
- Creation of a new vacuum schematic if different from base vehicle
- Owners manual supplement
- Manufacturer and installer retrofit record keeping
- Complete documentation of the retrofit system and installation procedure
- Complies with exhaust emission levels equivalent to those of the base-certified vehicle
- If approval is granted on a passenger car, light-duty truck, or medium-duty vehicle, it would automatically qualify the system for use in heavy duty engines without additional testing (assuming the use of similar emission control systems)
- Full coverage warranty for 3 years or 50,000 miles
- A cost-limited extended warranty for 7 years or 70,000 miles.

4. TAILPIPE AND EVAPORATIVE EMISSIONS TESTING REQUIREMENTS

The build-from vehicle falls under CARB Category II (i.e., vehicles with gross vehicle weight registered less than or equal to 14,000 lb and not originally certified to a chassis dynamometer-based exhaust emission standard).

From the Final Order, Attachment A, Section 5(c):

For durability, bench-test and emission-data vehicles in Category II, test vehicles shall have accumulated a total mileage greater than 4,000 miles and less than 10,000 miles with the original fuel system prior to emission testing. If the manufacturer chooses to use the option as described in l(b) (e) for pre-1994 model year vehicles, then the 10,000-mile limit shall not be applicable. A test vehicle's engine and emission control system shall be equipped and calibrated as certified. The vehicle shall then be tested for exhaust and, if applicable,

evaporative emissions using the test procedures set forth in the “California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.” The inertia weight setting shall be equal to the average of the vehicle's curb weight and gross vehicle weight rating and road load horsepower based on the frontal area of the vehicle without modifications, as determined in “California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles,” Section 9.b. The test results shall be defined as the baseline emission rates. After the baseline emission rates have been measured, the retrofit system shall be installed.

(i) The procedures outlined in paragraphs 5(b)(iii) through 5(b)(vi) shall be used with the following modifications: "useful life" shall equal 120,000 miles for vehicles in Category II; the durability or bench-test vehicle's emission rates of regulated pollutants measured at 4,000 + 100 miles after the installation of the retrofit system shall not exceed 1.10 times the baseline rates; the deteriorated exhaust emissions of regulated pollutants projected to 120,000 miles shall not exceed 1.3 times the baseline emissions; and the deteriorated evaporative emissions of regulated pollutants projected to 120,000 miles shall not exceed the baseline emissions plus 0.5 grams.

For the assumed build-from vehicle, the only emissions testing requirement is a Federal Test Procedure (FTP CVS75) and highway comparison to the baseline vehicle. No evaporative emissions test is required due to use of a closed fuel system and non-hydrocarbon fuel.

5. ONBOARD DIAGNOSTICS LEVEL II COMPLIANCE

The largest hurdle in receiving an Executive Order for a hydrogen fuel retrofit system is maintaining compliance with the current CARB Onboard Diagnostics Level II (OBDII) standards. These requirements are outlined in the following OBDII Final Regulation Orders:

- Title 13, California Code Regulations, Section 1968.2, Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBDII)
<http://www.arb.ca.gov/regact/obd02/fro1968-2.pdf>
- Title 13, California Code of Regulations, Section 1968.5, Enforcement of Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines
<http://www.arb.ca.gov/regact/obd02/fro1968-5.pdf>.

The HICE vehicle used to develop certification requirements utilizes a diagnostic tool to check and clear fault codes. However, this system is not compliant with current requirements for powertrain control module OBDII regulations in the following ways:

- The system does not meet the standardized requirement (SAE J1978) for generic scan tool communication
- The system is not compliant with standard SAE J1979 parameter identifiers monitoring
- The system is deficient in OBDII monitoring requirements

- The system has not been tested for, nor demonstrated compliance with, CARB requirements.

5.1 Generic Scan Tool Use

Current hydrogen fuel conversions typically use an add-on or piggy-back engine control unit. This is required to provide the unique electronic drivers required for supporting the Quantum hydrogen fuel injectors universally used for HICE vehicles. The HICE certification vehicle utilizes aftermarket engine control unit hardware. This hardware has never been used in an OBDII-compliant program and requires low-level (OBDII) driver development and hardware changes to become compliant. Following these changes, a significant amount of software development also will be required. One issue experienced with these particular vehicles is the fact that the build-from vehicle utilizes the J1850 messaging protocol, which is not supported by the aftermarket engine control unit. A message translator module is used to communicate between the aftermarket engine control unit and the rest of the stock vehicle modules (e.g., ABS, body, and dash). Additional software development will be required in the translator module to enable use of a generic scan tool.

5.2 Parameter Identifiers Monitoring

CARB requires a standard list of parameter identifiers for querying information from the powertrain control module that would need to be resolved. These include “Freeze Frame”-stored engine parameters for diagnosing malfunction indicator lamp illumination. A significant amount of software development will be required for the HICE certification vehicle to achieve parameter identifiers monitoring compliance.

5.3 Onboard Diagnostics Level II Monitoring

CARB requires monitoring all emissions related sensors and emission components. A Roush letter to CARB dated September 18, 2006 (see Appendix A), addresses the following OBDII monitors:

- **Catalyst monitor**—Not applicable because catalytic converters are removed. A letter explaining the decision to remove the converters was sent to CARB on August 30, 2006 (see Appendix A).
- **Misfire monitor**—Not applicable because no hydrocarbons are emitted during misfire and no catalysts will be damaged from misfire. CARB questioned whether a misfire monitor would still be desired for detecting degraded performance. However, because a misfire has no emissions impact, the monitor is not a regulatory requirement.
- **Evaporative system monitor**—Not applicable because there is no evaporative fuel system and the fuel system is sealed.
- **Fuel system monitor**—This monitor is required as emission of nitrogen oxides is influenced by the fuel/air ratio. A richer than requested mixture would increase nitrogen oxides. Because the hydrogen fuel management system is running open loop with no feedback from heated exhaust gas oxygen sensors or universal exhaust gas oxygen sensors, the conventional way of monitoring fuel shifts does not apply. Roush proposed a monitor to CARB that monitors the closed loop idle control to determine if a rich fuel shift has occurred. CARB was reluctant to agree to its use and requested that reliability of using universal exhaust gas oxygen sensors to monitor fuel shifts be investigated. Hydrogen fueled vehicles currently operating in Vancouver, Canada, as part of the AVTA’s fleet testing of HICE vehicles have universal exhaust gas oxygen sensors installed for the purpose of monitoring the durability of the sensor in a hydrogen environment.

- **Oxygen sensor monitor**—Not applicable because the system does not utilize O₂ sensors for fuel control. However, this would be required if universal exhaust gas oxygen sensors are used as inputs for the fuel system monitor.
- **Secondary air monitor**—Not applicable because the system does not utilize secondary air.
- **EGR system monitor**—Not applicable because the system does not utilize exhaust gas recirculation.
- **PCV system monitor**—Not required because hydrogen fuel contains no hydrocarbons; therefore, there will be no fuel-related crankcase vapor detrimental to the atmosphere. However, the positive crankcase ventilation system is still present on the vehicle.
- **Engine cooling monitor**—This monitor checks for a stuck open thermostat. Because the additional cold start fueling is based on engine coolant temperature at startup and decays away with time, no fueling would be modified for a non-functional thermostat. Spark is not modified for engine coolant temperature; therefore, the monitor is not applicable.
- **Cold start emissions reduction strategy monitor**—Not applicable.
- **Air conditioning system monitor**—Not applicable.
- **Variable valve timing monitor**—Not applicable.
- **Direct ozone reduction system monitor**—Not applicable.
- **Comprehensive component monitor**—HICE certification vehicle software performs the basic functions of this monitor. Additional sensor rationality checks will be required for full compliance. These checks will require significant software development.

6. EXPERIMENTAL PERMIT

During discussions with CARB, Roush was encouraged to seek an experimental permit allowing use of HICE vehicles in California. This permit would allow acquisition of data from the HICE certification vehicle and provide an opportunity to further mature the OBD compliance. The time period for using an experimental permit is likely limited to a maximum of 2 years.

The following list of items needed for applying for an experimental permit was provided by CARB (see Appendix D):

- Brief description of proposed vehicle modifications, including the following:
 - Purpose of the modification
 - Basic theory of operation and functional characteristics
- Defined test program for obtaining pertinent data on driveability, fuel economy, and emission effects as applicable
- Statement indicating which, if any, emission control components are removed or modified

- Make, model, year, and license number or vehicle identification number of vehicle(s) modified (if modifications are to a heavy-duty vehicle, include the engine serial number)
- Statement indicating disposition of the modified vehicle(s) at the end of the test program. Vehicles would either need to be updated to full OBD compliance or removed from road use in California.

Additional experimental permit information requested from Roush by CARB includes the following:

- In the near term, is there a plan to certify the hydrogen vehicles in California?
- Provide details on the durability test plan (i.e., components and emissions)
- Provide details on plan to develop a CARB-compliant OBDII System
- Length of test program
- Number of test vehicles
- Purchaser or owner of hydrogen kits or converted vehicles (in California)
- Acknowledgment from vehicle owner/operator that the permit will be valid for a fixed period of time, after which the vehicles would need to be converted back to the original certified configuration, shipped out of California, or converted to a certified hydrogen system.

Appendix A

Roush Correspondence with CARB

Appendix A

Roush Correspondence with CARB

ROUSH.

EMISSIONS LABORATORY

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Livonia, MI 48150
Telephone: (734) 779-7002
Fax: (734) 779-7902
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To: Rose Castro
California Air Resources Board
Date: 8/9/06
Subject: VC27156 Exemption for Hydrogen-fueled Internal Combustion Vehicle

Content	Page
1) Introduction	1
2) Vehicle Specifications	2
2) HICE Modification Challenges	2
3) Emissions Certification Plans	3
4) OBD II Plans	3
5) Production Status	3
6) Emissions Results	4

1) Introduction

ETEC and Roush Industries, working together, have developed 100% hydrogen internal combustion engine (HICE) pickup trucks. As the manufacturer of this vehicle, we are seeking a CARB Executive Order (EO) to sell this vehicle for use in California, and would like to apply for an exemption from Vehicle Code Section (VS) 27156 using Application B – Compliance Criteria Parts Application

Hydrogen as a fuel has certain advantages over fossil fuels. One advantage is the potential for low greenhouse gas emissions. Depending on the source of the hydrogen gas the greenhouse gas emissions will be lower than gasoline and if renewable energy is used to generate the hydrogen they may approach zero. Another advantage is the fuel contains no carbon molecules, so there are virtually zero hydrocarbon and carbon monoxide emissions.

Our hydrogen-fueled internal combustion engine full-size pickup carries six (6) people and has all of the utility of a pickup with zero hydrocarbon emissions. In performance and feel, it is very much like driving a gasoline fueled vehicle. This vehicle is not just for show, it will work right alongside an existing fleet of pickup trucks.

What better way for State and/or Federal agencies to demonstrate its support and commitment to the emerging hydrogen infrastructure than to actually use hydrogen fueled vehicles in its fleet? What better way to promote the growing number of local Hydrogen Energy Stations? These vehicles are essentially hydrogen burners so whomever wants to demonstrate the use of hydrogen fuel as an alternative would want to buy these vehicles;

Universities, utility companies, municipalities, military, or anyone who would want to demonstrate the viability of hydrogen or the impact it may have.

2) Vehicle Specifications

- a) Base vehicle is a 2005/2006 Chevrolet Silverado 1500HD equipped with a 4-door cab and room for six people.
- b) Hydrogen engine based on a 6.0L GM V8 with electronic port fuel injection and a supercharger/intercooler system optimized to achieve sufficient power and torque.
- c) 195 Horsepower and 260 lb-ft torque.
- d) 4-Speed automatic transmission.
- e) 10.5 kg of hydrogen fuel stored on-board at a pressure of 350 bar (5,000 psi), in three (3) 150-liter aluminum lined, carbon-fiber reinforced tanks.
- f) Driving range exceeds 250 km (155 miles).
- g) HICE conversion yields significant reductions in vehicle emissions compared to the gasoline-powered base engine.
- h) HC<10 ppm, NOx < 25 ppm steady-state as measured on an engine dynamometer. Feedgas = Tailpipe as no catalysts are used.

2) HICE Modification Challenges

- a) Engine Modifications
 - i) Integration of Lysholm supercharger to intake manifold (max. boost pressure = 12 psi).
 - ii) Integration of large liquid-to-air intercooler.
 - iii) Integration of OEM electronic throttle body.
 - iv) Selection of spark plugs for operation in hydrogen combustion environment.
- b) Engine control hardware and software integration efforts
 - i) Complete removal of OEM powertrain control module (PCM).
 - ii) Selection and integration of appropriate aftermarket PCM.
 - iii) Development of engine control strategies for hydrogen lean-burn operation.
 - iv) Development of matching transmission control strategies.
 - v) Implementation of J1850 communication to maintain seamless integration with existing OEM vehicle equipment.

3) Emissions Certification Plans

- a) CARB and EPA emissions certification process.
- b) Targeted applicable standards are Tier 2 – Bin 8.
- c) Refueling Test – waiver justification per 40 CFR 86.1801(k)(3)
- d) Particulate Test – waiver justification per 40 CFR 86.094-23(c)(1)
- e) LDT idle CO Test – waiver justification per 40 CFR 86.829-01(b)(5)
- f) Cold CO Test – waiver justification per 40 CFR 86.201(a)
- g) SFTP Test – waiver justification per 40 CFR 86.1810-01(h)(i)(4)
- h) Evaporative Test – waiver justification per 40 CFR 600.307-95
- i) Deterioration Factors -
- j) To date, emissions development was conducted at Argonne National Lab's 4-wheel chassis dynamometer, with dilution air scrubbing capability.

4) OBD II Plans

Hydrogen fueled vehicles do not produce hydrocarbons through the combustion process. Therefore, OBDII threshold for MIL illumination do not pertain to this vehicle.

Please see attached document, "H2ICE OBD Diagnostic List (081006).xls" for a complete list of sensors and their comprehensive component monitors (OBD – CCM).

5) Production Status

- a) Nine conversion vehicles are currently in production.
- b) One vehicle will participate in the Department of Energy's Advance Vehicle Testing activity (HICEV America test program).
- c) Eight vehicles were purchased by Powertech Labs to support the Industrial Waste Hydrogen Utilization Project (IWHUP) in BC, Canada.
- d) IWHUP will use recovered waste hydrogen to supply a network of refueling stations serving British Columbia's Hydrogen Highway™. Local businesses will lease the HICE trucks from Powertech Labs and operate them for a two year period.
- e) Additional vehicles will be produced on demand.

6) Emissions Results

- a) Currently, all vehicle emissions testing was conducted at the Argonne National Lab, using their 4-wheel chassis dynamometer, with dilution air scrubbing capability.

FTP75 Emission Results

Date	THC	NOx	CO	CO2	FE (mi/kg)
3/9/2006	0.0009	0.1236	0.0172	0.00	13.60
3/10/2006	0.0005	0.1281	0.0148	1.17	13.71

TIER 2 - BIN 8 50k STDS.

NMOG	NOx	CO
0.125	0.14	3.4

HWFET Emission Results

Date	THC	NOx	CO	CO2	FE (mi/kg)
3/9/2006	0.0001	0.0863	0.0061	0.00	19.57
3/10/2006	0.0000	0.0642	0.0084	0.23	19.65

Please contact me to further discuss the application process. We are anxiously awaiting the approval to sell this vehicle, and support the Hydrogen infrastructure that is being assembled in California and other parts of the world.

Sincerely,

Timothy Werner
Roush Industries
Emissions Lab Manager
734-779-7870
Email: tawern@roushind.com

August 30, 2006

Jason Wong
California Air Resources Board
OBD Certification Division

Subject: Catalytic Converter Delete On ETEC-Roush Hydrogen-fueled Internal Combustion Engine Vehicle (HICE)

Mr. Wong,

Working together, ETEC and Roush industries have developed a 100% hydrogen fueled internal combustion engine (HICE) light duty truck. We are seeking a CARB Executive Order (EO) to enable the sale and use of these vehicles in California, and would like to apply for an exemption. The base vehicle is a 2005-06 Chevrolet Silverado / GMC Sierra 1500HD (this may include the 2500HD series as well – TBD).

One advantage of hydrogen as a fuel over fossil fuels is that the fuel contains no carbon molecules. This ensures that there are virtually zero hydrocarbon and carbon monoxide emissions emitted from a running engine. NOx is the only regulated emissions constituent emitted from the engine.

Our strategy for NOx reduction in a hydrogen fueled vehicle is much different than that of a typical carbon based fuel such as gasoline or LPG. NOx reduction is achieved through lean-burn fuel control, and not through a conventional catalytic converter system. The Roush/ETEC hydrogen engine combustion operates at a fuel equivalence ratio of 0.45 (Lambda of 2.22) at all engine operating conditions. This lean operation reduces combustion pressure and temperature significantly, thus significantly reducing NOx. This strategy is the most feasible method for NOx control when operating on hydrogen.

The decision to remove the catalytic converters from the base vehicle was made because the catalyst system no longer contributes to any significant emissions reduction and poses a possible durability risk. Conventional catalysts like the original equipment removed from this vehicle, reduce NOx when operating rich of stoichiometry. Since the engine never operates in this condition, the catalyst system will not contribute to any NOx reduction. Potential risks associated with leaving the catalyst system in place are reduced exhaust system durability. If the vehicle encounters cylinder misfire, the unburned hydrogen from the cylinder could combust in the exhaust system. This could increase the temperature of the catalyst system to the point where the catalyst mechanically fails and plugs the exhaust system flow. This would have a large impact on driveability, and have an impact on warranty.

Since there are no emissions related drawbacks to removing the catalyst system, and there are potential risks for leaving the catalyst system in the exhaust, we feel that the best action is to remove the catalyst system from the vehicle.

Please contact me if you have any questions, or require further information.

Sincerely,

Timothy Werner
Roush Emissions Lab Manager
tawern@roushind.com

September 18, 2006

Mr. Jason Wong
California Air Resources Board
OBD Certification Division

Subject: OBD2 Monitor Information On ETEC-Roush Hydrogen-fueled Internal Combustion Engine Vehicle (H2ICE)

Mr. Wong,

Working together, ETEC and Roush industries have developed a 100% hydrogen fueled internal combustion engine (H2ICE) light duty truck. We are seeking a CARB Executive Order (EO) to enable the sale and use of these vehicles in California, and would like to apply for an exemption. The base vehicle is a 2005-06 Chevrolet Silverado / Sierra 1500HD (this may include the 2500HD series as well – TBD).

This vehicle is intended to support the emerging Hydrogen Highway and the associated infrastructure, and demonstrate the feasibility of Hydrogen as an alternative fuel. It is not intended as a commercially viable alternative to gasoline-powered vehicles. These vehicles are essentially hydrogen burners, so whomever wants to demonstrate the use of hydrogen fuel as an alternative, would want to buy these vehicles; universities, utility companies, municipalities, military, or anyone who would want to demonstrate the viability of hydrogen or the impact it may have.

GENERAL INFORMATION

The Hydrogen-fueled internal combustion (H2ICE) powertrain is controlled by a Roush developed PCM (engine and transmission controller). The OEM PCM has been completely removed from the vehicle. Custom algorithms were developed for the uniqueness of hydrogen operation, and the engine and transmission were calibrated for optimal emissions and drivability.

The custom PCM contains algorithms to detect a component malfunction, store a pending or confirmed fault code, and illuminate the MIL as required. The OBD II system is designed to operate, maintenance-free, for the life of the vehicle and cannot be reprogrammed or deactivated based on age and/or mileage of the vehicle. Although a generic scan tool can not be used to read error codes, a laptop containing all of the necessary software and hardware to do so will be provided with each new vehicle or fleet of vehicles sold (anticipated sales are 10-20 vehicles per year).

As this vehicle is intended to be a technology demonstrator, any and all service will be performed by Roush-designated personnel. This means that the vehicle will never be taken to standard service station or dealership for service. If a MIL is illuminated, specially selected personnel will analyze the error codes (using the laptop provided with the vehicle/fleet).

The intent of an OBD system is to diagnose and notify the user when an emissions controlled sensor, actuator, or other hardware has failed, or is failing to the point that emissions are

negatively impacted above a specific threshold. Roush feels that the vehicle meets the intent of this law as it pertains to hydrogen fueled vehicle emissions. Hydrogen as a fuel can not be classified with other typical fuels (e.g. gasoline, LPG, CNG) as the combustion characteristics are vastly different, thus the OBD system functionality must also be different, and requires re-examination by CARB.

OBD II SYSTEM

One advantage of hydrogen as a fuel over fossil fuels is that the fuel contains no carbon molecules. This ensures that there are virtually zero hydrocarbon and carbon monoxide emissions emitted from a running engine. NOx is the only measurable regulated emissions constituent emitted from the engine.

The strategy for NOx reduction in our hydrogen fueled vehicle is much different than that of a typical carbon based fuel such as gasoline or LPG. NOx reduction is achieved through lean-burn fuel control, and not through a conventional catalytic converter system. The Roush/ETEC hydrogen engine combustion operates at a fuel equivalence ratio of 0.45 (Lambda of 2.22) at all engine operating conditions. This lean operation reduces combustion chamber temperatures significantly, thus significantly reducing NOx. This strategy is the most feasible method for NOx control when operating on hydrogen. Combustion operation at or near stoichiometry creates a significant amount of NOx, such that a catalytic converter would not be capable of reducing NOx to the values obtained with lean fuel control.

1. CATALYST MONITOR

The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that the following occurs:

- ⊗ LEV II, ULEV II and MDV SULEV II:
 - NMOG > 1.75 x standard, or
 - NMHC conversion efficiency < 50%
 - NOx > 3.5 x standard

This application does not require the use of catalytic converters for emissions reduction so the OE catalysts have been removed, and thus, no need for this monitor.

Hydrogen fuel contains no hydrocarbons, therefore, the NMOG and NMHC limits do not apply to this vehicle. While the combustion process does make NOx, reduction of NOx through the OE catalytic converters is not possible as the vehicle never operates in a condition rich of stoichiometry (which is required for NOx reduction using three-way catalysts). This is one reason that the catalysts have been removed from the vehicle.

2. MISFIRE MONITOR

The OBD II system shall detect a misfire malfunction pursuant to the following:

- ⊗ Misfire causing catalyst damage
- ⊗ Misfire causing emissions to exceed 1.5 x standards.

This application does not require misfire monitoring as there are no catalysts to be damaged, nor the possibility of increase emissions as a result of misfire.

During a misfire event, unburned hydrogen will be expelled through the combustion chamber and out the tailpipe. Since hydrogen contains no hydrocarbons, nor carbon monoxide, these limits do not apply. NOx is a byproduct of combustion at very high temperatures. A misfire produces very low cylinder pressure, thus very low temperatures. Therefore, there is very minimal NOx produced during a misfire event. Hydrogen can burn

in the exhaust, elevating catalyst mid-bed temperatures, potentially causing catastrophic damage. This is another factor in the decision to remove the OE catalysts.

3. EVAPORATIVE SYSTEM MONITOR

The OBD II system shall detect an evaporative system malfunction when any of the following conditions exist:

- ⊞ No purge flow from the evaporative system to the engine can be detected by the OBD II system.
- ⊞ The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.040 inch diameter orifice.
- ⊞ The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.020 inch diameter orifice.

This application does not require evaporative system monitoring as this is a hydrogen fuel application using a closed fuel storage system. The possibility of vapor generation does not exist.

4. FUEL SYSTEM MONITOR

The OBD II system shall detect a malfunction of the fuel delivery system (including feedback control based on a secondary oxygen sensor) when any of the following conditions exist:

- ⊞ When the fuel delivery system is unable to maintain a vehicle's emissions at or below 1.5 x standards.
- ⊞ When the adaptive feedback control has used up all of the adjustment allowed by the manufacturer.
- ⊞ Whenever the fuel control system fails to enter closed-loop operation (if employed) within a manufacturers specified time interval.

For this application, NO_x would be the only emissions constituent that could increase with a fuel system malfunction. Due to the lean-burn operation of the engine, a rich shift would increase emissions, but a lean shift would not. Therefore, a rich shift would be the only fuel system monitor code required. Typically, a fuel shift is compensated or diagnosed with oxygen sensor feedback. However, an oxygen sensor is not utilized for fuel control in this application.

A fueling shift could be created by out of specification sensors or actuators. This application utilizes open loop fuel control at all times, such that a shift in overall fueling will cause an abnormal engine response. For a rich fuel shift, the engine response would be increased torque at idle due to high torque sensitivity to Air/Fuel ratio at our given lean-burn operating point. The impact would manifest itself as a shift in closed loop idle air control; less throttle required to achieve the same desired engine speed. The monitor is applied such that when the closed loop idle control throttle value exceeds the normal expected value for the current operating conditions by a calibratable value, for a calibratable time period, an error will be detected and the MIL will be illuminated. Roush is proposing to use this as the fuel system monitor.

Related Issues

- Vacuum Leak
An "unmetered air" condition, such as a disconnected vacuum hose, would create a leaner than normal mode which would have no detrimental impact on NO_x emissions.

- Exhaust Leak
Since oxygen sensors are not utilized for fuel control, an exhaust leak would not affect the fuel control and thus have no impact on NOx emissions.

5. OXYGEN SENSOR MONITOR

The OBD II system shall detect a malfunction of the oxygen sensor(s) when any of the following conditions exist:

5.1. Primary Sensor:

- ⊞ Prior to any failure or deterioration of the oxygen sensor voltage, response rate, amplitude, or other characteristics (drift, bias) that would cause a vehicle's emissions to exceed 1.5 x standards.
- ⊞ Either a lack of circuit continuity or out of range values.
- ⊞ The sensor output voltage, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD II system monitoring device.

5.2. Secondary Sensor:

- ⊞ Prior to any failure or deterioration of the oxygen sensor voltage, response rate, amplitude, or other characteristics (drift, bias) that would cause a vehicle emissions to exceed 1.5 x standards.
- ⊞ Either a lack of circuit continuity or out of range values.
- ⊞ The sensor output voltage, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD II system monitoring device.

5.3. Sensor Heaters:

- ⊞ When the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation.
- ⊞ Open or short circuits that conflict with the commanded state of the heater.

This application does not require Oxygen Sensor Monitoring as this application does not utilize oxygen sensors for fueling control. The vehicle runs open-loop fueling operation at all times (requested fuel/air equivalence ratio is 0.45 for all engine speed/load operation conditions).

6. SECONDARY AIR SYSTEM MONITOR

The OBD II system shall detect a malfunction of the secondary air system prior to a decrease from the manufacturer's specified air flow during normal operation when any of the following conditions exist:

- ⊞ Prior to any failure that would cause a vehicle's emissions to exceed 1.5 x standards.
- ⊞ No detectable amount of air flow is delivered.

This application does not require Secondary Air System Monitoring as this application is not equipped with a secondary air system. A secondary air system was not original equipment (OE) for this application.

7. EGR SYSTEM MONITOR

The OBD II system shall detect a malfunction of the EGR system prior to an increase or decrease from the manufacturer's specified EGR flow rate when any of the following conditions exist:

- ⊞ Prior to any failure that would cause a vehicle's emissions to exceed 1.5 x standards.
- ⊞ No detectable amount of EGR flow.

This application does not require EGR System Monitoring as this application is not equipped with an EGR system. An EGR system was not original equipment (OE) for this application.

8. PCV SYSTEM MONITOR

The OBD II system shall detect a malfunction of the PCV system when a disconnection of the system occurs between the crankcase and the PCV valve, or between the PVC valve and the intake manifold:

The PCV system is primarily designed to route residual gasoline vapor from the crankcase, to the intake manifold for combustion. It is a sealed system intended to prevent hydrocarbons in the crankcase to vent to the atmosphere.

Hydrogen fuel contains no hydrocarbons, thus there will be no fueling related crankcase vapor detrimental to the atmosphere. In our application, a PCV system is employed, but we believe that the PCV System Monitor is not required.

9. ENGINE COOLING SYSTEM MONITOR

The OBD II system shall detect a thermostat malfunction if within a time interval after starting the engine either of the following two conditions exist:

- ⌘ The coolant temperature does not reach the highest temperature required by the OBD II system to enable diagnostics.
- ⌘ The coolant temperature does not reach a warmed-up temperature within 20°F of the manufacturer's nominal thermostat regulating temperature.
 - Subject to Executive Officer approval, a manufacturer may utilize lower temperatures for this criterion upon the Executive Officer determining that the manufacturer has demonstrated that the fuel, spark timing, and/or other coolant temperature-based modifications to the engine control strategies would not cause an emission increase of 50 or more percent of any of the applicable standards.

This application does not require Engine Cooling System Monitoring as the calibrations for fuel control, and spark advance are not modified as a function of coolant temperature.

The one exception is for the calculation of start fuel. Fuel to start is modified as a function of coolant temperature at start, but not once the engine is running. The start fuel is decreased as a function of time since the engine has started. Following the start, coolant temperature is no longer used for any fuel nor spark calculation. There are no engine control strategies based on coolant temperature that would cause an emissions increase of 50 or more percent of any applicable standards.

10. COLD START EMISSION REDUCTION STRATEGY MONITOR

The OBD II system shall detect a malfunction of the Cold Start Emission Reduction Strategy prior to any failure or deterioration of the individual components associated with the Cold Start Emission Reduction Control Strategy when any of the following conditions exist:

- ⌘ Prior to any failure that would cause a vehicle's emissions to exceed 1.5 x standards.

This application does not require Cold Start Emission Reduction Strategy Monitor because this application does not incorporate a specific engine control strategy to reduce cold start emissions.

11. AIR CONDITIONING A/C SYSTEM COMPONENT MONITOR

The OBD II system shall detect a malfunction of the A/C System prior to any failure or deterioration of an electronic component of the air conditioning system when any of the following conditions exist:

- ⌘ Prior to any failure or deterioration that would cause a vehicle's emissions to exceed 1.5 x standards.

This application does not require Air Conditioning system monitoring as no single electronic component failure or deterioration causes emissions to exceed 1.5 x any of the appropriate applicable standards, nor is used as part of the diagnostic strategy for any other monitored system or component.

12. VARIABLE VALVE TIMING (VVT) SYSTEM MONITOR

This application does not require VVT system monitoring as this application is not equipped with a VVT system. A VVT system was not original equipment (OE) for this application.

13. DIRECT OZONE REDUCTION (DOR) SYSTEM MONITOR

This application does not require Direct Ozone Reduction (DOR) system monitoring as this application is not equipped with a DOR system. A DOR system was not original equipment (OE) for this application.

14. COMPREHENSIVE COMPONENT MONITOR

The OBD II system shall monitor for malfunction any electronic powertrain component/system not otherwise described in sections 1-13 of this document that wither provides input to (directly or indirectly) or receives commands from the on-board computer and:

- ⌘ Can affect emissions during any reasonable in-use driving condition, or
- ⌘ Is used as part of the diagnostic strategy for any other monitored system or component

Refer to attachment titled "H2ICE OBD Diagnostic List (081006).xls" for a complete list of all components monitored.

EMISSION TESTING RESULTS

Currently, all vehicle emissions testing were conducted at the Argonne National Lab, using their 4-wheel chassis dynamometer, with dilution air scrubbing capability. The following are results from emissions testing of this vehicle:

FTP75 Emission Results

Date	THC	NOx	CO	CO2	FE (mi/kg)
3/9/2006	0.0009	0.1236	0.0172	0.00	13.60
3/10/2006	0.0005	0.1281	0.0148	1.17	13.71
7/11/06	0.0000	0.0579	0.0842	0.00	13.89
7/12/06	0.0009	0.0641	0.0528	0.19	14.03

TIER 2 – BIN 8 50k STDS.

NMOG	NOx	CO
0.125	0.14	3.4

HWFET Emission Results

Date	THC	NOx	CO	CO2	FE (mi/kg)
3/9/2006	0.0001	0.0863	0.0061	0.00	19.57
3/10/2006	0.0000	0.0642	0.0084	0.23	19.65
7/12/06	0.0000	0.0270	0.0478	0.00	20.57

Please contact me to further discuss our request for the approval of our OBD2 system. We are anxiously awaiting the approval to sell this vehicle, and support the Hydrogen infrastructure that is begin assembled in California and other parts of the world.

Sincerely,


Timothy Werner
Roush Industries
Emissions Lab Manager
734-779-7870
Email: tawern@roushind.com

Appendix B

CARB Executive Order A-006-1340

Appendix B

CARB Executive Order A-006-1340

 AIR RESOURCES BOARD	GENERAL MOTORS CORPORATION	EXECUTIVE ORDER A-006-1340 New Diesel or Incomplete Medium-Duty Vehicles Using Certified Engines
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Pursuant to the authority vested in the Air Resources Board by Health and Safety Code Division 26, Part 5, Chapter 2; and pursuant to the authority vested in the undersigned by Health and Safety Code Sections 39515 and 39516 and Executive Order G-02-003;

IT IS ORDERED AND RESOLVED: The following diesel or incomplete medium-duty vehicles (MDV) with a manufacturer's GVWR from 8501 to 14000 pounds are certified as described below. Production vehicles shall be in all material respects the same as those for which certification is granted.

ENGINE DESCRIPTION									
MODEL YEAR	ENGINE FAMILY	ENGINE MANUFACTURER	EMISSION STD CATEGORY ²	FUEL TYPE ¹	STANDARDS & TEST PROCEDURE	ENGINE SIZES (L)	ECS & SPECIAL FEATURES ³	OBD COMPLIANCE	
	6GMXH06.0583			Gasoline					
	EXECUTIVE ORDER								
2006	A-006-1327	GENERAL MOTORS CORPORATION	ULEV		Otto	6.0	2TWC, 2HO2S(2), SFI	OBD(F)	
Gasoline, LPG or Alcohol Vehicles Only			VEHICLE DESCRIPTION						
EVAPORATIVE		FUEL TANK CAPACITY (gallons)	VEHICLE MODEL YEAR	VEHICLE MAKE & MODELS		ENGINE (L)	ENGINE MODELS / CODES (rated power, in hp)	OBD COMPLIANCE	
FAMILY	UL (K)								
6GMXE0300998	150	26, 27, 34	2006	CK10: Chevrolet Silverado 1500HD, GMC Sierra 1500HD; CK20: Chevrolet Silverado 2500, Silverado 2500HD; GMC Sierra 2500, Sierra 2500HD		6.0	LQ4 / 30 (300), LQ4 / 40 (300)	OBD(F)	
6GMXE0300998	150	26, 27, 34, 50	2006	CK30: Chevrolet Silverado 3500, Silverado 3500 Cab Chassis; GMC Sierra 3500, Sierra 3500 Cab Chassis		6.0	LQ4 / 30 (300), LQ4 / 40 (300)	OBD(F)	
6GMXE0300998	150	33, 57	2006	G30: Chevrolet Express Commercial Cutaway 3500, GMC Savana Special Cutaway 3500		6.0	LQ4 / 30 (300)	OBD(F)	
6GMXE0300998	150	30	2006	Isuzu NPR; W35: Chevrolet W3500, GMC W3500		6.0	LQ4 / 30 (300)	OBD(F)	

¹=not applicable; GVWR=gross vehicle weight rating; 13 CCR xyz=Title 13, California Code of Regulations, Section xyz; 40 CFR 86.abc=Title 40, Code of Federal Regulations, Section 86.abc;

²letter: hp=horsepower; kw=kilowatt;

³CNG/LNG=compressed/liquefied natural gas; LPG=liquefied petroleum gas; E85=85% ethanol fuel; MF=multi fuel a.k.a BF=bi fuel; DF=dual fuel; FF=flexible fuel;

¹EC=emission control system; 2TWC=two-wayoxidizing catalyst; WU (prefix) =warm-up catalyst; DPF=diesel particulate filter; HO2S/O2S=heated/oxygen sensor; HAFS/AFS=heated/air/fuel-ratio sensor (a.k.a., universal or linear oxygen sensor); TBI=throttle body fuel injection; SFIMFI=sequential/multi port fuel injection; DGI=direct gasoline injection; GGAB=gaseous carburetor; IDI/DI=indirect/direct diesel injection; TC/GC=turbo/super charger; CAC=charge air cooler; EGR=exhaust gas recirculation; PAIR/AIR=pulse/secondary air injection; SPL=sneak puff limiter; CCMF=check mass flow; CCM=check mass; CCM=

¹ not applicable; GVWR=gross vehicle weight rating; 13 CCR xyz=Title 13, California Code of Regulations, Section xyz; 40 CFR 86.abc=Title 40, Code of Federal Regulations, Section 86.abc; (2004may26)
² =liter; hp=horsepower; kw=kilowatt;
³ CNG/LNG=compressed/liquefied natural gas; LPG=liquefied petroleum gas; E85=85% ethanol fuel; MF=multi fuel a.k.a BF=bi fuel; DF=dual fuel; FF=flexible fuel;
⁴ SULEV / ULEV / LEV=super ultra / ultra / low emission vehicle;
⁵ ECS=emission control system; TWC/OC=three-way/oxidizing catalyst; WU (prefix)=warm-up catalyst; DPF=diesel particulate filter; HO2S/O2S=heated/oxygen sensor; HAFS/AFS=heated/air-fuel-ratio sensor (a.k.a., universal or linear oxygen sensor); TBI=throttle body fuel injection; SFIM/FI=sequential/multi port fuel injection; DGI=direct gasoline injection; GCARB=gaseous carburetor; IDI/DDI=indirect/direct diesel injection; TCSC=turbocharger; CAC=charge air cooler; EGR=exhaust gas recirculation; PAIR/AIR=pulsed/secondary air injection; SPL=speed limit; OBD(F) / (P) / (S)=full / partial / on-board diagnostic; ECM/PCM=engine/powertrain control module; EM=engine modification; 2 (prefix)=parallel; (2) (suffix)=in series;

Following are: 1) the FTP exhaust emission standards or family emission limit(s) as applicable under 13 CCR 1956.8; 2) the EURO and NTE limits under the applicable California exhaust emission standards and test procedures for heavy-duty diesel engines and vehicles (Test Procedures); and 3) the corresponding certification levels, in g/bhp-hr, for this engine family. "Diesel" CO, EURO and NTE certification compliance may have been demonstrated by the manufacturer as provided under the applicable Test Procedures in lieu of testing. (For dual- and flexible-fuel, the CERT values in brackets [] are those when tested on conventional test fuel.)

	NMHC		NOx		NMHC+NOx		CO		PM		HCHO	
	FTP	EURO	FTP	EURO	FTP	EURO	FTP	EURO	FTP	EURO	FTP	EURO
STD	*	*	*	*	*	*	14.4	*	*	*	0.050	*
FEL	*	*	*	*	0.8	*	*	*	*	*	*	*
CERT	*	*	*	*	0.6	*	5.6	*	*	*	0.003	*
NTE	*	*	*	*	*	*	*	*	*	*	*	*

* g/bhp-hr=grams per brake horsepower-hour; FTP=Federal Test Procedure; EURO=Euro III European Steady-State Cycle; NTE=Not-to-Exceed emission limit; STD=standard or emission test cap; FEL=family emission limit; CERT=certification level; NMHC/HC=non-methane/hydrocarbon; NOx=oxides of nitrogen; CO=carbon monoxide; PM=particulate matter; HCHO=formaldehyde;

BE IT FURTHER RESOLVED: Certification to the FEL(s) listed above, as applicable, is subject to the following terms, limitations and conditions. The FEL(s) is the emission level declared by the manufacturer and serves in lieu of an emission standard for certification purposes in any averaging, banking, or trading (ABT) programs. It will be used for determining compliance of any engine in this family and compliance with such ABT programs.


BE IT FURTHER RESOLVED: The listed engine models have been certified to the optional emission standards and test procedures in 13 CCR 1956.8 applicable to diesel or incomplete MDV with a 8501-14000 pound GVWR and shall be subject to 13 CCR 2139(c) (in-use testing of engines certified for use in diesel or incomplete MDV with a 8501-14000 pound GVWR).

BE IT FURTHER RESOLVED: The listed engine models have been certified to the Option 1 federal NMHC+NOx emission standard listed above pursuant to 13 CCR 1956.8.

BE IT FURTHER RESOLVED: For the listed vehicle models the manufacturer has submitted the materials to demonstrate certification compliance with 13 CCR 1965 (emission control labels), 13 CCR 1968.2 (on-board diagnostic, full or partial compliance), 13 CCR 1976(b)(1)(F) (evaporative emission standards), 13 CCR 2035 et seq. (emission control warranty), and 13 CCR 2235 [fill pipes and openings of motor vehicle fuel tanks]. (The braces {} are for gasoline, LPG or alcohol fueled vehicles only. The brackets [] are for gasoline or alcohol fueled vehicles only.)

Vehicles certified under this Executive Order shall conform to all applicable California emission regulations. The Bureau of Automotive Repair will be notified by copy of this Executive Order.

Executed at El Monte, California on this 22nd day of April 2005.


Allen Lyons, Chief
Mobile Source Operations Division

Appendix C

Alternate Fuel Retrofit Systems Final CARB Regulatory Orders

Appendix C

Alternate Fuel Retrofit Systems Final CARB Regulatory Orders

*FINAL REGULATORY ORDER

FINAL REGULATORY ORDER

This final regulatory order consists of the following documents:

- Attachment A: Amendments to the "California Certification and Installation Procedures for Alternative Fuel Retrofit Systems for Motor Vehicles Certified for 1994 and Subsequent Model Years"
- Attachment B: Amendments to the "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas Fuels"
- Attachment C: Amendments to the "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels"
- Attachment D: Amendments to Article 5, Chapter 1, Division 3, Title 13 of the California Code of Regulations
 - Amendments to Section 2030 of Chapter 5
 - Amendments to Section 2031 of Chapter 5
- Attachment E: Section 1956.9 Optional Exhaust Emissions Standards for Retrofitted Heavy-Duty Engines

ATTACHMENT A

**MODIFICATIONS TO THE
"CALIFORNIA CERTIFICATION AND INSTALLATION PROCEDURES
FOR ALTERNATIVE FUEL RETROFIT SYSTEMS FOR MOTOR VEHICLES
CERTIFIED FOR 1994 AND SUBSEQUENT MODEL YEARS"
AS DECIDED AT THE BOARD HEARING ON JULY 27, 1995**

State of California
AIR RESOURCES BOARD

CALIFORNIA CERTIFICATION AND INSTALLATION PROCEDURES
FOR ALTERNATIVE FUEL RETROFIT SYSTEMS FOR MOTOR VEHICLES
CERTIFIED FOR 1994 AND SUBSEQUENT MODEL YEARS
AND FOR ALL MODEL YEAR MOTOR VEHICLE RETROFIT SYSTEMS
CERTIFIED FOR EMISSION REDUCTION CREDIT

Adopted: March 11, 1993
Amended: April 26, 1995
Amended: November 21, 1995

Note: Changes approved by the Board on July 27, 1995, are indicated by strike-out (deletion) and underline (addition).

TABLE OF CONTENTS

		Page
1.	APPLICABILITY	A-1
2.	DEFINITIONS	A-2
3.	GENERAL REQUIREMENTS	A-3
	(a) Product Specifications	A-3
	(b) Emission Control Labels	A-4
	(c) Owner's Manuals	A-5
	(d) Manufacturer Recordkeeping Requirement	A-5
	(e) Installer Recordkeeping Requirement	A-6
4.	REQUEST FOR CERTIFICATION	A-6
5.	TEST PROCEDURES	A-7
	(a) Description of Vehicle Categories	A-7
	(b) Test Procedures for Vehicles in Category I	A-8
	(c) Test Procedures for Vehicles in Category II <u>Not Being</u> <u>Certified for Credit-Generation Purposes</u>	A-10
	(d) Test Procedures for Vehicles in Category III <u>Not Being</u> <u>Certified for Credit-Generation Purposes</u>	A-11
	(e) <u>Test Procedures for Vehicles in Category II Certified</u> <u>for Emission Reduction Credits</u>	A-12
	(f) <u>Test Procedures for Vehicles in Category III Certified</u> <u>for Emission Reduction Credits</u>	A-13
	(g) <u>Alternate Test Procedure for Vehicles in Category I, or</u> <u>for Vehicles in Categories II or Category III Not Being</u> <u>Certified for Credit Generation Purposes</u>	A-13
	(h) <u>Alternate Test Procedure for Vehicles in Category II or</u> <u>Category III Certified for Credit Generation</u>	A-14
6.	APPROVAL	A-14
	(a) Issuance of Executive Orders	A-14
	(b) Carry-Over and Carry-Across	A-15

	Page
7. INSTALLATION REQUIREMENTS	A-15
8. IN-USE ENFORCEMENT TEST REQUIREMENTS	A-17
9. WARRANTY REQUIREMENTS	A-19
(a) Requirements of Manufacturers	A-19
(b) Extended Warranty Requirements.	A-19
(c) Requirements of Installers	A-20

California Certification and Installation Procedures
for Alternative Fuel Retrofit Systems for Motor Vehicles
Certified for 1994 and Subsequent Model Years
and for all Model Year Motor Vehicle Retrofit Systems
Certified for Emission Reduction Credit

1. APPLICABILITY

- (a) "Certification and Installation Procedures for Alternative Fuel Retrofit Systems for Motor Vehicles Certified for 1994 and Subsequent Model Years and Retrofit Procedures for Emission Reduction Credit for all Model Years" ("these Procedures") apply to alternative fuel retrofit systems designed for installation on gasoline- or diesel-fueled light-, medium-, and heavy-duty motor vehicles for 1994 and subsequent model years, and alternative fuel and conventional fuel retrofit systems for emission reduction credits for all model years.
- (b) Only these procedures shall be used to certify a retrofit system for the purpose of generating emission reduction credits. Each retrofit system manufacturer shall certify all engine family systems to be used for generating emission reduction credits regardless of model year (MY) or fuel used.
- (c) Only these Procedures shall be used to certify a retrofit system for installation on a transitional low-emission vehicle ("TLEV"), low-emission vehicle ("LEV"), or ultra-low-emission vehicle ("ULEV") or to certify a retrofit system designed to convert a vehicle to TLEV, LEV, or ULEV emission standards (as defined in Section 1960.1, Title 13, CCR).
- (d) Each manufacturer shall certify a minimum of 15 percent of 1994, 55 percent of 1995, 55 percent of 1996, and 100 percent of 19967 and subsequent model year engine family retrofit systems according to the requirements of these Procedures except as provided in paragraph 1.(b). "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas or Natural Gas Fuels," (for certifying liquefied petroleum gas or natural gas retrofit systems) and "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels" (for certifying alcohol and alcohol/gasoline retrofit systems) shall be used to certify the remaining percentage of 1994, 1995, and 19956 model year engine family systems and 1993 and prior model year engine family systems, except as provided in paragraph 1.(b) and 1.(e) The percentages shall be determined from the total number of retrofit systems certified and shall be met prior to the end of the next respective calendar year.

(b)

(e) A retrofit system manufacturer may as an option use these Procedures to certify non-credit generating alternative fuel retrofit systems designed for installation on pre-1994 model year gasoline- or diesel-fueled light-, medium-, and heavy-duty motor vehicles, with the following addition: the Executive Officer may order 25,000 mile durability vehicle testing for alternative fuel retrofit systems designed for installation on pre-1994 model year vehicles which include hardware or components other than the fuel conversion system as part of the overall retrofit system.

(e)

(f) A certification for an alternative fuel retrofit system issued pursuant to these Procedures shall have the effect of a certification of an alternative fuel retrofit system pursuant to Health and Safety Code Section 43006. A certification for retrofit equipment utilizing any fuel, issued pursuant to these regulations, and shall also have the effect of an exemption issued pursuant to Vehicle Code Sections #27156 and 38395.

2. DEFINITIONS

"Alternative fuel" refers to liquefied petroleum gas, natural gas, alcohol and alcohol/gasoline fuels.

An "alternative fuel retrofit system" or "~~retrofit~~ system" is a package of fuel, ignition, emission control, and engine components that are modified, removed, or added during the process of modifying a motor vehicle to operate on an alternative fuel. Such systems can be optionally certified to generate credits.

"Conventional fuel" means gasoline or diesel fuel.

"Credit-generating conventional fuel retrofit system" is a retrofit system that is certified to generate credits and that operates exclusively on the fuel for which the engine family was originally certified.

"Credits" refers to mobile source emission reduction credits.

"Driveability" of a vehicle refers to the smooth delivery of power, as demanded by the driver. Typical causes of driveability degradation are rough idling, misfiring, surging, hesitation, or insufficient power. Conversion from gasoline to gaseous fuels usually entails a loss of volumetric efficiency, resulting in some power loss. Normal power loss shall not be considered to be driveability degradation.

"Dual fuel" refers to a retrofit system which utilizes both an alternative fuel and a conventional fuel without further hardware changeover required.

"Installer" refers to a person who installs alternative fuel or credit-generating conventional fuel retrofit systems on motor vehicles.

"Retrofit system" is a package of fuel, ignition, emission control, and engine components that are modified, removed, or added during the process of modifying an engine to operate at an emission rate lower than the rate to which the engine family was originally certified.

"Retrofit system manufacturer" or "manufacturer" refers to a person who manufactures or assembles an alternative fuel or credit-generating conventional fuel retrofit system for sale in California and requests or is granted the Executive Order certifying the alternative fuel or credit-generating conventional fuel retrofit system.

"Tier 1" refers to the emission standards applicable to 1995 and subsequent model year light-duty vehicles, not considered as TLEV's, ULEV'S or LEV'S, and as described in Section 1960.1, Title 13, California Code of Regulations.

For purposes of these Procedures "useful life" is the duration, expressed in miles, of the longest durability period for the new vehicle or engine emission standards to which the vehicle or engine family was certified. (This is typically 50,000 miles for light-duty vehicles. However, as of the 1993 model year, a phase-in of new, more stringent, light-duty standards with 100,000 mile useful life requirements will begin.)

3. GENERAL REQUIREMENTS

(a) Product Specifications:

In addition to all other standards or requirements imposed, the following general requirements shall apply to all alternative fuel or credit-generating conventional fuel retrofit systems to be certified for installation on California-certified gasoline or diesel-fueled motor vehicles:

- (i) Alternative fuel retrofit systems for gaseous fuels shall be equipped with a lockoff valve, actuated by an electrical or vacuum signal, preventing delivery of fuel to the carburetor, or fuel injection system, while the engine is shut down.
- (ii) The driveability of a vehicle equipped with a retrofit system shall not be degraded in such a way as to encourage consumer tampering. To verify that the driveability of a retrofitted vehicle is acceptable, the Executive Officer may require that an independent laboratory evaluate driveability. The Executive Officer's determination that driveability must be evaluated shall be based on an engineering evaluation of the retrofit system described in the application for certification or on reports or observations that retrofit systems similar in design to the system for which certification is sought have caused driveability degradation. The cost of this evaluation shall be borne by the applicant.
- (iii) If the vehicle to be retrofitted was certified with an on-board diagnostic (OBD) system pursuant to Section 1968 or 1968.1, Title 13, California Code of Regulations (CCR), the proper

function of the on-board diagnostic system shall not be impaired as a result of the installation and operation of the alternative fuel or credit-generating conventional fuel retrofit system. This requirement may necessitate modification of the OBD system to prevent it from storing erroneous trouble codes (e.g., storing a code signifying faulty operation of the evaporative canister purge valve because the evaporative emission control system has been removed). All modifications to OBD components, programming or wiring, must be fully specified as parts of the retrofit system. If the retrofit system includes modifications to the OBD system, the applicant must submit an analysis showing that these modifications will not adversely affect OBD performance. Notwithstanding, for 1998 and previous model year vehicles, retrofit system manufacturers may request Executive Officer approval to disable specific on-board diagnostic monitoring strategies for which monitoring may not be reliable with respect to the use of alternative fuels (e.g., oxygen sensor response rate checks). The manufacturer shall submit data and/or an engineering evaluation to justify the request.

- (iv) With the exception of idle speed control and throttle position control, no component or calibration of the fuel system that could affect emission performance shall be adjustable by the system installer or the vehicle's user.

(b) Emission Control Labels:

"California Motor Vehicle Emission Control Label Specifications," incorporated by reference in Title 13, CCR, Section 1965, shall apply to installations of alternative fuel or credit-generating conventional fuel retrofit systems, with the following additions:

- (i) The retrofit system manufacturer shall provide a supplemental Emission Control Information label, which shall be affixed in a permanent manner to each retrofitted vehicle, in a location adjacent to the original Emission Control Information Label. If the supplemental label cannot be placed adjacent to the original label, it shall be placed in a location where it can be seen by a person viewing the original label.
- (ii) The supplemental label shall clearly state that the vehicle has been equipped with an alternative fuel retrofit system designed to allow it to operate on a fuel other than gasoline or diesel, and shall identify the fuel(s) which the vehicle is designed to use. The label shall show the vehicle model year; the Executive Order number certifying the retrofit system; the retrofit system manufacturer's name, address, and telephone number; and shall state that the retrofitted vehicle complies with California emission requirements. If the retrofit system has been certified as being capable of converting the vehicle into a Tier 1, TLEV, LEV, or ULEV, the label shall prominently display the title, "Tier 1 Vehicle," "Transitional Low-Emission Vehicle," "Low-Emission Vehicle," or "Ultra-Low-Emission Vehicle," as appropriate. If the retrofit system has been certified for credit-generation use on a heavy-duty vehicle, the label will

state the applicable credit standards, as defined in Section 1956.9, Title 13, California Code of Regulations. The label shall also list any original parts that were removed during installation of the retrofit system, as well as any changes in tune-up specifications required for the retrofit system. In addition, the label shall show the installer's name, address, and telephone number; the date on which the retrofit system was installed; and the mileage (retrofitted vehicle odometer reading) and date at which the retrofit system warranty expires. It is not necessary for emission control labels installed with retrofit systems to be machine readable. The supplemental label for an alternative fuel retrofit vehicle shall clearly state that the vehicle has been equipped with an alternative fuel retrofit system designed to allow it to operate on a fuel other than gasoline or diesel, and shall identify the fuel(s) that the vehicle is designed to use.

- (iii) The retrofit system manufacturer shall provide a vacuum hose routing diagram for each alternative fuel retrofit system sold, and for any other retrofit that includes changes to the vacuum hose routing. The vacuum hose routing diagram shall be placed underhood in a permanent manner at a visible and accessible location and shall show modifications to the original vacuum system.

(c) Owner's Manuals:

Each retrofit system installed shall include an owner's manual containing at least the following information:

- (i) a brief description of the retrofit system, including major components and their theory of operation;
- (ii) the correct refueling procedure for alternative fuel retrofits;
- (iii) a listing of necessary service and service intervals, as well as tune-up data, which differ from the service requirements specified by the vehicle's or engine's original manufacturer;
- (iv) the name, address, and phone number of the installer, as well as a list of the names, addresses, and phone numbers of the major dealers in California who supply parts for, or service, the retrofit system; and
- (v) warranty information.

(d) Manufacturer Recordkeeping Requirement:

Manufacturers of retrofit systems shall maintain a record of the vehicle identification numbers and California license plate numbers of those vehicles on which their product has been installed. As part of this record, manufacturers shall identify the installation date and the certification number of those systems installed on each vehicle and shall identify the vehicles' owners at the time of installation, including the owners' current addresses and phone numbers at the time of installation. The retrofit system

manufacturer shall supply a copy of all installation information to the Executive Officer upon request.

(e) Installer Recordkeeping Requirement:

Installers of retrofit systems shall maintain a record as specified in paragraph 3(d) and shall provide this information to retrofit system manufacturers upon request.

4. REQUEST FOR CERTIFICATION

(a) A request for certification of an alternative fuel or credit-generating conventional fuel retrofit system may be submitted by an authorized representative of the retrofit system manufacturer intending to offer the retrofit system for sale or installation in the State of California.

(b) A separate request shall be required for each model year, even though the emission standards for certifying new vehicles may be the same for consecutive model years. The request shall include all test data and other information required pursuant to these Procedures, except where other provisions of these Procedures allow carry-over or carry-across of test data from an engine family to the engine family(ies) for which certification is sought. Procedures governing carry-over and carry-across are discussed under paragraph 6, "Approval."

(c) The request for certification shall be submitted in writing, signed by an authorized representative of the retrofit system manufacturer, and shall include the following:

(i) Identification and description of the engine families for which the retrofit system to be certified is designed; the emission standards applicable to those engine families; and if applicable, a statement that the retrofit system is designed [A] to convert conventional vehicles into either TLEVs, LEVs or ULEVs, [B] to convert a TLEV into either an LEV or ULEV, or [C] to convert an LEV into a ULEV, [D] to convert 1994 or earlier model year vehicles into Tier 1 Vehicles, or [E] to convert heavy-duty vehicles for emission reduction credit. For [E] include the credit standard(s) proposed for certification from the "Optional Exhaust Emission Standards for Retrofitted Heavy-Duty Engines", as contained in Section 1956.9, Title 13, California Code of Regulations.

(ii) A complete description of the alternative fuel retrofit system, including details of the carburetor, mixer, regulator, vaporizer, or fuel injection system; the feedback mixture control system (if applicable), part number(s), calibration data, hose routing, specifications for the fuel tank, and pressure regulator; a sample of the emission control label as specified in 3.(b); a sample of the warranty statement as specified in 9(a) and (b); and all necessary modifications to the engine, emission control system, or other parts of the vehicle.

- (iii) Procedures for installing and maintaining the retrofit system, including tune-up specifications and discussion of any special tools or techniques required for proper installation, maintenance, or operation.
- (iv) An agreement to supply the Air Resources Board, within 45 calendar days of the Executive Officer's request, with any one or more of the vehicles used for certification testing, or to provide Air Resources Board personnel with the equipment to inspect and test such vehicles at the applicant's facility, if requested by the Executive Officer.
- (v) For retrofit systems being certified for credit-generation, the manufacturer shall provide, in writing, the name(s) and address(es) of the fabrication, assembly line(s), and test facility(ies) where the retrofit kit is manufactured and tested.
- (vi) For retrofit systems being certified for credit-generation, the manufacturer shall provide an engineering analysis upon request from the Executive Officer. Such analysis shall describe the detailed operating theory of the retrofit system based on accepted scientific and engineering principles. Final certification will require ARB acceptance and approval of the analysis.
- (vii) For conventional fuel retrofits for credit-generation, the manufacturer shall provide a complete description of the major components of the retrofit system and part number(s).

5. TEST PROCEDURES

(a) Description of Vehicle Categories:

For the purposes of these certification Procedures, the motor vehicle fleet is divided into three major categories:

- I. Passenger cars, light-duty trucks, and medium-duty vehicles as defined in "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" (as incorporated by reference in Section 1960.1, Title 13, CCR), which were certified to an exhaust emission standard based on a chassis-dynamometer test procedure;
- II. Vehicles with gross vehicle weight ratings less than or equal to 14,000 lbs and not originally certified to a chassis dynamometer-based exhaust emission standard; and
- III. Vehicles with gross vehicle weight ratings greater than 14,000 lbs.

(b) Test Procedures for Vehicles in Category I:

Vehicles in Category I may certify under these provisions, or under the alternate test procedures given in 5(g).

For vehicles in Category I, the emission standards and test procedures set forth in the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" also apply to the certification of alternative fuel or credit-generating conventional fuel retrofit systems, with the following exceptions:

- (i) The applicable emission standards shall be at least as stringent as the emission standards applicable to the engine families for which the retrofit systems to be certified are designed. For credit-generation, the applicable emission standards shall be the Tier 1 and LEV program standards. Dual-fuel vehicles must be certified on each of the two fuels. For dual-fuel vehicles certified for credit, the certification standards for the two fuels shall be no more than one tier apart. In addition, vehicles retrofitted to operate on a given alternative fuel shall also be subject to any additional emission standards applicable to new motor vehicles that are designed to operate on the alternative fuel, and that are of the model year and vehicle class for which certification is sought. A maximum of one emission-data vehicle per engine family for which certification is sought shall be required. Where durability testing is required, a bench-test vehicle may be substituted for a durability vehicle and may also be considered an emission-data vehicle. Prior to the commencement of testing, the choice of durability vehicle or bench-test vehicle, emission-data vehicle(s) and engine(s) must be approved by the Executive Officer as being representative of the range of engine families for which certification is sought.
- (ii) For the purpose of applying the provisions of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" to certification testing of alternative fuel or credit-generating conventional fuel retrofit systems, test vehicles equipped with an alternative fuel or credit-generating conventional fuel retrofit system shall be assumed to have zero miles of mileage accumulation at the time that the retrofit system is installed. Mileage may be subsequently accumulated by driving the vehicle on the road, following a typical suburban route, or on a chassis dynamometer using the Automobile Manufacturer's Association mileage accumulation cycle (40 C.F.R., Part 86, Appendix IV, as adopted January 28, 1977).
- (iii) Vehicle mileage accumulation on a durability vehicle or bench aging of retrofit system components shall be conducted to determine deterioration factors. Prior to the commencement of any emission or bench aging, the applicant's test plan must be approved by the Executive Officer. Approval of the test plan shall be contingent upon a demonstration by the applicant that bench aging produces deterioration factors at least as great as durability vehicle testing.
- (iv) Bench aging conducted in lieu of vehicle mileage accumulation shall be conducted for a period of time such that the resulting

deterioration of the retrofit system is equivalent to that which would occur during durability vehicle mileage accumulation over a mileage equal to the useful life of the vehicle.

- (v) Vehicle mileage accumulation on a durability vehicle shall be performed in conjunction with emission testing. Before beginning vehicle mileage accumulation of the retrofit system, the system shall be installed on the durability vehicle, the vehicle shall be driven 4,000 + 100 miles and then tested. An alternative fuel retrofit the vehicle shall be tested using the alternative fuel. A dual-fuel retrofit system shall be emission tested using each fuel that it is capable of operating on. At the conclusion of vehicle mileage accumulation, a second emission test or series of tests shall be performed.

Alternatively, if bench aging is used to determine deterioration factors, then bench aging shall be performed in conjunction with emission testing of a bench-test vehicle. Before beginning bench aging of the retrofit system, it shall be installed on the bench-test vehicle, the vehicle shall be driven for 4,000 + 100 miles, and the vehicle shall then be emission tested. Alternative fuel retrofits shall be tested using the alternative fuel. A dual-fuel retrofit system shall be emission tested using each fuel that it is capable of operating on. After the emission tests are completed, the retrofit system shall be removed from the vehicle and subjected to bench aging. At the conclusion of bench aging, the retrofit system shall be reinstalled on the bench-test vehicle, and a second emission test or series of tests shall be performed.

- (vi) For exhaust emissions of each regulated pollutant measured during the vehicle mileage accumulation or bench-test procedure, a deterioration factor shall be calculated by dividing the emission rate obtained during the second emission test by that obtained during the first. If the resulting quotient is less than one, the deterioration factor shall be assigned a value of one. The deterioration constant for evaporative emissions shall be calculated by subtracting the evaporative emissions found during the first emission test from those found during the second test. If the resulting difference is less than zero, the deterioration constant shall be assigned a value of zero.
- (vii) Choices of vehicle models, engines, and transmissions for use in emission-data vehicles shall be approved by the Executive Officer as being representative of the engine families for which certification is sought, prior to the commencement of testing. Following installation of the retrofit system, the emission-data vehicle shall be driven 4,000 + 100 miles to stabilize emission rates. After the specified mileage has been accumulated, the emission-data vehicles' exhaust and evaporative emissions, where applicable, shall be tested, using the appropriate procedure as set forth in "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty

Vehicles." Dual fuel vehicles shall be emission tested using each fuel that the vehicle is capable of operating on.

- (viii) The deteriorated emissions of emission-data vehicles shall be calculated using the deterioration factors and constants found during vehicle mileage accumulation or bench testing. The useful life exhaust emission values are defined as the product of each emission value at 4,000 miles times the corresponding deterioration factor. For evaporative emissions, the certification emission value is equal to the sum of the emissions measured at, or extrapolated to 4,000 miles, plus the deterioration constant. The durability vehicle, bench-test vehicle, and all emission-data vehicles shall meet the applicable new vehicle useful life emission standards, as well as all applicable emission standards for intermediate mileage levels, for the vehicles' model year and fuel type(s).

(c) Test Procedures for Vehicles in Category II Not Being Certified for Credit-Generation Purposes:

Vehicles in Category II not being certified for credit may certify under these provisions, or under the alternate test procedures given in 5(g).

For durability, bench-test and emission-data vehicles in Category II, test vehicles shall have accumulated a total mileage greater than 4,000 miles and less than 10,000 miles with the original fuel system, prior to emission testing. If the manufacturer chooses to use the option as described in 1(b) (e) for pre-1994 model year vehicles, then the 10,000 mile limit shall not be applicable. A test vehicle's engine and emission control system shall be equipped and calibrated as certified. The vehicle shall then be tested for exhaust and, if applicable, evaporative emissions using the test procedures set forth in the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles". The inertia weight setting shall be equal to the average of the vehicle's curb weight and gross vehicle weight rating and road load horsepower based on the frontal area of the vehicle without modifications, as determined in "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," Section 9.b. The test results shall be defined as the baseline emission rates. After the baseline emission rates have been measured, the retrofit system shall be installed.

- (i) The procedures outlined in paragraphs 5(b)(iii) through 5(b)(vi) shall be used with the following modifications: "useful life" shall equal 120,000 miles for vehicles in Category II; the durability or bench-test vehicle's emission rates of regulated pollutants measured at 4,000 + 100 miles after the installation of the retrofit system shall not exceed 1.10 times the baseline rates; the deteriorated exhaust emissions of regulated pollutants projected to 120,000 miles shall not exceed 1.3 times the baseline emissions; and the deteriorated evaporative emissions of regulated pollutants

projected to 120,000 miles shall not exceed the baseline emissions plus 0.5 grams.

- (ii) When the Executive Officer determines that deterioration factors determined in paragraph 5(c)(i) may be carried across or carried over to other engine families in Category II, the representative emission-data vehicles shall be tested as specified in paragraph 5(b)(vii). Emission rates measured at 4,000 \pm 100 miles after installation of the retrofit system shall not exceed 1.10 times the vehicles' baseline rates.
- (d) Test Procedures for Vehicles in Category III Not Being Certified for Credit-Generation Purposes:

Vehicles in Category III not being certified for credit may certify under these provisions, or under the alternate test procedures given in 5(g).

Applicants requesting certification for retrofit systems for use in Category III vehicles shall submit a test plan utilizing eight mode chassis dynamometer testing, subject to the Executive Officer's approval, to verify that the retrofit system will not cause excess emissions from engine families for which certification is sought. Test vehicles shall have accumulated a total mileage greater than 4,000 miles and less than 10,000 miles with the original fuel system prior to emission testing. If the manufacturer chooses to use the option as described in 1(b) for pre-1994 model year vehicles, then the 10,000 mile limit shall not be applicable. A test vehicle's engine and emission control system shall be equipped and calibrated as certified. The vehicle shall then be tested for exhaust emissions using the eight mode chassis dynamometer test as specified in the test plan. The test result shall be defined as the baseline emission rate. After the baseline emission rate has been measured, the retrofit system shall be installed. Emission rates shall then be measured at 4,000 \pm 100 miles after installation of the retrofit system using the eight mode chassis dynamometer test specified in the test plan.

- (i) ~~Subject to the Executive Officer's approval of the applicant's test plan prior to commencing testing, testing utilizing procedures other than the eight mode chassis dynamometer test shall be allowed.~~
- (ii) Emission testing shall be conducted to determine exhaust emission rates of carbon monoxide and the sum of non-methane hydrocarbons plus nitrogen oxides. Emissions shall not exceed 1.10 times the baseline rates.
- (iii) The procedures outlined in paragraphs 5(b)(iii) through 5(b)(vi) shall be used with the following modifications: "useful life" shall equal 180,000 miles for vehicles in Category III; the durability or bench-test vehicle's emission rates of CO, and the sum of non-methane hydrocarbons plus NOx measured at 4,000 \pm 100 miles shall not exceed 1.10 times the baseline rates; the deteriorated exhaust emissions projected to 180,000 miles shall not exceed 1.3 times the baseline

emissions; and, the deteriorated evaporative emissions projected to 180,000 miles shall not exceed baseline emissions plus 0.5 grams. For the purposes of this section, the evaporative baseline emissions shall be estimated by the manufacturer based on good engineering principles and judgment. The manufacturer's test plan shall specify the evaporative baseline emissions estimate and describe how this estimate was derived.

- (iviii) The Executive Officer may allow carry-across of durability data from certification bench testing of retrofit systems designed for vehicles in Categories I or II to Category III retrofit system applications, if the Executive Officer determines that the carry-across durability data will adequately represent the durability performance of the retrofit system to be certified.
- (iv) Applicants requesting certification for retrofit systems designed to allow Category III vehicles to operate on an alternative fuel in addition to diesel fuel shall conduct smoke opacity testing on the emission-data vehicle(s) utilizing the peak smoke opacity standards and procedures set forth in "Heavy-Duty Diesel Vehicle Smoke Opacity Test Procedure," as incorporated by reference in Title 13, CCR, Section 2182. Smoke opacity testing shall be conducted using each fuel that the retrofitted vehicle is designed to operate on. The applicable peak smoke opacity standard shall be that set for the model year for which certification is sought.
- (vi) The selection of duty cycle(s) and all other aspects of the test procedure shall be subject to approval by the Executive Officer, and emission testing shall commence only after the Executive Officer has approved the test plan. The Executive Order shall be issued following review of the test data and determination that they meet the criteria specified in the test plan.

(e) Test Procedures for Vehicles in Category II Certified for Emission Reduction Credit

Vehicles in Category II certified for emission reduction credit may use these provisions, or the alternate test plan as given in 5(h).

The procedures outlined in paragraphs 5(c)(i) and (ii) shall be used with the following modifications:

- (i) Certification for credit-generation purposes shall be conducted on the retrofitted engine system, utilizing an engine dynamometer, and not on the engine and vehicle combination. The test procedure used shall be the same procedure used to certify the engine family when new.
- (ii) Emissions for any pollutant shall not exceed the baseline rate by more than a factor of 1.10. Baseline emissions for pre- and post-retrofit comparison purposes will be the certification emission levels determined during the original engine family certification, except:

- [A] The baseline for particulate matter (PM) emissions for diesel engines whose PM emission levels were not determined during the new engine family certification process shall be 0.6 gram/bhp-hr.
 - [B] Formaldehyde emissions from any 1993 and earlier model year engine operating on methanol- or ethanol-based fuel shall be at or below the 1993 model year standard. Formaldehyde emissions from any 1994 or subsequent model year engine operating on methanol- or ethanol-based fuel shall be at or below the formaldehyde standard for that model year.
 - [C] For diesel engines, baseline carbon monoxide and hydrocarbon emissions shall be the original emission certification value for the engine's model year.
 - [D] For engine families originally certified to a combined HC plus NOx standard, the baseline HC and NOx standards will be the combined standard pro-rated by the HC and NOx portions, respectively, of the original emission certification levels. If the original emission certification levels are not available, the HC and NOx baseline standards will be pro-rated by the HC and NOx certification standards of the next later model year with separate HC and NOx standards.
- (iii) The "useful life" shall be 120,000 miles for vehicles in Category II, and 180,000 miles for vehicles in Category III. Deteriorated exhaust emissions projected to the useful life shall not exceed the baseline rate by more than a factor of 1.30, except for the pollutant(s) for which credits will be generated, which will not exceed the credit standard declared on the certification application as required under 4(c)(i). The deteriorated evaporative emissions, if any, projected to the useful life shall not exceed baseline emissions.
- (f) Test Procedures for Vehicles in Category III Certified for Emission Reduction Credit
- Vehicles in Category III certified for emission reduction credit may use these provisions, or the alternate test plan as given in 5(h).
- The procedures outlined in paragraphs 5(d)(i) through (v) shall be used with the modifications listed in 5(e)(i) through 5(e)(iii).
- (g) Alternate Test Procedure for Vehicles in Category I, or for Vehicles in Categories II, or III Not Being Certified for Credit Generation Purposes
- The manufacturer shall submit data from durability testing conducted using the test procedures used in new vehicle or engine certification. The deteriorated useful life emission levels shall meet the applicable emission standards for vehicles or engines of that model year and fuel type. The Executive Officer may certify the retrofit system based on review of the durability

test data. If durability test data are not available, the manufacturer shall use the following procedures:

- (i) The retrofit manufacturer shall submit derived deterioration factors. The manufacturer shall submit test data that shows similar performance characteristics between the retrofitted vehicle or engine and the original equipment manufacturer vehicle or engine. The manufacturer shall submit test data showing component durability of the retrofit system. The manufacturer shall also submit a test plan describing the procedures that will be used to validate the derived deterioration factors within two years. The manufacturer derived deterioration factors and the test plan must be reviewed and approved by the Executive Officer.
- (ii) The retrofit system shall be installed on the test vehicle or engine. Certification shall be conducted on the retrofitted vehicle or engine, using the same test procedure used to certify the engine family when new. Deteriorated useful life emissions based on manufacturer derived deterioration factors shall meet the applicable new engine emission standards.
- (iii) Following retrofit system certification, the manufacturer will conduct engine aging, either in-use or on a dynamometer, according to the specified test plan. Emissions testing shall be conducted on the aged retrofit vehicle or engine system using the same test procedure used to certify the engine family when new. Deteriorated useful life emissions based on durability testing shall meet the applicable new vehicle or engine emission standards for that vehicle model. The manufacturer shall submit test data to verify the derived deterioration factors within two years of certification of the retrofit system.
- (iv) Vehicles in Category III must meet the requirements of 5(d)(iii) and 5(d)(iv).
- (h) Alternate Test Procedure for Vehicles in Category II or Category III Certified for Credit Generation Purposes

The procedures outlined in 5(g) shall be used, with the following modifications:

 - (i) The manufacturer shall also meet the requirements in 5(e)(i) and 5(e)(ii).
 - (ii) Deteriorated useful life emissions based on durability testing shall not exceed the original equipment manufacturer engine certification emissions level by more than a factor of 1.30, except for the pollutant(s) for which credits will be generated, which will not exceed the credit standard declared on the certification application

as required under 4(c)(i). The deteriorated evaporative emissions, if any, projected to the useful life, shall not exceed baseline emissions.

6. APPROVAL

(a) Issuance of Executive Orders:

If, after reviewing the test data and other information submitted by the retrofit system manufacturer, the Executive Officer determines that the retrofit system meets the applicable emission standards or the criteria of an approved test plan, as applicable, an Executive Order shall be issued certifying the retrofit system for sale and installation on vehicles in the engine families specified in the application. The Executive Order shall specify, if applicable, that the retrofit system is certified as [A] converting a conventional motor vehicle into a TLEV, LEV or ULEV, [B] converting a TLEV into a LEV or ULEV, or [C] converting a LEV into a ULEV or [D] for heavy-duty credit conversions, the applicable credit standard(s).

(b) Carry-Over and Carry-Across:

- (i) Carry-over of emission test data from the previous model year to the following model year will be allowed, if the Executive Officer determines that the carry-over data will adequately represent the emissions performance of the retrofit system to be certified. Carry-across to similar engine families will also be allowed.
- (ii) An original equipment manufacturer (OEM) that produces retrofit hardware which upgrades an old engine to the identical configuration of a newer engine family that the manufacturer also produces, may carry-across the newer engine family certification test data for the retrofit hardware certification process. (For these purposes, the term "identical" means that all engine parts on the retrofitted engine which affect emissions, such as pistons, cylinder heads, etc., must be of the same design and construction as those on the newer engine family. Engine calibration, including injection timing must also be identical.)
- (iii) Applications for carry-over and carry-across must be accompanied by an engineering analysis demonstrating that the emissions and durability of the retrofit system and engine family for which certification is being sought will be adequately represented by a certified retrofit system/engine family application.
- (iv) Applications for carry-over and carry-across will be evaluated according to the criteria contained in EPA Advisory Circular 17F, which is incorporated herein by reference, and paragraph 4.b+4 c.5 of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles." These include, but are not limited to, similarity of catalyst location and configuration.

similarity of fuel metering system, similarity of emission control system logic and design, and similarity of any other features that may affect the durability of the retrofit system's emission performance.

7. INSTALLATION REQUIREMENTS

- (a) Prior to releasing a converted vehicle to the consumer, the installer of an alternative fuel or credit-generating conventional fuel retrofit system shall submit the converted vehicle to a Bureau of Automotive Repair Referee Smog Check Station for inspection and testing except as provided in 7 (b).
 - (i) The installer of an alternative fuel or credit-generating conventional fuel retrofit system shall keep a copy of the certificate of compliance, issued by the Bureau of Automotive Repair Referee Smog Check Station, as part of the record specified in paragraph 3(e). The certificate of compliance shall contain, but need not be limited to, the following: the vehicle's identification number, the vehicle's model year and make, the date of installation, and the emissions category to which the retrofitted system is certified (i.e., conventional vehicle, TLEV, LEV, or ULEV) or, for heavy-duty vehicles, the credit standard to which the system is certified. The original certificate of compliance shall be submitted to the vehicle owner upon the vehicle's release.
 - (ii) The installer of an alternative fuel or credit-generating conventional fuel retrofit system shall not release the converted vehicle to the consumer without the issuance of a certificate of compliance for the vehicle by a Bureau of Automotive Repair Referee Smog Check Station.
 - (iii) The installer of an alternative fuel or credit-generating conventional fuel retrofit system shall also meet the requirements of paragraph 9(c).
- (b) The retrofit system installer may request Air Resources Board approval to use the alternative inspection schedule for fleet installation of the same retrofit kit on more than 10 vehicles with engines from similar engine families. If approval is granted, the installer shall submit ten vehicles with engines from similar engine families, retrofitted with the same kit, to a Bureau of Automotive Repair Station as provided in 7 (a)(i) and 7 (a)(ii).
 - (i) If all ten vehicles receive a certificate of compliance, for subsequent applications of the same type, the installer need only submit every tenth retrofitted vehicle to the Bureau of Automotive Repair pursuant to 7 (a)(i) and 7 (a)(ii). For the remaining vehicles included in the alternative inspection schedule that are not submitted to the Bureau of Automotive Repair, the installer shall maintain a record of the vehicle's identification number, the vehicle's model year and make, the engine size, the manufacturer and fuel type of the retrofit kit, the date of installation, and the emissions category to which the retrofitted system is certified (i.e., conventional vehicle, TLEV, LEV, or ULEV), or for heavy-duty vehicles, the credit standard to which the system is certified. The Air

Resources Board may require random inspection of any vehicles subject to the alternative inspection schedule.

(ii) If any of the ten vehicles fail to pass inspection, the next set of ten retrofitted vehicles shall be subject to inspection at the Bureau of Automotive Repair, until an entire group of 10 passes.

8. IN-USE ENFORCEMENT TEST REQUIREMENTS

(a) Manufacturers of alternative fuel or credit-generating conventional fuel retrofit systems shall, upon order by the Executive Officer, perform in-use enforcement emission testing of their products. The Executive Officer may order in-use enforcement emission testing of not more than 20 percent of a manufacturer's certified retrofit systems/engine family applications per year. If 20 percent constitutes less than one of a manufacturer's certified systems, the Executive Officer may order in-use enforcement emission testing of not more than one certified system/engine family application per year. Manufacturers shall be required to perform emission testing of not less than ten vehicles per certified retrofit system/engine family application selected by the Executive Officer for in-use enforcement emission testing. Upon order by the Executive Officer, manufacturers shall perform the applicable emission tests pursuant to the following:

(i) No vehicle shall be accepted by the manufacturer as a representative vehicle for enforcement testing unless the following criteria are met:

- (1) California certified and registered.
- (2) Odometer indication of less than certified useful-life mileage and vehicle age within useful-life time period.
- (3) No indication of abuse (e.g., racing, overloading, misfueling, or other misuse), neglect, improper maintenance or other factors that would have an effect on emission performance.
- (4) No major repair to engine or major repair of vehicle resulting from collision.
- (5) Lead content of fuel sample from the vehicle tank meets applicable standards.
- (6) No indication of any problem that might jeopardize the safety of laboratory personnel.

(ii) The manufacturer shall, under ARB supervision, perform diagnosis or restorative maintenance on those vehicles selected for in-use enforcement testing. The manufacturer or a laboratory approved by the Executive Officer shall (1) identify part numbers of all essential emission control system components; (2) check air filter, all drive belts, all fluid levels, radiator cap, all vacuum hoses and electrical wiring related to emission control for integrity; check fuel metering

and emission control system components for maladjustments and/or tampering, and record all discrepancies; (3) check ignition system with oscilloscope and replace any defective components; i.e., spark plugs, wires, etc.; (4) check compression; (5) check and adjust engine parameters to manufacturer's specifications; and (6) perform maintenance if the vehicle is within 500 miles of scheduled maintenance service.

- (iii) For vehicles in Category I, the manufacturer or a laboratory approved by the Executive Officer shall perform the applicable emission test procedures set forth in the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles." The applicable emission standards shall be the vehicle's useful life standards as well as any intermediate emission standards, as stated in the Executive Order.
- (iv) For vehicles in Category II not certified for credit generation, in-use enforcement exhaust and, if applicable, evaporative emissions shall be performed using the test procedures set forth in the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles". The inertia weight setting shall be equal to the average of the vehicle's curb weight and gross vehicle weight rating and road load horsepower based on the frontal area of the vehicle without modifications, as determined in "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," Section 9.b. For vehicles in Category III not certified for credit generation, in-use enforcement exhaust emission tests shall be performed in accordance with the test plan approved by the Executive Officer prior to certification testing of the engine family applications specified for in-use enforcement testing. For vehicles in Categories II and III which are certified for credit generation, in-use enforcement testing will consist of repeating the procedures and requirements of paragraphs 5(e) and 5(f), respectively, except as provided for in paragraph 8(a)(viii), below.
- (v) The applicable exhaust emission standards for vehicles in Categories II and III shall be the baseline emission rates established during certification testing of the engine family applications specified for in-use enforcement testing times 1.3, except as provided in paragraphs 5(e) and 5(f) for credit generating systems. The applicable evaporative emission standards for vehicles in Categories II and III shall be the baseline emission rates established during certification testing of the engine family applications specified for in-use enforcement testing plus 0.5 grams except as provided in paragraphs 5(e) and 5(f) for credit generating systems.
- (vi) Manufacturers shall complete in-use enforcement testing within 6 months of the issuance of the in-use compliance testing order and shall submit all test data to the Executive Officer within 30 calendar days following completion of testing.

- (vii) Following review of manufacturer in-use enforcement test data, the Executive Officer may conduct confirmatory in-use enforcement testing.
- (viii) OEM upgrade systems certified for credit-generation use as described in paragraph 6(b), shall be subject to the new engine family in-use testing requirements for the engine family on which the system is originally certified. Such systems will not be subject to the in-use enforcement testing requirements of these Procedures.
- (b) If the results of the in-use vehicle emission tests conducted pursuant to paragraphs 8(a)(i) through 8(a)(viii) indicate that the average emissions of the test vehicles for any pollutant exceed the applicable emission standards or specified limits for credit generation certification, the entire vehicle population so represented shall be deemed to exceed such standards. Upon order by the Executive Officer, the manufacturer shall have 45 days to submit an influenced recall plan in accordance with Sections 2111 through 2121, Title 13, CCR. If no such recall plan is submitted, the Executive Officer may order corrective action including recall of the affected vehicles in accordance with Sections 2122 through 2135, Title 13, CCR. For the purpose of these Procedures, the term "manufacturer," as referenced in Sections 2111 through 2135, Title 13, CCR, shall mean "retrofit system manufacturer."

9. WARRANTY REQUIREMENTS

(a) Requirements of Manufacturers:

The manufacturer of an alternative fuel or credit-generating conventional fuel retrofit system shall warrant to the person having the vehicle retrofitted and to each subsequent purchaser of the vehicle that the alternative fuel or credit-generating conventional fuel retrofit system is designed and manufactured to conform with the applicable requirements of these Procedures and is free from defects in materials and workmanship which cause the alternative fuel or credit-generating conventional fuel retrofit system to fail to conform with the applicable requirements of these Procedures or cause damage to any part on the retrofitted vehicle. This warranty shall be effective for three years or 50,000 miles, whichever first occurs, of customer service, and shall cover the full repair or replacement costs including the costs of diagnosis, labor, and parts (including any part on the retrofitted vehicle that is damaged due to a defect in the alternative fuel or credit-generating conventional fuel retrofit system).

(b) Extended Warranty Requirements:

Each manufacturer of an alternative fuel or credit-generating conventional fuel retrofit system shall identify in its application for certification the warranted parts whose individual replacement cost, at the time of certification, exceeds the cost limit defined in paragraph 9(b)(i). The replacement cost shall include the cost of the diagnosis, parts, and labor. The costs shall be those of the highest cost metropolitan area of California. Each manufacturer shall warrant to the person having the vehicle

retrofitted and to each subsequent purchaser of the vehicle that those parts identified in its application for certification as exceeding the cost limit defined in paragraph 9(b)(i) are free from defects in materials and workmanship which cause the alternative fuel or credit-generating conventional fuel retrofit system to fail to conform with the requirements of these Procedures or cause damage to any part on the retrofitted vehicle, for seven years or 70,000 miles, whichever first occurs.

- (i) The cost limit shall be calculated using the following equation:

$$\text{Cost limit}_n = \$300 \times (\text{CPI}_{n-2}/121.9)$$

where:

Cost limit_n is the cost limit for the year in which the alternative fuel or credit-generating conventional fuel retrofit system is to be certified.

n is the year in which the alternative fuel or credit-generating conventional fuel retrofit system is to be certified.

CPI is the annual average consumer price index for California published by the United States Bureau of Labor Statistics.

- (ii) The cost limit shall be revised annually by the Executive Officer. The highest cost metropolitan area in California shall be identified by the Executive Officer.
- (iii) Each manufacturer shall submit to the Executive Officer the documentation used to identify the warranted parts required in this subsection. The documentation shall include the estimated retail parts costs, labor rates in dollars per hour, and the labor hours necessary to replace the parts.
- (c) Requirements of Installers:

Each installer of an alternative fuel or credit-generating conventional fuel retrofit system shall warrant to the person having the vehicle retrofitted and to each subsequent purchaser of the vehicle that the alternative fuel or credit-generating conventional fuel retrofit system will not fail to conform with the applicable requirements of these Procedures due to incorrect installation, and that no part on the retrofitted vehicle will be damaged due to incorrect installation. Installers of alternative fuel or credit-generating conventional fuel retrofit systems shall install only those systems of a certified configuration and shall agree to indemnify the person having the vehicle retrofitted and to each subsequent purchaser of the vehicle for the cost of repair of any vehicle upon which a noncertified configuration was installed. In addition, the installer shall agree to indemnify the person having the vehicle retrofitted and to each subsequent purchaser of the vehicle for any tampering fines that may be imposed as a result of improper installation of the alternative fuel or credit-generating conventional fuel retrofit system. The warranties and agreements to indemnify shall be effective for three years or

50,000 miles, whichever first occurs, of customer service, and shall cover the full repair or replacement costs including the costs of diagnosis, labor, and parts (including any part on the retrofitted vehicle that is damaged due to incorrect installation of the alternative fuel or credit-generating conventional fuel retrofit system).

Before an installer installs an alternative fuel or credit-generating conventional fuel retrofit system, he or she shall have submitted to the ARB a sample of the warranty statement to be provided by the installer in accordance with this paragraph.

ATTACHMENT B

**AMENDMENTS TO THE CALIFORNIA EXHAUST EMISSION STANDARDS
AND TEST PROCEDURES FOR SYSTEMS DESIGNED TO CONVERT MOTOR VEHICLES
CERTIFIED FOR 1993 AND EARLIER MODEL YEARS TO USE
LIQUEFIED PETROLEUM GAS OR NATURAL GAS FUELS**

State of California
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS
AND TEST PROCEDURES FOR SYSTEMS
DESIGNED TO CONVERT MOTOR VEHICLES
CERTIFIED FOR 1993 AND EARLIER MODEL YEARS
TO USE LIQUEFIED PETROLEUM GAS OR NATURAL GAS FUELS

Adopted: April 16, 1975
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TABLE OF CONTENTS

	<u>PAGE</u>
1. GENERAL APPLICABILITY	1
2. DEFINITIONS	2
3. GENERAL STANDARDS	2
4. NON-APPLICABLE REGULATIONS	2
5. APPLICATION FOR APPROVAL	3
6. EMISSION STANDARDS AND TEST PROCEDURES	5
7. SELECTION OF TEST VEHICLES	6
8. VEHICLE TESTING	6
9. CALCULATION PROCEDURES	10
10. APPROVAL	16
11. CHANGES TO CONVERSION SYSTEM AFTER APPROVAL	17
12. NON-CONVENTIONAL SYSTEMS	17
13. INSTALLATION REQUIREMENTS	18

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES
FOR SYSTEMS DESIGNED TO CONVERT MOTOR VEHICLES
CERTIFIED FOR 1993 AND EARLIER MODEL YEARS TO USE
LIQUEFIED PETROLEUM GAS OR NATURAL GAS FUELS

The authority for these Exhaust Emission Standards and Test Procedures is found in Sections 43004 and 43006 of the California Health and Safety Code which contain the following:

43004. "--the standards applicable under this part for exhaust emissions for gasoline-powered motor vehicles shall apply to motor vehicles which have been modified or altered to use a fuel other than gasoline or diesel."

43006. "The state board may certify the fuel system of any motor vehicle powered by a fuel other than gasoline or diesel which meets the standards specified by Section 43004 and adopt test procedures for such certification."

1. GENERAL APPLICABILITY

"California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas or Natural Gas Fuels" ("these test procedures" or "these procedures") are applicable to any single- or dual-fuel motor vehicle conversion system using liquefied petroleum gas (LPG) or natural gas (NG) in lieu of the original gasoline or diesel fuel system for 1993 and earlier model year emission-controlled vehicles used or registered in the State of California.

A retrofit system manufacturer may apply these test procedures to certify conversion systems for 1994, and 1995, and 1996 model-year vehicles in accordance with the following implementation phase-in schedule. Each manufacturer may certify a maximum of 85 percent of its total 1994 model-year engine family conversion systems, and 45 percent of its total 1995 model-year systems, and 45 percent of its total 1996 model-year systems, according to the requirements of these test procedures and "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels." The remaining percentage of each manufacturer's certified 1994, and 1995, and 1996 model-year engine family conversion systems and all of 1996 and subsequent model-year engine family conversion systems shall be certified according to "California Certification and Installation Procedures for Alternative Fuel Retrofit Systems For Motor Vehicles Certified For 1994 and Subsequent Model Years and for All Model-Year Motor Vehicle Retrofit Systems Certified for Emission Reduction Credit." The percentages shall be determined from the total number of conversion systems certified and shall be met prior to the end of the applicable next respective calendar year. If the above referenced 85 percent maximum is exceeded for 1994 or the above referenced 45 percent maximum is exceeded for 1995 or 1996, the Executive Officer shall rescind the Executive Order for those conversion systems most recently certified which caused the

percentages to be exceeded. These procedures shall not be used to certify a retrofit system for installation on a transitional low-emission vehicle ("TLEV"), low-emission vehicle ("LEV"), or ultra-low-emission vehicle ("ULEV") or to certify a retrofit system designed to convert a vehicle to TLEV, LEV, or ULEV emission standards (as defined in Section 1960.1, Title 13, CCR). These procedures shall not be used to certify retrofits for emission reduction credit.

2. DEFINITIONS

The definitions shall be the same as those in the applicable model year California exhaust emission standards and test procedures for passenger cars, light-duty trucks, and medium-duty vehicles.

All provisions of these procedures (except where specifically noted) shall apply to single-fuel liquefied petroleum gas (LPG), single-fuel natural gas (NG), AND DUAL-FUEL (LPG/gasoline or NG/gasoline)

3. GENERAL STANDARDS

- (a) In addition to all other standards or requirements imposed, any modification of a gasoline- or diesel-fueled motor vehicle to allow the use of liquefied petroleum gas or natural gas as a fuel:
 - (i) Shall not in its operation or function cause the emission into the ambient air of any noxious or toxic substance that is not emitted in the operation of such vehicle without such modification, except as specifically permitted by regulation; and
 - (ii) Shall not in its operation, function, or malfunction, result in any unsafe condition endangering the motor vehicle, its occupants, other persons, or property in close proximity to the vehicle, in accordance with the safety requirements specified for the original vehicle.
- (b) In the case of a dual-fuel conversion, where the vehicle may run on gasoline (or diesel) or a gaseous fuel, removal of originally required emission control systems will not be permitted. These provisions shall not apply to heated intake air systems or the original air cleaner when replaced by an air cleaner compatible with the LPG/NG carburetor.

4. NON-APPLICABLE REGULATIONS

All requirements in the referenced California exhaust emission standards and test procedures for gasoline or diesel-powered vehicles not directly related to exhaust emission test procedures shall not be applicable to these procedures.

5. APPLICATION FOR APPROVAL

- a. An application for approval of a modification to use LPG and NG fuel in a gasoline- or diesel-powered engine may be made by any engine, vehicle, or conversion equipment manufacturer.
- b. An application shall be required for each model year even though the exhaust emission standards for approval of new vehicles may be the same for consecutive model years.
- c. The application shall be in writing, signed by an authorized representative of the manufacturer, and shall include the following:

- i. Identification and description of the vehicles in each vehicle category and engine displacement ranges for which approval is requested.

There are three vehicle categories.

- a) Passenger Cars (PC)
- b) Light-Duty Trucks (LDT) and Medium-Duty Vehicles (MDV)
- c) Heavy-Duty Vehicles (HDV) powered by Heavy-Duty Engines (HDE)

- ii. A complete description and identification of the conversion system, including carburetor model number(s), carburetor configuration/calibration codes(s), vaporizer/regulator model number(s), evidence of proper assembly of the fuel tank and fuel lines, and the necessary modification to the engine or vehicle.
- iii. A statement of recommended maintenance procedures, including initial installation and initial tuning, and equipment necessary to ensure that the vehicle and engine in operation conform to the regulations. If the procedures are not uniform, then the specific procedures for each difference make and model shall be given. A description of the program for training of personnel for such maintenance and installation.
- iv. An agreement that upon the Executive Officer's request any one or more of the test vehicles will be supplied to the Air Resources Board (ARB) for such testing as it may require, or (by mutual consent between the ARB and applicant) will be made available at the manufacturer's facility for such testing. Provided, that in the latter case, it is further agreed that the instrumentation and equipment specified by the ARB will be made available for testing operations. Any testing conducted at a manufacturer's facility pursuant to this subparagraph will be scheduled as promptly as possible.

- v. An agreement that up to two test vehicles per vehicle category will be made available to the ARB for testing for such reasonable periods as may be required. These vehicles shall be selected from time to time by the Executive Officer and shall be typical of production models available for sale to the public. They shall also be representative of the engines and transmissions offered by the vehicle manufacturers.
- vi. An agreement that the modifications made in the field will be properly identified. To meet this requirement, the model number shall be permanently marked on the carburetor. A permanent label, to be affixed in the engine compartment where it may be easily read, covering the following for the specific installation, shall be furnished. The label shall set forth the following:
 - 1. Manufacturer's name and address.
 - 2. The California Air Resources Board certification number identified as "CARB E.O. No. B-XX."
 - 3. Spark timing.
 - 4. Idle speed.
 - 5. Mixture adjustment (if used) including idle, cruise, and/or full throttle together with the method.
 - 6. Diagrams for vacuum hose routing and electrical wiring harness.
 - 7. Carburetor, vaporizer/regulator model numbers, and carburetor configuration/calibration codes.
- vii. For retrofit systems applicable to 1994, and 1995, and 1996 model year vehicles, a complete listing of the engine families for which the manufacturer's retrofit systems are designed for installation. The number of a manufacturer's 1994, and 1995, and 1996 model-year engine family retrofit systems certified according to these test procedures shall be limited according to the phase-in schedule described in the General Applicability section of these procedures.
- d. An application may be made for certification to emission standards or to typical baseline emission levels.

6. EMISSION STANDARDS AND TEST PROCEDURES FOR PC, LDT, MDV, AND HDE

(a) For certification to emission standards, the appropriate model-year exhaust emission standards to be used are the applicable California new vehicle exhaust emission standards. Test procedures shall be the applicable California new vehicle certification test procedures for the model-year of the test vehicle. Compliance is demonstrated by applying a deterioration factor to both the cold and hot start emission test results to project the emission levels to the end of the vehicle's useful life and comparing the results with the emission standards. These test results must meet the applicable emission standards. A retest is permitted if the vehicle fails the first test. The assigned deterioration factor will be based on gasoline-powered or diesel-powered vehicle certification deterioration rates as specified by the Executive Officer. In addition, dual-fuel systems will require CVS-75 tests using the original fuel with the conversion system installed. This test result (with the certification deterioration factor or, if not available, an assigned deterioration factor applied) must also meet the applicable emissions standards.

(b) For certification to typical baseline emission levels, the exhaust emission levels to be used are those from representative vehicles in good operating condition selected by the Executive Officer for testing. Test procedures shall be the applicable California test procedures for the model-year of the vehicle. Back-to-back tests must be conducted and a significant increase in the emissions from the baseline may be cause for denial. In order to improve data reliability, the manufacturer may elect to perform two back-to-back tests, in which case a significant increase in the average emissions of the two conversion system tests over the average baseline test emissions may be cause for denial. Test variability will be considered in establishing significant increases in emissions. In addition, for dual-fuel systems, a CVS-72 test using the original fuel with the conversion system is required. This test shall also not significantly increase emissions from the baseline level.

The test variability factors applicable for back-to-back tests are 1.10 for HC and NO_x and 1.15 for CO emissions. The conversion system meets the compliance requirements when the emission data from the tests with the conversion system installed, are at or below the emission levels of the baseline emissions with the variability factors applied.

- (c) For certification of conversion systems to be installed only on heavy-duty engines, the appropriate model-year exhaust emission standards and applicable (diesel or gasoline) exhaust emission test procedures shall be used. However, approval of a conversion system to be installed on PC or LDT/KDV shall automatically qualify the system for use with heavy-duty engines with similar or less sophisticated emission control systems without additional testing.
- (d) The durability of all systems will be determined by an engineering evaluation. For cause, and based on the engineering evaluation, the Executive Officer may require durability tests.

7. SELECTION OF TEST VEHICLES FOR THE LIMITED FLEET

A maximum of two test vehicles may be required by the Executive Officer for each vehicle category. One test vehicle can represent the worst case and the other the most popular vehicle for which the conversion system is applicable. The Air Resources Board will notify the applicant in writing of the vehicles which can be used to demonstrate compliance. In requesting emission tests, the Air Resources Board will consider emission control system similarity over vehicle categories when determining the test fleet size.

8. VEHICLE TESTING

To assure better test data utilization, each applicant shall obtain prior approval in writing from the Executive Officer on the test vehicle fleet.

(a) Test Vehicles

(1) Vehicles Certifying to New Vehicle Exhaust Emission Standards

Each test vehicle shall be a California certified version having been driven a minimum of 4,000 miles on gaseous fuel. The vehicle mileage accumulation must be done by driving the vehicle on the road following a route of typical suburban type driving, or on a chassis dynamometer utilizing the Automobile Manufacturer's Association (AMA) mileage accumulation cycle. The applicant may request and the Executive Officer may allow test vehicles with less mileage if the applicant demonstrates emission stability. Emission stability can be demonstrated by performing two (2) consecutive CVS-75 emission tests with 500 miles of AMA type driving between tests and showing no change in emissions outside of test variability.

Each test vehicle must also be subjected to a thorough examination prior to any emissions test(s) to detect and correct possible defects and deviations from manufacturer's specifications in emissions-related parts.

Testing may be performed at any independent laboratory properly equipped to conduct the tests. The test vehicles shall be under the control of the laboratory for the entire test period. Return of test vehicles to the applicant during the test period may invalidate the test results.

The laboratory's report must be submitted directly to the Executive Officer and contain all related information, including failed test data. Tests performed for research and development purposes before the application is submitted need not be reported. The applicant may not edit the laboratory report but may submit additional clarifying comments or information.

(ii) Vehicles Certifying to Typical Emission Levels

Each test vehicle shall be a California certified version having been driven a minimum of 4,000 miles on the original certification fuel as required for new vehicle certification. In the event that a manufacturer acquires a vehicle with less than 4,000 miles, the vehicle mileage must be brought to 4,000 miles by driving the vehicle on the road following a route of typical suburban type driving, or by accumulating mileage on a chassis dynamometer utilizing the AMA mileage accumulation cycle. The Executive Officer may allow test vehicles with less mileage if the applicant demonstrates emission stability. Emission stability can be demonstrated by performing two (2) consecutive CVS-75 emission tests with 500 miles of AMA type driving between tests and showing no change in emissions outside of test variability.

Each test vehicle must also be subjected to a thorough examination prior to the baseline test to detect and correct possible defects and deviations from manufacturer's specification in emissions-related parts. The baseline emissions of the test vehicle should be typical for that particular make and model-year. Typical vehicle emissions will be determined by using the vehicle surveillance test data, supplemented by assembly-line test and certification test data as required and appropriate.

If a vehicle exceeds typical emission values, the applicant may make a full diagnostic evaluation of the vehicle, make any necessary repairs, and retest the vehicle. If no abnormal conditions of the engine or the emission controls are noted, the vehicle will be accepted as a test vehicle and its emissions data will be used for comparison with conversion system test results. The applicant may forego the above and select another test vehicle from the given list of alternative vehicles.

Testing may be performed at any laboratory properly equipped to conduct the tests. The test vehicle shall be under the control of the laboratory for the entire test period. Return of the test vehicle to the applicant during the test period may invalidate prior test results.

After the baseline test has been run, prior approval must be obtained from the Executive Officer before any servicing, maintenance, or parts replacements are made, except those that are in accordance with the written instructions provided with the application. The same fuel shall be used for the back-to-back tests using gasoline or diesel. There should be sufficient fuel in the fuel tank to permit the baseline and with conversion system tests. The laboratory shall record all the above information and include it as part of the report. The laboratory's report must be submitted directly to the Executive Officer and contain all related information, including failed test data. Tests performed for research and development purposes before the application is submitted need not be reported. The applicant may not edit the laboratory report but may submit additional clarifying comments or information.

(b) Test Sequence

(i) Straight liquefied petroleum or natural gas conversions certifying to emission standards

1. Adjust vehicle to vehicle manufacturer's specification.
2. Install conversion system in accordance with conversion system manufacturer's installation instructions (permanent installation of gaseous fuel tank is not required).
3. Run one cold start CVS-75 test using gaseous fuel.
4. Run one cold start CVS-75 test using gaseous fuel (only if first CVS-75 test fails the emission standards).

(ii) Dual-fuel systems certifying to standards

1. Adjust vehicle to vehicle manufacturer's specifications.
2. Install conversion system in accordance with the conversion system manufacturer's installation instructions (permanent installation of gaseous fuel tank is not required).
3. Run one cold start CVS-75 test using gaseous fuel.
4. Run one cold start CVS-75 test using gaseous fuel (only if first CVS-75 test on gaseous fuel fails the emission standards).
5. Run one hot start CVS-72 test using gasoline or diesel fuel.
6. Run one hot start CVS-72 test using gasoline or diesel fuel (only if first CVS-72 test on gasoline or diesel fuel fails the emission standards).

(iii) Straight liquefied petroleum or natural gas conversions certifying to typical baseline emission levels

1. Adjust vehicle to vehicle manufacturer's specification.
2. Run one cold start CVS-75 test using gasoline or diesel fuel.
3. Install conversion system in accordance with conversion system manufacturer's installation instructions (permanent installation of gaseous fuel tank is not required).
4. Run one cold start CVS-75 test using gaseous fuel.

(iv) Dual-fuel systems certifying to typical baseline emission levels

1. Adjust vehicle to vehicle manufacturer's specifications.
2. Run two baseline tests using gasoline or diesel fuel. One is a cold start CVS-75, and the other is a hot start CVS-72.
3. Install conversion system in accordance with the conversion system manufacturer's installation instructions (permanent installation of gaseous fuel tank is not required).

4. Repeat cold start CVS-75 test using gaseous fuel and the hot start CVS-72 test using gasoline or diesel as the fuel.
5. As an alternative, the applicant may delete the two hot start CVS-72 tests and in their places run a cold start CVS-75 test with conversion system using gasoline or diesel fuel.

9. CALCULATION PROCEDURES

The following calculation procedures are based on the Federal CVS-1975 Test Procedure. The final reported test results shall be computed by use of the following formulas:

Meaning of Symbols

PC	-	Passenger cars
LDT	-	Light-duty trucks
MDV	-	Medium-duty vehicles (over 6000-8500 lbs. GVW)
HDV	-	Heavy-duty vehicles (those vehicles over 8500 lbs. GVW)
CO_{conc}	=	Carbon monoxide concentration of the dilute exhaust sample corrected for background, water vapor, and CO_2 extraction, in ppm.
CO_{dm}	=	Carbon monoxide concentration of the dilution air sample as measured, in ppm.
CO_d	=	Carbon monoxide concentration of the dilution air corrected for water vapor extraction, in ppm.
CO_e	=	Carbon monoxide concentrations of the dilute exhaust sample volume corrected for water vapor and carbon dioxide extraction, in ppm. The calculation assumes the carbon to hydrogen ratio of the fuel to be 1:3.802 for natural gas and 1:2.655 for LPG.
CO_{em}	=	Carbon monoxide concentration of the dilute exhaust sample as measured, in ppm.
CO_{mass}	=	Carbon monoxide emissions, in grams per test phase.
CO_{2conc}	=	Carbon dioxide concentration of the dilute exhaust sample corrected for background and water vapor, in percent.

- CO_{2e} = Carbon dioxide concentration of the dilute exhaust sample, in percent.
- CO_{2mass} = Carbon dioxide emissions, in grams per test phase.
- Density $_{CO}$ = Density of carbon monoxide is 32.97 g/ft³ of 68°F and 760 mm Hg pressure.
- Density $_{HC}$ = Density of hydrocarbons is 18.64 g/ft³ for natural gas and 17.28 g/ft³ for LPG assuming an average carbon to hydrogen ratio of 1:3.802 for natural gas and 1:2.656 for LPG, at 68°F and 760 mm Hg pressure.
- Density $_{NO_2}$ = Density of oxides of nitrogen is 54.16 g/ft³ assuming they are in the form of nitrogen dioxide, at 68°F and 760 mm Hg pressure.
- DF = Dilution Factor.
- H = Absolute humidity in grains of water per pound of dry air.
- HC $_{conc}$ = Hydrocarbon concentration for the dilute exhaust sample corrected for background, in ppm carbon equivalent, i.e., equivalent propane x 3.
- HC $_d$ = Hydrocarbon concentration of the dilution air as measured, in ppm carbon equivalent.
- HC $_e$ = Hydrocarbon concentration of the dilute exhaust sample, in ppm carbon equivalent.
- HC $_{mass}$ = Hydrocarbon emissions, in grams per test phase.
- K $_H$ = Humidity correction factor.
- N = Number of revolutions of the positive displacement pump during the test phase while samples are being collected.
- HO $_{xconc}$ = Oxides of nitrogen concentration of the dilute exhaust sample corrected for background, in ppm.

NO_{x_d}	=	Oxides of nitrogen concentration of the dilute air as measured, in ppm.
NO_{x_e}	=	Oxides of nitrogen concentration of the dilute exhaust sample as measured, in ppm.
$NO_{x_{mass}}$	=	Oxides of nitrogen emissions, in grams per test phase.
P_B	=	Barometric pressure, in mm Hg.
P_d	=	Saturated vapor pressure, in mm Hg at ambient dry bulb temperature.
P_i	=	Pressure depression below atmospheric measured at the inlet to the positive displacement pump.
T_p	=	Average temperature of dilute exhaust entering positive displacement pump during test while samples are being collected, in degrees Rankine.
R_a	=	Relative humidity of the ambient air, in percent.
V_{mix}	=	Total dilute exhaust volume in cubic feet per test phase corrected to standard conditions (528°R and 760 mm Hg).
V_o	=	Volume of gas pumped by the positive displacement pump, in cubic feet per revolution. This volume is dependent on the pressure differential across the positive displacement pump.
Y_{ct}	=	Mass emissions as calculated from the "transient" phase of the cold start test, in grams per test phase.
Y_{ht}	=	Mass emissions as calculated from the "transient" phase of the cold start test, in grams per test phase.
Y_s	=	Mass emissions as calculated from the "stabilized" phase of the cold start test, in grams per test phase.

Y_{wm} = Weighted mass emissions of each pollutant, i.e., HC, CO, or NO_x , in grams per vehicle mile.

For passenger cars, light-duty trucks, and medium-duty vehicles:

(a) The mass emissions of each pollutant in grams per mile is
 $Y_{wm} = (0.43Y_{ct} + 0.57Y_{ht} - Y_s)/7.5$

(b) The mass of each pollutant for each phase of both the cold start test and the hot start test is determined from the following:

(1) Hydrocarbon mass:

$$HC_{mass} = V_{mix} \times \text{Density}_{HC} \times (HC_{conc}/1,000,000)$$

(2) Oxides of nitrogen mass:

$$NO_{x_{mass}} = V_{mix} \times \text{Density}_{NO_2} \times K_H \times (NO_{x_{conc}}/1,000,000)$$

K_H = humidity correction factor

(3) Carbon monoxide mass:

$$CO_{mass} = V_{mix} \times \text{Density}_{CO} \times (CO_{conc}/1,000,000)$$

(4) Carbon dioxide mass:

$$CO_{2_{mass}} = V_{mix} \times \text{Density}_{CO_2} \times (CO_{2_{conc}}/100)$$

$$V_{mix} = \frac{V_o \times H \times (P_b - P_t) \times 528}{(760)(T_p)}$$

$$HC_{conc} = HC_e - HC_d(1 - 1/DF)$$

$$NO_{x_{conc}} = NO_{x_e} - NO_{x_d}(1 - 1/DF)$$

$$CO_{conc} = CO_e - CO_d(1 - 1/DF)$$

$$CO_e = (1 - 0.02901 CO_{2_e} - 0.000323 R_a) CO_{em} \text{ for natural gas}$$

$$CO_e = (1 - 0.02328 CO_{2_e} - 0.000323 R_a) CO_{em} \text{ for LPG}$$

$$CO_d = (1 - 0.000323 R_a) CO_{dm}$$

$$K_H = \frac{1}{1 - 0.0047(H - 75)}$$

$$H = \frac{(43.478 R_a)(Pd)}{P_d - P_d \times R_a / 100}$$

$$DF = \frac{9.77}{CO_{2e} + (HC_e + CO_e) \times 10^{-4}} \quad \text{for natural gas}$$

$$DF = \frac{11.7}{CO_{2e} + (HC_e + CO_e) \times 10^{-4}} \quad \text{for LPG}$$

For hydrocarbons the Y_{wm} value must be multiplied by the methane content correction factor (MCCF).

$$HC_{wm} = Y_{wm} \times MCCF$$

HC_{wm} = weighted mean HC mass in gms per vehicle mile after correction for methane content

For 1981 and earlier model year vehicles, the MCCF values as determined by the vehicle manufacturer and approved by the ARB during certification shall be used. In the absence of such values, the following shall apply:

Gasoline = PC = 0.85 (catalyst only)
 PC = 1.0 (non catalyst cars)
 LDT = 1.0
 MDV = 1.0
 HDV = 1.0

Natural Gas = 0.5 (all vehicle categories)

LPG = 0.75 (all vehicle categories)

In the alternative, the applicant may choose to determine the actual MCCF by using the "California Non-Methane Hydrocarbon Test Procedures" adopted May 24, 1978.

For 1982 and later model year vehicles, non-methane hydrocarbons must be determined using non-methane instrumentation. In the alternative, the applicant may measure only total hydrocarbons during all testing. However, in such event, no methane credit will be given either gasoline or gaseous fuels.

Sample Calculation:

(1) For the "transient" phase of the cold-start test assume

$$V_o = 0.29344 \text{ cu ft per revolution; } H = 10,485;$$

$$R_a = 48.2\%; P_B = 762 \text{ mm Hg; } P_d = 22.225 \text{ mm Hg; } P_i = 70 \text{ mm Hg;}$$

$$T_p = 570^\circ R; HC_e = 105.8 \text{ ppm carbon equivalent; } NO_{x_e} = 11.2 \text{ ppm;}$$

$$CO_{em} = 306.6 \text{ ppm; } CO_{2e} = 1.43\%; HC_d = 12.1 \text{ ppm}$$

$$NO_{x_d} = 0.8 \text{ ppm; } CO_{dm} = 15.3 \text{ ppm.}$$

Then, for an LPG fueled vehicle:

$$V_{mix} = \frac{(0.29344)(10,485)(762-70)(528)}{(760)(570)} = 2595.0 \text{ cu ft per test phase}$$

$$H = \frac{(43.478)(48.2)(22.225)}{762 - (22.225 \times 48.2/100)} = 62 \text{ grains of water/pound dry air}$$

$$K_H = \frac{1}{1 - 0.0047(62-75)} = 0.9424$$

$$CO_e = (1 - 0.02328(1.43) - 0.000323(48.2))306.6 = 291.6 \text{ ppm}$$

$$CO_d = (1 - 0.000323(48.2))15.3 = 15.1 \text{ ppm}$$

$$DF = \frac{11.7}{1.43 + (105.8 + 291.6) \times 10^{-4}} = 7.961$$

$$HC_{conc} = 105.8 - 12.1(1 - 1/7.961) = 95.22 \text{ ppm}$$

$$HC_{mass} = (2595)(17.28)(95.22/1,000,000) = 4.270 \text{ grams per test phase}$$

$$NO_{x_{conc}} = 11.2 - 0.8(1 - 1/7.961) = 10.50 \text{ ppm}$$

$$NO_{x_{mass}} = (2595)(54.16)(10.50/1,000,000)(0.9424) = 1.391 \text{ grams per test phase}$$

$$CO_{conc} = (291.6) - 15.1(1 - 1/7.961) = 278.4 \text{ ppm}$$

$$CO_{mass} = (2595)(32.97)(278.4/1,000,000) = 23.82 \text{ grams per test phase}$$

(ii) For the "stabilized" portion of the cold-start test assume that similar calculations resulted in $HC_{mass} = 0.62$ grams per test phase; $NO_{x_{mass}} = 1.27$ grams per test phase; and $CO_{mass} = 5.98$ grams per test phase.

(iii) For the "transient" portion of the hot-start test assume that similar calculations resulted in $HC_{mass} = 0.51$ grams per test phase; $NO_{x_{mass}} = 1.38$ grams per test phase; and $CO_{mass} = 5.01$ grams per test phase.

(iv) For an LPG fueled vehicle:

$$HC_{vm} = \frac{(0.43)(4.27) + (0.57)(0.51) + 0.62}{7.50} \times 0.75 = 0.275 \text{ grams per vehicle mile}$$

$$CO_{vm} = \frac{(0.43)(23.82) + (0.57)(5.01) + 5.98}{7.50} = 2.54 \text{ grams per vehicle mile.}$$

$$NO_{x_{vm}} = \frac{(0.43)(1.391) + (0.57)(1.38) + 1.27}{7.50} = 0.354 \text{ grams per vehicle mile}$$

10. APPROVAL

- (a) If, after a review of the data and other information submitted by the manufacturer, the Executive Officer determines that a modification to use LPG or NG conforms to these procedures, he or she will issue an Executive Order of approval for such modifications.
- (b) Such Executive Order may be issued upon such terms as the Executive Officer deems necessary to ensure that any modifications to use LPG or NG will meet the requirements of these procedures.
- (c) Approval for a conversion system for a given model year is deemed as approval for all previous model years unless specifically limited in the Executive Order. Approval for subsequent model years (i.e., carryover) may be given, after request by the applicant, if further engineering evaluation and/or testing demonstrates that the system will meet the standards for the applicable model year and engine displacements.

- (d) Approval for installation on vehicles with similar emission control systems (i.e., carry-across) may be given, if requested by the applicant, if further engineering evaluation and/or testing demonstrates that the system will meet standards for the applicable model-year(s) and engine displacement(s).

11. CHANGES TO CONVERSION SYSTEM AFTER APPROVAL

All changes to the conversion system, including installation changes, must be submitted to the Executive Officer. The Executive Officer may require additional testing prior to approval.

12. NON-CONVENTIONAL SYSTEMS

The Executive Officer may deviate from these procedures for non-conventional systems, such as diesel fuel used in conjunction with LPG, in the event that such systems cannot be tested using these procedures. Such deviations shall be limited to those necessary for the proper testing and evaluation of such systems.

13. INSTALLATION REQUIREMENTS

a. Beginning January 1, 1994, installers of alternative fuel retrofit systems shall submit the converted vehicles to a Bureau of Automotive Repair Referee Smog Check Station for inspection and testing, prior to releasing the converted vehicles to the consumer, except as provided in 13 b.

i. Installers of alternative fuel retrofit systems shall not release the converted vehicle(s) to the consumer without the issuance of a certificate of compliance for the vehicle(s) by a Bureau of Automotive Repair Referee Smog Check Station.

b. The retrofit system installer may request Air Resources Board approval to use the alternative inspection schedule for fleet installation of the same retrofit kit on more than 10 vehicles with engines of the same size. If approval is granted, the installer shall submit ten vehicles with engines from similar engine families, retrofitted with the same kit, to a Bureau of Automotive Repair Referee Station.

i. If all ten vehicles receive a certificate of compliance, for subsequent applications of the same type, the installer need only submit every tenth retrofitted vehicle to the Bureau of Automotive Repair for inspection. For the remaining vehicles included in the alternative inspection schedule that are not submitted to the Bureau of Automotive Repair for inspection, the installer shall maintain a record of the vehicle's identification number, the vehicle's model year and make, the date of installation, and the emissions category to which the retrofitted system is certified (i.e., conventional vehicle, TLEV, LEV, or ULEV), or for heavy-duty vehicles, the credit standard to which the system is certified. The Air Resources Board may require random inspections of vehicles subject to the alternative inspection schedule.

ii. If any of the ten vehicles fail to pass inspection, the next set of ten retrofitted vehicles shall be subject to inspection at the Bureau of Automotive Repair, until an entire group of ten passes.

bc. Installation of retrofit systems certified according to the requirements of these test procedures for 1994, and 1995, and 1996 model years shall be restricted to those engine families listed in the Executive Order.

ATTACHMENT C

**AMENDMENTS TO THE CALIFORNIA EXHAUST EMISSION STANDARDS
AND TEST PROCEDURES FOR SYSTEMS DESIGNED TO CONVERT MOTOR VEHICLES
CERTIFIED FOR 1993 AND EARLIER MODEL YEARS TO USE
ALCOHOL OR ALCOHOL/GASOLINE FUELS**

State of California
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS
AND TEST PROCEDURES FOR SYSTEMS
DESIGNED TO CONVERT MOTOR VEHICLES
CERTIFIED FOR 1993 AND EARLIER MODEL YEARS
TO USE ALCOHOL OR ALCOHOL/GASOLINE FUELS

Adopted: April 28, 1983
Amended: March 11, 1993
Amended: November 21, 1995

Note: Changes approved by the Board on July 27, 1995, are indicated by strike-out (deletion) and underline (addition).

TABLE OF CONTENTS

	<u>PAGE</u>
I. GENERAL APPLICABILITY	1
II. DEFINITIONS	2
III. GENERAL STANDARDS	2
IV. EXEMPT VEHICLES	2
V. NON-APPLICABLE REGULATIONS	3
VI. TEST FLEET	3
VII. HEAVY-DUTY VEHICLES	4
VIII. TEST VEHICLES	4
IX. DATA TO BE RECORDED	5
X. CALCULATION PROCEDURE	6
XI. APPLICATION FOR APPROVAL	13
XII. VEHICLES REQUIRING ALTERNATE TESTING	15
XIII. APPROVAL CRITERIA	15
XIV. FINAL APPROVAL	16
XV. CHANGES TO CONVERSION SYSTEM AFTER APPROVAL	16
XVI. INSTALLATION REQUIREMENTS	17

**CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES
FOR SYSTEMS DESIGNED TO CONVERT MOTOR VEHICLES
CERTIFIED FOR 1993 AND EARLIER MODEL YEARS TO USE
ALCOHOL OR ALCOHOL/GASOLINE FUELS**

The authority for these Exhaust Emission Standards and Test Procedures is found in Sections 43004 and 43006 of the California Health and Safety Code which contain the following:

43004. "--the standards applicable under this part for exhaust emissions for gasoline-powered motor vehicles shall apply to motor vehicles which have been modified or altered to use a fuel other than gasoline or diesel."

43006. "The state board may certify the fuel system of any motor vehicle powered by a fuel other than gasoline or diesel which meets the standards specified by Section 43004 and adopt test procedures for such certification."

I. GENERAL APPLICABILITY

"California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels" ("these test procedures" or "these procedures") are applicable to any single- or dual-fuel motor vehicle conversion system using alcohol or alcohol/gasoline fuels in lieu of the original certification fuel system for 1993 and earlier model year emission-controlled vehicles used or registered in the State of California.

A retrofit system manufacturer may apply these test procedures to certify conversion systems for 1994, and 1995, and 1996 model-year vehicles in accordance with the following implementation phase-in schedule. Each manufacturer may certify a maximum of 85 percent of its total 1994 model-year engine family conversion systems, and 45 percent of its total 1995 model-year systems, and 45 percent of its total 1996 model-year systems, according to the requirements of these test procedures and "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas or Natural Gas Fuels." The remaining percentage of each manufacturer's certified 1994, and 1995, and 1996 model-year engine family conversion systems and all of 19967 and subsequent model-year engine family conversion systems shall be certified according to "California Certification and Installation Procedures for Alternative Fuel Retrofit Systems For Motor Vehicles Certified For 1994 and Subsequent Model Years and for All Model-Year Motor Vehicle Retrofit Systems Certified for Emission Reduction Credit." The percentages shall be determined from the total number of conversion systems certified and shall be met prior to the end of the applicable next respective calendar year. If the above referenced 85 percent maximum is exceeded for 1994 or the above referenced 45 percent maximum is exceeded for 1995 or 1996, the Executive Officer shall rescind the Executive Order for those conversion systems most recently certified which caused the percentages to be exceeded. These procedures shall not be used to

certify a retrofit system for installation on a transitional low-emission vehicle ("TLEV"), low-emission vehicle ("LEV"), or ultra-low-emission vehicle ("ULEV") or to certify a retrofit system designed to convert a vehicle to TLEV, LEV, or ULEV emission standards (as defined in Section 1960.1, Title 13, CCR). These procedures shall not be used to certify retrofits for emission reduction credits.

II. DEFINITIONS

The definitions used in these test procedures shall be the same as those in the California Exhaust Emission Standards and Test Procedures for passenger cars, light-duty trucks, medium-duty vehicles, and heavy-duty engines and vehicles.

The term alcohol fuel shall mean methanol, ethanol, methanol/ethanol blends, methanol/gasoline blends, or ethanol/gasoline blends for purposes of these procedures, and all provisions shall apply to methanol, ethanol, and blends unless specifically noted. However, federally approved fuels or fuel additives which comply with Section 211(f) of the Clean Air Act (42 U.S.C. 7545(f)) are not deemed alcohol fuels for the purposes of this procedure. Dual-fuel vehicle shall mean a vehicle capable of operating on either the original certification fuel or alcohol fuel, but not both concurrently.

III. GENERAL STANDARDS

In addition to all other standards or requirements imposed, any modification of an original certification-fuel motor vehicle to allow the use of alcohol fuel:

- A. Shall not cause, in the operation or function of the vehicle, the emission into the ambient air of any noxious or toxic substance which may present a significant hazard to public health or welfare that is not emitted in the operation of such vehicle without such modification, except as specifically permitted by regulation; and
- B. Shall not result, in the operation, function, or malfunction of the vehicle, in any unsafe condition endangering the motor vehicle, its occupants, other persons, or property in close proximity to the vehicle, in accordance with the safety requirements specified for the original vehicle.

IV. EXEMPT VEHICLES

Vehicles participating in the Department of Motor Vehicles' Methanol Fuel Experimental Program may, but are not required to, have a certified conversion system. Owners or lessees of these vehicles shall, however, annually obtain a Certificate of Compliance in accordance with the provisions of Title 13, California Code of Regulations, section 2177.

Y. NON-APPLICABLE REGULATIONS

All subjects in the referenced California Exhaust Emission Standards and Test Procedures for non-alcohol-powered vehicles not directly related to exhaust or evaporative emission testing shall not be applicable to these procedures.

VI. TEST FLEET

Each applicant is required to test a limited fleet to obtain certification. Emissions tests will be conducted at an independent laboratory at the conversion device manufacturer's expense. Fleet vehicles shall be selected by the Executive Officer.

A. FLEET SELECTION

The passenger car, light-duty truck, and medium-duty vehicle¹ test fleets shall consist of three to ten vehicles for each alcohol fuel system. The number of test vehicles required will depend upon the manufacturer's application outlining the vehicles for which approval is requested, and may be reduced from three if the fuel system applies to a limited number of vehicles. Vehicles will be selected to include a wide variation in engine size from different vehicle manufacturers, and engines with unusual or sensitive emission control systems.

B. SINGLE FUEL TESTING

The following test sequence shall be used when testing a fleet vehicle for straight alcohol or alcohol blend operation:

1. Adjust vehicle to manufacturer's specifications.
2. Run one cold start CVS-75 test (baseline).
3. Install conversion system in accordance with conversion system manufacturer's instructions.
4. Run one cold start CVS-75 test on the modified vehicle using alcohol fuel.

1. For the purposes of these procedures, 1977 and older medium-duty vehicles shall be selected and tested in accordance with the heavy-duty protocol contained in Section VII.

C. DUAL-FUEL TESTING

The following test sequence shall be used when testing a dual-fuel vehicle:

1. Adjust vehicle to vehicle manufacturer's specifications.
2. Run one cold start CVS-75 test (baseline).
3. Run one hot start CVS-72 test (baseline).
4. Install conversion system in accordance with conversion system manufacturer's instructions.
5. Run one cold start CVS-75 test using the appropriate alcohol fuel.
6. Run one hot start CVS-72 using the original certification fuel.

Dual-fuel system manufacturers may elect to delete steps 3 and 6 by substituting a cold start CVS-75 gasoline test for step 6.

The Executive Officer may require Sealed Housing Evaporative Determination (SHED) tests in addition to the required emission tests for any system that, in the judgement of the Executive Officer, may increase evaporative emissions (e.g., change in fuel tank surface area).

VII. HEAVY-DUTY VEHICLES

Approval of an alcohol fuel system for passenger cars, light-duty trucks, or 1978 and newer medium-duty vehicles can qualify that system for use on heavy-duty vehicles over 8500 pounds GVWR and 1977 and older medium-duty vehicles, provided an engineering evaluation indicates similar emissions patterns are anticipated.

If approval is sought solely for heavy-duty vehicles over 8500 pounds GVWR and/or 1977 and older medium-duty vehicles, the Executive Officer shall select engines and require tests in accordance with the provisions of Section XII of this procedure.

VIII. TEST VEHICLES

Each test vehicle shall be a California certified version having between 4,000 and 50,000 miles. In the event that a manufacturer acquires a vehicle with less than 4,000 miles, the vehicle mileage must be brought to 4,000 miles by driving the vehicle on the road, or by accumulating mileage on a chassis dynamometer.

Each test vehicle shall be subjected to a thorough diagnostic examination prior to the baseline test to detect and correct possible defects and deviations from manufacturer's specifications for emissions-related parts. Baseline emission results within applicable standards shall be taken as an indicator that the vehicle is acceptable for testing. Baseline emission results exceeding applicable standards shall be grounds for rejecting a test vehicle unless the applicant chooses to perform a second diagnostic examination. If the second diagnostic examination does not reveal a malfunction in the engine/emission control system, the vehicle shall be deemed an acceptable test vehicle. If the second diagnostic test reveals a fault or maladjustment, the vehicle shall be deemed unacceptable for test purposes. The applicant may either make repairs and retest the vehicle, or may obtain another vehicle acceptable to the staff.

Any properly equipped emission test laboratory may perform the test. Test vehicles shall be under the control of the laboratory for the entire test period. Return of a test vehicle to an applicant during the test period may invalidate test results.

After a fleet baseline test has been run on the original certification fuel (e.g., Indolene fuel for gasoline-powered vehicles), prior approval is required from the Executive Officer before any servicing, maintenance, modifications, or parts replacements are made that are not listed in the applicant's written instructions. A chemical analysis of the fuel must be performed and reported. The analysis should include a determination of purity and water content. The laboratory shall record all the above information and include it as part of the report submitted to the Executive Officer. The report must be submitted directly to the Executive Officer and must contain all related information, including failed tests. Tests performed for research and development purposes before the application is submitted need not be reported. The applicant may not edit the laboratory report but may submit additional clarifying comments or information.

IX. DATA TO BE RECORDED

Vehicle:

- Make, Model and Model Year
- Vehicle Identification Number or License Number
- Odometer Reading
- Engine Displacement

Fuel System:

- Original Fuel Tank Capacity
- Alcohol Fuel Tank Capacity
- Type of Fuel Metering System

Tuning Specifications:

- Idle RPM
- Ignition Timing
- Carburetor Setting (specify method used)
- Other

Dynamometer Setting Specifications:

- Inertia Loading
- Curb Weight
- Road Load Horsepower at 50 mph
- Drive Wheel Tire Pressure

X. CALCULATION PROCEDURE

The final reported test results shall be computed by use of the following calculations for neat methanol or neat ethanol as a guide. Calculations for blends of ethanol or methanol will be determined based on the relative proportions of the constituents. Unburned fuel (UBF) emissions shall mean unburned original certification fuel, methanol or ethanol and all other oxygenated and non-oxygenated hydrocarbon by-products of combustion. Correction factors shall be determined and applied to UBF emissions from alcohol-fueled vehicles. In the absence of an acceptable empirically derived factor, a factor of 2.5 shall be applied.

A description of the laboratory equipment used and the emission tests performed shall be attached to any emission data submitted to the Air Resources Board. An applicant shall have the option of using a gas chromatograph (GC) or equivalent to determine concentrations of unburned fuel in exhaust or evaporative gas samples. If a flame ionization detector (FID) is used, instrument calibration procedures and corrections for FID response to oxygenated hydrocarbons must be specified. A heated sample line shall be used in conjunction with a FID for measurement of UBF from alcohol-fueled vehicles.

No allowance or trade-off shall be permitted to reduce exhaust emission levels of alcohol-fueled vehicles on the basis of low evaporative emission levels.

Meaning of Symbols

CO_{conc} = Carbon monoxide concentration of the dilute exhaust sample corrected for background, water vapor, and CO_2 extraction, in ppm.

CO_{dm} = Carbon monoxide concentration of the dilution air sample as measured, in ppm.

- CO_d = Carbon monoxide concentration of the dilution air corrected for water vapor extraction, in ppm.
- CO_e = Carbon monoxide concentrations of the dilute exhaust sample volume corrected for water vapor and carbon dioxide extraction, in ppm.
- CO_{em} = Carbon monoxide concentration of the dilute exhaust sample as measured, in ppm.
- CO_{mass} = Carbon monoxide emissions, in grams per test phase.
- CO_{2conc} = Carbon dioxide concentration of the dilute exhaust sample corrected for background and water vapor, in percent.
- CO_{2e} = Carbon dioxide concentration of the dilute exhaust sample, in percent.
- CO_{2mass} = Carbon dioxide emissions, in grams per test phase.
- $Density_{CO}$ = Density of carbon monoxide is 32.97 g/ft³ at 68°F and 760 mm. Hg pressure.
- $Density_{CO_2}$ = Density of carbon dioxide is 51.85 g/ft³ at 68°F and 760 mm. Hg pressure.
- $Density_{NO_2}$ = Density of oxides of nitrogen is 34.16 g/ft³ assuming they are in the form of nitrogen dioxide, at 68°F and 760 mm Hg pressure.
- $Density_{USF}$ = Density of methanol (less the mass of oxygen) is 18.93 g/ft³ and density of ethanol (less the mass of oxygen) is 17.74 g/ft³ on a per carbon atom basis at 68°F and 760 mm Hg pressure.
- DF = Dilution Factor
- H = Absolute humidity in grains of water per pound of dry air.
- HC_d = Hydrocarbon concentration of the dilution air as measured, in ppm carbon equivalent.

K_H	• Humidity correction factor.
N	• Number of revolutions of the positive displacement pump during the test phase while samples are being collected.
$NO_{x\text{conc}}$	• Oxides of nitrogen concentration of the dilute exhaust sample corrected for background, in ppm.
NO_{x_d}	• Oxides of nitrogen concentration of the dilute air as measured, in ppm.
NO_{x_e}	• Oxides of nitrogen concentration of the dilute exhaust sample as measured, in ppm.
$NO_{x\text{mass}}$	• Oxides of nitrogen emissions, in grams per test phase.
P_B	• Barometric pressure, in mm Hg.
P_d	• Saturated vapor pressure in mm Hg at ambient dry bulb temperature.
P_i	• Pressure depression below atmospheric measured at the inlet to the positive displacement pump.
T_p	• Average temperature of dilute exhaust entering positive displacement pump during test while samples are being collected, in degrees Rankine.
R_a	• Relative humidity of the ambient air, in percent.
USF_{conc}	• Unburned fuel concentration for the dilute exhaust sample corrected for background, in ppm carbon equivalent, i.e.; equivalent propane x 3.
USF_e	• Unburned fuel concentration of the dilute exhaust sample, in ppm carbon equivalent.
USF_{mass}	• Unburned fuel emissions, in grams per test phase.
Y_{mix}	• Total dilute exhaust volume in cubic feet per test phase corrected to standard conditions (528°R and 760 mm Hg).

- V_o = Volume of gas pumped by the positive displacement pump, in cubic feet per revolution. This volume is dependent on the pressure differential across the positive displacement pump.
- Y_{ct} = Mass emissions as calculated from the "transient" phase of the cold start test, in grams per test phase.
- Y_{ht} = Mass emissions as calculated from the "transient" phase of the cold start test, in grams per test phase.
- Y_s = Mass emissions as calculated from the "stabilized" phase of the cold start test, in grams per test phase.
- Y_{wm} = Weighted mass emissions of each pollutant, i.e., UBF, CO , or NO_x , in grams per vehicle mile.

A. For passenger cars, medium-duty vehicles and light-duty trucks:

The mass of each emission in grams per mile is

$$Y_{wm} = (0.43Y_{ct} + 0.57Y_{ht} + Y_s)/7.5$$

B. The mass of each pollutant for each phase of both the cold start test and the hot start test is determined from the following:

1. Unburned fuel mass:

$$UBF_{mass} = V_{mix} \times \text{Density}_{UBF} \times (UBF_{conc}/1,000,000)$$

2. Oxides of nitrogen mass:

$$NO_{x_{mass}} = V_{mix} \times \text{Density}_{NO_2} \times K_H \times (NO_{x_{conc}}/1,000,000)$$

3. Carbon monoxide mass:

$$CO_{mass} = V_{mix} \times \text{Density}_{CO} \times (CO_{conc}/1,000,000)$$

4. Carbon dioxide mass:

$$CO_{2_{mass}} = V_{mix} \times \text{Density}_{CO_2} \times (CO_{2_{conc}}/100)$$

$$V_{mix} = \frac{V_c \times H \times (P_g - P_i) \times 528}{(760)(T_p)}$$

$$UBF_{conc} = UBF_e - HC_d (1-1/DF)$$

$$NO_{x\text{conc}} = NO_{x_e} - NO_{x_d} (1-1/DF)$$

$$CO_{\text{conc}} = CO_e - CO_d (1-1/DF)$$

$$CO_e = (1-0.03 CO_{2_e} - 0.000323 R_a) CO_{em} \text{ for methanol}$$

$$CO_e = (1-0.025 CO_{2_e} - 0.000323 R_a) CO_{em} \text{ for ethanol}$$

$$CO_d = (1-0.000323 R_a) CO_{dm}$$

$$K_h = \frac{1}{1-0.0047(H-75)}$$

$$H = \frac{(43.478 R_a)(P_d)}{P_B - P_d \times R_a / 100}$$

$$DF = \frac{11.57}{CO_{2_e} + (UBF_e - CO_e) \times 10^{-4}} \text{ for methanol}$$

$$DF = \frac{12.29}{CO_{2_e} + (UBF_e - CO_e) \times 10^{-4}} \text{ for ethanol}$$

For gasoline fuel the Y_{wm} value must be multiplied by the methane content correction factor (MCCF).

$$UBF_{wm} = Y_{wm} \times MCCF$$

UBF_{wm} = weighted mean unburned fuel mass in grams per vehicle mile after correction for methane content

The following MCCF values (or as determined by the vehicle manufacturer and approved by the ARB during certification) may be used on all gasoline tests:

Catalyst equipped passenger cars = 0.89
All other vehicles = 1.0

The applicant, if he or she so desires, may determine the actual MCCF of a fuel by using the "California Non-Methane Hydrocarbon Test Procedures" adopted May 24, 1978. For alcohol fuels, reference to "HC" in the non-methane test procedures shall mean "UBF" where appropriate. The fuel used to calibrate the flame ionization detector and method of calibration shall be specified.

The above HCCF values are valid through 1981 model year vehicles. Beginning with 1982 model year vehicles the non-methane unburned fuel emissions must be determined using non-methane instrumentation. The above factors can no longer be used. The applicant may test for total unburned fuel, but no factor will be permitted.

Example calculation of mass emission values:

a. For the "transient" phase of the cold-start test assume:

$$V_o = 0.29344 \text{ cu ft per revolution; } N = 10,485;$$

$$R_a = 48.2\%; P_b = 762 \text{ mm Hg; } P_d = 22.225 \text{ mm Hg; } P_i = 70 \text{ mm Hg;}$$

$$T_p = 570^\circ R; \text{USF}_e = 105.8 \text{ ppm carbon equivalent; } \text{NO}_{x_e} = 11.2 \text{ ppm;}$$

$$\text{CO}_{em} = 306.6 \text{ ppm; } \text{CO}_{2e} = 1.43\%; \text{HC}_d = 12.1 \text{ ppm}$$

$$\text{NO}_{x_d} = 0.8 \text{ ppm; } \text{CO}_{dm} = 15.3 \text{ ppm.}$$

Then, for a methanol fueled vehicle:

$$V_{mix} = \frac{(0.29344)(10,485)(762-70)(570)}{(760)(570)} = 2555.0 \text{ cu ft per test phase}$$

$$H = \frac{(43.478)(48.2)(22.225)}{762 - (22.225 \pm 48.2/100)} = 62 \text{ grains of water/pound dry air}$$

$$K_h = \frac{1}{1-0.0047(62-75)} = 0.9425$$

$$\text{CO}_e = (1-0.03(1.43) - 0.000323(48.2))306.6 = 288.7 \text{ ppm}$$

$$\text{CO}_d = (1-0.000323(48.2))15.3 = 15.1 \text{ ppm}$$

$$DF = \frac{11.57}{1.43 - (105.8 - 288.7) \times 10^{-4}} = 7.87$$

$$\text{USF}_{conc} = 105.8 - 12.1(1-1/7.87) = 95.24 \text{ ppm}$$

$$\text{USF}_{mass} = (2555)(18.93)(95.24/1,000,000) = 4.63 \text{ grams per test phase}$$

$$\text{NO}_{x_{conc}} = 11.2 - 0.8(1-1/7.87) = 10.50 \text{ ppm}$$

$$NO_{x\text{mass}} = (2595)(54.16)(10.50/1,000,000)(0.9424) = 1.391 \text{ grams per test phase}$$

$$CO_{\text{conc}} = (298.7) - 15.1(1-1/7.87) = 275.5 \text{ ppm}$$

$$CO_{\text{mass}} = (2595)(32.97)(275.5/1,000,000) = 23.57 \text{ grams per test phase}$$

- b. For the "stabilized" portion of the cold-start test assume that similar calculations result in $UBF_{\text{mass}} = 0.31$ grams per test phase;

$$NO_{x\text{mass}} = 1.27 \text{ grams per test phase; and}$$

$$CO_{\text{mass}} = 5.98 \text{ grams per test phase.}$$

- c. For the "transient" portion of the hot-start test assume that similar calculations resulted in $UBF_{\text{mass}} = 0.25$ grams per test phase;

$$NO_{x\text{mass}} = 1.38 \text{ grams per test phase;}$$

$$\text{and } CO_{\text{mass}} = 5.01 \text{ grams per test phase.}$$

- d. For a methanol fueled vehicle:

$$UBF_{\text{vm}} = \frac{(0.43)(1.68) + (0.57)(0.25) - 0.31}{7.50} = 0.33 \text{ grams per vehicle mile}$$

$$CO_{\text{vm}} = \frac{(0.43)(23.57) + (0.57)(5.01) - 5.98}{7.50} = 2.53 \text{ grams per vehicle mile.}$$

$$NO_{x\text{vm}} = \frac{(0.43)(1.391) + (0.57)(1.27) - 1.27}{7.50} = 0.354 \text{ grams per vehicle mile}$$

XI. APPLICATION FOR APPROVAL

- A. An application for approval to use alcohol fuel in a non-original, certification-fuel engine may be made by any engine, vehicle, or conversion system manufacturer.
- B. An application shall be required for each model year even though the exhaust emission standards for approval of new vehicles may be the same for consecutive model years.
- C. The application shall be in writing, signed by an authorized representative of the manufacturer, and shall include the following:
 - 1. Identification and description of the vehicles for which approval is requested. The application may limit the years, makes, and models for which a system is applicable.
 - 2. A complete description of all modifications and additions to the engine or vehicle.
 - 3. A written specification of the recommended fuel and fuel composition including the amount of variation in composition that may be tolerated. Specifications allowing more than 1,000 ppm of water shall be accompanied by an explanation of the need for, or purpose of, such allowance.
 - 4. Emissions data on such vehicles and engines tested in accordance with the applicable exhaust emission test procedures and standards.
 - 5. A statement of recommended maintenance procedures, including initial installation and initial tuning, and equipment necessary to ensure that the vehicle and engine in operation conform to the specific procedures for each different make and model shall be given. A description of the program for training personnel for such maintenance and installation.
 - 6. An agreement, that upon the Executive Officer's request, any one or more of the test vehicles will be supplied to the ARB, for such testing as may be required, or (by mutual consent between the ARB and applicant) will be made available at the manufacturer's facility for such testing. Provided, that in the latter case, it is further agreed that the instrumentation and equipment specified by the ARB will be made available for testing operations. Any testing conducted at a manufacturer's facility pursuant to this subparagraph will be scheduled as promptly as possible.
 - 7. An agreement that a reasonable number of vehicles will be made available to the ARB for testing for such reasonable periods as may be required. These vehicles shall be selected from time to time by the Executive Officer and shall be typical of production models available for sale to the public.

8. A sample or facsimile of a proposed engine compartment label and an agreement that the modifications made in the field will be properly identified. The model number shall be permanently marked on the carburetor. A permanent label covering the following for the specific installation shall be furnished for installation on the air cleaner or any other area where it may be easily read. The label shall be set for the following:
- a. Manufacturer's name and address.
 - b. Approved by the California ARB for use on _____ model year vehicles with engine size _____ in³ to _____ in³.
 - c. Spark timing.
 - d. Idle speed.
 - e. Mixture adjustment (if used) including idle, cruise, and/or full throttle together with the method.
 - f. Type of fuel.
 - g. Date of installation.
 - h. Carburetor Model No.
 - i. A statement, "for vehicles over 8,500 lbs GVW only," if applicable.
 - j. For dual-fuel systems, a description of any changes to the Original Equipment Manufacturer's evaporative emission-control systems.
9. An agreement that labels will be applied to the exterior of a modified vehicle adjacent to fill pipes specifying the correct fuel for each tank.
10. For retrofit systems applicable to 1994, and 1995, and 1996 model year vehicles, a complete listing of the engine families for which the manufacturer's conversion systems are designed for installation. The number of a manufacturer's 1994, and 1995, and 1996 model-year engine family retrofit systems certified according to these test procedures shall be limited according to the phase-in schedule described in the General Applicability section of these procedures.

XII. VEHICLES REQUIRING ALTERNATE TESTING

Vehicles equipped with the following systems require individual consideration and may require tests other than those described in this procedure. The Executive Officer shall make the determination of the required testing, taking into account any test plans submitted by the applicant.

- Heavy-duty engines
- Vehicles equipped with closed-loop feedback emission controls
- Engines that have altered compression ratios
- Engines of unconventional design

XIII. APPROVAL CRITERIA

A. EMISSIONS

The Executive Officer shall review the applicant's emission data and any other laboratory data available to determine the conversion system's effect on emissions. Test data from the vehicles must demonstrate that operation on alcohol fuel (modified configuration) results in no significant increase in emissions. A significant increase in a vehicle's emissions when operated on alcohol fuel shall be grounds for denial of certification even if the emissions are within applicable standards.

B. DRIVEABILITY

The Executive Officer shall evaluate the effects of the alcohol fuel conversion system on the vehicle's performance or

driveability. Cold starting and operating performance will be considered as part of the evaluation procedure. If the system degrades the driveability or vehicle performance such that owners may be tempted to adjust the engine settings or tamper with required emission control systems to improve driveability or vehicle performance, the Executive Officer may find that the alcohol fuel conversion system will increase emissions.

C. DURABILITY

If the Executive Officer has reason to believe, on the basis of an engineering evaluation, that an alcohol fuel conversion system will affect the durability of the vehicle emission control system, or the conversion system itself does not demonstrate durability equivalent to the part or system replaced or added to, he or she may find that the modification will increase emissions. The manufacturer may be required to submit durability data in order to show that the durability of the vehicle emission control system is not affected, and/or that the fuel conversion system demonstrates adequate durability.

XIV. FINAL APPROVAL

- A. If, after a review of the data and other information submitted by the manufacturer, the Executive Officer determines that a modification to use alcohol fuel conforms to the procedures outlined in these regulations, the Executive Officer will issue an Executive Order of approval for such modifications.
- B. The Executive Order may be issued upon such terms as the Executive Officer deems necessary to ensure that any modifications to use alcohol fuel will meet the requirements of the procedures outlined in these regulations.
- C. Approval for a conversion system for a given model year is deemed as approval for all previous model years, unless otherwise specified in the Executive Order. Approval for subsequent model years may be given, after request by the applicant, if further evaluation and/or testing demonstrates that the system will meet the standards for the applicable model year.

XV. CHANGES TO CONVERSION SYSTEM AFTER APPROVAL

All changes made to the conversion system, including installation changes, must be submitted to the Executive Officer for approval. The Executive Officer may require additional testing prior to approval.

XVI. INSTALLATION REQUIREMENTS

- A. Beginning January 1, 1994, installers of alternative fuel retrofit systems shall submit the converted vehicles to a Bureau of Automotive Repair Referee Smog Check Station for inspection and testing, prior to releasing the converted vehicles to the consumer, except as provided in E.
1. Installers of alternative fuel retrofit systems shall not release the converted vehicle(s) to the consumer without the issuance of a certificate of compliance for the vehicle(s) by a Bureau of Automotive Repair Referee Smog Check Station.
- B. The retrofit system installer may request Air Resources Board approval to use the alternative inspection schedule for fleet installation of the same retrofit kit on more than 10 vehicles with engines of the same size. If approval is granted, the installer shall submit ten vehicles with engines from similar engine families, retrofitted with the same kit, to a Bureau of Automotive Repair Referee Station.
- i. If all ten vehicles receive a certificate of compliance, for subsequent applications of the same type, the installer need only submit every tenth retrofitted vehicle to the Bureau of Automotive Repair for inspection. For the remaining vehicles included in the alternative inspection schedule that are not submitted to the Bureau of Automotive Repair for inspection, the installer shall maintain a record of the vehicle's identification number, the vehicle's model year and make, the date of installation, and the emissions category to which the retrofitted system is certified (i.e., conventional vehicle, TLEV, LEV, or ULEV), or for heavy-duty vehicles, the credit standard to which the system is certified. The Air Resources Board may require random inspection of any vehicles subject to the alternative inspection schedule.
- ii. If any of the ten vehicles fail to pass inspection, the next set of ten retrofitted vehicles shall be subject to inspection at the Bureau of Automotive Repair, until an entire group of ten passes.
- BC. Installation of retrofit systems certified according to the requirements of these test procedures for 1994, and 1995, and 1996 model years shall be restricted to those engine families listed in the Executive Order.

ATTACHMENT D

**AMENDMENTS
TO ARTICLE 5, CHAPTER 1, DIVISION 3, TITLE 13
OF THE CALIFORNIA CODE OF REGULATIONS AND
TO SECTIONS 2030 AND 2031 OF ARTICLE 5**

AMENDMENTS TO ARTICLE 5, CHAPTER 1, DIVISION 3, TITLE 13
OF THE CALIFORNIA CODE OF REGULATIONS
AND SECTION 2030 OF ARTICLE 5

Approval of Systems Designed to Convert Motor Vehicles to Use Fuels
Other Than the Original Certification Fuel or
to Convert Motor Vehicles for Emission Reduction Credit

Adopted: April 28, 1975
Amended: March 16, 1977
Amended: May 21, 1981
Amended: June 2, 1983
Amended: October 18, 1984
Amended: May 7, 1993
Amended: November 21, 1995

Note: Changes approved by the Board on July 27, 1995, are indicated by
strike-out (deletion) and underline (addition).

Article 5. Approval of Systems Designed to Convert Motor Vehicles to Use Fuels Other Than the Original Certification Fuel or to Convert Motor Vehicles for Emission Reduction Credit

2030. Liquefied Petroleum Gas or Natural Gas Retrofit Systems.

a) Applicable Standards and Test Procedures.

The standards and test procedures for approval of systems designed to convert 1993 and earlier model year motor vehicles to use liquefied petroleum gas or natural gas fuels are contained in "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas or Natural Gas Fuels" adopted by the State Board on April 16, 1975, as amended March 11, 1993 November 21, 1995. The standards and test procedures for approval of systems designed to convert 1994 and subsequent model year motor vehicles to use liquefied petroleum gas or natural gas fuels are contained in "California Certification and Installation Procedures for Alternative Fuel Retrofit Systems for Motor Vehicles Certified for 1994 and Subsequent Model Years and for all Model Year Motor Vehicle Retrofit Systems Certified for Emission Reduction Credit," adopted by the State Board March 11, 1993, as amended November 21, 1995. At the option of the retrofit system manufacturer, the standards and test procedures for approval of systems designed to convert 1994 and subsequent model year vehicles to use liquefied petroleum gas or natural gas fuels may be used for approval of systems designed to convert 1993 and earlier model year motor vehicles to use liquefied petroleum gas or natural gas fuels in lieu of the "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas or Natural Gas Fuels."

b) Implementation Phase-In Schedule.

Notwithstanding subsection (a), a retrofit system manufacturer may apply "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas or Natural Gas Fuels" to certify retrofit systems for 1994 and 1995 model-year vehicles in accordance with the following implementation phase-in schedule. Each manufacturer may certify a maximum of 85 percent of its total 1994 model-year engine family retrofit systems, and 45 percent of its total 1995 model-year systems, and 45 percent of its total 1996 model-year systems, according to the requirements of these test procedures and "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels", adopted by the State Board on April 28, 1983, as amended March 11, 1993 November 21, 1995. The remaining percentage of each manufacturer's certified 1994, and 1995, and 1996 model-year engine family retrofit systems and all of 1996 and subsequent model-year engine family retrofit systems shall be certified according to "California Certification and Installation Procedures for Alternative Fuel Retrofit Systems For Motor Vehicles Certified For 1994 and Subsequent Model Years and for all Model Year Motor Vehicle Retrofit Systems Certified for Emission Reduction

Credit." The percentages shall be determined from the total number of retrofit systems certified and shall be met prior to the end of the applicable next respective calendar year. "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas or Natural Gas Fuels" shall not be applied to certify a retrofit system for installation on a transitional low-emission vehicle ("TLEV)", low-emission vehicle ("LEV)", or ultra-low emission vehicle ("ULEV)" or to certify a retrofit system designed to convert a vehicle to TLEV, LEV, or ULEV emission standards (as defined in Section 1960.1, Title 13, California Code of Regulations), or to certify a retrofit system for emission reduction credits.

NOTE: Authority cited: Sections 39515, 39600, 39601 and 43006, Health and Safety Code. Reference: Sections 43000, 43004, 43006, 43008.6, 43013 and 43108, Health and Safety Code; and Sections 27156, 38391 and 38395, Vehicle Code.

AMENDMENTS TO ARTICLE 5, CHAPTER 1, DIVISION 3, TITLE 13
OF THE CALIFORNIA CODE OF REGULATIONS
AND SECTION 2031 OF ARTICLE 5

Approval of Systems Designed to Convert Motor Vehicles to Use Fuels
Other Than the Original Certification Fuel or
to Convert Motor Vehicles for Emission Reduction Credit

Adopted: June 2, 1983
Amended: May 7, 1993
Amended: November 21, 1995

Note: Changes approved by the Board on July 27, 1995, are indicated by
strike-out (deletion) and underline (addition).

Article 5. Approval of Systems Designed to Convert Motor Vehicles to Use Fuels Other Than the Original Certification Fuel or to Convert Motor Vehicles for Emission Reduction Credit

2031. Alcohol or Alcohol/Gasoline Fuels Retrofit Systems.

a) Applicable Standards and Test Procedures.

The standards and test procedures for approval of systems designed to convert 1993 and earlier model year motor vehicles to use alcohol or alcohol/gasoline fuels in lieu of the original certification fuel system are contained in "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels," adopted by the State Board April 28, 1983, as amended March 11, 1993 November 21, 1995. The standards and test procedures for approval of systems designed to convert 1994 and subsequent model year motor vehicles to use alcohol or alcohol/gasoline fuels are contained in "California Certification and Installation Procedures for Alternative Fuel Retrofit Systems for Motor Vehicles Certified for 1994 and Subsequent Model Years and for all Model Year Motor Vehicle Retrofit Systems Certified for Emission Reduction Credit," adopted by the State Board March 11, 1993, as amended November 21, 1995. At the option of the retrofit system manufacturer, the standards and test procedures for approval of systems designed to convert 1994 and subsequent model year motor vehicles to use alcohol or alcohol/gasoline fuels may be used for approval of systems designed to convert 1993 and earlier model year motor vehicles to use alcohol or alcohol/gasoline fuels in lieu of the "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels."

b) Implementation Phase-In Schedule.

Notwithstanding subsection (a), a retrofit system manufacturer may apply "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels" to certify retrofit systems for 1994 and 1995 model-year vehicles in accordance with the following implementation phase-in schedule. Each manufacturer may certify a maximum of 85 percent of its total 1994 model-year engine family retrofit systems, and 45 percent of its total 1995 model-year systems, and 45 percent of its total 1996 model-year systems, according to the requirements of these test procedures and the "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Liquefied Petroleum Gas or Natural Gas Fuels," adopted by the State Board on April 16, 1975, as amended March 11, 1993 November 21, 1995. The remaining percentage of each manufacturer's certified 1994, and 1995, and 1996 model-year engine family retrofit systems and all of 1996 and subsequent model-year engine family retrofit systems shall be certified according to "California Certification and Installation Procedures for Alternative Fuel Retrofit Systems For Motor Vehicles Certified For 1994 and Subsequent Model Years and for all Model Year Motor Vehicle Retrofit Systems Certified for Emission Reduction

Credit. The percentages shall be determined from the total number of retrofit systems certified and shall be met prior to the end of the applicable next respective calendar year. "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles Certified for 1993 and Earlier Model Years to Use Alcohol or Alcohol/Gasoline Fuels" shall not be applied to certify a retrofit system or installation on a transitional low-emission vehicle ("TLEV"), low-emission vehicle ("LEV"), or ultra-low-emission vehicle ("ULEV") or to certify a retrofit system designed to convert a vehicle to TLEV, LEV, or ULEV emission standards (as defined in Section 1960.1, Title 13, California Code of Regulations), or to certify a retrofit system for emission reduction credits.

NOTE: Authority cited: Sections 39515, 39600, 39601 and 43006, Health and Safety Code. Reference: Sections 43000, 43004, 43006, 43008.6, 43013 and 43108, Health and Safety Code; and Sections 27156, 38391 and 38395, Vehicle Code.

SECTION 1956.9, TITLE 13, CCR

Optional Exhaust Emission Standards for Retrofitted Heavy-Duty Engines

Adopted: November 21, 1995

SECTION 1956.9, TITLE 13, CCR

§ 1956.9 Optional Exhaust Emission Standards for Retrofitted Heavy-Duty Engines

1973 and later model-year heavy-duty engines that have been retrofitted to produce emissions less than the original certification emission level may be certified to optional emission standards as follows:

(a)(1) Total Hydrocarbons

$(X - n \times 0.2)$ grams per brake horsepower-hour

where $X = 0.75 \times$ new engine total hydrocarbon standard for the engine's model year, with the further requirement that X is rounded down to the nearest lower 0.2 grams per brake horsepower-hour increment; and where n is an integer such that $n \times 0.2$ is greater than or equal to zero. For diesel engines, $X = 0.75 \times$ original emission certification value for the engine's model year. For engines originally certified to a combined hydrocarbon plus oxides of nitrogen standard, $X = 0.75 \times$ original engine certification standard pro-rated by the hydrocarbon portion of the original emission certification level. If the original emission certification levels are not available, the hydrocarbon baseline standard shall be pro-rated by the hydrocarbon and oxides of nitrogen values of the next later model year with separate hydrocarbon and oxides of nitrogen standards.

(a)(2) Non-methane Hydrocarbons

For engines originally certified to an optional non-methane hydrocarbon standard,

$(X - n \times 0.2)$ grams per brake horsepower-hour

where $X = 0.75 \times$ new engine non-methane hydrocarbon standard for the engine's model year, with the further requirement that X is rounded down to the nearest lower 0.2 grams per brake horsepower-hour increment; and where n is an integer such that $n \times 0.2$ is greater than or equal to zero. For diesel engines, $X = 0.75 \times$ original emission certification value for the engine's model year.

(b) Carbon Monoxide

$(X - n \times 5.0)$ grams per brake horsepower-hour

where $X = 0.75 \times$ new engine carbon monoxide standard for the engine's model year, with the further requirement that X is rounded down to the nearest lower 5 grams per brake horsepower-hour increment; and where n is an integer such that $n \times 5.0$ is greater than or equal to zero. For diesel engines, $X = 0.75 \times$ original emission certification value for the engine's model year.

(c) Oxides of Nitrogen

$(X - n \times 0.5)$ grams per brake horsepower-hour

where $X = 0.75 \times$ new engine oxides of nitrogen standard for the engine's model year, with the further requirement that X is rounded down to the nearest lower 0.5 grams per brake horsepower-hour increment; and where n is an integer such that $n \times 0.5$ is greater than or equal to zero. For engines originally certified to a combined hydrocarbon plus oxides of nitrogen standard, $X = 0.75 \times$ original engine certification standard, pro-rated by the oxides of nitrogen portion of the original emission certification level. If the original emission certification levels are not available, the oxides of nitrogen baseline standard shall be pro-rated by the hydrocarbon and oxides of nitrogen values of the next later model year with separate hydrocarbon and oxides of nitrogen standards.

(d) Particulate Matter

$(X - n \times 0.05)$ grams per brake horsepower-hour

where $X = 0.75 \times$ new diesel engine particulate matter standard for the engine's model year, with the further requirement that X is rounded down to the nearest lower 0.05 grams per brake horsepower-hour increment; and where n is an integer such that $n \times 0.05$ is greater than or equal to zero. For diesel engines that were not originally certified to a particulate matter emission standard, $X = 0.75 \times 0.6$ grams per brake horsepower-hour. Gasoline engines may not be certified to an optional exhaust emission standard for particulate matter.

(e) 1972 and earlier model year engines may be certified to credit standards as described in (a)(1), (b), (c), and (d) using 1973 model year new engine emission standards as the basis for calculating "X."

(f) The test procedures for determining compliance with an optional standard shall be the test procedure used to originally certify the engine. To certify to an optional emission standard, a retrofitted engine must meet all of the requirements of "California Certification and Installation Procedures for Alternative Fuel Retrofit Systems for Motor Vehicles Certified for 1994 and Subsequent Model Years and for all Model Year Motor Vehicle Retrofit Systems Certified for Emissions Reduction Credit," adopted March 11, 1993, as amended November 21, 1995, which is incorporated by reference herein.

Note: Authority cited: Sections 43701 (b) and (c), Health and Safety Code
Reference: Sections 39002, 39003, 43000, 43004, 43006, 43008, 43013, and 43108, Health and Safety Code; and Sections 27156, 38391 and 38395, Vehicle Code.

Appendix D

CARB Correspondence Concerning Experimental Permit

Appendix D

CARB Correspondence Concerning Experimental Permit



Air Resources Board

Robert F. Sawyer, Ph.D., Chair
9480 Telstar Avenue, Suite 4
El Monte, California 91731 www.arb.ca.gov



This is in response to your request for instructions on how to obtain an experimental permit under the provisions of Health and Safety Code Section 43014.

To apply for an experimental permit, you must submit the following:

1. A brief description of your proposed modification. This description shall include:
 - A. The purpose of the modification.
 - B. Its basic theory of operation and functional characteristics.
2. A defined test program for obtaining pertinent data on driveability, fuel economy, and emission effects as applicable.
3. A statement indicating which, if any, emission control components are removed or modified.
4. The make, model, year, and license number or vehicle identification number (VIN) of the vehicle(s) you plan to modify. If you are modifying a heavy-duty vehicle, please include the engine serial number.
5. A statement indicating the disposition of the modified vehicle(s) at the end of the test program.

Please forward all correspondence to:

Annette Hebert, Chief
Mobile Source Operations Division
California Air Resources Board
9480 Telstar Avenue, Suite 4
El Monte, CA 91731

If you have any questions, please contact Ms. Rose Castro, Manager, Aftermarket Parts Section, at (626) 575-6848.

Sincerely,

Jackie Lourenco, Chief
New Vehicle/Engine Programs Branch

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

California Vehicle Code 27156 Exemption Guidelines for Aftermarket H₂ Systems

California Vehicle Code 27156 anti-tampering exemption is obtained from the Air Resources Board (ARB) through an application process. The exemption procedures for on-road vehicle applications are contained in the “Procedures for Exemption of Add-On and Modified Parts” (Procedures). The process is divided into two phases: the application phase and the testing phase. During the application phase, there will be an exchange of information between the manufacturer and the ARB on the aftermarket system and its applicability. Once the ARB evaluates the system and its vehicle/engine application, the ARB will select the appropriate test vehicle(s)/engine(s) and lay out the test plan. During the testing phase, the manufacturer will arrange with an independent test laboratory to carry out the ARB test plan. At the completion of testing, the ARB will review the data and deny or issue an exemption. For exemption, the manufacturer will need to demonstrate emissions, durability, and On-Board Diagnostic II (OBD II) System compliance. The general guidelines for obtaining an exemption are outlined below:

Application

- Complete and submit the general criteria parts application in the Procedures.

Include with application:

1. System and system application^a
2. Detailed description of system^b
3. Fuel^c
4. Installation instructions and adjustment instructions
5. System label
6. New tune-up/vacuum hose routing label
7. Existing emissions, durability, and OBD II System test data^d
8. CA Smog Check^e
9. Safety information^f
10. Manufacturer warranty (if any)

a System: ICE to H₂-ICE; hybrid ICE-electric to hybrid H₂-ICE-electric; engine modification; engine change; or other

System application: year, make, and model of vehicle/engine to be converted; base engine platform and new platform (for engine change)

b Operating principles; parts added; parts removed; parts modified; fueling/spark calibration; and OBD II System

c H₂, H₂-CNG mixture, or other; method of mixing (i.e. on-board, at fueling station, or other). Has the ARB Stationary Source Division evaluated the fuel blend?

d What vehicle/engine was tested (i.e. year, make, and model); what types of tests were performed? Is the tested system identical to production system?

e Can the converted vehicle be tested under the Smog Check Program?

f Does the H₂/H₂-CNG tank meet handling and storage safety standards established by USDOT, NHTSA, CHP, etc.?

Testing

- Once the application phase is complete, commence testing following the ARB test plan.
 1. Emissions – test and compare emissions against new vehicle/engine emission standards
 2. Durability – provide test data and/or information showing system, component, and emissions durability
 3. OBD II System – provide engineering evaluation and test data showing functional OBD II System. OBD II System will be evaluated by the ARB Advanced Engineering Section

Mail all correspondences to:

California Air Resources Board
9480 Telstar Avenue, Suite 4
El Monte, CA 91731
Attn: Aftermarket Parts Section

State of California
AIR RESOURCES BOARD

**Vehicle Code Sections 27156 and 38391 Exemption Application
for General Criteria Parts**

1. Name of Applicant
Address
Phone ()
2. Name of Device Manufacturer*
Address
Phone ()
3. Name of Authorized Representative**
Address
Phone ()
4. Test procedure (check one)
The test procedure to be used is:
_____ Cold Start CVS-75 Federal Test Procedure
_____ Cold 505
_____ Hot Start CVS-75 (applicable to some diesel-powered vehicles)
5. Evaluation Criteria (check one)
This application is for certification to:
_____ Emission Standards
_____ Typical Baseline Emission Levels

* If different from name of applicant. Device as used herein is defined to mean add-on or modified part.

** An authorized representative may be required to prove that he/she is authorized to act on behalf of an

California Environmental Protection Agency

AIR RESOURCES BOARD

9480 Telstar Ave., Suite 4

El Monte, CA 91731-2988

applicant or manufacturer.

6. Device Name (s)

7. Briefly describe the purpose of the device

8. Briefly describe the operation of the device

9. List vehicle names, model year, engine displacements and systems that are compatible with the device, and for which exemption is requested. Specify the correct device model for each vehicle.

10. The following information is required for the Air Resources Board (ARB) to complete an evaluation. Please place a check mark next to the items that are **enclosed** with the application and provide an explanation for items that are not checked.
- (a)___ A detailed description of the device including operating principles, cross-sectional drawing, electrical schematics, and other such material to assist the staff in understanding its operation.
 - (b)___ Copies of all advertising material to be used in selling devices including a sample or facsimile of the packaging label. (Optional)
 - (c)___ A copy of the installation and adjustment instructions and drawings that will be included with the device.
 - (d)___ A facsimile or prototype of the identification plate or label to be attached permanently to or imprinted on or near each device offered for sale. The plate or label should be placed such that it is visible after the device is installed, and should contain:
 - i) the manufacturers name
 - ii) the device name and model number
 - iii) the Air Resources Board exemption number identified as
ARB E.O. No. D-XXX.
 - (e)___ A facsimile or prototype engine compartment plate or label located adjacent to, but not covering, the vehicle manufacturers Vehicle Emission Control Information (tune-up) label. This plate or label is only required if a change is recommended to vehicle manufacturers tune-up parameters. In addition to the recommended tune-up parameter changes, the plate or label must contain the same information as the device label.
 - (f)___ A list of the companies or persons that will manufacture the device under license.
11. The ARB may require one or more devices for testing. Do you agree to provide the device(s) free of costs?___yes___no. The device(s) will be returned only if return is requested at the time the device(s) are submitted.

California Environmental Protection Agency

AIR RESOURCES BOARD

9480 Telstar Ave., Suite 4

El Monte, CA 91731-2988

Emission Statements

I affirm that to the best of my knowledge this device shall not cause the emission into the ambient air of any noxious or toxic matter that is not emitted in the operation of such motor vehicle without such device.

I understand that an exemption, if granted, does not constitute a certification, accreditation, approval, or any other type of endorsement by the Air Resources Board of any claims concerning alleged benefits of a device. I further understand that no claims of any kind concerning anti-pollution benefits may be made for an exempted device.

Signature of Authorized Representative:

Date: