Appendix A

Roush Correspondence with CARB

Appendix A

Roush Correspondence with CARB

ROUSH

EMISSIONS LABORATORY

12449 Levan Rd.
Livonia, MI 48150
Telephone: (734) 779-7002
Fax: (734) 779-7902
www.roushind.com

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 engined 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 then 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-fiver 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, suing 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 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

ROUSH®

ROUSH INDUSTRIES, INC.

EMISSIONS LABORATORY
12249 Levan Road
Livonia, Michigan 48150

Author's Phone: (734) 779-7870
Facsimile: (734) 779-7902
www.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

ROUSH®

ROUSH INDUSTRIES, INC.
EMISSIONS LABORATORY
12249 Levan Road
Livonia, Michigan 48150

Author's Phone: (734) 779-7870
Facsimile: (734) 779-7902
www.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. <u>CATALYST MONITOR</u>
   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. <u>MISFIRE MONITOR</u>
   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, NOx 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 NOx 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 TIMIMG (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

California Environmental Protection Agency AIR RESOURCES BOARD	GENERAL MOTORS CORPORATION	EXECUTIVE ORDER A-006-1340 New Diesel or Incomplete Medium-Duty Vehicles Using Certified Engines

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	GENERAL MOTORS CORPORATION				6.0	2TWC, 2HO2S(2), SFI	OBD(F)
2006	A-006-1327		ULEV		Otto			

Gasoline, LPG or Alcohol Vehicles Only			VEHICLE DESCRIPTION				
EVAPORATIVE FAMILY	EVAPORATIVE UL (K)	FUEL TANK CAPACITY (gallons)	VEHICLE MODEL YEAR	VEHICLE MAKE & MODELS	ENGINE (L)	ENGINE MODELS / CODES (rated power, in hp)	OBD COMPLIANCE
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)

* =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)
L=liter; hp=horsepower; kw=kilowatt;
[1] 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;
[2] SULEV / ULEV / LEV=super ultra / ultra / low emission vehicle;
[3] 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; SFI/MFI=sequential/multi port fuel injection; DGI=direct gasoline injection; GCARB=gaseous carburetor; IDI/DDI=indirect/direct diesel injection; TC/SC=turbo/super charger; CAC=charge air cooler; EGR=exhaust gas recirculation; PAIR/AIR=pulsed/secondary air injection; SPL=smoke puff limiter; OBD(F) / (P) / ($)=full / partial / partial with a fine / 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.) [4]

	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	*		*		*		*		*		*	

[4] 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