State of California
AIR RESOURCES BOARD

Resolution 83-44

December 15, 1983

Agenda Item No.:83-18-2

WHEREAS, Sections 39600 and 39601 of the Health and Safety Code authorize the Air Resources Board (the "Board") to adopt standards, rules, and regulations necessary for the proper execution of the powers and duties granted to and imposed upon the Board by law;

WHEREAS, Sections 43004, 43006, and 43013 of the Health and Safety Code authorize the Board to adopt standards and test procedures for vehicles modified or altered to use a gaseous fuel which are equivalent to those for gasoline powered motor vehicles;

WHEREAS, the Board has established in regulation, at Section 2030, Title 13, California Administrative Code, standards and test procedures for approval of systems designed to convert motor vehicles to use liquefied petroleum gas or natural gas fuels;

WHEREAS, the Board has adopted exhaust emission standards for passenger cars, light-duty trucks, and medium-duty vehicles, as set forth in Sections 1960.1 et seq., Title 13, California Administrative Code, and for heavy-duty engines and vehicles as set forth in Sections 1956.5 et seq., Title 13, California Administrative Code;

WHEREAS, the staff has prepared draft amendments to the "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles to Use Liquefied Petroleum Gas or Natural Gas Fuels", which were first adopted by the Board on April 16, 1975, and last amended on April 18, 1981;

WHEREAS, the proposed amendments would conform the standards and test procedures for liquefied petroleum gas and natural gas conversion systems to the Board's current new vehicle and engine certification regulations, simplify the gaseous fuel conversion systems certification procedures, provide more flexibility for compliance with the procedures for meeting applicable emission standards, and reduce the amount of testing required for certification;

WHEREAS, the California Environmental Quality Act and Board regulations require that no project having significant adverse environmental impacts be adopted as originally proposed if feasible alternatives or mitigation measures are available;

WHEREAS, a public hearing and other administrative proceedings have been held in accordance with the provisions of the Administrative Procedure Act (Government Code, Title 2, Division 3, Part 1, Chapter 3.5);

WHEREAS, the Board finds that:

the proposed amendments to the Board's regulations are necessary in order to conform the emission standards for engines modified or altered to use liquefied petroleum gas or natural gas fuels pursuant to the provisions of Health and Safety Code Section 43004;

the technology needed to alter or modify such engines to comply with the new vehicle emission standards is feasible and available;

the proposed amendments will provide additional flexibility for manufacturers to comply with the procedures and reduce the amount of testing required for certification and, hence, the costs to some manufacturers for certification, while assuring that approved conversion systems will comply with applicable emission standards;

the proposed amendments to the Board's regulations will not result in potentially significant adverse impacts on the environment.

NOW, THEREFORE, BE IT RESOLVED that the Board hereby approves the amendment to Section 2030 of Title 13, California Administrative Code, as set forth in Attachment A, and the amendments to the "California Exhaust Emission Standards and Test Procedures for Systems Designed to Convert Motor Vehicles to Use Liquefied Petroleum Gas or Natural Gas Fuels" as set forth in Attachment B.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to adopt the amended regulation and the amended test procedures after they have been made available to the public for at least 15 days.

BE IT FURTHER RESOLVED that the Board hereby determines that the regulatory amendments adopted herein are consistent with Section 202(a) of the Clean Air Act, and these amendments do not render California standards and regulations, individually or in the aggregate with other California motor vehicle emission regulations, less protective of public health and welfare than the comparable federal standards.

BE IT FURTHER RESOLVED that, to the extent a waiver is necessary, the Executive Officer shall forward the adopted and amended regulations to the Environmental Protection Agency with a request for a waiver of federal pre-emption or for confirmation that they are within the scope of an existing waiver, pursuant to Section 209(b)(1) of the Clean Air Act.

I certify that the above is a true and correct copy of Resolution 83-45, as adopted by the Air Resources Board.

Harold Holmes, Board Secretary

Public Hearing to Consider Amendments to Title 13, California Administrative Code, Section 2030, Regarding the Standards and Test Procedures for Approval of Systems Designed to Convert Motor Vehicles to Use Liquefied Petroleum Gas or Natural Gas Fuels

Public Hearing Date: December 15, 1983
Public Availability Date: July 31, 1984

On December 15, 1983, the Air Resources Board (the "Board") considered the adoption of proposed amendments to Section 2030, Title 13, California Administrative Code, regarding the "California Exhaust Emission Standards and Test Procedures for Approval of Systems Designed to Convert Motor Vehicles to Use Liquefied Petroleum Gas or Natural Gas Fuels." Attached is a copy of the Board's Resolution 83-44, approving the amendments. Appended to Resolution 83-44 is the approved language showing additions to the originally proposed language by double underline and deletions by slashes.

In approving these amendments, the Board directed the Executive Officer to adopt the regulation and test procedures after making them available to the public for a period of at least 15 days.

ATTACHMENT A

Amend Title 13, California Administrative Code, Section 2030 to read as follows:

Liquefied Petroleum Gas and Natural Gas. The standards and test procedures for approval of systems designed to convert 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 to Use Liquefied Petroleum Gas or Natural Gas Fuels" adopted by the ~~State Board~~ state board on April 16, 1975, ~~and~~ as amended ~~on April 18, 1981~~ August , 1984.

Note: Authority cited: Section 39515, 39600, 39601, and 43006, Health and Safety Code. Reference: Sections 43000, 43004, 43006, 43013, ~~and~~ 43101, and 43104, Health and Safety Code.

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CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR SYSTEMS DESIGNED TO CONVERT MOTOR VEHICLES 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

   This test procedure is 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 emission controlled vehicles registered in the State of California.

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) conversion systems.

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. Emission Standards and Test Procedures~~

~~(a) Passenger Cars and Light Duty Trucks.~~

~~An applicant for straight LPG, NG, and/or dual fuel conversion systems may choose the years, makes and models of the vehicles for which the system will be applicable. The test vehicles shall be chosen from the most recent year vehicle models, and shall be designated by the Executive Officer. The applicant is encouraged to propose a test fleet for consideration by the Executive Officer.~~

~~The exhaust emission standards to be used for approval are the applicable California emission standards or typical emission levels of vehicles in good operating condition for those passenger cars and light duty trucks selected by the Executive Officer as test vehicles. Test procedures shall be the applicable California test procedures for the model year of the test vehicle. Separate approval shall be required for each engine size class. Back to back tests must be conducted and a significant increase in emissions from the baseline, even if the vehicle meets the applicable model year standards, may be cause for denial. In addition, for dual fuel systems, the Executive Officer may require CVS 72 or CVS 75 tests on gasoline with the conversion system. 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.~~

In comparing the emission figures, test variability will be taken into consideration. The allowable variability will be based on the previous experience of the testing facility and statistical analysis of the test data.

(b) Heavy-Duty Vehicles (Single and/or Dual Fuel Systems)

1) Vehicles over 6000 lbs. (1977 or older)

Approval of a system for passenger vehicles shall automatically qualify that system for use on 1977 or older model vehicles over 6000 lbs. GVW with engines in the same size class and with similar emission control systems. If no passenger vehicle within a certain engine class is available for test, the Executive Officer may permit another engine class or a previous year model to be tested.

2) Vehicles Between 6,000 8500 lbs (1978 or newer, Medium Duty Vehicles)

These vehicles must be tested in accordance with the provisions of subparagraph (a).

3) Vehicles over 8500 lbs. (1978 or newer)

Approval of a system for passenger vehicles, light duty trucks, or medium duty vehicles shall automatically qualify that system for use on vehicles over 8,500 lbs. GVW with engines in the same size class and with similar emission control systems for the same or older model years. If an engine in a certain size class is not available, the Executive Officer may permit the substitution of another engine in a different class or a previous model year engine.

In the alternative, the applicant may request permission from the Executive Officer to test the conversion system on an engine dynamometer. A detailed description of the test procedure and calculations must accompany such a request and must be approved by the Executive Officer prior to initial tests. Approval by this method shall only apply to systems when used on heavy duty vehicles over 8,500 lbs. GVW. A significant increase in emissions from the baseline, even if the vehicle meets the applicable heavy duty engine emissions standards, may be cause for denial.

~~(c) Dual-Fuel-Systems-(gasoline-and-LPG-or-NG)~~

~~In-addition-to-meeting-the-applicable-exhaust-emission standards,-the-vehicle's-exhaust-emissions-may-not-be significantly-increased-above-the-baseline-exhaust emissions-when-operating-on-gasoline-with-the-conversion system-installed.--Compliance-with-this-provision-may-be judged-by-the-hot-start-California-CVS-1972-test procedure,-or-the-applicable-cold-start-California CVS-1975-test-procedure-at-the-option-of-the-applicant.~~

~~(d) Crankcase-Emissions---None-permitted~~

~~(e) Fuel-Evaporative-Emissions~~

~~No-increase-above-the-gasoline-system-baseline-is permitted-for-dual-fuel-systems.~~

5. ~~6.~~ Application for Approval

(a) An application for approval of a modification to use LPG or 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 code(s), vaporizer/regulator model number(s), evidence of proper assembly of the fuel tank and fuel lines, and the necessary ~~of all~~ modifications ~~and additions~~ to the engine or vehicle.

~~(iii) A description of the laboratory equipment used and the exhaust emission tests performed to ascertain compliance with the General Standards.~~

~~(iv) Emission data on such vehicles and engines tested in accordance with the applicable exhaust emission test procedures and standards.~~

(iii) ~~(v)~~ 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 different make and model shall be given. A description of the program for training of personnel for such maintenance and installation.

(iv) ~~(vi)~~ 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) ~~(vii)~~ An agreement that up to two test vehicles per vehicle category ~~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. They shall also be representative of the engines and transmissions offered by the vehicle manufacturers.

(vi) ~~(viii)~~ 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. ~~for installation on the air cleaner or any other area where it may be easily read.~~ The label shall set forth the following:

1. Manufacturer's name and address.
2. ~~Approved by~~ The California Air Resources Board certification number identified as "CARB E.O. No. B-XX". ~~for use on ----- model year vehicles with engine sizes ----- in.^{3} to ----- in.^{3}.~~
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.

~~6. Type of fuel (LPG, NG, or dual fuel).~~
~~7. Date of installation.~~
7. ~~8.~~ Carburetor, ~~Model No.~~ vaporizer/regulator model numbers, and carburetor configuration /calibration codes.
~~9. Vaporizer Model No.~~
~~10. A statement "For vehicles over 8500 lbs. GVW only", if applicable.~~
~~11. A list of non applicable systems (e.g. : Fuel injection, 3 way catalyst, etc.) if space permits.~~

~~(ix) For dual fuel systems, a description of any changes to the Original Equipment Manufacturer's the evaporative emission control system.~~

(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 ~~(DF)~~ 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. ~~This~~ These test results must meet the applicable emission standards. A retest is permitted if the vehicle fails the first test. The assigned ~~DF~~ 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 ~~DF~~ deterioration factor or, if not available, an assigned ~~DF~~ 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 ~~average~~ 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 ~~averaged~~ emissions. In addition, for dual-fuel systems, a CVS-~~7~~ 72 test~~s~~ using the original fuel ~~with the conversion system are~~ 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 NOx 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/MDV shall automatically qualify the system for use with heavy-duty engines with similar or less sophisticated emission control systems witnout 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 ~~will~~ may be required by the Executive Officer for each vehicle category ~~carburetor-model conversion-system~~. 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.

~~If the applicant submits additional carburetor-model conversion systems, one (but not both) of the previous test vehicles may be used. One vehicle shall represent the smallest engine size class for which approval is requested and the other the largest engine size class requested. The Executive Officer may, for cause, request up to two additional test vehicles for each carburetor model. The engine size classes are as follows:~~

~~Class A---0 through 140 cubic inches~~
~~Class B---Over 140 through 200 cubic inches~~
~~Class C---Over 200 through 250 cubic inches~~
~~Class D---Over 250 through 300 cubic inches~~
~~Class E---Over 300 through 375 cubic inches~~
~~Class F---Over 375 cubic inches~~
~~Class G---Engines which cannot be classified because of unusual design.~~

~~If the application is for both light and medium duty vehicles, then a total of four test vehicles will be required for each carburetor model conversion system.~~

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. No research and development vehicles should be used in the certification fleet.

(a) Test Vehicles

(i) Vehicles Certifying to New Vehicle Exnaust 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 venicle 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 venicle 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

~~(a)~~ 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 ~~CVS-75 urban cycle~~ 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. Run Baseline Test (Cold start CVS-75).~~

2.~~3.~~ Install conversion system in accordance with conversion system manufacturer's installation instructions (permanent installation of gaseous fuel tank is not required).

3.~~4.~~ 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. Run two baseline tests. One is a cold start CVS-75 and the other is a hot start CVS-72.~~

2.3. 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 ~~cold~~ hot start CVS-~~75~~ 72 test using gasoline or diesel fuel.

6. Run one ~~cold~~ hot start CVS-~~75~~ 72 test using gasoline or diesel fuel (only if first CVS-75 tests on gasoline or diesel fuel fails the emission standards).

~~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.~~

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

1. Adjust venicle to venicle manufacturer's specification.

2. Run ~~two~~ one cold start CVS-75 ~~tests~~ 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 ~~two~~ one cold start CVS-75 test~~s~~ using gaseous fuel.

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

1. Adjust vehicle to vehicle manufacturer's specifications.

2. Run two ~~cold/start/CVS-75~~ baseline tests using gasoline or diesel fuel. ~~One is a cold start CVS-75, and 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).

~~A/ Run/two/cold/start/CVS-75/tests/using/gaseous/fuel~~

~~B/ Run/two/cold/start/CVS-75/tests/using/gaseous/fuel~~

~~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.~~

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.

~~Each vehicle tested for each carburetor (mixer) model must meet the requirements of this procedure.~~

~~9. Data to be Recorded:~~

~~Vehicle:~~

~~Make and Model~~
~~Vehicle Identification Number~~
~~Odometer Reading~~
~~Engine Displacement~~

~~Model year~~
~~License Number~~

~~Fuel-System:~~

~~Nominal-Fuel-Tank-Capacity:~~ ~~Gasoline-or-Diesel~~ ~~LPG/NG~~

~~Fuel-Tank-Location~~
~~Model-of-Carburetor~~
~~Number-of-Carburetor-Barrels~~
~~Model-of-Vaporizer-and/or-Regulator~~

~~Tuning-Specifications:~~

~~Idle-RPM~~
~~Ignition-Timing~~
~~Carburetor-Setting-(Method-used)~~
~~Other~~

~~Dynamometer-Setting-Specifications:~~

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

~~Note:~~ ~~All-maintenance-(repairs-and/or-adjustments)-are-to-be recorded.~~

9. ~~10.~~ 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 venicles 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 1:2.656 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.

$CO_{2_{conc}}$ = Carbon dioxide concentration of the dilute exhaust sample corrected for background and water vapor, in percent.

CO_{2_e} = Carbon dioxide concentration of the dilute exhaust sample, in percent.

$CO_{2_{mass}}$ = Carbon dioxide emissions, in grams per test phase.

$Density_{CO}$ = Density of carbon monoxide is 32.97 g/ft^3 of 68°F and 760 mm. Hg pressure.

$Density_{CO_2}$ = Density of carbon dioxide is 51.85 grams per cubic foot at 68°F and 760 mm. Hg pressure.

$Density_{HC}$ = Density of hydrocarbons is 18.64 g/ft^3 for natural gas and 17.28 gms/ft^3 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/ft^3 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.

NOx_{conc} = Oxides of nitrogen concentration of the dilute exhaust sample corrected for background, in ppm.

NOx_d = Oxides of nitrogen concentration of the dilute air as measured, in ppm.

NOx_e = Oxides of nitrogen concentration of the dilute exhaust sample as measured, in ppm.

NOx_{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 temp.

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).

Vo = 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 hot 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 NOx, 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

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

(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:

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

(2) Oxides of nitrogen mass:

$$NOx_{mass} = V_{mix} \times Density_{NO_2} \times K_H \times (NOx_{conc}/1{,}000{,}000)$$

K_H = humidity correction factor

(3) Carbon monoxide mass:

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

(4) Carbon dioxide mass:

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

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

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

$$NOx_{conc} = NOx_e - NOx_d\ (1-1/DF)$$

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

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

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

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

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

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

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

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

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 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 = 0.89 (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 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:

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

V_o = 0.29344 cu ft per revolution; N = 10,485;

R_a = 48.2%; P_B = 762 mm Hg; P_d = 22.225 mm Hg; P_i = 70 mm Hg;

T_p = 570°R; HC_e = 105.8 ppm carbon equivalent; NOx_e = 11.2 ppm;

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

NOx_d = 0.8 ppm; CO_{dm} = 15.3 ppm.

Then, for an LPG fueled vehicle:

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

$$H = \frac{(43.478)\ (48.2)\ (22.225)}{762-(22.225X48.2/100)} = 62 \text{ grains of water/pound dry air}$$

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

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

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

$$DF = \frac{11.7}{1.43+(105.8+291.6)X10^{-4}} = 7.961$$

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

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

NOx_{conc} = 11.2-0.8(1-1/7.961)=10.50 ppm

NOx_{mass} = (2595)(54.16)(10.50/1,000,000)(0.9424) = 1.391 grams per test phase

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

CO_{mass} = (2595)(32.97)(278.4/1,000,000) = 23.82 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; NOx_{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; NOx_{mass} = 1.38 grams per test phase; and CO_{mass} = 5.01 grams per test phase.

(iv) For an LPG fueled vehicle:

$$HC_{wm} = \frac{(0.43)(4.27)+(0.57)(0.51)+0.62}{7.50} \times 0.75 = 0.275$$

grams per vehicle mile

$$CO_{wm} = \frac{(0.43)(23.82)+(0.57)(5.01)+5.98}{7.50} = 2.54$$

grams per vehicle mile

$$NOx_{wm} = \frac{(0.43)(1.391)+(0.57)(1.38)+1.27}{7.50} = 0.354$$

grams per vehicle mile

10. ~~11.~~ 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 ~~size-class~~.

(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 the standards for the applicable model-year(s) and engine displacement(s).

11. ~~12.~~ Changes to Conversion System After Approval

All changes made 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. ~~13.~~ 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.

State of California
AIR RESOURCES BOARD

Response to Significant Environmental Issues

Item: Public Hearing to Consider Proposed Amendments to Title 13, California Administrative Code, Section 2030, Regarding the Standards and Test Procedures for Approval of Systems Designed to Convert Motor Vehicles to Use Liquefied Petroleum Gas or Natural Gas Fuels

Agenda Item No.: 83-18-2

Public Hearing Date: December 15, 1983

Response Date: August 15, 1984

Issuing Authority: Executive Officer

Comment: No comments were received identifying any significant environmental issues pertaining to this item. The staff report identified no adverse environmental effects.

Response: N/A

CERTIFIED: _____
Executive Officer

Date: 9/14/84