MAIL-OUT #93-05

State of California
AIR RESOURCES BOARD

Notice of Public Availability of Modified Text
and Supporting Documents and Information

PUBLIC HEARING TO CONSIDER AMENDMENTS TO CERTIFICATION REQUIREMENTS AND PROCEDURES FOR LOW-EMISSION PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

Public Hearing Date: January 14, 1993
Public Availability Date: March 22, 1993
Deadline for Public Comment: April 5, 1993

At a public hearing held January 14, 1993, the Air Resources Board (the Board or ARB) considered amendments to certification requirements and test procedures for low-emission passenger cars, light-duty trucks, and medium-duty vehicles, including the adoption of reactivity adjustment factors (RAFs) for transitional low-emission vehicles (TLEVs) and low-emission vehicles (LEVs) operating on Phase 2 gasoline. The amendments affect sections 1960.1, 1976 and 2061, Title 13, California Code of Regulations (CCR), and four ARB Test Procedures that are incorporated by reference in those sections: "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles," "California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," and "California Non-Methane Organic Gas Test Procedures." The proposed regulatory action is described in detail in the Initial Statement of Proposed Rulemaking released on September 25, 1992, the Supplement to Initial Statement of Proposed Rulemaking (Mail-out #92-59) released on November 13, 1992 and the Modeling Protocol and Final Results released on December 15, 1992.

At the hearing, the Board approved the regulatory amendments proposed by the staff with various modifications to the originally proposed regulatory language. The modifications to the original staff proposal include:

- Adopt interim reactivity adjustment factors for 1993 through 1997 model-year TLEVs and LEVs operating on Phase 2 gasoline of 0.98 and 0.95, respectively (as discussed below, since the hearing the proposed LEV RAF has been revised to 0.94)

- Identify reactivity of LEV and ultra low-emission vehicles (ULEVs) operating on conventional gasoline of 3.13 grams ozone per gram NMOG

- Update test requirements for hybrid electric vehicles

- Amend 50°F NMOG emission requirement for TLEVs to two times the TLEV emission standard.

- Modify provisions of Assembly-Line Test Procedures pertaining to canister loading.

- Allow gasoline to methanol ratios during quality audit testing.

- Clarify fuel to be used during assembly-line quality audit testing.

Appended as Attachment I is a copy of Board Resolution 93-3, which sets forth the Board's action. Included with the resolution is an Attachment F, which describes the modifications to the original proposal suggested by the staff and approved by the Board. Appended as Attachment II is the modified text of sections 1960.1, with additions to the originally proposed text shown by ***bold italics*** and deletions shown by ~~strikeout~~.

The four Test Procedures being amended in this rulemaking are voluminous and include very technical and detailed provisions that are of limited general interest. For all persons who testified at the hearing, submitted written comments at the hearing or during the public comment period, or requested notification of the availability of the modifications to the originally proposed text, Attachment III includes the complete texts of the test procedures being amended in this rulemaking, with the modifications to the originally proposed texts clearly indicated. For the other recipients of this notice, Attachment III contains a form that may be used to request ~~copies of the complete modified texts of the Test Procedures.~~ Copies of the Test Procedures showing the modifications to the original proposal can be requested from Donna Barragan, Mobile Source Division, California Air Resources Board, 9528 Telstar Avenue, El Monte, California 91731, fax no. (818) 575-6699.

The modified texts of the regulations and Test Procedures being made available in conjunction with this notice include a few additional corrections identified since the January 14, 1993 hearing. These additional modifications are described in Attachment IV; they include a revision of the RAF for LEVs operated on phase 2 gasoline from 0.95 to 0.94 to reflect a reevaluation of the speciated exhaust peak that represents methyl-tertiary butyl ether (MTBE) coeluted with 2,3-dimethyl butane.

In addition, the staff has added to the rulemaking record the following documents and information:

- "Establishment of Corrections to Reactivity Adjustment Factors for Transitional Low-Emission Vehicles and Low-Emission Vehicles Operating on Phase 2 Reformulated Gasoline: Modeling Protocol and Updated Final Results," California Air Resources Board Research Division, March 1, 1993

- Memorandum from ARB Monitoring and Laboratory Division Chief Bill Loscutoff to ARB Mobile Source Division Chief Don Drachand, dated November 18, 1992, and the attachment thereto

A copy of the first document is appended as Attachment V. It includes a discussion of the airshed modeling performed based on the RAFs for TLEVs and LEVs operating on Phase 2 reformulated gasoline certification fuel. Copies of the second document were distributed at the January 14, 1993 hearing, and are available upon request from Donna Barragan at the address listed above. This document contains responses to comments dated October 20, 1992 from the Motor Vehicle Manufacturers Association pertaining to the proposed amendments to the California Non-Methane Organic Gas Test Procedures, and includes a discussion of the modifications being made to the originally proposed text of this Test Procedure.

In accordance with section 11346.8 of the Government Code, the Board directed the Executive Officer to adopt the proposed regulatory language after making the modified regulatory language and additional supporting documents and information available to the public for comment for a period of at least 15 days, provided that the Executive Officer shall consider such written comments as may be submitted during this period, shall make such modifications as may be appropriate in light of the comments received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

Written comments must be submitted to the Board Secretary, Air Resources Board, P.O. Box 2815, Sacramento, California 95812, no later than the deadline for public comment identified above, for consideration by the Executive Officer prior to final action. Only comments relating to the modifications or supporting documents and information described in this notice will be considered by the Executive Officer.

Sincerely,

K. D. Drachand, Chief
Mobile Source Division

Attachments

ATTACHMENT I

State of California
AIR RESOURCES BOARD

Resolution 93-3

January 14, 1993

Agenda Item No.: 93-1-3

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

WHEREAS, in section 43000 of the Health and Safety Code the Legislature has declared that the emission of air contaminants from motor vehicles is the primary cause of air pollution in many parts of the state;

WHEREAS, section 43018(a) of the Health and Safety Code, enacted by the California Clean Air Act of 1988, directs the Board to endeavor to achieve the maximum degree of emission reduction possible from vehicular and other mobile sources in order to accomplish the attainment of the state ambient air quality standards at the earliest practicable date;

WHEREAS, section 43018(b) of the Health and Safety Code directs the Board no later than January 1, 1992 to take whatever actions are necessary, cost-effective, and technologically feasible in order to achieve, by December 31, 2000, a reduction of reactive organic gases (ROG) of at least 55 percent and a 15 percent reduction in the emissions of oxides of nitrogen (NOx) from motor vehicles, and the maximum feasible reductions in particulates (PM), carbon monoxide (CO), and toxic air contaminants from vehicular sources;

WHEREAS, section 43018(c) of the Health and Safety Code provides that in carrying out section 43018, the Board shall adopt standards and regulations which will result in the most cost-effective combination of control measures on all classes of motor vehicles and motor vehicle fuel, including but not limited to reductions in motor vehicle exhaust and evaporative emissions, reductions in in-use vehicular emissions through durability and performance improvements, requiring the purchase of low-emission vehicles by state fleet operators, and specification of vehicular fuel composition;

WHEREAS, section 43101 of the Health and Safety Code directs the Board to adopt and implement emission standards for new motor vehicles which the Board has found to be necessary and technologically feasible to carry out the purposes of Division 26 of the Health and Safety Code;

WHEREAS, section 43104 of the Health and Safety Code directs the Board to adopt test procedures for determining whether new motor vehicles are in compliance with the emission standards established by the Board;

WHEREAS, in a 1990-1991 rulemaking, the Board adopted the Low-Emission Vehicle regulations, which require the phased introduction of vehicles meeting standards for four progressively more stringent categories of light-duty vehicles: Transitional Low-Emission Vehicles (TLEVs), Low-Emission Vehicles (LEVs), Ultra-Low-Emission Vehicles (ULEVs), and Zero-Emission Vehicles (ZEVs);

WHEREAS, the Low-Emission Vehicle regulations include a protocol under which the Executive Officer is to establish reactivity adjustment factors (RAFs) for representative vehicle/fuel combinations by applying a reactivity scale based on the maximum incremental reactivity (MIR) of individual hydrocarbon species to hydrocarbon exhaust speciation profiles; these RAFs are to be applied to the non-methane organic gas exhaust mass emissions from TLEVs, LEVs and ULEVs operating on fuels other than conventional gasoline, to determine compliance with applicable emission standards;

WHEREAS, following a hearing on November 14, 1991, the Board adopted amendments to the Low-Emission Vehicle regulations which established a RAF for TLEVs operated on methanol (M85) and made various changes regarding the calculation and use of RAFs for low-emission vehicles;

WHEREAS, at a June 11, 1992 public meeting, the staff presented a status report to the Board on the progress being made by the industry to comply with the Low-Emission Vehicle regulations; following the staff's presentation and comments from industry representatives and other members of the public, the Board adopted Resolution 92-46, which found that the low-emission vehicle standards continue to be technologically feasible within the required timeframes;

WHEREAS, in conjunction with a public hearing notice dated September 15, 1992, the staff proposed a wide range of regulatory amendments to the Low-Emission Vehicle regulations and to the general certification requirements and procedures for light- and medium-duty vehicles, intended to augment various provisions, improve clarity and facilitate implementation; these amendments include the establishment of a test procedure and certification requirements for hybrid electric vehicles, revision of the requirements for compliance with the NMOG and formaldehyde standards at 50°F, establishment of RAFs for TLEVs and LEVs operated on Phase 2 reformulated gasoline certification fuel, and establishment of a methane RAF for compressed natural gas (CNG) low-emission vehicles;

WHEREAS, the staff's proposal would be effected by amendments to Title 13, California Code of Regulations, sections 1960.1, 1976 and 2061 as set forth in Attachment A hereto; amendments to the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, which is incorporated by reference in section 1960.1, as set forth in Attachment B hereto; amendments to the California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles, which is incorporated by reference in section 1976, as set forth in Attachment C hereto; amendments to the

California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, which is incorporated by reference in section 2016, as set forth in Attachment D hereto; and amendments to the California Non-Methane Organic Gas Test Procedures, as set forth in Attachment E hereto;

WHEREAS, the California Environmental Quality Act and Board regulations require that an action not be adopted as proposed where it will have significant adverse environmental impacts if feasible alternatives or mitigation measures are available which would substantially reduce or avoid such impacts;

WHEREAS, the Board has considered the impact of the proposed regulatory action on the economy of the state;

WHEREAS, a public hearing and other administrative proceedings have been held in accordance with the provisions of Chapter 3.5 (commencing with section 11340), Part 1, Division 3, Title 2 of the Government Code; and

WHEREAS, the Board finds that:

The amendments approved herein, including the revisions pertaining to test procedures for hybrid electric vehicles, cold CO requirements, ZEV certification procedures, test procedures for ethanol vehicles, 50°F test requirements, the ZEV credit system, RAFs for Phase 2 reformulated gasoline certification fuel, a methane RAF for CNG low-emission vehicles, deterioration factors for engine-specific RAFs, and calculation of penalties for violations, are necessary and appropriate to add specificity, enhance clarity, and facilitate implementation of the low-emission vehicle requirements;

It is appropriate at this time to establish RAFs for TLEV and LEV light-duty vehicles operating on Phase 2 reformulated gasoline certification fuel, and to establish baseline values of reactivity expressed in grams of ozone/ gram NMOG for LEVs and ULEVs operating on conventional gasoline, only for the 1993 through 1997 model-years, so that any additional data and analytical methods can be considered in the subsequent adoption of RAFs and baseline reactivity values for such categories for the 1998 and subsequent model years;

The baseline values of reactivity approved herein for 1993 through 1997 LEVs and ULEVs operating on conventional gasoline are appropriately based on tests of vehicles equipped with advanced emission control systems demonstrated by the Board to be capable of achieving compliance with LEV and ULEV standards when operating on conventional gasoline;

The RAFs approved herein for the TLEV and LEV emission categories for vehicles operating on Phase 2 reformulated gasoline are appropriately based on application of the established MIRs to the best available speciated hydrocarbon exhaust emission data from vehicles operating on these fuels and meeting the TLEV and LEV standards;

Confirmatory modeling indicates that there is little or no bias in the application of the established MIR scale to the speciated exhaust of TLEVs and LEVs operating on Phase 2 reformulated gasoline, and thus no correction factor is necessary or appropriate for the Phase 2 reformulated gasoline RAFs for these vehicle categories; and

The amendments approved herein will not have any significant adverse environmental impacts.

NOW, THEREFORE, BE IT RESOLVED that the Board hereby approves the amendments to sections 1960.1, 1976 and 2061, and the documents incorporated therein, as set forth in Attachments A through E hereto, with the modifications described in Attachment F hereto.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to incorporate into the approved amendments the modifications described in Attachment F hereto, with such other conforming modifications as may be appropriate, and to adopt the amendments approved herein, after making the modified regulatory language available for public comment for a period of 15 days, provided that the Executive Officer shall consider such written comments regarding the modifications as may be submitted during this period, shall make modifications after comments have been received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to schedule a rulemaking hearing by March, 1994, to establish baseline values of reactivity for 1998 and subsequent model-year LEVs and ULEVs operating on conventional gasoline, and RAFs for 1998 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles operated on Phase 2 reformulated gasoline certification fuel, subject to the availability of suitable test vehicles; in proposing such baseline values and RAFs the Executive Officer shall work cooperatively with industry to identify any relevant new data or analytical methods.

BE IT FURTHER RESOLVED that it is the intent of the Board that any proposed revisions to the baseline reactivity values for LEVs and ULEVs shall not reduce the stringency of the adopted emission standards, except as may result from improved test methods and data analysis.

BE IT FURTHER RESOLVED that the Board directs the staff to continue to evaluate the need to adjust the RAF process in order to account for the

reactivity of emissions of CO from low-emission vehicles, and to report back to the Board as appropriate on recommendations in this area.

BE IT FURTHER RESOLVED that the Board hereby determines that the amendments approved herein will not cause the California motor vehicle emission standards, in the aggregate, to be less protective of public health and welfare than applicable federal standards.

BE IT FURTHER RESOLVED that the Board hereby finds that separate California motor vehicle emission standards and test procedures are necessary to meet compelling and extraordinary conditions.

BE IT FURTHER RESOLVED that the Board finds that the California motor vehicle emission standards and test procedures as amended herein will not cause the California requirements to be inconsistent with section 202(a) of the Clean Air Act and raise no new issues affecting previous waiver determinations of the Administrator of the Environmental Protection Agency pursuant to section 209(b) of the Clean Air Act.

BE IT FURTHER RESOLVED that the Executive Officer shall, upon adoption, forward the amendments to the Environmental Protection Agency with a request for confirmation that the amendments are within the scope of an existing waiver of federal preemption pursuant to section 209(b) of the Clean Air Act.

I hereby certify that the above is a true and correct copy of Resolution 93-3 as adopted by the Air Resources Board.

Pat Hutchens

Pat Hutchens, Board Secretary

Resolution 93-3

January 14, 1993

Identification of Attachments to the Resolution

Attachment A: Amendments to Title 13, California Code of Regulations, sections 1960.1, 1976, and 2061, as appended to the Staff Report released September 25, 1992.

Attachment B: Amendments to the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, as made available by the ARB's Mobile Source Division September 25, 1992.

Attachment C: Amendments to the California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles, as made available by the ARB's Mobile Source Division September 25, 1992.

Attachment D: Amendments to the California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, as made available by the ARB's Mobile Source Division September 25, 1992.

Attachment E: Amendments to the California Non-Methane Organic Gas Test Procedures, as made available by the ARB's Mobile Source Division September 25, 1992.

Attachment F: Staff's Suggested Changes to the Original Proposal, distributed at the hearing on January 14, 1993.

Public Hearing to Consider Amendments to Certification Requirements and Procedures for Low-Emission Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles

January 14, 1993

STAFF'S SUGGESTED MODIFICATIONS TO THE ORIGINAL PROPOSAL

The staff report for the proposed amendments to the certification requirements and test procedures for low-emission passenger cars, light-duty trucks and medium-duty vehicles was originally released to the public on September 25, 1992. A supplement to this staff report, pertaining to reactivity adjustment factors (RAFs), was released on November 13, 1992. A modeling protocol and final results for corrections to the proposed RAFs was released December 15, 1992. Based on further analyses conducted by staff and comments received on these documents and the regulations referenced therein, the staff is recommending modifications to the originally proposed regulatory amendments. These suggested modifications are described in the following three parts:

Part A: **Suggested Modifications Pertaining to RAFs**

Part B: **Suggested Modifications Pertaining to the NMOG Test Procedures**

Part C: **Suggested Modifications Other Than Those Pertaining to RAFs and the NMOG Test Procedures**

Part A

Suggested Modifications Pertaining to RAFs

Modify the reactivity adjustment factors (RAFs) for TLEVs and LEVs operated on Phase 2 reformulated gasoline certification fuel to be 0.98 and 0.95 respectively. Identify the 'g ozone potential per g NMOG' (baseline reactivity value) for conventional gasoline as 3.13 for all LEVs and ULEVs in the passenger car and light-duty truck 0-5750 lbs. LVW category. Provide that these RAFs and baseline reactivity values apply to 1993-1997 model-year vehicles.

Section Affected: California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, section 13.a. and 13.d. (pp. 13-1 and 13-2)

Note that the modified RAFs and baseline reactivity values reflect a reinterpretation of aspects of the speciated exhaust emission data, specifically the identification of the compounds represented by two of the peaks and the resulting assignment of MIRs to these peaks. It had originally been assumed that iso-octane (2,2,4-trimethyl pentane) co-eluted with an olefin in approximately a 50/50 ratio. After further examination, staff concluded that even though an olefin does co-elute with iso-octane, the peak is predominantly iso-octane (greater than 95%). Therefore, the iso-octane MIR value of 0.93 was assigned to the peak, rather than the previously assigned value of 2.59. It had also been assumed that 4-ethyl toluene (C9 Dialkyl Benzenes) co-elutes with a cycloalkane; subsequent analysis indicates that the peak is predominantly 4-ethyl toluene and therefore the 7.2 MIR value for 4-ethyl toluene has been applied to the peak rather than the 4.59 value previously applied. The attached Summary of Test Data and accompanying tables present the corrected specific reactivities of the vehicles tested for this rulemaking.

Part B

Suggested Modifications Pertaining to the NMOG Test Procedures

Modify the originally proposed amendments to the California Non-Methane Organic Gas Test Procedures to reflect the modifications identified in the "ARB Responses" set forth in the November 18, 1992 memorandum from Monitoring and Laboratory Division Chief Bill Loscutoff to Mobile Source Division Chief Don Drachand, and the attachment thereto.

Include additional modifications to reflect the requested changes pertaining to chemical abstract system numbers, and the species identified, set forth on pages 6 and 7 of the January 4, 1993, letter from Trescott E. Jensen of the Environmental Research Consortium.

Part C

Suggested Modifications Other Than Those Pertaining to RAFs and the NMOG Test Procedures

Except as otherwise indicated, the text of the originally proposed amendments is shown below in underline to indicate additions and ~~strikeout~~ to show deletions. The modifications now proposed by staff are shown in ***bold italics*** to show additions and ~~***bold italics***~~ to show deletions.

1. Modify the definition of hybrid electric vehicles (HEVs) to allow the use of a shut-off switch for the auxiliary power unit (APU) on Type A and Type B HEVs. These are the HEVs that will generate credits for calculating a manufacturer's Non-Methane Organic Matter (NMOG) fleet average.

Section Affected: California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles (Exhaust Standards and Test Procedures), section 2.Av. (p. 2-5)

> Av. . . . . This definition shall also apply to any hybrid electric vehicle which allows the operator to control the time or mode of operation of the auxiliary power unit either directly or indirectly ***(with the exception that a mechanism which allows the operator only to shut off the auxiliary power unit is permissible for Type A and Type B HEVs),*** to any hybrid electric vehicle which can be operated solely through the use of the auxiliary power unit, to any hybrid electric vehicle which utilizes a climate control system that cannot be operated without using the auxiliary power unit, and ***to*** all other types of hybrid electric vehicles, excluding Type A and Type B hybrid electric vehicles.

2. Delete the originally proposed new language providing that, in determining the number of Tier 1 vehicles eligible for the alternative in-use compliance standards, a manufacturer is to apply the maximum percentage to the manufacturer's total projected sales of Tier 1 vehicles only. With this deletion, the manufacturer would apply the required percentages to the manufacturer's total projected sales of low-emission vehicles as well as conventional vehicles.

Section affected: Exhaust Standards and Test Procedures, section 3.f, note (8) (p. 3-10), and Title 13, California Code of Regulations, section 1960.1(f)(2), note (8).

> ~~(8) For the 1995 and 1996 model years, all manufacturers, except those certifying to optional diesel standards, are~~

permitted alternative in-use compliance. Alternative in-use compliance is permitted for 60% of a manufacturer's vehicles in the 1995 model year and 20% of a manufacturer's vehicles in the 1996 model year. For the 1995 and 1996 model years, small volume manufacturers only are permitted alternative in-use compliance for 100% of the fleet. The percentages shall be applied to the manufacturers' total projected sales of California-~~certified~~ *-certified* passenger cars and light-duty trucks *certified to the emission standards in this Section 3(f) of these test procedures* for the model year. . . .

3. The regulations do not specify the battery state-of-charge during the highway fuel economy test for hybrid electric vehicles. In order to ensure that the emission performance of HEV APUs is reasonably characterized, two conditions would be identified for the validity of the emission test.

Section affected: California Exhaust Emission Standards and Test Procedures, section 11.c. (p. 11-2)

Add the following text at the end of the first paragraph of section 11.c:

Hybrid electric vehicles shall be tested with the battery state-of-charge set such that one of the following two conditions is satisfied: (1) the state-of-charge is at the lowest level allowed by the control unit of the auxiliary power unit; or (2) the state-of-charge is set such that auxiliary power unit operation will be at its maximum level at the beginning and throughout the emission test.

4. Under the originally proposed amendments to the 50 degree Fahrenheit requirement, NMOG and formaldehyde emissions at 50 degrees Fahrenheit would not be permitted to exceed the 50,000 mile certification standard multiplied by a factor of 1.75 for all TLEVs. Staff is proposing that the multiplicative factor for TLEVs be changed to 2.0.

Section affected: Exhaust Standards and Test Procedures, section 11.K (p. 11-4).

5. Clarify the vehicle selection process for cold temperature CO compliance. The current test procedures do not expressly identify the method for the selection of vehicles to be used to demonstrate compliance with cold temperature CO exhaust emission standards.

Sections affected: Exhaust Standards and Test Procedures, Appendix II (p. II-3)

C. For determining cold temperature CO exhaust emission compliance for each engine family, the Executive Officer shall select for testing the vehicle expected to emit the highest emissions from the vehicles selected in accordance with sections I.A. and I.B. of this Appendix. The selected vehicle shall be tested by the manufacturer in accordance with the test procedures in Subpart C, Part 86, Title 40, Code of Federal Regulations or with alternative procedures requested by the manufacturer and approved in advance by the Executive Officer.

6. Correct the display of the table of Maximum Incremental Reactivities (MIRs) being replaced in this rulemaking by showing in strikeout the table as established following the hearing on November 14, 1991. This correction will have no regulatory effect.

Section affected: Exhaust Standards and Test Procedures, Appendix VIII, section (10). (pp. VIII-8 through VIII-10.)

7. Modify the battery state-of-charge conditions for hybrid electric vehicle emission testing to better ensure an accurate representation of auxiliary power unit emissions.

Section affected: California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles (Evaporative Standards and Test Procedures), section 4.g.i.E. (p. 25)

E. During the 12 to 36 hour soak specified in subparagraph D. above, the vehicle's canister shall be purged with a volume of air equivalent to 300 canister charcoal bed volumes at a flow rate of 48 SCFH (22.7 slpm). For hybrid electric vehicles, the battery pack shall be discharged to ~~or just below the state/of/charge at which operation of the auxiliary power unit will be initiated by the vehicle's control strategy/~~ *the state of charge that satisfies one of the following two conditions: (1) the state of charge is at the lowest level allowed by the control unit of the auxiliary power unit, or (2) the state of charge is set such that auxiliary power unit operation will be at its maximum level at the beginning and through the emission test.*

8. Delete the originally proposed requirement that HEVs perform additional 24-hour diurnal test increments as necessary to ensure that the APU will be operated to purge the evaporative emission canister. In addition, delete the originally proposed requirement that testing of the evaporative emission control system and evaporative emission control purge system be performed during the final 24-hour diurnal test cycle.

Sections affected: Evaporative Standards and Test Procedures, section 4.g.i.L. and section 4.g.i.M. (p. 26) These two subsections, part of the orginally proposed new language, would be deleted.

9. For Type C HEVs, add a requirement that any APU activation switch must be on for the duration of emission testing.

Section affected: Evaporative Standards and Test Procedures, section 4.g.iii(i). (p. 27)

iii(i) . . . <u>One Urban Dynamometer Driving Schedule (UDDS) shall be used for preconditioning.</u> ***If the auxiliary power unit is capable of being manually activated (which would cause the vehicle to be classified as a Type C HEV), the auxiliary power unit shall be activated at the beginning and throughout the emission test.***

10. Delete the requirement that the manufacturer shall record the weight of the evaporative emission canister at the conclusion of the running loss test procedure for HEVs.

Section affected: Evaporative Standards and Test Procedures, section 4.g.viii.D. (p. 33) This subsection, part of the orginally proposed new language, would be deleted.

11. Delete the requirement that additional tests may be required for HEVs to ensure that the APU will be operated to purge the evaporative emission control canister during emission testing.

Section affected: Evaporative Standards and Test Procedures, section 4.g.x.H. (p. 35) The originally proposed new sentence in that subsection would be deleted.

12. Revise the procedure for ensuring proper operation of the evaporative emission control system, to reduce manufacturers' testing burden.

Section affected: Evaporative Standards and Test Procedures, section 4.g.x.K. (pp. 36-37.)

Delete the originally proposed new section 4.g.x.K. Replace it with the following text for subsection K and new subsections L and M:

K. Add section (u) to read: The manufacturer shall specify the working capacity of the evaporative emission control canister, and shall specify the number of 24-hour diurnals

that can elapse before the APU will activate solely for the purposes of purging the canister of hydrocarbon vapor.

L. Add section (v) to read: In order to determine that the working capacity of the canister is sufficient to store the hydrocarbon vapor generated over the manufacturer specified number of days between auxiliary power unit activation events for the purposes of purging the evaporative canister, the evaporative canister shall be weighed after completion of the 72-hour diurnal period. The weight of the vapor contained in the canister shall not exceed the working capacity of the canister multiplied by three days and divided by the manufacturer specified number of days between auxiliary power unit activation events.

M. Add section (w) to read: The manufacturer shall specify the time interval of auxiliary power unit operation necessary to purge the evaporative emission control canister, and shall submit an engineering analysis to demonstrate that the canister will be purged to within five percent of its working capacity over the time interval.

13. Modify the provisions in the Assembly-Line Test Procedures pertaining to canister loading. The originally proposed third option for satisfying the requirement is that manufacturers shall demonstrate "that there does not exist a measurable difference in exhaust emissions" between vehicles with and without loaded canisters. A modification would be made to provide that manufacturers shall demonstrate "the difference or lack of difference in exhaust emissions" between vehicles with and without loaded canisters, and that this difference (additive and not less than 0) would be applied to the audit vehicles tested without loaded canisters. This difference shall be based on the average results of at least 10 vehicles tested (under both conditions) per engine family. Manufacturers would submit for approval beforehand their test plan and how many vehicles they would be testing to establish any difference. In addition, for each of the three canister loading options, a provision would be added requiring that the canister be cycled no less than two times.

Section affected: California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles (Assembly-Line Test Procedures), section D.2.(c)(i), (ii), and (iii) (pp. 8-9)

(i) The vehicle canister loading procedure shall be conducted in accordance with subsections 4.g.iii.C. and 4.g.iii.D., *except that prior to the canister loading, the canister shall be cycled no less than 2 times using the method specified in subsection 4.c.iii, utilizing the fuel used in normal operation, in order to place a heel on the canister.* Alternative methods of loading the original canister may be

used, provided such a method is approved in advance by the Executive Officer on the basis of achieving canister loading comparable to the prescribed method.

OR

(ii) The vehicle canister loading procedure described in subsections 4.g.iii.C. and 4.g.iii.D. shall be employed for a canister which is loaded separate from the vehicle, and then attached prior to the exhaust tests, with the original canister disabled. Such a canister loaded separate from the vehicle shall be identical in nominal working bed capacity, charcoal bed volume and configuration to the original canister present on the vehicle. The loading procedure for this canister shall be as described in subsections 4.g.iii.C. and 4.g.iii.D., except ~~that~~ *for the following: (1)* the rate of butane loading shall not exceed 40 grams/hour, *and (2) prior to the loading, the canister shall be cycled at least 2 times according to the method specified in subsection 4.c.iii, utilizing the fuel used in normal operation. If the canister has been cycled for use in a previous exhaust test, this step may be omitted.* An alternative to this option (ii) may be used provided such a method is approved in advance by the Executive Officer on the basis of whether the flow of vapor from the canister to the engine is comparable to the prescribed method.

OR

(iii) Data shall be submitted to the Executive Officer demonstrating ~~that there does not exist a measurable difference~~ the difference or lack of difference in exhaust emissions, for ~~both~~ hydrocarbons, ~~and~~ OMHCE *and carbon monoxide*, between vehicles possessing a canister(s) loaded in accordance with subsections 4.g.iii.C. and 4.g.iii.D. *and cycled no less than 2 times according to the method specified in subsection 4.c.iii utilizing the fuel used in normal operation,* and vehicles possessing an unloaded canister(s). For the purposes of this section, the preparation and preconditioning of vehicles with an unloaded canister shall be conducted in an identical manner as described in 2.(c)(1) of this procedure for vehicles equipped with a loaded canister, except that canister loading requirements contained in subsections 4.g.iii.C. and 4.g.iii.D. shall be omitted.

A test plan for generation of such data shall be submitted to the Executive Officer for approval prior to testing. Such testing shall involve a minimum of ten (10) vehicles for each engine family chosen to use this option, tested both with loaded and unloaded canisters. This testing shall be conducted during the first calendar quarter of production for

a given model-year in order to properly apply the results to each quality-audit vehicle which is tested. Such testing shall establish a measured exhaust emissions difference for each vehicle, for hydrocarbons, OMHCE, and carbon monoxide. For each pollutant these differences shall be averaged to generate average exhaust emissions differences (referred to below as D). These differences shall be applied, as an additive factor, to the applicable exhaust emissions results of each quality-audit vehicle that is not tested with a canister loaded in accordance with 2.(c)(1)(i) or 2.(c)(1)(ii). Compliance with the applicable exhaust emission standards shall be based on the sum of D and the measured quality-audit emission data for each vehicle. However, in no case shall this additive factor be applied when its value is less than zero.

14. Provide for the use of a methanol to gasoline ratio for two percent quality audit testing for fuel-flexible vehicles (FFVs).

The original regulatory proposal would require that one percent of FFVs be assembly-line tested on both gasoline and methanol. Based on concerns expressed by industry regarding handling and disposal of methanol, staff is proposing new language that would allow manufacturers the option of developing a gasoline NMOG to M85 NMOG certification ratio which would allow manufacturers to quality-audit test solely on gasoline but would also ensure that the emission standards are met by the alternative fuel. If manufacturers choose this option, they would have to test the full two percent of FFVs during assembly-line testing.

Sections affected: Assembly-Line Test Procedures, new section D.5.(e) (p. 12)

Add a new section D.5.(e) to read as follows:
(e) For fuel-flexible vehicles certified to either organic material non-methane hydrocarbon equivalent (OMNMHCE) or non-methane organic gas (NMOG) standards, the manufacturer may request from the Executive Officer the use of a methanol (M85) exhaust emission to gasoline NMHC exhaust emission ratio which shall be established during certification testing for each certification test data vehicle for the applicable engine family. The average of the individual test ratios of measured M85 NMOG to gasoline NMHC emissions for the engine family shall be submitted to the Executive Officer in the application for certification. Following approval of the application for certification, the manufacturer may conduct quality-audit testing on the engine family by measuring gasoline NMHC exhaust emissions rather than M85 NMOG exhaust emissions. The measured gasoline NMHC exhaust emissions shall be multiplied by the M85 NMOG to gasoline NMHC ratio submitted in the application for certification for the engine family to

determine the equivalent NMOG exhaust emission values for the quality audit test vehicle. The equivalent NMOG exhaust emission value shall be used in place of the measured NMOG exhaust emission value in determining the reactivity adjusted exhaust NMOG results. The equivalent reactivity adjusted NMOG exhaust emission values shall be compared to the NMOG exhaust emission standard applicable to the vehicle emission category (TLEV, LEV, or ULEV) in which the engine family was certified. Manufacturers which choose this option shall test the full two percent of the vehicles selected for quality-audit testing.

15. Clarify the fuel to be used in assembly-line testing. The current regulations do not clearly specify the choice of fuels for assembly-line testing. New language is being proposed which would clarify that for 1993 and 1994 model-year vehicles, Indolene as well as Phase 1 or Phase 2 fuel may be used. For all 1995 and subsequent model-year vehicles, all assembly-line quality audit tests would be conducted with Phase 2 fuel. This requirement would apply to both low-emission vehicles and conventional vehicles.

Sections affected: Assembly-Line Test Procedures, new section D.5.(f). (p. 12)

Add a new section D.5.(f) to read as follows:

(f) For 1993 and 1994 model-year vehicles, the manufacturer has the option of using the fuel meeting the specifications set forth in Section 9.a(1), 9.a(1)(i), or 9.a(1)(ii) of the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles for purposes of quality audit testing. All 1995 and subsequent conventional and low-emission vehicles which certify with fuel meeting the specifications set forth in Section 9.a(1) of the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles must use that fuel for purposes of quality audit testing. All 1995 and subsequent conventional and low-emission vehicles which certify with fuel meeting the specifications set forth in Section 9.a(ii) of the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles must use that fuel for purposes of quality audit testing.

SUMMARY OF TEST DATA
(corrected for iso-octane and 4-ethyltoluene)

Preliminary RAF Determination

RAF for TLEV vehicles operated on Phase 2 gasoline

Vehicle	Phase 2 (Ozone/g)
Camry	3.57
LeSabre '92	3.13
Tempo	3.77
Jetta	3.56
Celica	3.10
Pontiac (GM)	3.63
Regal (GM)	3.32
Saturn(GM-A)	3.18
Saturn(GM-M)	2.97
LeSabre(GM)	3.33
T-Bird	3.50
Crown Vic	3.34
Average	3.36

Preliminary RAF for TLEV vehicles = 3.365/3.420=0.98

RAF for LEV vehicles operated on Phase 2 gasoline

Vehicle	RF-A (Ozone/g)	Phase 2 (Ozone/g)
Jetta	3.09	2.79
Lexus 400	3.63	2.96
Celica	2.73	2.82
LeSabre '90	3.19	2.94
Escort	NA	3.30
Cougar	NA	2.84
Lumina	NA	3.30
Escort (F)	NA	3.04
T-Bird	2.95	2.75
Tempo	3.16	NA
Average	3.13	2.97

NA- data not applicable

Preliminary RAF for LEV vehicles =2.970/3.125 = 0.95

1. The Lexus 300 shown on the first page (Summary of Test Data) of the Appendix B in the September 25, 1992 mail-out was actually a Cougar. This correction was made in our subsequent mail-out and since this vehicle met LEV standards, it was also moved to the LEV category.

2. The Escort shown in the TLEV category in the September 25, 1992 mail-out was moved to the LEV category in our subsequent mail-out since that vehicle also met LEV standards.

3. In Table V (Comparison of RF-A vs. Phase 2) of the supplement to the Initial Staff Report (mail-out #92-59), the Celica data on Phase 2 gasoline were obtained while the vehicle was equipped with an EHC. This data has been replaced with results of the Celica operating on Phase 2 without an EHC which is shown below.

Vehicle	Fuel	NMOG	CO	NOx	Ozone/mi
Celica	Phase 2	0.096	1.06	0.111	0.308

4. In Table V (Comparison of RF-A vs. Phase 2) of the supplement to the Initial Staff Report (mail-out #92-59), the Cougar data on RF-A that was obtained on a 1991 model-year vehicle was compared with the Cougar data on Phase 2 that was obtained on a 1992 model-year vehicle. Since then, the Cougar data on RF-A has been replaced with that from a 1992 model-year vehicle shown below.

Vehicle	Fuel	NMOG	CO	NOx	Ozone/mi
1992 Cougar	RF-A	0.120	2.19	0.181	0.344

5. In Table II of the attachment titled "Summary of Test Data" to mail-out #92-59 released on November 13, 1992, it was found that test no. 4C50 on the Tempo was done using Phase 2 gasoline instead of RF-A gasoline. Since then, test 4C50 has been replaced by test 4C51 using on RF-A gasoline. The results are shown below:

Vehicle	Test no:	NMOG	CH4	CO	NOx	Ozone/mi	Ozone/gram
Tempo	4C51	0.054	0.034	0.90	0.163	0.168	3.109

6. In Table III of the attachment titled "Summary of Test Data" to mail-out #92-59 released on November 13, 1992, the Ford Thunderbird was incorrectly labeled as 1991 model-year vehicle, it is actually a 1992 model-year vehicle.

Table I
Summary of Test Results of TLEV-level Vehicles
Operated on Phase 2 Certification Fuel

Vehicle	Emission Contr. Systems	Test #	Species Table #	NMOG (g/mi)	CH4 (g/mi)	CO (g/mi)	NOx (g/mi)	Ozone/ mile	Ozone/ gram
1992	EGR, SFI,	61C4	I-11a	0.089	0.018	0.69	0.224	0.294	3.315
T-Bird	TWC, HO2,	61C5	I-11a	0.078	0.016	0.68	0.265	0.278	3.573
3.8 L	7,600 mi	61C6	I-11b	0.074	0.018	0.76	0.275	0.267	3.597
			Mean:	0.080	0.017	0.71	0.255	0.280	3.495
1992	HO2(2),	50C8	I-12a	0.108	0.035	1.86	0.337	0.362	3.348
Crown Vic	TWC(2), EGR	50C9	I-12b	0.083	0.029	1.60	0.317	0.280	3.380
4.6 L	SFI	50C10	I-12c	0.115	0.036	1.76	0.324	0.357	3.116
6,500 mi	"	50C11	I-12c	0.088	0.034	1.36	0.274	0.309	3.524
			Mean:	0.099	0.034	1.65	0.313	0.327	3.342

Cumulative Average	0.100	0.023	1.54	0.186	0.336	3.365

Table I
Summary of Test Results of TLEV-level Vehicles
Operated on Phase 2 Certification Fuel

Vehicle	Emission Contr. Systems	Test #	Species Table #	NMOG (g/mi)	CH4 (g/mi)	CO (g/mi)	NOx (g/mi)	Ozone/ mile	Ozone/ gram
1992	TWC(2), EGR	13C9	I-1a	0.085	0.013	1.65	0.161	0.313	3.706
Camry	O2 (2), MFI	13C10	I-1a	0.108	0.015	2.11	0.139	0.372	3.457
2.2 L		13C11	I-1b	0.094	0.015	1.68	0.111	0.305	3.261
5,700 mi		13C14	I-1c	0.090	0.017	2.08	0.140	0.348	3.864
			Mean:	0.094	0.015	1.88	0.138	0.335	3.572
1992	TWC, O2,	39C5	I-2a	0.119	0.024	1.44	0.145	0.350	2.937
LeSabre	MFI	39C7	I-2a	0.108	0.020	1.21	0.156	0.357	3.297
3.8 L	10,300 mi	39C8	I-2b	0.116	0.023	1.33	0.133	0.364	3.142
			Mean:	0.114	0.022	1.33	0.145	0.357	3.125
1992	EGR, SFI,	4C29	I-3a	0.099	0.027	0.91	0.203	0.372	3.755
Tempo	TWC, HO2,	4C30	I-3a	0.106	0.034	1.62	0.202	0.411	3.882
2.3L	PSAI	4C33	I-3b	0.114	0.029	1.50	0.159	0.434	3.800
12,950 mi		4C34	I-3b	0.093	0.024	1.25	0.145	0.338	3.621
			Mean:	0.103	0.029	1.32	0.177	0.389	3.765
1991	HO2, TWC,	24C15	I-4a	0.092	0.018	1.89	0.086	0.332	3.617
Jetta	MFI	24C17	I-4a	0.123	0.019	2.04	0.096	0.424	3.449
1.8 L*		24C18	I-4b	0.121	0.018	1.84	0.085	0.425	3.524
11,400 mi		24C19	I-4b	0.106	0.016	1.80	0.089	0.390	3.667
			Mean:	0.111	0.018	1.89	0.089	0.393	3.564
1990	EGR, O2,	27C32	I-5a	0.093	0.015	0.94	0.129	0.267	2.883
Celica	MFI,	27C34	I-5b	0.106	0.016	1.10	0.092	0.338	3.180
2.2 L	TWC (2)	27C35	I-5b	0.109	0.016	1.18	0.109	0.327	3.002
15,300 mi		27C36	I-5c	0.076	0.013	1.00	0.115	0.253	3.325
			Mean:	0.096	0.015	1.06	0.111	0.296	3.098
Pontiac(GM)	8,700 mi	4103	I-6a	0.109	0.032	2.19	0.251	0.395	3.630
2.0 L		4110	I-6b	0.109	0.027	1.99	0.271	0.393	3.620
			Mean:	0.109	0.030	2.09	0.261	0.394	3.625
Regal(GM)	725 mi	4127	I-7a	0.122	0.027	2.02	0.127	0.390	3.200
3.8 L		4137	I-7b	0.123	0.028	1.99	0.125	0.445	3.610
		4149	I-7c	0.124	0.022	1.63	0.138	0.390	3.150
			Mean:	0.123	0.026	1.88	0.130	0.408	3.320
Saturn(GM)	5,200 mi	4290	I-8a	0.104	0.029	2.75	0.260	0.328	3.140
1.9 L, auto		4327	I-8b	0.084	0.020	1.84	0.181	0.270	3.210
			Mean:	0.094	0.025	2.30	0.221	0.299	3.175
Saturn(GM)	6,200 mi	4128	I-9a	0.097	0.019	1.39	0.268	0.285	2.930
1.9 L,manual		4138	I-9b	0.098	0.024	1.62	0.211	0.294	3.000
			Mean:	0.098	0.022	1.51	0.240	0.290	2.965
LeSabre(GM)	3,300 mi	4505	I-10a	0.072	0.016	0.93	0.151	0.232	3.220
3.8 L		4559	I-10b	0.076	0.018	0.89	0.153	0.251	3.320
		4572	I-10c	0.090	0.017	0.98	0.155	0.300	3.330
		4831	I-10d	0.073	0.020	0.81	0.157	0.259	3.560
		4847	I-10e	0.082	0.016	0.81	0.176	0.284	3.470
		4854	I-10f	0.088	0.015	0.92	0.161	0.271	3.080
			Mean:	0.080	0.017	0.89	0.159	0.266	3.330

Table II
Summary of Test Results of LEV-level Vehicles
Operated on RF-A Certification Fuel

Vehicle	Emission Contr. Systems	Test #	Species Table #	NMOG (g/mi)	CH4 (g/mi)	CO (g/mi)	NOx (g/mi)	Ozone/ mile	Ozone/ gram
1991	HO2, TWC,	24C5	II-1a	0.049	0.026	1.40	0.148	0.152	3.087
Jetta	MFI, EHC	24C6	II-1b	0.052	0.025	1.38	0.152	0.165	3.151
1.8 L		24C7	II-1b	0.064	0.027	1.44	0.138	0.198	3.119
10,700 mi		24C25	II-1c	0.059	0.023	1.44	0.144	0.177	3.011
			Mean:	0.056	0.025	1.42	0.146	0.173	3.092
1992	TWC, HO2 (2),	25C8	II-2a	0.055	0.024	0.29	0.187	0.182	3.286
Lexus 400	CC-TWC (2),	25C9	II-2a	0.064	0.030	0.57	0.215	0.221	3.445
4.0 L	O2 (2), EGR,	25C10	II-2b	0.077	0.029	0.44	0.202	0.299	3.890
7,350 mi	MFI, EHC(2)	25C12	II-2b	0.071	0.027	0.42	0.201	0.274	3.886
			Mean:	0.067	0.028	0.43	0.201	0.244	3.627
1990	EGR, O2,	27C11	II-3a	0.055	0.018	0.45	0.231	0.145	2.649
Celica	TWC (2),	27C12	II-3a	0.069	0.019	0.61	0.226	0.203	2.921
2.2 L	MFI, EHC	27C13	II-3b	0.060	0.018	0.48	0.266	0.157	2.632
13,800 mi		27C14	II-3b	0.062	0.018	0.48	0.240	0.169	2.709
			Mean:	0.062	0.018	0.51	0.241	0.169	2.728
1990	EGR, O2,	28C29	II-4a	0.061	0.020	0.49	0.159	0.196	3.200
LeSabre*	TWC,	28C30	II-4a	0.056	0.017	0.48	0.167	0.171	3.068
3.8 L	SFI, EHC	28C32	II-4b	0.058	0.015	0.38	0.179	0.205	3.564
17,500 mi		28C39	II-4c	0.072	0.017	0.55	0.165	0.211	2.942
			Mean:	0.062	0.017	0.48	0.168	0.196	3.194
1992	TWC,HO2,EGR	38C30	II-5a	0.051	0.028	0.98	0.169	0.146	2.880
T-Bird	SFI,EHC(2)	38C35	II-5b	0.055	0.033	1.28	0.191	0.162	2.948
3.8 L	12,950 mi	38C40	II-5c	0.044	0.030	1.25	0.180	0.132	3.030
			Mean:	0.050	0.030	1.17	0.180	0.147	2.953
1992	EGR, SFI,PSAI	4C46	II-6a	0.057	0.034	0.93	0.153	0.189	3.302
Tempo	TWC, HO2,EHC	4C47	II-6b	0.062	0.037	1.02	0.156	0.193	3.113
2.3 L	13,500 mi	4C51	II-6c	0.054	0.034	0.90	0.163	0.166	3.061
			Mean:	0.058	0.035	0.95	0.157	0.183	3.159

Cumulative Average	0.059	0.026	0.82	0.182	0.185	3.125

Table III
Summary of Test Results of LEV-level Vehicles
Operated on Phase 2 Certification Fuel

Vehicle	Emission Contr. Systems	Test #	Species Table #	NMOG (g/mi)	CH4 (g/mi)	CO (g/mi)	NOx (g/mi)	Ozone/ mile	Ozone/g
1991Jetta 1.8 L 10,800 mi	HO2, TWC, MFI, EHC	24C10	III-1a	0.035	0.016	1.05	0.083	0.085	2.410
		24C11	III-1a	0.030	0.016	1.09	0.104	0.086	2.890
		24C22	III-1b	0.045	0.018	1.35	0.112	0.118	2.630
		24C23	III-1b	0.038	0.018	1.32	0.156	0.123	3.235
			Mean:	0.037	0.017	1.20	0.114	0.103	2.791
1992 Lexus 400 4.0 L 7,450 mi	TWC, HO2(2), CC-TWC(2), O2(2); EGR MFI, EHC(2)	25C13	III-2a	0.041	0.019	0.30	0.139	0.110	2.670
		25C14	III-2a	0.035	0.017	0.28	0.154	0.109	3.108
		25C15	III-2b	0.036	0.018	0.28	0.132	0.118	3.324
		25C16	III-2b	0.052	0.019	0.32	0.140	0.143	2.745
			Mean:	0.041	0.018	0.30	0.141	0.120	2.962
1990 Celica 2.2L 15,050 mi	EGR, O2, TWC (2), MFI, EHC	27C19	III-3a	0.072	0.016	0.88	0.141	0.196	2.745
		27C25	III-3a	0.071	0.014	0.76	0.145	0.194	2.740
		27C27	III-3b	0.074	0.012	0.63	0.143	0.223	3.013
		27C29	III-3b	0.067	0.014	0.70	0.176	0.187	2.773
			Mean:	0.071	0.014	0.74	0.151	0.200	2.818
1990 LeSabre 3.8L 17,600 mi	EGR, O2, TWC, SFI, EHC(1)	28C33	III-4a	0.048	0.012	0.42	0.203	0.146	3.006
		28C34	III-4a	0.046	0.013	0.48	0.196	0.126	2.750
		28C35	III-4b	0.069	0.014	0.43	0.254	0.207	2.997
		28C41	III-4b	0.051	0.015	0.49	0.180	0.153	3.009
			Mean:	0.054	0.014	0.46	0.208	0.158	2.941
~~1993~~ Escort 1.9L 4,650 mi	~~TWC, EGR~~ HO2, SFI	~~41C4~~ 41C7	~~III-5a~~ III-5a	~~0.049~~ 0.056	~~0.010~~ 0.013	~~0.74~~ 0.87	~~0.091~~ 0.068	~~0.161~~ 0.187	~~3.326~~ 3.330
		41C8	III-5b	0.064	0.011	0.82	0.052	0.210	3.288
		41C9	III-5c	0.049	0.011	0.78	0.079	0.157	3.237
			Mean:	0.055	0.011	0.80	0.073	0.179	3.295
1992 Cougar 5.0 L 11,800 mi	EGR, HO2(2), SAI, TWC, CC-TWC (2), SFI	36C5	III-6a	0.055	0.030	1.24	0.156	0.164	2.954
		36C6	III-6a	0.058	0.031	1.17	0.146	0.170	2.907
		36C7	III-6b	0.055	0.020	0.84	0.178	0.154	2.794
		36C8	III-6b	0.069	0.031	1.07	0.157	0.186	2.713
			Mean:	0.059	0.028	1.08	0.159	0.169	2.842
1992 Lumina 3.1 L 4,850 mi	UF-TWC, O2, EGR, MFI, LTMEM	44C3	III-7a	0.066	0.025	1.12	0.147	0.204	3.073
		44C4	III-7a	0.071	0.027	1.66	0.131	0.240	3.378
		44C5	III-7b	0.079	0.027	1.67	0.098	0.252	3.203
		44C7	III-7c	0.065	0.018	1.03	0.112	0.232	3.537
			Mean:	0.070	0.024	1.37	0.122	0.232	3.298
1993 Escort (F) 1.9L	TWC, EGR, HO2, SFI	4931	III-8a	0.049	0.036	1.16	0.045	0.148	3.057
		4932	III-8b	0.054	0.007	1.07	0.053	0.172	3.159
		4951	III-8c	0.079	0.011	1.47	0.050	0.234	2.974
		4952	III-8d	0.055	0.010	1.08	0.044	0.158	2.901
		4961	III-8e	0.060	0.010	0.97	0.045	0.187	3.098
			Mean:	0.059	0.015	1.15	0.047	0.180	3.038
1992 T-Bird 3.8 L 13,000 mi	TWC, HO2, EGR, SFI, EHC(2)	38C36	III-9a	0.046	0.027	0.88	0.177	0.133	2.881
		38C37	III-9a	0.051	0.022	0.86	0.165	0.134	2.620
		38C38	III-9b	0.051	0.020	0.79	0.174	0.138	2.720
		38C39	III-9b	0.035	0.023	0.72	0.162	0.097	2.764
			Mean:	0.046	0.023	0.81	0.170	0.126	2.746
Cumulative Average				0.055	0.018	0.88	0.132	0.163	2.970

SECTION 1960.1, TITLE 13, CCR

Amend Title 13, California Code of Regulations, section 1960.1 to read as follows:[1]

1960.1. **Exhaust Emission Standards and Test Procedures - 1981 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.**

(a) through (d) [No Change]

(e)(1) and (e)(2) [No Change]

(e)(3) The exhaust emissions from 1992 and subsequent model-year transitional low-emission vehicles, low-emission vehicles, and ultra-low-emission vehicles, including fuel-flexible and dual-fuel vehicles, shall meet all the requirements of (g)(1) and (h)(2) with the following additions:

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1. The regulatory amendments originally proposed in this rulemaking are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions from existing regulations. Modifications to the originally noticed text are designated by ***bold italics*** and ~~***slash out***~~ to represent additions and deletions, respectively.

EXHAUST EMISSION STANDARDS FOR
TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES,
AND ULTRA-LOW-EMISSION VEHICLES IN THE
LIGHT-DUTY AND MEDIUM-DUTY VEHICLE WEIGHT CLASSES (5)(6)(7)
["milligrams per mile" (or "mg/mi")]

Vehicle Type (1)	Vehicle Weight (lbs.)(2)	Durability Vehicle Basis (mi)	Vehicle Emission Category(3)	Formaldehyde (mg/mi)(4)(5)
PC and LDT	All 0-3750	50,000	TLEV	15 (23)
			LEV	15 (15)
			ULEV	8 (12)
		100,000	TLEV	18
			LEV	18
			ULEV	11
LDT	3751-5750	50,000	TLEV	18 (27)
			LEV	18 (18)
			ULEV	9 (14)
		100,000	TLEV	23
			LEV	23
			ULEV	13
MDV	0-3750	50,000	LEV	15 (15)
			ULEV	8 (12)
		120,000	LEV	22
			ULEV	12
MDV	3751-5750	50,000	LEV	18 (18)
			ULEV	9 (14)
		120,000	LEV	27
			ULEV	13
MDV	5751-8500	50,000	LEV	22 (22)
			ULEV	11 (17)
		120,000	LEV	32
			ULEV	16
MDV	8501-10,000	50,000	LEV	28 (28)
			ULEV	14 (21)
		120,000	LEV	40
			ULEV	21
MDV	10,001-14,000	50,000	LEV	36 (36)
			ULEV	18 (27)
		120,000	LEV	52
			ULEV	26

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.

(2) For light-duty or medium-duty vehicles, Vehicle Weight shall mean "Loaded Vehicle Weight" (or "LVW") or "Test Weight" (or "TW"), respectively.

(3) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(4) Formaldehyde exhaust emission standards apply to vehicles certified to operate on any available fuel, including fuel-flexible and dual-fuel vehicles.

(5) The standards in parentheses are intermediate in-use compliance standards for 50,000 miles.

a. For PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles, intermediate in-use compliance standards shall apply to TLEVs through the 1995 model year, LEVs and ULEVs through the 1998 model year. In-use Gcompliance with standards beyond 50,000 miles shall be waived through 1995 for TLEVs, and through 1998 for LEVs and ULEVs.

b. For MDVs from 0-14,000 lbs. TW, including fuel-flexible and dual-fuel vehicles, intermediate in-use compliance standards shall apply to LEVs and ULEVs through the 1999 model year. In-use Gcompliance with standards beyond 50,000 miles shall be waived through the 1999 model year for LEVs and ULEVs.

(6) Manufacturers shall demonstrate compliance with the above standards ~~for formaldehyde at 50 degrees F according to the procedures specified~~ in section 11k of the "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(k). Hybrid electric, natural gas, and diesel-fueled vehicles shall be exempt from 50 degrees F test requirements.

(7) In-use compliance testing shall be limited to PCs and LDTs with fewer than 75,000 miles and MDVs with fewer than 90,000 miles.

(f)(1) The exhaust emissions from new 1993 and 1994 model passenger cars and light-duty trucks, except those produced by a small volume manufacturer, shall not exceed:

1993 AND 1994 MODEL-YEAR PASSENGER CAR AND LIGHT-DUTY TRUCK EXHAUST EMISSIONS STANDARDS (5)(8)(9)
(grams per mile)

Vehicle Type(1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Non-Methane Hydrocarbons (2)(7)	Carbon Monoxide (7)	Oxides of Nitrogen (1)(3)(4)
PC	All	50,000	0.39 (0.25)	7.0 (3.4)	0.4
PC(6)	All	50,000	0.39 (0.25)	7.0 (3.4)	0.7
PC	All	100,000	(0.31)	(4.2)	n/a
Diesel PC (Option 2)	All	100,000	0.46 (0.31)	8.3 (4.2)	1.0
LDT	0-3750	50,000	0.39 (0.25)	9.0 (3.4)	0.4
LDT (6)	0-3750	50,000	0.39 (0.25)	9.0 (3.4)	0.7
LDT	0-3750	100,000	(0.31)	(4.2)	n/a
Diesel LDT (Option 2)	0-3750	100,000	0.46 (0.31)	10.6 (4.2)	1.0
LDT	3751-5750	50,000	0.50 (0.32)	9.0 (4.4)	1.0
LDT	3751-5750	100,000	(0.40)	(5.5)	n/a
Diesel LDT (Option 1)	3751-5750	100,000	0.50 (0.40)	9.0 (5.5)	1.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"n/a" means not applicable.

(2) For methanol-fueled vehicles certifying to these standards, including fuel-flexible-fueled vehicles when certifying on methanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Hydrocarbon Equivalent" (or "OMHCE"). For methanol- or ethanol-fueled vehicles certifying to the phase-in standards in parenthesis, including fuel-flexible vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(3) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 1.33 times the applicable passenger car standards and 2.00 times the applicable light-duty truck and medium-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded

in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(4) The standard for in-use compliance for passenger cars and light-duty trucks certifying to the 0.4 g/mi NOx standard shall be 0.55 g/mi NOx for 50,000 miles. If the in-use compliance level is above 0.4 g/mi NOx but does not exceed 0.55 g/mi NOx, and based on a review of information derived from a statistically valid and representative sample of vehicles, the Executive Officer determines that a substantial percentage of any class or category of such vehicles exhibits, prior to 50,000 miles or 5 years, whichever occurs first, an identifiable, systematic defect in a component listed in section 1960.1.5(c)(2), Title 13, California Code of Regulations, which causes a significant increase in emissions above those exhibited by vehicles free of such defects and of the same class or category and having the same period of use and mileage, then the Executive Officer may invoke the enforcement authority under subchapter 2.5, Title 13, California Code of Regulations, commencing with section 2111, to require remedial action by the vehicle manufacturer. Such remedial action shall be limited to owner notification and repair or replacement of the defective component. As used in this section, the term "defect" shall not include failures which are the result of abuse, neglect, or improper maintenance. This provision is applicable for the 1993 model year only.

(5) Diesel passenger cars and light-duty trucks certifying to these standards are subject to a particulate exhaust emission standard of 0.08 g/mi, determined on a 50,000 mile durability vehicle basis.

(6) This set of standards is optional. A manufacturer may choose to certify to these standards pursuant to the conditions set forth in section 1960.1.5.

(7) The emission standards in parenthesis are phase-in standards. For the 1993 model year, each manufacturer must certify a minimum of 40% of their vehicles to the phase-in standards or the more stringent standards in section 1960.1, (g)(1). ~~For the 1994 model year, each manufacturer must certify a minimum of 80% of their vehicles to the phase-in standards or the more stringent standards in section 1960.1, (g)(1).~~ The percentages shall be applied to the manufacturer's total projected sales of California-certified passenger cars and light-duty trucks for the 1993 model year. For 1994 and subsequent model years, each manufacturer shall comply with the fleet average requirements specified in section 1960.1, (g)(2).

(8) The following conditions shall apply to the in-use compliance standards for 1993 and 1994 model-year passenger cars and light-duty trucks only.

a. The in-use compliance standards for those passenger cars and light-duty trucks certifying to the 0.25 g/mi non-methane hydrocarbon and 3.4 g/mi carbon monoxide standards shall be 0.32 g/mi non-methane hydrocarbon and 5.2 g/mi carbon monoxide for 50,000 miles.

b. The in-use compliance standards for those light-duty trucks certifying to the 0.32 g/mi non-methane hydrocarbon and 4.4 g/mi carbon monoxide standards shall be 0.41 g/mi non-methane hydrocarbon and 6.7 g/mi carbon monoxide for 50,000 miles.

c. In-use compliance standards shall be waived beyond 50,000 miles.

(9) All passenger cars and light-duty trucks, except those diesel vehicles certifying to optional 100,000 mile standards, are subject to non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards determined on a 50,000 mile durability basis and non-methane hydrocarbon and carbon monoxide standards determined on a 100,000 mile basis.

(f)(2) The exhaust emissions from new 1995 and subsequent model passenger cars and light-duty trucks shall not exceed:

1995 AND SUBSEQUENT MODEL-YEAR PASSENGER CAR AND LIGHT-DUTY TRUCK EXHAUST EMISSIONS STANDARDS (5)(6)(8)(10)
(grams per mile)

Vehicle Type(1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Non-Methane Hydrocarbons (2)(7)	Carbon Monoxide (7)	Oxides of Nitrogen (1)(3)
PC	All	50,000	0.25	3.4	0.4(4)
PC	All	100,000	0.31	4.2	0.6(9)n/a
Diesel PC (Option 2)	All	100,000	0.31	4.2	1.0
LDT	0-3750	50,000	0.25	3.4	0.4(4)
LDT	0-3750	100,000	0.31	4.2	0.6(9)n/a
Diesel LDT (Option 2)	0-3750	100,000	0.31	4.2	1.0
LDT	3751-5750	50,000	0.32	4.4	0.7
LDT	3751-5750	100,000	0.40	5.5	0.97(9)n/a
Diesel LDT (Option 1)	3751-5750	100,000	0.40	5.5	1.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"n/a" means not applicable.

(2) For methanol- or ethanol-fueled vehicles certifying to these standards, including fuel-flexible-fueled vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(3) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 1.33 times the applicable passenger car standards and 2.00 times the applicable light-duty truck standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(4) Small volume manufacturers may choose to certify to an optional 0.7 g/mi NOx standard for the 1995 model year only, pursuant to the conditions set forth in sections 1960.1 (f)(1) and 1960.1.5.

(5) Diesel passenger cars and light-duty trucks certifying to these standards are subject to a particulate exhaust emission standard of 0.08 g/mi, determined on a 50,000 mile durability vehicle basis.

(6) For all vehicles, except those certifying to optional diesel standards, in-use compliance with the exhaust emission standards shall be limited to vehicles with less than 75,000 miles.

(7) For the 1995 and 1996 model years, all manufacturers, except those certifying to optional diesel standards, are permitted alternative in-use compliance. Alternative in-use compliance is permitted for 60% of a manufacturer's vehicles in the 1995 model year and 20% of a manufacturer's vehicles in the 1996 model year. For the 1995 and 1996 model years, small volume manufacturers only are permitted alternative in-use compliance for 100% of the fleet. The percentages shall be applied to the manufacturers' total projected sales of California-certified passenger cars and light-duty trucks for the model year. "Alternative in-use compliance" shall consist of the following:

a. For all passenger cars and those light-duty trucks from 0-3750 lbs., loaded vehicle weight, except those diesel vehicles certifying to optional 100,000 mile standards, in-use compliance standards shall be 0.32 g/mi non-methane hydrocarbon and 5.2 g/mi carbon monoxide for 50,000 miles.

b. For light-duty trucks from 3751-5750 lbs., loaded vehicle weight, except those diesel light-duty trucks certifying to optional 100,000 mile standards, in-use compliance standards ~~shall be 0.41 g/mi non-methane hydrocarbon and 6.7 g/mi~~ carbon monoxide for 50,000 miles.

c. In-use compliance standards shall be waived beyond 50,000 miles.

(8) All passenger cars and light-duty trucks, except those diesel vehicles certifying to optional standards, are subject to non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards determined on a 50,000 mile durability basis and non-methane hydrocarbon and carbon monoxide standards determined on a 100,000 mile durability basis.

(9) 100,000 mile NOx standards are applicable for 1996 and subsequent model-year vehicles.

(10) Each manufacturer shall also comply with the requirements specified in section 1960.1, (g)(2).

(g)(1) The exhaust emissions from new 1992 and subsequent model-year light-duty transitional low-emission vehicles, low-emission vehicles, and ultra-low-emission vehicles shall not exceed:

EXHAUST EMISSION STANDARDS
FOR TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES
AND ULTRA-LOW-EMISSION VEHICLES IN PASSENGER CAR
AND LIGHT-DUTY TRUCK VEHICLE CLASSES (6)(7)(8)(9)(10)
[grams per mile (or "g/mi")]

Vehicle Type (1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Vehicle Emission Category (2)	Non-Methane Organic Gases (3)(4)	Carbon Monoxide	Oxides of Nitrogen (5)
PC and LDT	All 0-3750	50,000	TLEV	0.125 (0.188)	3.4 (3.4)	0.4 (0.4)
			LEV	0.075 (0.100)	3.4 (3.4)	0.2 (0.3)
			ULEV	0.040 (0.058)	1.7 (2.6)	0.2 (0.3)
		100,000	TLEV	0.156	4.2	0.6
			LEV	0.090	4.2	0.3
			ULEV	0.055	2.1	0.3
LDT	3751-5750	50,000	TLEV	0.160 (0.238)	4.4 (4.4)	0.7 (0.7)
			LEV	0.100 (0.128)	4.4 (4.4)	0.4 (0.5)
			ULEV	0.050 (0.075)	2.2 (3.3)	0.4 (0.5)
		100,000	TLEV	0.200	5.5	0.9
			LEV	0.130	5.5	0.5
			ULEV	0.070	2.8	0.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.

(2) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(3) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions. To demonstrate compliance with an NMOG standard, NMOG emissions shall be measured in accordance with the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991 and last amended _____, which is incorporated herein by reference. For TLEVs, LEVs, and ULEVs certified to operate exclusively on any fuel other than conventional gasoline, and for fuel-flexible and dual-fuel TLEVs, LEVs, and ULEVs when certifying on a fuel other than ~~conventional~~ gasoline, manufacturers shall multiply NMOG exhaust certification ~~mass emission~~ levels at ~~50,000~~ and ~~100,000~~ ~~miles~~ by the applicable reactivity adjustment factor set forth in section 13 of the "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(k), or established by the ~~Executive Officer pursuant to Appendix VIII of the foregoing test~~ procedures. In addition, natural gas vehicles certifying to TLEV, LEV or ULEV standards shall calculate a reactivity-adjusted methane exhaust emission value by multiplying the methane exhaust certification level by the applicable methane reactivity adjustment factor set forth in section 13 of the above-referenced test procedures. The product of the NMOG exhaust certification ~~mass~~

~~emission~~ levels and the reactivity adjustment factor shall be compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance. For natural gas vehicles, the reactivity-adjusted NMOG value shall be added to the reactivity-adjusted methane value and then compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance.

a. Each manufacturer shall certify PCs or LDTs to meet the exhaust mass emission standards for TLEVs, LEVs, ULEVs, or the exhaust emission standards of sections 1960.1 (e)(1), 1960.1 (f)(1), or 1960.1 (f)(2), Title 13, California Code of Regulations, or as Zero-Emission Vehicles such that the manufacturer's fleet average NMOG values for California-certified PCs and LDTs from 0-3750 lbs. "Loaded Vehicle Weight" (or "LVW"), and LDTs from 3751-5750 lbs. LVW ~~sold~~ produced and delivered for sale in California are less than or equal to the requirement for the corresponding Model Year, Vehicle Type, and LVW Class in section 1960.1 (g)(2), Title 13, California Code of Regulations.

(4) Fuel-flexible and dual-fuel PCs and LDTs from 0-5750 lbs. LVW shall be certified to exhaust mass emission standards for NMOG established for the operation of the vehicle on any available fuel other than ~~conventional~~ gasoline, and ~~conventional~~ gasoline.

a. For TLEVs, LEVs, and ULEVs, when certifying for operation on a fuel other than ~~conventional~~ gasoline, manufacturers shall multiply exhaust NMOG certification ~~mass emission~~ levels at ~~50,000 and 100,000 miles~~ by the applicable reactivity adjustment factor. In addition to multiplying the exhaust NMOG certification levels by the applicable reactivity adjustment factor, natural gas vehicles shall multiply the exhaust methane certification level by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. The exhaust NMOG certification levels for fuel-flexible or dual-fuel vehicles when certifying on gasoline shall not be multiplied by a reactivity adjustment factor.

b. For PCs and LDTs from 0-3750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For TLEVs, 0.25 g/mi and 0.31 g/mi for 50,000 and 100,000 miles, respectively.
   (ii) For LEVs, 0.125 g/mi and 0.156 g/mi for 50,000 and 100,000 miles, respectively.
   (iii) For ULEVs, 0.075 g/mi and 0.090 g/mi for 50,000 and 100,000 miles, respectively.

c. For LDTs from 3751-5750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For TLEVs, 0.32 g/mi and 0.40 g/mi for 50,000 and 100,000 miles, respectively.
   (ii) For LEVs, 0.160 g/mi and 0.200 g/mi for 50,000 and 100,000 miles, respectively.
   (iii) For ULEVs, 0.100 g/mi and 0.130 g/mi for 50,000 and 100,000 miles, respectively.

(5) The maximum projected emissions of "Oxides of Nitrogen" (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR 600

Subpart B) shall be not greater than 1.33 times the applicable light-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) The standards in parentheses are intermediate in-use compliance standards for 50,000 miles. For PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, intermediate in-use compliance standards shall apply to TLEVs through the 1995 model year, and LEVs and ULEVs through the 1998 model year. In-use Gcompliance with standards beyond 50,000 miles shall be waived through the 1995 model year for TLEVs, and through the 1998 model year for LEVs and ULEVs.

a. For TLEVs, LEVs, and ULEVs designed to operate on any fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on any fuel other than ~~conventional~~ gasoline, exhaust NMOG mass emission results ~~levels~~ shall be multiplied by the applicable reactivity adjustment factor to determine compliance with intermediate in-use compliance standards for NMOG. In addition to multiplying the exhaust NMOG ~~certification levels~~ ***emission results*** by the applicable reactivity adjustment factor, natural gas vehicles shall multiply the exhaust methane ~~certification level~~ ***emission results*** by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. Exhaust NMOG mass emissions from fuel-flexible or dual-fuel vehicles when operating on gasoline shall not be multiplied by a reactivity adjustment factor.

b. For fuel-flexible and dual-fuel PCs and LDTs from 0-3750 lbs. LVW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.32 g/mi, 0.188 g/mi, and 0.100 g/mi for TLEVs, LEVs, and ULEVs, respectively.

c. For fuel-flexible and dual-fuel PCs and LDTs from 3751-5750 lbs. LVW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.41 g/mi, 0.238 g/mi, and 0.128 g/mi for TLEVs, LEVs, and ULEVs, respectively.

(7) Manufacturers of diesel vehicles shall also certify to particulate standards at 100,000 miles. For all PCs and LDTs from 0-5750 lbs LVW, the particulate standard is 0.08 g/mi, 0.08 g/mi, and 0.04 g/mi for TLEVs, LEVs, and ULEVs, respectively.

(8) Manufacturers shall demonstrate compliance with the above standards for NMOG, CO, and NOx at 50 degrees F according to the procedure specified in section 11k of the "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(k). ~~For~~ Hybrid electric, natural gas, and diesel-fueled vehicles ~~shall be exempt from 50 degrees F test requirements., compliance with the particulate standard shall also be demonstrated as specified in section 11k of the foregoing test procedures.~~

(9) In-use compliance testing shall be limited to vehicles with fewer than 75,000 miles.

(10) Deterioration factors for hybrid electric vehicles shall be based on the emissions and mileage accumulation of the auxiliary power unit. For certification purposes only, Type A hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors), and demonstrating compliance with 100,000 mile emission standards shall not be required. For certification purposes only, Type B hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 100,000 mile emission standards (using 75,000 mile deterioration factors). For certification purposes only, Type C hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 100,000 mile emission standards (using 100,000 mile deterioration factors).

(g)(2) The fleet average non-methane organic gas exhaust emission values from a ~~manufacturer's sales of~~ the passenger cars and light-duty trucks produced and delivered for sale in California by a manufacturer each model year shall not exceed:

FLEET AVERAGE NON-METHANE ORGANIC GAS EXHAUST EMISSION REQUIREMENTS FOR LIGHT-DUTY VEHICLE WEIGHT CLASSES (7)(8)(9)
[grams per mile (or "g/mi")]

Vehicle Type (1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)(7)	Model Year	Fleet Average Non-Methane Organic Gases (2)(3)(4)(5)(6)
PC and LDT	All 0-3750	50,000	1994	0.250
			1995	0.231
			1996	0.225
			1997	0.202
			1998	0.157
			1999	0.113
			2000	0.073
			2001	0.070
			2002	0.068
			2003 & subsequent	0.062
LDT	3751-5750	50,000	1994	0.320
			1995	0.295
			1996	0.287
			1997	0.260
			1998	0.205
			1999	0.150
			2000	0.099
			2001	0.098
			2002	0.095
			2003 & subsequent	0.093

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.

(2) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions.

(3) For the purpose of calculating fleet average NMOG values, a manufacturer may adjust the certification levels of hybrid electric vehicles (or "HEVs") based on the range of the HEV without the use of the engine. For the purpose of calculating the adjusted NMOG emissions, the following definitions shall apply:
"Type A HEV" shall mean an HEV which achieves a minimum range of 60 miles over the ~~Dynamometer Driving Cycle as defined by~~ the All-Electric Range Test 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(k). ~~"Federal Highway Fuel Economy Test Procedure"~~

~~(HWFET: 40 CFR 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 60 miles. This definition shall also apply to vehicles which have no tailpipe emissions, but use fuel fired heaters, regardless of the operating range of the vehicle.~~

~~"Type B HEV" shall mean an HEV which achieves a range of 40 - 59 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET: 40 CFR 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 40 miles.~~ All-Electric Range Test 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(k).

~~"Type C HEV" shall mean an HEV which achieves a range of 0 - 39 miles over the~~ All-Electric Range Test ~~Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET: 40 CFR 600 Subpart B) without the use of the engine, an HEV which enables the vehicle operators to control the engine time and modes of operation either directly or indirectly, an HEV which can be operated solely through the use of the engine, and all other HEVs excluding "Type A" and "Type B" HEVs~~ 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(k).

a. For the purpose of calculating fleet average NMOG values, vehicles which have no tailpipe emissions but use fuel-fired heaters and which are not certified as ZEVs shall be treated as "Type A HEV ULEVs."

(4) Each manufacturer's fleet average NMOG value for the total number of PCs and LDTs from 0-3750 lbs. "Loaded Vehicle Weight" (or "LVW") ~~sold~~ produced and delivered for sale in California shall be calculated in units of g/mi NMOG according to the following equation, where the term "Produced" means produced and delivered for sale in California as: {[(No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (e)(1) and Produced ~~Sold~~ x (0.39)] + [No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (f)(1) and Produced x (0.25)] + [(No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (f)(2) and Produced ~~Sold~~ x (0.25)] + [(No. of Transitional Low-Emission Vehicles (or "TLEVs") excluding HEVs and Produced ~~Sold~~) x (0.125)] + [(No. of Low-Emission Vehicles (or "LEVs") excluding HEVs and Produced ~~Sold~~) x (0.075)] + [(No. of Ultra-Low-Emission Vehicles (or "ULEVs") excluding HEVs and Produced ~~Sold~~) x (0.040)] + (HEV contribution factor)}/(Total No. of Vehicles Produced ~~Sold~~, Including Zero-Emission Vehicles and HEVs):

a. "HEV contribution factor" shall mean the NMOG emission contribution of HEVs to the fleet average NMOG value. The HEV contribution factor shall be calculated in units of g/mi as follows, where the term "Produced" means produced and delivered for sale in California:

HEV contribution factor = {[No. of "Type A HEV" TLEVs Produced ~~Sold~~] x (0.100) + [No. of "Type B HEV" TLEVs Produced ~~Sold~~] x (0.113) + [No. of "Type C HEV" TLEVs Produced ~~Sold~~] x (0.125)} + {[No. of "Type A HEV" LEVs Produced ~~Sold~~] x (0.057) + [No. of "Type B HEV" LEVs Produced ~~Sold~~] x (0.066) + [No. of "Type C HEV" LEVs Produced ~~Sold~~] x (0.075)} + {[No. of "Type A HEV" ULEVs Produced ~~Sold~~] x (0.020) + [No. of "Type B HEV" ULEVs Produced ~~Sold~~] x (0.030) + [No. of "Type C HEV" ULEVs Produced ~~Sold~~] x (0.040)}

b. "Zero-Emission Vehicles" (or "ZEVs") classified as LDTs 3751-5750 lbs. LVW which have been counted toward the ZEV requirements for PCs and LDTs 0-3750 lbs. LVW as specified in note (9) shall be included in the equation of note (4). ~~medium-duty vehicles by weight may be designated as light-duty vehicles for the purpose of calculating fleet average NMOG values.~~

c. Beginning with the 1996 model year, manufacturers that produce and deliver for sale in California PCs and LDTs 0-3750 lbs. LVW that are certified to federal Tier I exhaust emission standards in 40 CFR 86.094-8 and 86.094-9 shall add the following term to the numerator of the fleet average NMOG equation in note (4) and calculate their fleet average NMOG values accordingly:
[(No. of Vehicles Certified to federal Tier I exhaust emission standards and Produced) x (0.25)]

(5) Manufacturers that certify LDTs from 3751-5750 lbs. LVW, shall calculate a fleet average NMOG value in units of g/mi NMOG according to the following equation, where the term "Produced" means produced and delivered for sale in California as:
{[(No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (e)(1), and Produced ~~Sold~~ x (0.50)] + [(No. of Vehicles Certified to the Phase-In Exhaust Emission Standards in section 1960.1 (f)(1), and Produced x (0.32)] + [(No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (f)(2), and Produced ~~Sold~~ x (0.32)] + [(No. of TLEVs Produced ~~Sold~~ excluding HEVs) x (0.160)] + [(No. of LEVs Produced ~~Sold~~ excluding HEVs) x (0.100)] + [(No. of ULEVs Produced ~~Sold~~ excluding HEVs) x (0.050)] + (HEV contribution factor)}/(Total No. of Vehicles Produced ~~Sold~~, Including ZEVs and HEVs).

a. "HEV contribution factor" shall mean the NMOG emission contribution of HEVs to the fleet average NMOG. The HEV contribution factor shall be calculated in units of g/mi as follows, where the term "Produced" means produced and delivered for sale in California:
HEV contribution factor = {[No. of "Type A HEV" TLEVs Produced ~~Sold~~] x (0.130) + [No. of "Type B HEV" TLEVs Produced ~~Sold~~] x (0.145) + [No. of "Type C HEV" TLEVs Produced ~~Sold~~] x (0.160)} + {[No. of "Type A HEV" LEVs Produced ~~Sold~~] x (0.075) + [No. of "Type B HEV" LEVs Produced ~~Sold~~] x (0.087) + [No. of "Type C HEV" LEVs Produced ~~Sold~~] x (0.100)} + {[No. of "Type A HEV" ULEVs Produced ~~Sold~~] x (0.025) + [No. of "Type B HEV" ULEVs

Produced ~~Sold~~] x (0.037) + [No. of "Type C HEV" ULEVs Produced ~~Sold~~] x (0.050)]

b. Only ZEVs which have been certified as LDTs 3751-5750 lbs. LVW and which have not been counted toward the ZEV requirements for PCs and LDTs 0-3750 lbs. LVW as specified in note (9) shall be included in the equation of note (5).

c. Beginning with the 1996 model year, manufacturers that produce and deliver for sale in California LDTs 3751-5750 lbs. LVW that are certified to the Tier I exhaust emission standards in 40 CFR 86.094-9 shall add the following term to the numerator of the fleet average NMOG equation in note (5) and calculate their fleet average NMOG values accordingly:
[(No. of Vehicles Certified to federal Tier I exhaust emission standards and Produced and Delivered for Sale in California) x (0.32)]

(6) As used in this subsection, the term "small volume manufacturer" shall mean any vehicle manufacturer with California sales less than or equal to 3000 new ~~LDVs~~ PCs, LDTs and MDVs per model year based on the average number of vehicles sold by the manufacturer each model year from 1989 to 1991, except as noted below. For manufacturers certifying for the first time in California, model-year sales shall be based on projected California sales. In 2000 and subsequent model years, small volume manufacturers shall comply with the fleet average NMOG requirements set forth below.

a. Prior to the model year 2000, compliance with the specified fleet average NMOG requirements shall be waived.

b. In 2000 and subsequent model years, small volume manufacturers shall not exceed a fleet average NMOG value of 0.075 g/mi for PCs and LDTs from 0-3750 lbs. LVW calculated in accordance with note (4) ~~for 50,000 miles~~.

c. In 2000 and subsequent model years, small volume manufacturers shall not exceed a fleet average NMOG value of 0.100 g/mi for LDTs from 3751-5750 lbs. LVW calculated in accordance with note (5) ~~for 50,000 miles~~.

d. If a manufacturer's average California sales exceeds 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the fleet average requirements applicable for larger manufacturers as specified in section 1960.1 (g)(2) beginning with the fourth model year after the last of the three consecutive model years.

e. If a manufacturer's average California sales falls below 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall be treated as a small volume manufacturer and shall be subject to requirements for small volume manufacturers as specified in section 1960.1 (g)(2) beginning with the next model year.

(7) In ~~1994~~ *1992* and subsequent model years, manufacturers that achieve fleet average NMOG values lower than the fleet average NMOG requirement for the corresponding model year shall receive

credits in units of g/mi NMOG determined as: {[(Fleet Average NMOG Requirement) - (Manufacturer's Fleet Average NMOG Value)] x (Total No. of Vehicles Produced and Delivered for Sale in California ~~Sold~~, Including ZEVs and HEVs)}.

a. Manufacturers with fleet average NMOG values greater than the fleet average requirement for the corresponding model year shall receive debits in units of g/mi NMOG equal to the amount of negative credits determined by the aforementioned equation. For any given model year, the total g/mi NMOG credits or debits earned for PCs and LDTs 0-3750 lbs. LVW and for LDTs 3751-5750 lbs. LVW shall be summed together. The resulting amount shall constitute the g/mi NMOG credits or debits accrued by the manufacturer for the model year.

b. For the 1994 through 1997 model years, manufacturers shall equalize emission debits within three model years and prior to the end of the 1998 model year by earning g/mi NMOG emission credits in an amount equal to their g/mi NMOG debits, or by submitting a commensurate amount of g/mi NMOG credits to the Executive Officer that were earned previously or acquired from another manufacturer. For 1998 and subsequent model years, manufacturers shall equalize emission debits by the end of the following model year. If emission debits are not equalized within the specified time period, the manufacturer shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the emission debits are not equalized by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's emission standards shall be determined by dividing the total amount of g/mi NMOG emission debits for the model year by the g/mi NMOG fleet average requirement for PCs and LDTs 0-3750 lbs. LVW applicable for the model year in which the debits were first incurred.

c. The g/mi NMOG emission credits earned in any given model year shall retain full value through the subsequent model year.

d. The g/mi NMOG value of any credits not used to equalize the previous model-year's debit, shall be discounted by 50% at the beginning of the second model year after being earned, discounted to 25% of its original value if not used by the beginning of the third model year after being earned, and will have no value if not used by the beginning of the fourth model year after being earned.

~~e. Any g/mi NMOG emission credits earned by a manufacturer may be applied toward either the fleet average requirement for passenger cars and light-duty trucks from 0-3750 lbs. LVW, or the fleet average requirement for light-duty trucks from 3751-5750 lbs. LVW, at the manufacturer's discretion.~~

(8) Manufacturers that produce and deliver for sale in California ~~sell~~ vehicles certified to the phase-in exhaust emission standards in section 1960.1 (f)(1), or vehicles certified to the

exhaust emission standards in sections 1960.1 (f)(2) or 1960.1 (g)(1) and/or ZEVs, in the 1992 and 1993 model years, shall receive emission credits ~~for the sale of these vehicles~~ as determined by the equations in footnotes (4), ~~or~~ (5), and (7) ~~depending upon Vehicle Weight Class, and footnote (7).~~

a. For PCs and LDTs from 0-3750 lbs. LVW, the fleet average NMOG requirement for calculating a manufacturer's emission credits shall be 0.390 and 0.334 g/mi NMOG for vehicles certified for the 1992 and 1993 model years, respectively.

b. For LDTs from 3751-5750 lbs. LVW, the fleet average NMOG requirement for calculating a manufacturer's emission credits shall be 0.500 and 0.428 g/mi NMOG for vehicles certified for the 1992 and 1993 model years, respectively.

c. Emission credits earned prior to the 1994 model year shall be considered as earned in the 1994 model year and discounted in accordance with the schedule specified in footnote (7).

(9) While meeting the fleet average requirements, each manufacturer shall certify, produce, and deliver for sale in California ~~its sales fleet of passenger cars and light-duty trucks from 0-3750 lbs. LVW shall be composed of~~ at least 2% ZEVs each model year from 1998 through 2000, 5% ZEVs in 2001 and 2002, and 10% ZEVs in 2003 and subsequent model years. These percentages shall be applied to the manufacturer's total production of PCs and LDTs 0-3750 lbs. LVW delivered for sale in California.

~~a.~~ Manufacturers ~~which produce for sale in California more~~ ZEVs than required in a given model year shall earn ZEV credits, which shall have units of g/mi NMOG. The amount of ZEV credits earned shall be equal to the number of ZEVs required to be produced and delivered for sale in California for the model year subtracted from the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year and then multiplied by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for the model year. All ZEVs credits earned prior to the 1998 model year shall be treated as if earned in the 1998 model year and shall be discounted in accordance with notes (7)c and (7)d.

~~a~~ b. A manufacturer may meet the ZEV requirements in any given model year by submitting to the Executive Officer a commensurate amount of ZEV credits. ~~g/mi NMOG emission credits earned exclusively from the sale of ZEVs.~~ These credits may be earned previously by the manufacturer or acquired from another manufacturer. The amount of ZEV credits required to be submitted shall be calculated by subtracting the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year from the number of ZEVs required to be produced by the manufacturer for the model year and then multiplying by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for that model year.

~~b~~ c. Manufacturers which certify, produce, and deliver for sale in California ~~sell~~ fewer ZEVs than required in a given model year shall make up the deficit by the end of the next model year by ~~selling an additional number of~~ ZEVs equal to

~~their deficit or~~ by submitting to the Executive Officer a commensurate amount of ZEV ~~g/mi NMOG~~ credits ~~earned exclusively from the sale of ZEVs~~. The amount of ZEV credits required to be submitted shall be calculated by subtracting the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year from the number of ZEVs required to be produced by the manufacturer for the model year and then multiplying by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for the model year in which the deficit is incurred.

d. Any manufacturer which fails to produce and deliver for sale in California the required number of ZEVs or submit an appropriate amount of ZEV credits and does not make up ZEV deficits within the specified time period shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the ZEV deficits are not balanced by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's standards shall be calculated according to the following equation: (No. of ZEVs required to be produced and delivered for sale in California for the model year) - (No. of ZEVs actually produced and delivered for sale in California for the model year) - [(Amount of ZEV credits submitted for the model year) / (the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for the model year)].

e. ZEVs classified as MDVs or as LDTs 3751-5750 lbs. LVW may be counted toward the ZEV requirement for PCs and LDTs 0-3750 lbs. LVW and included in the calculation of ZEV credits as specified in note (9)a., if the manufacturer so designates.

~~e~~ f. Small volume manufacturers shall not be required to meet the percentage ZEV requirements. However, small volume manufacturers may earn and market credits for ZEVs they produce and ~~sell~~ deliver for sale in California.

~~d~~ g. Intermediate volume manufacturers as defined in section 1960.1 (o) shall not be required to meet the percentage ZEV requirements before the 2003 model year.

(h)(1) The exhaust emissions from new 1995 and subsequent model medium-duty vehicles shall not exceed:

1995 AND SUBSEQUENT MODEL-YEAR
MEDIUM-DUTY VEHICLE EXHAUST EMISSIONS STANDARDS (1)(2)(3)(7)(8)
(grams per mile)

Test Weight(lbs.)	Durability Vehicle Basis(mi)	Non-Methane Hydrocarbons(4)	Carbon Monoxide	Oxides of Nitrogen(5)	Particulates (6)
0-3,750	50,000	0.25	3.4	0.4	n/a
0-3,750	120,000	0.36	5.0	0.55	0.08
3,751-5,750	50,000	0.32	4.4	0.7	n/a
3,751-5,750	120,000	0.46	6.4	0.98	0.10
5,751-8,500	50,000	0.39	5.0	1.1	n/a
5,751-8,500	120,000	0.56	7.3	1.53	0.12
8,501-10,000	50,000	0.46	5.5	1.3	n/a
8,501-10,000	120,000	0.66	8.1	1.81	0.12
10,001-14,000	50,000	0.60	7.0	2.0	n/a
10,001-14,000	120,000	0.86	10.3	2.77	0.12

(1) "n/a" means not applicable.
"Test Weight" shall mean the average of the vehicle's curb weight and gross vehicle weight.

(2) Manufacturers have the option of certifying engines used in incomplete and diesel medium-duty vehicles from 8501-14,000 pounds, gross vehicle weight to the heavy-duty engine standards and test procedures set forth in section 1956.8(e), Title 13, California Code of Regulations. Manufacturers certifying incomplete or diesel medium-duty vehicles to the heavy-duty engine standards and test procedures shall specify, in the application for certification, an in-use compliance test procedure, as provided in section 2139(c), Title 13, California Code of Regulations.

(3) For the 1995 model year only, manufacturers of medium-duty vehicles may certify a maximum of 50 percent of their vehicles to the applicable 1994 model-year standards and test procedures. For the 1995 model year only, small volume manufacturers may certify 100 percent of their vehicles to the applicable 1994 model-year standards and test procedures. The percentage shall be based upon each manufacturer's projected sales of California-certified medium-duty vehicles.

(4) For methanol- and ethanol-fueled vehicles certifying to these standards, including flexible-fueled vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(5) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 2.00 times the applicable medium-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in

accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) Particulate standards are only applicable for diesel vehicles and shall be determined on a 120,000 mile basis.

(7) In-use compliance testing shall be limited to vehicles with less than 90,000 miles. For the 1995 through 1997 models, alternative in-use compliance is available for medium-duty vehicle manufacturers. A manufacturer may use alternative in-use compliance for up to 100 percent of its fleet in the 1995 and 1996 model years and up to 50 percent of its fleet in the 1997 model year. Small volume manufacturers may use alternative in-use compliance for up to 100 percent of their fleets in the 1995 through 1997 model years. The percentages shall be determined from the manufacturers' projected California sales of medium-duty vehicles. For vehicles certified to the standards and test procedures of this subsection, "alternative in-use compliance" shall consist of an in-use allowance of 25 percent over the applicable 1995 model-year non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen 50,000 mile emission standards and a waiver of the emission standards beyond 50,000 miles.

(8) All medium-duty vehicles, except diesel-fueled vehicles and those incomplete and diesel vehicles certifying to heavy-duty engine test procedures, are subject to 50,000 mile and 120,000 mile non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards. Diesel-fueled vehicles shall be subject to 120,000 mile non-methane hydrocarbon, carbon monoxide, oxides of nitrogen, and particulate standards only.

(h)(2) The exhaust emissions from new 1992 and subsequent model-year medium-duty low-emission vehicles, and ultra-low-emission vehicles shall not exceed:

EXHAUST EMISSION STANDARDS FOR LOW-EMISSION VEHICLES,
AND ULTRA-LOW-EMISSION VEHICLES IN THE
MEDIUM-DUTY VEHICLE WEIGHT CLASS (8)(9)(10)(11)(12)(13)(14)(15)(16)
[grams per mile (or "g/mi")]

Test Weight lbs.) (1)	Durability Vehicle Basis (mi)	Vehicle Emission Category (2)	Non-Methane Organic Gases (3)(4)	Carbon Monoxide	Oxides of Nitrogen (5)	Particulates (6)(7)
0-3750	50,000	LEV	0.125 (0.188)	3.4 (3.4)	0.4 (0.4)	n/a
		ULEV	0.075 (0.100)	1.7 (2.6)	0.2 (0.3)	n/a
	120,000	LEV	0.180	5.0	0.6	0.08
		ULEV	0.107	2.5	0.3	0.04
3751-5750	50,000	LEV	0.160 (0.238)	4.4 (4.4)	0.7 (0.7)	n/a
		ULEV	0.100 (0.128)	2.2 (3.3)	0.4 (0.5)	n/a
	120,000	LEV	0.230	6.4	1.0	0.10
		ULEV	0.143	3.2	0.5	0.05
5751-8500	50,000	LEV	0.195 (0.293)	5.0 (5.0)	1.1 (1.1)	n/a
		ULEV	0.117 (0.156)	2.5 (3.8)	0.6 (0.8)	n/a
	120,000	LEV	0.280	7.3	1.5	0.12
		ULEV	0.167	3.7	0.8	0.06
8501-10000	50,000	LEV	0.230 (0.345)	5.5 (5.5)	1.3 (1.3)	n/a
		ULEV	0.138 (0.184)	2.8 (4.2)	0.7 (1.0)	n/a
	120,000	LEV	0.330	8.1	1.8	0.12
		ULEV	0.197	4.1	0.9	0.06
10,001-14000	50,000	LEV	0.300 (0.450)	7.0 (7.0)	2.0 (2.0)	n/a
		ULEV	0.180 (0.240)	3.5 (5.3)	1.0 (1.5)	n/a
	120,000	LEV	0.430	10.3	2.8	0.12
		ULEV	0.257	5.2	1.4	0.06

(1) "Test Weight" (or "TW") shall mean the average of the vehicle's curb weight and gross vehicle weight.

(2) "LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(3) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions. To determine compliance with an NMOG standard, NMOG emissions shall be measured in accordance with "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991 and last amended _____, which is incorporated herein by reference.

a. For LEVs and ULEVs certified to operate on any available fuel other than conventional gasoline, including fuel-flexible or dual-fuel vehicles when certifying on a fuel other than conventional gasoline, manufacturers shall multiply the exhaust NMOG certification mass emission levels at 50,000 and 120,000 miles by the applicable reactivity adjustment factor set forth in section 13 of the "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(k), or established by the Executive Officer pursuant to Appendix VIII of the foregoing test procedures. In addition, natural gas vehicles certifying to LEV or ULEV standards shall calculate a reactivity-adjusted methane exhaust emission value by multiplying the methane exhaust certification level by the applicable methane reactivity adjustment factor set forth in section 13 of the above-referenced test procedures. The product of the exhaust NMOG certification ~~mass emission~~ levels and the reactivity adjustment factor shall be compared to the exhaust NMOG mass emission standard established for the particular vehicle emission category to determine compliance. For natural gas vehicles, the reactivity-adjusted NMOG value shall be added to the reactivity-adjusted methane value and then compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance.

(4) Fuel-flexible and dual-fuel medium-duty vehicles (or "MDVs") from 0-14,000 lbs. TW shall be certified to exhaust mass emission standards for NMOG established for the operation of the vehicle on any fuel other than ~~conventional~~ gasoline, and ~~conventional~~ gasoline.

a. For LEVs and ULEVs when certifying on the fuel other than gasoline, manufacturers shall multiply the exhaust NMOG certification ~~mass emission~~ levels at ~~50,000~~ and ~~120,000~~ ~~miles~~ by the applicable reactivity adjustment factor. In addition to multiplying the exhaust NMOG certification levels by the applicable reactivity adjustment factor, natural gas vehicles shall multiply the exhaust methane certification level by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. When certifying on gasoline, the exhaust NMOG certification levels of fuel-flexible and dual-fuel vehicles shall not be multiplied by a reactivity adjustment factor.

b. For MDVs from 0-3750 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.25 g/mi and 0.36 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.125 g/mi and 0.180 ~~0.190~~ g/mi for 50,000 and 120,000 miles, respectively.

c. For MDVs from 3751-5750 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.32 g/mi and 0.46 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.160 g/mi and 0.230 g/mi for 50,000 and 120,000 miles, respectively.

d. For MDVs from 5751-8500 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for ~~operation on conventional gasoline shall be:~~
   (i) For LEVs, 0.39 g/mi and 0.56 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.195 g/mi and 0.280 g/mi for 50,000 and 120,000 miles, respectively.

e. For MDVs from 8501-10,000 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.46 g/mi and 0.66 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.230 g/mi and 0.330 g/mi for 50,000 and 120,000 miles, respectively.

f. For MDVs from 10,001-14,000 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.60 g/mi and 0.86 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.300 g/mi and 0.430 g/mi for 50,000 and 120,000 miles, respectively.

(5) The maximum projected emissions of "Oxides of Nitrogen" (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall not be greater than 2.00 times the applicable MDV standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) Particulate standards are only applicable for diesel vehicles and shall be determined on a 120,000 mile basis.

(7) "n/a" means not applicable.

(8) Manufacturers have the option of certifying engines used in incomplete and diesel MDVs to the heavy-duty engine standards and test procedures set forth in section 1956.8(h), Title 13, California Code of Regulations. Manufacturers certifying incomplete or diesel MDVs to the heavy-duty engine standards and test procedures shall specify in the application for certification an in-use compliance procedure as provided in section 2139(c), Title 13, California Code of Regulations.

(9) The standards in parenthesis are intermediate in-use compliance standards for 50,000 miles. For MDVs from 0-14,000 lbs. TW, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, intermediate in-use compliance standards shall apply to LEVs and ULEVs through the 1999 model year. In-use Ccompliance with standards beyond 50,000 miles shall be waived through the 1999 model year for LEVs and ULEVs.

a. For LEVs and ULEVs designed to operate on any available fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, NMOG emission results ~~levels~~ shall be multiplied by the applicable reactivity adjustment factor. In addition to multiplying the exhaust NMOG ~~certification level~~ ***emission results*** by the applicable reactivity adjustment factor, natural gas vehicles shall multiply the exhaust methane ~~certification level~~ ***emission results*** by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. For fuel-flexible and dual-fuel vehicles when operating on gasoline, NMOG emission results shall not be multiplied by a reactivity adjustment factor.

b. For fuel-flexible and dual-fuel MDVs from 0-3750 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.32 g/mi and 0.188 g/mi for LEVs and ULEVs, respectively.

c. For fuel-flexible and dual-fuel MDVs from 3751-5750 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.41 g/mi and 0.238 g/mi for LEVs and ULEVs, respectively.

d. For fuel-flexible and dual-fuel MDVs from 5751-8500 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.49 g/mi and 0.293 g/mi for LEVs and ULEVs, respectively.

e. For fuel-flexible and dual-fuel MDVs from 8501-10,000 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.58 g/mi and 0.345 g/mi for LEVs and ULEVs, respectively.

f. For fuel-flexible and dual-fuel MDVs from 10,001-14,000 lbs. TW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.75 g/mi and 0.450 g/mi for LEVs and ULEVs, respectively.

(10) Each manufacturer's MDV fleet shall be defined as the total number of MDVs from 0-14,000 lbs. TW certified and ~~sold~~ produced and delivered for sale in California.

a. Manufacturers of MDVs shall certify an equivalent of 25% of their MDV fleet to LEV standards in the 1998 model year, 50% of their MDV fleet to LEV standards in the 1999 model year, 75% of their MDV fleet to LEV standards in the 2000 model year, 95% of their MDV fleet to LEV standards in the 2001 model year, 90% of their MDV fleet to LEV standards in the 2002 model year, and 85% of their MDV fleet to LEV standards in the 2003 and subsequent model years.

b. Manufacturers of MDVs shall certify an equivalent of 2% of their MDV fleet to ULEV standards in each model year from 1998 through 2000, 5% of their MDV fleet to ULEV standards in the 2001 model year, 10% of their MDV fleet to ULEV standards in the 2002 model year, and 15% of their MDV fleet to ULEV standards in the 2003 and subsequent model years.

c. These requirements shall not apply to small volume manufacturers. Small volume manufacturers shall comply with the requirements of note (15) below.

(11) For the purpose of calculating "Vehicle Equivalent Credits" (or "VECs"), the contribution of hybrid electric vehicles (or "HEVs") will be calculated based on the range of the HEV without the use of the engine. For the purpose of calculating the contribution of HEVs to the VECs, the following definitions shall apply:

"Type A HEV" shall mean an HEV which achieves a minimum range of 60 miles over the All-Electric Range Test as defined in the "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 (k). ~~Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET; 40 CFR Part 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 60 miles. This definition shall also apply to vehicles which have no tailpipe~~

~~emissions, but use fuel fired heaters, regardless of the operating range of the vehicle.~~

"Type B HEV" shall mean an HEV which achieves a range of 40 - 59 miles over the All-Electric Range Test as defined in the "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 (k). ~~Dynamometer Driving Cycle as defined by the "Federal Highway fuel Economy Test Procedure" (HWFET, 40 CFR part 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 40 miles.~~

"Type C HEV" shall mean an HEV which achieves a range of 0 - 39 miles over the All-Electric Range Test ~~Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET, 40 CFR Part 600 Subpart B) without the use of the engine, an HEV which enables the vehicle operators to control the engine time and modes of operation either directly or indirectly, an HEV which can be operated solely through the use of the engine,~~ and all other HEVs excluding "Type A" and "Type B" HEVs as defined in the "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 (k).

a. For the purpose of calculating VECs, electric vehicles which utilize fuel fired heaters and which are not otherwise certified as ZEVs shall be treated as "Type A HEV ULEVs."

(12) In 1992 and subsequent model years, manufacturers that produce and deliver for sale in California ~~sell~~ MDVs in excess of the equivalent requirements for LEVs and/or ULEVs shall receive VECs calculated in accordance with the following equation, where the term "Produced" means produced and delivered for sale in California as: {[(No. of LEVs Produced ~~Sold~~ excluding HEVs) + (No. of "Type C HEV" LEVs Produced ~~Sold~~)] + [(No. of "Type B HEV" LEVs Produced ~~Sold~~) x (1.1)] + [(No of "Type A HEV" LEVs Produced ~~Sold~~) x (1.2)] - (Equivalent No. of LEVs Required to be Produced ~~Sold~~)} + {[(No. of ULEVs Produced ~~Sold~~ excluding HEVs) x (1.4)] + [(No. of "Type C HEV" ULEVs Produced ~~Sold~~) x (1.4)] + [(No. of "Type B HEV" ULEVs Produced ~~Sold~~) x (1.5)] + [(No. of "Type A HEV" ULEVs Produced ~~Sold~~) x (1.7)] - [(Equivalent No. of ULEVs Required to be Produced ~~Sold~~) x (1.4)]} + [(No. of ZEVs Produced ~~Sold~~ as MDVs) x (2.0)].

a. Manufacturers that fail to produce and deliver for sale in California ~~sell~~ the equivalent quantity of MDVs certified to LEV and/or ULEV exhaust emission standards, shall receive "Vehicle-Equivalent Debits" (or "VEDs") equal to the amount of negative VECs determined by the aforementioned equation.

b. Manufacturers shall equalize emission debits within one model year by earning VECs in an amount equal to their previous model-year's total of VEDs, or by submitting a commensurate amount of VECs to the Executive Officer that were earned previously or acquired from another manufacturer. Any manufacturer which fails to equalize emission debits within the specified time period shall be subject to the Health and Safety Code civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the emission debits

are not equalized by the end of the specified time period. for the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's emission standards shall be equal to the amount of VEDs incurred.

c. The VECs earned in any given model year shall retain full value through the subsequent model year.

d. The value of any VECs not used to equalize the previous model-year's debit, shall be discounted by 50% at the beginning of second model year after being earned, discounted to 25% of its original value if not depleted by the beginning of the third model year after being earned, and will have no value if not depleted by the beginning of the fourth model year after being earned.

e. Any VECs earned prior to the 1998 model year shall be treated as earned in the 1998 model year and discounted in accordance with the schedule specified in note (12)(d).

~~e~~ f. Only ZEVs certified as MDVs shall be included in the calculation of VECs.

(13) Manufacturers shall demonstrate compliance with the above standards for NMOG, carbon monoxide, and oxides of nitrogen at 50 degrees F according to the procedure specified in section 11k of the "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(k). Hybrid electric, natural gas, and diesel-fueled vehicles shall be exempt from 50 degrees F test requirements. ~~For diesel vehicles, compliance with the particulate standard shall also be demonstrated as specified in section 11k of the foregoing test procedures.~~

(14) In-use compliance testing shall be limited to vehicles with fewer than 90,000 miles.

(15) Deterioration factors for hybrid electric vehicles shall be based on the emissions and mileage accumulation of the auxiliary power unit. For certification purposes only, Type A hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors), and demonstrating compliance with 120,000 mile emission standards shall not be required. For certification purposes only, Type B hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 120,000 mile emission standards (using 90,000 mile deterioration factors). For certification purposes only, Type C hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 120,000 mile emission standards (using 120,000 mile deterioration factors).

(16) As used in 1960.1 (h)(2), Title 13, CCR, the term "small volume manufacturer" shall mean any vehicle manufacturer with California sales less than or equal to 3000 new PCs, LDTs, and MDVs per model year based on the average number of vehicles sold by the manufacturer each model year from 1992 to 1994, except as otherwise noted below. For manufacturers certifying for the first time in California, model-year sales shall be based on projected California sales. In 2001 and subsequent model years, small volume manufacturers shall comply with the requirements set forth below:

a. Prior to the model year 2001, small volume manufacturers shall not be required to certify, produce, or deliver LEVs and ULEVs for sale in California.

b. In 2001 and subsequent model years, small volume manufacturers shall certify, produce, and deliver for sale in California LEVs in a quantity equivalent to 100% of their MDV fleet .

c. If a manufacturer's average California sales exceeds 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the LEV and ULEV requirements applicable for larger manufacturers as specified in 1960.1 (h)(2) beginning with the fourth model year after the last of the three consecutive model years.

e. If a manufacturer's average California sales falls below 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall be treated as a small volume manufacturer and shall be subject to requirements for small volume manufacturers as specified in 1960.1 (h)(2) beginning with the next model year.

(i) and (j) [No Change]

(k) The test procedures for determining compliance with these standards are set forth in "California Exhaust Emission Standards and Test Procedures for 1981 through 1987 Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles", adopted by the State Board on November 23, 1976, as last amended May 20, 1987, and in "California Exhaust Emission ~~Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars,~~ Light-Duty Trucks, and Medium-Duty Vehicles", adopted by the state board on May 20, 1987 as last amended ~~August 19, 1992~~ [INSERT], both of which are incorporated herein by reference.

(l) through (o) [No Change]

(p) The cold temperature exhaust carbon monoxide emission levels from new 1996 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles shall not exceed:

1996 AND SUBSEQUENT MODEL-YEAR COLD TEMPERATURE CARBON MONOXIDE EXHAUST EMISSIONS STANDARDS FOR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES (1)(2)
(grams per mile)

Vehicle Type	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Carbon Monoxide
Passenger Car	All	50,000	10.0
Light-Duty Truck	0-3750	50,000	10.0
Light-Duty Truck	3751-5750	50,000	12.5
Medium-Duty Vehicle	0-3750	50,000	10.0
Medium-Duty Vehicle	3751-8500 (3)	50,000	12.5

(1) These standards are applicable to vehicles tested in accordance with 40 CFR Part 86 Subpart C, at a nominal temperature of 20°F (-7°C).
(2) Natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles are exempt from these standards.
(3) Medium-duty vehicles with a gross vehicle weight rating greater than 8,500 lbs. are exempt from this standard.

NOTE: Authority cited: Sections 39600, 39601, 43013, 43018, 43101, 43104, and 43105, Health and Safety Code. Reference: Sections 39002, 39003, 43000, 43009.5, 43013, 43018, 43100, 43101, 43101.5, 43102, 43103, 43104, 43105, 43106, 43107, 43204-43205.5, Health and Safety Code.

Attachment III

REQUEST FOR TEST PROCEDURES

On January 14, 1993, the Air Resources Board conducted a public hearing to consider amendments to California regulations for certifying light-duty and medium-duty motor vehicles. Included in this mail-out are a Notice of Public Availability of Modified Text, a description of the modifications to the originally proposed amendments (Attachment F to Resolution 93-3), and the revised text of sections 1960.1, 1976, and 2061 of Title 13, California Code of Regulations.

Incorporated by reference in these Title 13 sections are four Test Procedures which would also be modified as part of this rulemaking. These Test Procedures contain very specific requirements for certifying low-emission vehicles and may be of limited general interest. If you are interested in reviewing the text of any of these Test Procedures with the modifications to the originally proposed regulatory language clearly shown, please indicate below which procedures you would like to receive and mail or fax this form to:

Ms. Donna Barragan
California Air Resources Board
9528 Telstar Avenue
El Monte, California 91731

FAX: 818-575-6699

* * *

_____ California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Vehicles

_____ California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Vehicles

_____ California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Vehicles

_____ California NMOG Test Procedures

Name: _____

Company: _____

Address: _____

_____

ATTACHMENT IV

ADDITIONAL MODIFICATIONS

1. **RAF for LEVs Operated on Phase 2 gasoline.** In further evaluating the speciated exhaust data for TLEVs and LEVs operating on Phase 2 gasoline, the staff determined that methyl-tertiary butyl ether (MTBE) was mislabelled as 2,3-dimethyl butane. Recent gas chromatography/mass spectroscopy analysis reveals that the two compounds co-elute and the correct percentage of each compound in the peak is 70% MTBE (after an 84% response factor to the flame ionization detector is applied) and 30% 2,3-dimethylbutane. As a result, an incorrect maximum incremental reactivity (MIR) value was assigned to the peak in calculating the reactivity adjustment factors (RAFs) for TLEVs and LEVs . After the appropriate values are applied, (0.63 for MTBE and 1.07 for 2,3-dimethylbutane) the value of the RAF for TLEVs operating on Phase 2 gasoline remains at 0.98 and the RAF for LEVs operating on Phase 2 gasoline is reduced from 0.95 to 0.94. The modified text of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" (herein the Light and Medium Duty Test Procedures), reflects the revised RAF for LEVs operating on Phase 2 gasoline. (p. 13-1.)

2. **References to the Federal Test Procedures.** The Light and Medium Duty Test Procedures incorporate by reference the pertinent Federal Test Procedures contained in 40 C.F.R. Part 86. Appendix I to the Light and Medium Duty Test Procedures sets forth the specific sections of the Federal Test Procedures that are incorporated by reference, and the adoption or amendment date of the version of each section that is being incorporated by reference. The text of Appendix I that was originally proposed in this rulemaking did not include all of the revisions to Appendix I that had been adopted January 22, 1990 in the Board's rulemaking pertaining to standards and test procedures for methanol-powered vehicles. The modified text of Appendix I being made available for the 15-day comment period includes revisions made to correctly reflect actions taken in prior rulemakings. A few corrections have also been made to Appendix I and to the text of the Light and Medium Duty Test Procedures to assure that the references to the incorporated sections of the Federal Test Procedures in Appendix I and the text are consistent.

3. **Other Corrections.** Additional nonsubstantive modifications have been made to Title 13, California Code of Regulations, section 1960.1, and the the Light and Medium Duty Test Procedures, to assure the consistent use of terminology. These modifications are in section 1960.1(g)(1) note (6)a., section 1960.1(h)(2) note (9)a, and in the Light and Medium Duty Test Procedures sections 3.g. note (6)a. and 3.j. note (9)a.

Establishment of Corrections to Reactivity Adjustment Factors for Transitional Low-Emission Vehicles and Low-Emission Vehicles Operating on Phase 2 Reformulated Gasoline

Airshed Modeling Protocol and Updated Final Results

California Air Resources Board
Research Division

March 15, 1993

I. Summary

This report presents the complete protocol (or calculation methodology) and results for airshed modeling performed by Professor Armistead Russell and co-workers at Carnegie Mellon University (CMU) to establish corrections to reactivity adjustment factors (RAFs) for Transitional Low-Emission Vehicles (TLEVs) and Low-Emission Vehicles (LEVs) operating on Phase 2 reformulated gasoline. Although the maximum incremental reactivity (MIR) approach used to calculate the RAFs has been validated by airshed modeling results for individual organic gases (McNair *et al.* 1992; ARB 1992), and has been supported by the National Research Council (1991), RAF corrections are necessary because of differences in spatial and temporal patterns of emissions between motor vehicle fleets (ARB 1992). The following sections describe the processing of motor vehicle test data and other details of the emission inputs. When this information is combined with pre-existing documents describing other model inputs, the reader will have complete information to evaluate and, if desired, reproduce the airshed modeling results.

Reactivity adjustment factors of 0.98 and 0.94 are recommended for TLEVs and LEVs, respectively, operating on Phase 2 gasoline. The recommended values reflect improved MIR assignments for three coeluting pairs of organic gases. Previously, the airshed modeling results had implied the need for 5 and 4 percent increases for TLEVs and LEVs, respectively, operating on Phase 2 gasoline. Subsequently, it was discovered that the vehicle test data for aldehydes were inadvertently provided to Professor Russell in units of mass (mg) rather than mass emission rates (mg/mile). This error led to 4 percent higher RAF values than those used by Professor Russell to adjust the mass of the motor vehicle fleets. Thus, the airshed modeling results indicate that there is no need for a correction to the RAFs for TLEVs and LEVs operating on Phase 2 gasoline.

The aim of the airshed modeling protocol is to provide a rigorous test of the RAFs. The model inputs were selected to represent upper and lower bounds, rather than a best estimate, of future conditions. The final 1987 baseline emission inventory produced by the South Coast Air Quality Management District (SCAQMD) was used, with -4, +19, and +7 percent changes in emissions of nonmethane organic gases (NMOG), oxides of nitrogen (NO_x), and carbon monoxide (CO), respectively, from the draft inventory used in the previous study performed in 1991 (ARB 1992). The 1987 NMOG and CO emission inventories were doubled to respond to concerns on the underestimation of motor vehicle

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and other emissions (Pierson *et al.* 1990; Fujita *et al.* 1992; Harley *et al.* 1993), and to provide a more stringent test of the MIR scale, which defines reactivity where hydrocarbon control is most important, *i.e.*, at high NO_x concentrations. This departs from the 1991 study, which included a doubling of the on-road catalyst exhaust emissions of NMOG and CO, rather than a doubling of the entire inventory. The change to the 1987 baseline emission inventory necessitated a verification of the correction for the 85 percent methanol/15 percent gasoline (M85) case done in 1991. A matrix of two ozone episodes (1987 and 1982) in the South Coast Air Basin (SoCAB), two baseline emission inventories (1987 and 2010), and, in addition to the conventional fuel, two alternative fuels (Phase 2 gasoline and M85) and a zero motor vehicle hydrocarbon exhaust emission case for two levels of the new standards (TLEV and LEV) was modeled. This results in twenty-four model simulations for analysis. The results for M85 show better agreement overall with the equal ozone impacts required by the regulation than those reported in the 1991 study.

II. Calculation Methodology

The CIT airshed model is a three-dimensional, photochemical grid model, based on numerically solving the advection-diffusion equation. The model employs the Lurmann, Coyner and Carter (LCC) lumped molecule chemical mechanism. This family of chemical schemes is now referred to as the SAPRC mechanisms, as Carter is affiliated with the Statewide Air Pollution Research Center at the University of California at Riverside. The LCC mechanism is a predecessor of the SAPRC90 mechanism employed in determining the MIR scale. There are three versions of the LCC mechanism, each using various degrees of lumping to condense the hundreds of organic gases into a manageable number of species for model calculations. The CIT airshed model uses the most condensed version of the LCC, which has been shown previously (ARB 1992) to produce the same RAFs as the SAPRC90 mechanism. The LCC mechanism was extended to include the explicit chemical mechanisms for ethane, propane, methanol, and ethanol, normally lumped with other species in the LCC mechanism, because of the large fractions of these species found in the exhaust for some of the alternative fuels.

The CIT airshed model is used to simulate two three-day ozone episodes in the SoCAB. Both periods are conducive to high ozone formation, although each had different meteorological characteristics, and peak ozone concentrations occurred in different parts of the Basin during each episode. The August 30 to September 1, 1982 episode had very stagnant meteorological conditions leading to one of the highest one-hour ozone concentrations (0.35 ppm) recorded in the United States in 1982. The August 27 to 29, 1987 episode was an intensive measurement period during the Southern California Air Quality Study (SCAQS) with a one-hour peak ozone concentration of 0.29 ppm. The CIT airshed model has been evaluated and peer-reviewed for both periods (Russell *et al.* 1990; Harley *et al.* 1993). Initial and boundary conditions were derived from measurements, and were unchanged for all calculations. The initial conditions largely influence the model predictions for the first day or two. After that, emissions and boundary conditions predominate. The ideal situation for investigating the effects of different emission inventories is to minimize the influence of initial conditions. As a consequence, only the third day of the model simulation is reported. Boundary conditions have a minimal influence on model predictions as determined by sensitivity tests (Russell *et al.* 1990; Harley *et al.* 1993).

Emissions of nitrous acid (HONO), an important source of radicals that initiate ozone formation in the morning, were not added to the episodes as was done in the derivation of the MIR scale (ARB 1992). The CIT airshed model includes night-time reactions that create HONO concentrations similar to those observed during SCAQS.

III. Motor Vehicle Test Data

Six 1987 and six 2010 inventories were constructed by adjusting the on-road catalyst exhaust emissions of NMOG to account for changing fuels: a null inventory (NULL) for the case of no catalyst exhaust emissions of NMOG; conventionally-fueled vehicle (CFV) cases, corresponding to industry-average gasoline, termed RF-A in the Auto/Oil Air Quality Improvement Research Program (AQIRP) for TLEVs and LEVs; and alternative fuel inventories for TLEVs and LEVs operated on Phase 2 reformulated gasoline (PH2) and for TLEVs operated on M85 with motor vehicle emissions for each alternative fuel multiplied by the reciprocal of the RAF. Data from testing programs conducted by the California Air Resources Board (ARB), the Auto/Oil AQIRP, and Chevron Research & Technology Company were assigned organic gas identifications (OGID) corresponding to the list of species in the MIR scale adopted in the 1991 RAF regulation. The motor vehicle test data were renormalized in terms of weight fractions, and then the weight fractions for each species for all the tests on an individual vehicle were averaged. The composite profiles for each motor vehicle were averaged to create composite profiles for each fuel. Separate composite profiles were calculated for each bag of the U. S. Environmental Protection Agency's 1975 Federal Test Procedure (FTP).

During the gas chromatographic analysis of motor vehicle emissions, sometimes two compounds will coelute. Coelution is generally not a problem if both compounds are present in only small amounts or if they have similar reactivities. The testing program conducted by ARB was unable to resolve 2,2,4-trimethylpentane from an unidentified alkene, or 4-ethyltoluene from a C_{10} cycloalkane, and methyl *tert*-butyl ether (MTBE) from 2,3-dimethylbutane. For lack of better information, a 50/50 split was assumed for the first two coeluting pairs, and the third was assigned entirely to 2,3-dimethylbutane. Recent gas chromatography/mass spectroscopy analysis reveals that these assumptions were invalid. The first coeluting pair is almost all 2,2,4-trimethylpentane, and the second pair is entirely 4-ethyltoluene. For the Phase 2 gasoline, which is approximately 11 percent MTBE, the third coeluting pair is 70 percent MTBE (with an 84 percent response to the flame ionization detector) and 30 percent 2,3-dimethylbutane.

The composite profiles provided to Professor Russell for TLEVs and LEVs are given in Appendices A and B, respectively. These profiles did not include motor vehicle test results from ARB and the Auto/Oil AQIRP that were not available for processing. In addition, the new species assignments for the three coeluting pairs were also not available. Subsequently, it was discovered that the vehicle test data for aldehydes were inadvertently provided to Professor Russell in units of mass (mg) rather than mass emission rates (mg/mile). The composite profiles for TLEVs and LEVs for the complete data set are given in Appendices C and D, respectively. Note that the new species assignments for the three coeluting pairs were not applied to the data collected as part of the 1991 study, consistent with the philosophy of fixing the RAFs for at least three years after adoption.

The emission inventories for each fuel were adjusted by the calculated RAFs. Table I contains the original RAFs used by Professor Russell in the airshed modeling, and RAFs based on correct interpretation of the aldehyde data inadvertently supplied in the wrong units. The corrected RAFs are 4 percent higher than those used by Professor Russell. Table I also contains the current RAFs based on the entire data set of motor vehicle tests and new MIR assignments for the three coeluting pairs, as well as RAFs calculated with the Carbon Bond 4 (CB4) chemical mechanism and under maximum ozone incremental reactivity (MOIR) conditions. For Phase 2 gasoline and M85, the variation in the RAFs for the different chemical mechanism and reactivity scale is less than 6 percent.

As with the 1991 study, a more realistic distribution of exhaust emissions between the cold start, running, and hot start modes was used. The emission inventories developed for the SoCAB with EMFAC7E have the three phases of the FTP cycle combined according to local information on traffic patterns. Furthermore, different definitions of cold start and hot start emissions are used in the SoCAB inventory and the FTP. In EMFAC7E, the cold and hot starts are represented as an emissions increment due to the actual start. In the FTP, the Bag 1 and Bag 3 measurements reflect the start emissions increment as well as emissions accrued at the cold and hot stabilized rates, respectively. Thus, the Bag 2 result (which represents both cold and hot stabilized emissions) must be subtracted from the Bag 1 and Bag 3 results:

$$\text{Cold Start} = 3.59 \times (\text{BAG1} - \text{SCF26} \times \text{BAG2}) \quad (1)$$

where Cold Start is the EMFAC7E cold start emissions increment in grams/start, BAG1 is the FTP cold transient emissions in grams/mile, BAG2 is the FTP cold stabilized emissions in grams/mile, 3.59 is the mileage for the FTP cold transient test in miles/start, and SCF26 is the EMFAC7E speed correction factor (0.615 for current vehicles) to adjust the Bag 2 average speed (16 mph) to the Bag 1 average speed (26 mph).

The calculation is performed for each NMOG species in a composite profile, with any negative emissions increments set to zero. The emissions for all species are summed to get the total cold start emissions increment. The calculation of the EMFAC7E hot start emissions increment is done in a similar manner with the substitution of the Bag 3 result for the Bag 1 result in Equation 1. The Bag 2 mass emission rate and speciation results are used directly by EMFAC7E to represent the running exhaust emissions.

The three EMFAC7E exhaust emission modes are weighted according to activity data estimated by transportation models. Activity data for both the 1987 and 2010 baseline years for the SoCAB are given in Table II, with the resulting motor vehicle mass distributions provided to Professor Russell and the distributions based on the complete data set given in Tables III and IV, respectively. However, it is not known how the mass distributions for the alternatively-fueled vehicles change as a function of temperature or speed. The Phase 2 gasoline operating in TLEVs results in lower running and hot start emission fractions than conventional gasoline, perhaps due to increased catalyst efficiency resulting from the lower sulfur content of the reformulated fuel. However, this effect of the Phase 2 gasoline was not observed for LEVs. Another puzzling result is that TLEVs operating on RF-A had lower cold start fractions than the LEVs, which were equipped with electrically-heated catalysts. These issues should be investigated as part of future vehicle testing efforts.

IV. Baseline Emission Inventory

The aim of the airshed modeling protocol is to provide a rigorous test of the RAFs. The model inputs were selected to represent upper and lower bounds, rather than a best estimate, of future conditions. Both the 1982 and 1987 episodes were simulated with the same two emission inventories: 1) a baseline year, 1987, with a doubling of NMOG and CO emissions from all sources; and 2) a future year, 2010, with stringent controls. Using the same two inventories for both episodes allows a direct comparison of the effect of meteorological conditions on reactivity. The 2010 time frame is a realistic expectation of when motor vehicles that meet the requirements of the California Low-Emission Vehicles and Clean Fuels regulations will dominate the fleet, but is not considered a stringent test of the RAF approach because the low NMOG to NO_X ratio (3.9) is similar to the high NO_X conditions used to derive the MIR scale. The doubling of the 1987 NMOG and CO inventory responds to recent studies (Pierson *et al.* 1990; Fujita *et al.* 1992; Harley *et al.* 1993) that organic gas emissions from motor vehicles are underestimated by about a factor of two, and to concerns that a higher NMOG to NO_X ratio (8.4) is needed to provide a stringent test of the MIR scale.

Incremental reactivities are, by definition, mathematically additive, but at issue is how large an emission change is considered an "increment". Calculations by Chang and Rudy (1990) with an EKMA-type model indicate that individual emission increments appear to be additive for up to a 30 percent substitution of organic gas emissions in an airshed. In this study, for both the 1987 and 2010 inventories, the speciation for the TLEVs and LEVs were applied to the entire on-road catalyst motor vehicle fleet. This corresponds to 8 and 22 percent of the NMOG inventory in 1987 and 2010, respectively. This assumption of complete conversion of the fleet to TLEVs is not realistic, but does provide the most stringent test of the RAF approach. There was no attempt to modify the fleet emissions to reflect the lower mass emissions from LEVs; only the RAFs and speciation profiles were changed.

The final 1987 baseline emission inventory produced by the SCAQMD was used, with -4, +19, and +7 percent changes in NMOG, NO_X, and CO emissions, respectively, from the draft inventory used in the 1991 study. The major changes from the draft inventory are: 1) motor vehicle emissions of NMOG decreased and of NO_X increased with EMFAC7E; 2) area source evaporative emissions of NMOG increased from floating roof tanks, and NO_X emissions increased from locomotives and public utility equipment; 3) biogenic emissions were included; and 4) NMOG speciation profiles and assignments were updated. The final 1987 baseline emission inventory is documented in the 1991 Air Quality Management Plan, Technical Report III-C and Appendices III-A, III-B, and III-C.

Due to the large increase in NO_X emissions with the new inventory, it was decided to double the entire 1987 NMOG and CO emission inventories, rather than just the catalyst exhaust emissions of NMOG and CO as was done in the 1991 study. This change in the protocol is necessary to provide a stringent test of the MIR approach at a high NMOG to NO_X ratio, and is consistent with current ARB practices for airshed model sensitivity studies. The NULL case corresponds to NMOG exhaust emissions for catalyst-equipped motor vehicles from the baseline fleet, *i.e.*, without doubling. In the 1991 study, the NULL case was defined as zero NMOG exhaust emissions for catalyst-equipped motor vehicles. However, the high sensitivity of the Urban Airshed

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Model to formaldehyde emissions, which are primarily from motor vehicles, created the concern that zeroing emissions would lead to non-linear effects.

The 1987 baseline emission inventory represents an average summer weekday with day-specific stationary source emissions for the August 27 to 29 SCAQS episode. Except for the doubling of the NMOG and CO emissions, stationary source, off-road mobile emissions, diesel exhaust, and non-catalyst motor vehicle emissions were unchanged, as was NO_X. Evaporative emission rates and speciation profiles were also unchanged from the baseline motor vehicle fleet. These assumptions are not realistic, but the objective of the study was to test the way the reactivity scale is being applied in the ARB regulations, assuming that all fuels just meet the reactivity-adjusted standards. The 2010 emission inventory is a projection of the draft 1987 baseline emission inventory. The 2010 inventory was constructed in a similar manner to the 1987 inventory, except that the NMOG and CO emissions were not doubled to provide a lower bound of the NMOG to NO_X ratio, and for comparison with the 1991 study where the 2010 inventory gave the highest null test result. The mass emissions are summarized in Table V and the LCC species emissions are summarized in Table VI.

V. Results and Discussion

The CIT airshed model was used to simulate the air quality impacts of the twelve separate emission inventories on both sets of meteorological conditions. A matrix of two ozone episodes (1987 and 1982) in the South Coast Air Basin, two baseline emission inventories (1987 and 2010), and exhaust emissions from three alternative fuels (RF-A, Phase 2 gasoline, and M85) for two levels of the new standards (TLEV and LEV) was modeled. This results in twenty-four model simulations for analysis. The ozone predictions for the completed model simulations are summarized in Table VII. Four metrics are presented: 1) peak, one-hour average ozone basinwide; 2) spatial ozone exposure showing the number of hours and grids where ozone concentrations are greater than a prescribed value (*e.g.*, the 0.09 ppm California and 0.12 ppm national ambient air quality standards); 3) concentration-weighted spatial ozone dosage; and 4) population- and concentration-weighted ozone dosage. The NULL calculation gives results distinctly different than the CFV and the alternative fuel simulations for each ozone metric other than the peak. If this were not the case, it would be very difficult to assess the impact of the change in organic gas composition and additional emissions of the alternative fuels.

A useful statistic for judging how closely the RAF leads to an equal ozone impact is the "null test" (perhaps better stated as the "level playing field test"), defined as the concentration increment due to the alternative fuel, normalized relative to that of the conventional fuel:

$$\text{Null test result} = \frac{C_{AFV} - C_{NULL}}{C_{CFV} - C_{NULL}} \qquad (2)$$

where C_{AFV} is the concentration (or other metric) for an alternatively-fueled vehicle (AFV) simulation, and C_{CFV} and C_{NULL} are the corresponding metrics for the CFV and NULL simulations, respectively. The closer the null test result is to one, the closer the RAF comes to producing the desired result. If the value found from the multi-day airshed

modeling is greater or less than one, the exhaust is greater or less reactive, respectively, than the RAF would imply. The null test results are shown in Table VIII.

In general, the null test results for the ozone exposure and dosage metrics are within ±5 percent of the equal ozone impacts required by the regulation, with much closer agreement in many cases. However, the null test results for some of the ozone peak predictions show larger deviations from the desired result. In these cases, the ozone peak is found in a location that is less sensitive to NMOG emissions than much of the urban area, as reflected by the small differences (about 0.01 ppm) between the peak predictions in the CFV and NULL simulations. Thus, small differences in peak concentrations between the conventional- and alternatively-fueled vehicles are magnified in the normalization specified for the null test result in Equation 2. In the one case where there is a large difference (about 0.06 ppm) between the peak ozone predictions for the CFV and NULL simulations, for the 1982 meteorology with the 1987 emission inventory, the null test results are the most reasonable.

The change in the 1987 inventory necessitated a verification of the correction for the M85 case done in 1991. The results for M85 show better agreement overall with the equal ozone impacts required by the regulation than those reported in the 1991 study. The only formally adopted RAF to date, a value of 0.41 for M85 vehicles, includes a 10 percent increase based on the airshed modeling results for the population-weighted dosage statistic for the higher 1982 episode. The new airshed modeling results imply that only a 7 percent correction is needed. However, if the new MIR assignments for the three coeluting pairs are used for M85, the uncorrected RAF increases from 0.37 to 0.38. Applying the new correction results in a RAF of 0.41, the same as adopted in 1991.

The null test results for TLEVs and LEVs operating on Phase 2 gasoline are 5 and 4 percent increases, respectively. However, the error in the aldehyde data led to 4 percent higher RAF values than those used by Professor Russell. Chang and Rudy's (1990) work implies that ozone formation should be linear for these small perturbations (4 percent of the 22 percent the motor vehicle fleet comprises of the 2010 NMOG inventory) of organic gas emissions in the airshed. Thus, the airshed modeling results indicate that there is no need for a correction to the RAF for TLEVs and LEVs operating on Phase 2 gasoline.

VI. References

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Table I. RAFs at various stages of development.

Vehicle Type	Reactivity Adjustment Factors				
	Provided to CMU		Current[c]		
	Original[a]	Corrected[b]	MIR	CB4	MOIR
TLEV PH2	1.02	1.06	0.98	1.01	0.99
TLEV M85	0.37	0.37	0.37	0.39	0.39
LEV PH2	0.96	1.00	0.94	0.98	0.97

[a]Provided to Professor Russell of CMU, which does not include some vehicle test results from ARB, any test results from the Auto/Oil AQIRP, nor new MIR assignments for coeluting pairs. Motor vehicle aldehyde data was inadvertently supplied in units of mg rather than mg/mile.
[b]Correct interpretation of motor vehicle aldehyde data.
[c]Includes new MIR assignments for coeluting pairs, and all vehicle test results.

Table II. Activity data[a] for the South Coast Air Basin.

Baseline Year	Miles per Start	Cold Start Fraction	Hot Start Fraction
1987	8.3	0.58	0.42
2010	9.8	0.60	0.40

[a]Based on BURDEN model.

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Table III. Exhaust emissions distribution for test data for TLEVs and LEVs provided to CMU.

Vehicle Type	Percent of Mass in Each Exhaust Mode					
	1987 Activity Data			2010 Activity Data		
	Cold	Run	Hot	Cold	Run	Hot
TLEV RFA	72.2	21.9	5.9	70.5	24.3	5.2
TLEV PH2	87.3	9.8	2.9	86.4	11.0	2.6
TLEV M85	95.1	3.7	1.2	94.8	4.2	1.0
LEV RFA	81.6	13.7	4.8	80.5	15.3	4.3
LEV PH2	78.6	17.3	4.1	77.1	19.2	3.6

Table IV. Exhaust emissions distribution for test data for TLEVs and LEVs for the complete data set.

Vehicle Type	Percent of Mass in Each Exhaust Mode					
	1987 Activity Data			2010 Activity Data		
	Cold	Run	Hot	Cold	Run	Hot
TLEV RFA	72.2	21.9	5.9	70.5	24.3	5.2
TLEV PH2	83.2	12.0	4.7	82.3	13.5	4.2
TLEV M85	95.1	3.7	1.2	94.8	4.2	1.0
LEV RFA	81.0	13.9	5.1	79.9	15.5	4.6
LEV PH2	79.9	15.7	4.4	78.6	17.5	3.9

Table V. 1987 and 2010 emissions by pollutant and category.

Vehicle Type	Emissions (10^3 kg/day)					
	1987[a]			2010		
	NMOG	NO_x	CO	NMOG	NO_x	CO
NULL	3200	1352	12,028	901	967	3571
TLEV RFA	3459	1352	12,028	1150	967	3571
TLEV PH2	3454	1352	12,028	1145	967	3571
TLEV M85	3900	1352	12,028	1574	967	3571
LEV RFA	3459	1352	12,028	1150	967	3571
LEV PH2	3470	1352	12,028	1160	967	3571

[a]With NMOG and CO emissions doubled.

Table VI. LCC species profiles.

LCC Species	Fleet Emissions (kg-moles/day)				
	TLEV			LEV	
	RFA	PH2	M85	RFA	PH2
ETHE	816	512	226	459	501
ALKE	414	634	130	346	574
ALKA	1183	1071	377	1380	1340
TOLU	366	361	156	283	298
AROM	345	319	142	399	246
HCHO	150	393[a]	1318	345[a]	712[a]
ALD2	99	67	46	97	96
MEK	52	8	76	8	13
MEOH	0	0	18,363	0	0

[a]Based on incorrect aldehyde data approximately a factor of 3.6 too high.

Table VIIa. CIT airshed model predictions[a] for August 27 to 29, 1987 meteorology and 1987[b] inventory.

Ozone Statistic	Ozone Results					
	TLEV			LEV		NULL
	RFA	PH2	M85	RFA	PH2	
basin peak (ppb)	237.6	237.4	238.5	237.3	237.6	229.0
grid-hours[c] > 0.09 ppm	2779	2786	2780	2782	2780	2611
grid-hours[c] > 0.12 ppm	1499	1509	1502	1506	1505	1385
ppm-grid-hours[d] > 0.09 ppm	361	362	362	362	362	336
ppm-grid-hours[d] > 0.12 ppm	229	230	230	230	230	208
10^3 person-ppm-hours[e] > 0.09 ppm	3891	3902	3900	3883	3900	3236
10^3 person-ppm-hours[e] > 0.12 ppm	1961	1967	1971	1976	1964	1625

Table VIIb. CIT airshed model predictions[a] for August 27 to 29, 1987 meteorology and 2010 inventory.

Ozone Statistic	Ozone Results					
	TLEV			LEV		NULL
	RFA	PH2	M85	RFA	PH2	
basin peak (ppb)	159.7	160.0	159.3	159.8	160.2	151.4
grid-hours[c] > 0.09 ppm	2091	2094	2081	2098	2113	1806
grid-hours[c] > 0.12 ppm	764	756	755	770	787	480
ppm-grid-hours[d] > 0.09 ppm	241	241	240	242	244	200
ppm-grid-hours[d] > 0.12 ppm	101	100	100	102	104	62
10^3 person-ppm-hours[e] > 0.09 ppm	1605	1611	1583	1617	1641	1059
10^3 person-ppm-hours[e] > 0.12 ppm	155.7	150.2	152.5	166.6	185.4	67.1

[a]Results for third day of model simulation.
[b]With NMOG and CO emissions doubled.
[c]Summation of the number of grids × hours that any modeling grid experienced an ozone concentration greater than the prescribed value.
[d]Summation of the concentration × grids × hours that any modeling grid experienced an ozone concentration greater than the prescribed value.
[e]Summation of the population × concentration × hours for any modeling grid that experienced an ozone concentration greater than the prescribed value.

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Table VIIc. CIT airshed model predictions[a] for August 30 to September 1, 1982 meteorology and 1987[b] inventory.

Ozone Statistic	Ozone Results					
	TLEV			LEV		NULL
	RFA	PH2	M85	RFA	PH2	
basin peak (ppb)	498.4	498.6	501.0	499.9	501.5	438.2
grid-hours[c] > 0.09 ppm	5976	5957	5969	5984	5968	5667
grid-hours[c] > 0.12 ppm	4677	4686	4686	4677	4675	4383
ppm-grid-hours[d] > 0.09 ppm	1147	1146	1147	1148	1147	1054
ppm-grid-hours[d] > 0.12 ppm	1012	1014	1014	1012	1012	921
10^4 person-ppm-hours[e] > 0.09 ppm	1522	1519	1521	1523	1518	1289
10^4 person-ppm-hours[e] > 0.12 ppm	1336	1340	1340	1339	1336	1110

Table VIId. CIT airshed model predictions[a] for August 30 to September 1, 1982 meteorology and 2010 inventory.

Ozone Statistic	Ozone Results					
	TLEV			LEV		NULL
	RFA	PH2	M85	RFA	PH2	
basin peak (ppb)	239.5	241.4	242.5	239.4	240.1	217.7
grid-hours[c] > 0.09 ppm	4270	4305	4321	4309	4330	3581
grid-hours[c] > 0.12 ppm	2415	2448	2467	2435	2463	1894
ppm-grid-hours[d] > 0.09 ppm	583	588	592	588	592	462
ppm-grid-hours[d] > 0.12 ppm	390	395	399	393	398	287
10^3 person-ppm-hours[e] > 0.09 ppm	5765	5858	5850	5861	5934	3884
10^3 person-ppm-hours[e] > 0.12 ppm	4233	4312	4330	4311	4378	2745

[a]Results for third day of model simulation.
[b]With NMOG and CO emissions doubled.
[c]Summation of the number of grids × hours that any modeling grid experienced an ozone concentration greater than the prescribed value.
[d]Summation of the concentration × grids × hours that any modeling grid experienced an ozone concentration greater than the prescribed value.
[e]Summation of the population × concentration × hours for any modeling grid that experienced an ozone concentration greater than the prescribed value.

Table VIIIa. Null test results for CIT airshed model simulations of August 27 to 29, 1987 meteorology.

Ozone Statistic	Null Test Result					
	1987 Inventory[a]			2010 Inventory		
	TLEV		LEV	TLEV		LEV
	PH2	M85	PH2	PH2	M85	PH2
basin peak[b]	0.98	1.10	1.04	1.04	0.95	1.05
grid-hours > 0.09 ppm	1.04	1.01	0.99	1.01	0.96	1.05
grid-hours > 0.12 ppm	1.09	1.03	0.99	0.97	0.97	1.06
ppm-grid-hours > 0.09 ppm	1.04	1.04	1.00	1.00	0.98	1.05
ppm-grid-hours > 0.12 ppm	1.05	1.05	1.00	0.97	0.97	1.05
person-ppm-hours > 0.09 ppm	1.02	1.01	1.03	1.01	0.96	1.04
person-ppm-hours > 0.12 ppm	1.02	1.03	0.97	0.94	0.96	1.19

Table VIIIb. Null test results for CIT airshed model simulations of August 30 to September 1, 1982 meteorology.

Ozone Statistic	Null Test Result					
	1987 Inventory[a]			2010 Inventory		
	TLEV		LEV	TLEV		LEV
	PH2	M85	PH2	PH2	M85	PH2
basin peak[b]	1.00	1.04	1.03	1.09	1.14	1.03
grid-hours > 0.09 ppm	0.94	0.98	0.95	1.05	1.07	1.03
grid-hours > 0.12 ppm	1.03	1.03	0.99	1.06	1.10	1.05
ppm-grid-hours > 0.09 ppm	0.99	1.00	0.99	1.04	1.07	1.03
ppm-grid-hours > 0.12 ppm	1.02	1.02	1.00	1.05	1.09	1.05
person-ppm-hours > 0.09 ppm	0.99	1.00	0.98	1.05	1.05	1.04
person-ppm-hours > 0.12 ppm	1.02	1.02	0.99	1.05	1.07	1.04

[a]With NMOG and CO emissions doubled.
[b]Far downwind ozone peak. Peak relatively insensitive to NMOG emission changes, so ratio of two small numbers.

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Appendix A

Transitional Low Emitting Vehicle Profiles Provided to Professor Russell

California Air Resources Board Transitional Low Emitting Vehicle (TLEV) Profiles - November 13, 1992

Federal Test Procedure (FTP) weight fractions and mass in grams/mile

All standard deviations (SD) in percent

		--- U. S. National Average Gasoline (RF-A) ---								------ 85% Methanol/15% RF-A (M85/RF-A) ------						---------- Phase 2 Gasoline (Phase 2) ----------					
OGID	SAROAD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD
MASS		0.3659	6	0.0266	15	0.0549	10	0.1047	6	1.1006	14	0.0106	28	0.0241	29	0:2396	14	0.4642	5	0.0128	12	0.0283	15	0.1055	4
ETHANE	43202	0.0245	10	0.0841	27	0.0874	20	0.0399	14	0.0013	60	0.0349	87	0.0202	79	0.0026	50	0.0182	7	0.0436	26	0.0784	26	0.0244	10
PROPANE	43204	0.0025	50	0.0061	68	0.0053	30	0.0033	37	0.0001	84	0.0023	69	0.0036	83	0.0002	61	0.0009	28	0.0055	58	0.0092	77	0.0018	26
BUTANE	43212	0.0405	7	0.0430	33	0.0692	20	0.0442	10	0.0064	37	0.0459	107	0.0597	43	0.0094	42	0.0076	15	0.0217	43	0.0143	28	0.0091	14
PENTANE	43220	0.0264	9	0.0202	31	0.0345	18	0.0268	12	0.0029	26	0.0068	60	0.0237	42	0.0037	27	0.0068	12	0.0125	32	0.0078	22	0.0074	9
HEXANE	43231	0.0182	13	0.0187	26	0.0199	19	0.0183	13	0.0019	31	0.0000	0	0.0041	133	0.0019	32	0.0069	11	0.0086	85	0.0067	42	0.0072	9
HEPTANE	43232	0.0119	11	0.0168	33	0.0138	20	0.0129	13	0.0008	50	0.0000	0	0.0000	0	0.0008	50	0.0109	5	0.0085	61	0.0089	17	0.0111	6
OCTANE	43233	0.0061	7	0.0010	79	0.0028	38	0.0050	7	0.0001	133	0.0000	0	0.0000	0	0.0001	133	0.0045	10	0.0000	0	0.0048	28	0.0045	10
NONANE	43235	0.0022	55	0.0000	0	0.0006	116	0.0016	50	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0016	13	0.0000	0	0.0000	0	0.0014	13
DECANE	43238	0.0004	132	0.0013	136	0.0000	0	0.0006	91	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0006	15	0.0015	141	0.0000	0	0.0006	26
UNDECANE	43241	0.0010	38	0.0000	0	0.0000	0	0.0007	38	0.0001	159	0.0000	0	0.0000	0	0.0001	159	0.0004	33	0.0040	141	0.0000	0	0.0006	50
2MC3	43214	0.0057	60	0.0024	48	0.0026	30	0.0049	54	0.0000	77	0.0077	115	0.0046	83	0.0002	90	0.0008	11	0.0092	91	0.0022	27	0.0016	44
2MC4	98132	0.0378	9	0.0481	25	0.0625	18	0.0429	11	0.0037	22	0.0790	74	0.0342	40	0.0058	31	0.0633	16	0.0765	34	0.0758	13	0.0673	14
2MC5	43229	0.0266	17	0.0250	37	0.0364	19	0.0282	18	0.0024	58	0.0000	0	0.0123	103	0.0027	61	0.0248	13	0.0150	47	0.0237	18	0.0251	12
3MC5	43230	0.0154	16	0.0194	33	0.0229	18	0.0172	15	0.0012	58	0.0000	0	0.0000	0	0.0012	58	0.0111	12	0.0104	45	0.0118	20	0.0115	9
22DMC4	43291	0.0076	24	0.0026	88	0.0058	45	0.0069	24	0.0005	68	0.0000	0	0.0000	0	0.0005	68	0.0037	46	0.0010	141	0.0042	58	0.0038	46
23DMC4	98001	0.0115	23	0.0086	41	0.0140	28	0.0117	22	0.0004	101	0.0000	0	0.0000	0	0.0004	101	0.0377	19	0.0104	44	0.0108	37	0.0358	18
2MC6	43275	0.0037	71	0.0027	104	0.0034	100	0.0036	75	0.0003	108	0.0000	0	0.0000	0	0.0002	108	0.0000	0	0.0000	0	0.0000	0	0.0000	0
3MC6	43295	0.0133	9	0.0218	30	0.0198	24	0.0153	11	0.0011	40	0.0000	0	0.0058	133	0.0012	45	0.0133	4	0.0108	46	0.0138	17	0.0138	4
23DMC5	43274	0.0013	100	0.0000	0	0.0000	0	0.0010	100	0.0004	100	0.0000	0	0.0000	0	0.0004	100	0.0000	0	0.0000	0	0.0000	0	0.0000	0
24DMC5	43271	0.0017	64	0.0016	107	0.0012	101	0.0016	66	0.0001	189	0.0000	0	0.0000	0	0.0001	189	0.0000	0	0.0021	141	0.0000	0	0.0001	141
BRC7PAR	43106	0.0258	25	0.0372	33	0.0362	26	0.0286	24	0.0024	61	0.0000	0	0.0053	133	0.0024	62	0.0635	5	0.0441	32	0.0735	11	0.0659	5
2MC7	98140	0.0014	73	0.0009	101	0.0014	100	0.0014	77	0.0001	120	0.0000	0	0.0000	0	0.0001	120	0.0000	0	0.0000	0	0.0000	0	0.0000	0
3MC7	43298	0.0020	66	0.0013	103	0.0015	101	0.0019	67	0.0001	145	0.0000	0	0.0000	0	0.0001	145	0.0000	0	0.0000	0	0.0000	0	0.0000	0
23DMC6	98139	0.0033	15	0.0018	120	0.0020	40	0.0030	18	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0080	11	0.0028	112	0.0099	15	0.0082	11
24DMC6	43277	0.0012	66	0.0007	101	0.0008	101	0.0011	66	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
25DMC6	43278	0.0009	66	0.0006	101	0.0007	101	0.0009	67	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
224TMC5	43276	0.0061	66	0.0125	73	0.0108	66	0.0076	66	0.0018	59	0.0000	0	0.0020	189	0.0018	59	0.0000	0	0.0000	0	0.0000	0	0.0000	0
234TMC5	43279	0.0085	11	0.0104	35	0.0107	22	0.0093	11	0.0011	40	0.0000	0	0.0000	0	0.0011	40	0.0064	57	0.0048	83	0.0071	63	0.0066	57
BRC8PAR	43107	0.0300	23	0.0399	25	0.0367	23	0.0322	22	0.0021	59	0.0000	0	0.0116	76	0.0022	59	0.0678	5	0.0315	45	0.0847	10	0.0698	5
24DMC7	98142	0.0001	101	0.0001	155	0.0001	101	0.0001	101	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
225TMC6	98033	0.0037	10	0.0005	106	0.0016	60	0.0030	13	0.0003	71	0.0095	189	0.0000	0	0.0005	83	0.0089	8	0.0029	112	0.0125	10	0.0092	9
BRC9PAR	43108	0.0040	18	0.0063	121	0.0039	86	0.0047	32	0.0000	0	0.0000	0	0.0047	189	0.0003	189	0.0046	15	0.0125	58	0.0115	30	0.0059	19
BRC10PAR	43109	0.0006	107	0.0000	0	0.0000	0	0.0004	107	0.0002	120	0.0000	0	0.0000	0	0.0002	120	0.0001	141	0.0000	0	0.0000	0	0.0001	141
CYC5	43242	0.0010	78	0.0000	0	0.0004	111	0.0009	76	0.0004	93	0.0121	189	0.0007	189	0.0008	103	0.0000	141	0.0000	0	0.0000	0	0.0000	141
CYC6	43248	0.0015	71	0.0115	87	0.0022	114	0.0034	67	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	15	0.0000	0	0.0010	141	0.0006	36
MCYC5	43262	0.0074	9	0.0037	67	0.0068	27	0.0071	10	0.0007	50	0.0000	0	0.0073	133	0.0008	59	0.0038	14	0.0125	68	0.0037	56	0.0044	22
MCYC6	43261	0.0052	17	0.0039	58	0.0021	48	0.0046	18	0.0001	133	0.0000	0	0.0000	0	0.0001	133	0.0029	12	0.0006	98	0.0018	47	0.0028	11
13DMCYC5	90064	0.0004	100	0.0011	103	0.0007	105	0.0005	100	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
CYC8PAR	43116	0.0072	24	0.0019	67	0.0085	29	0.0067	23	0.0003	73	0.0000	0	0.0000	0	0.0003	73	0.0042	27	0.0049	81	0.0096	8	0.0047	20
CYC10PAR	98066	0.0023	32	0.0009	93	0.0002	88	0.0018	34	0.0002	69	0.0000	0	0.0000	0	0.0002	69	0.0023	26	0.0100	44	0.0022	49	0.0030	28
ETHENE	43203	0.0995	9	0.0303	34	0.0766	26	0.0880	10	0.0084	22	0.0228	108	0.0103	79	0.0091	19	0.0589	8	0.0289	18	0.0265	27	0.0573	8
PROPENE	43205	0.0368	10	0.0078	43	0.0168	17	0.0306	10	0.0045	18	0.0013	77	0.0028	100	0.0044	16	0.0444	7	0.0224	17	0.0226	24	0.0433	7
1C4=	43213	0.0063	12	0.0018	37	0.0036	29	0.0053	11	0.0003	72	0.0007	66	0.0006	74	0.0003	68	0.0075	40	0.0066	62	0.0058	70	0.0076	42
2MC3=	43215	0.0184	20	0.0051	35	0.0096	30	0.0154	18	0.0020	37	0.0005	104	0.0024	84	0.0020	36	0.0401	14	0.0258	18	0.0308	29	0.0402	14
1C5=	43224	0.0015	96	0.0016	155	0.0000	0	0.0014	86	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
2M1C4=	43225	0.0002	103	0.0000	0	0.0000	0	0.0001	102	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
3M1C4=	43223	0.0001	104	0.0000	0	0.0000	0	0.0001	104	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
1C6=	43245	0.0002	101	0.0005	124	0.0002	112	0.0002	105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6OLE1	43245	0.0022	46	0.0000	0	0.0009	92	0.0018	45	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0033	11	0.0000	0	0.0000	0	0.0030	12
C7OLE1	98005	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0046	159	0.0004	159	0.0002	35	0.0016	133	0.0007	83	0.0003	67
C8OLE1	43265	0.0070	24	0.0173	27	0.0106	25	0.0088	24	0.0007	58	0.0000	0	0.0058	76	0.0008	58	0.0199	6	0.0112	42	0.0259	14	0.0207	6
C9OLE1	43267	0.0005	40	0.0000	0	0.0000	0	0.0003	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0006	14	0.0000	0	0.0000	0	0.0005	14

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C-2C4=	43217	0.0001	105	0.0000	0	0.0000	0	0.0001	105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
T-2C4=	43216	0.0008	88	0.0000	0	0.0000	0	0.0006	88	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
2M2C4=	43228	0.0019	61	0.0005	155	0.0000	155	0.0015	62	0.0002	120	0.0000	0	0.0000	0	0.0002	120	0.0000	0	0.0000	0	0.0000	0	
C5OLE2	43226	0.0026	35	0.0000	0	0.0000	0	0.0020	35	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
C6OLE2	43246	0.0035	34	0.0048	155	0.0013	67	0.0032	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0048	10	0.0000	0	0.0000	0	0.0044	11
C8OLE2	43266	0.0070	24	0.0173	27	0.0106	25	0.0088	24	0.0007	58	0.0000	0	0.0058	76	0.0008	58	0.0199	6	0.0112	42	0.0259	14	0.0207	6
C9OLE2	98042	0.0005	40	0.0000	0	0.0000	0	0.0003	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0006	14	0.0000	0	0.0000	0	0.0005	14
13C4==	43218	0.0042	20	0.0022	41	0.0001	89	0.0034	19	0.0005	45	0.0000	0	0.0000	0	0.0005	45	0.0042	16	0.0054	29	0.0031	52	0.0044	16
ISOPRENE	43243	0.0008	68	0.0000	0	0.0000	0	0.0006	69	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0087	141	0.0000	0	0.0005	141
CYC5=	43292	0.0026	63	0.0018	114	0.0009	155	0.0022	62	0.0005	110	0.0000	0	0.0041	133	0.0006	109	0.0001	141	0.0000	0	0.0000	0	0.0001	141
CYC6=	43273	0.0004	101	0.0000	0	0.0000	0	0.0003	101	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
ETHYNE	43206	0.0420	16	0.0040	43	0.0009	71	0.0317	18	0.0037	41	0.0022	73	0.0029	82	0.0036	38	0.0385	18	0.0144	23	0.0024	55	0.0361	17
BENZENE	45201	0.0616	9	0.0736	26	0.0866	13	0.0683	12	0.0073	16	0.0271	106	0.0982	31	0.0097	19	0.0389	7	0.0190	42	0.0478	23	0.0399	9
TOLUENE	45202	0.0933	4	0.1271	18	0.1025	11	0.1004	5	0.0145	9	0.0203	104	0.0727	33	0.0162	9	0.0970	5	0.0416	32	0.0655	17	0.0955	5
EBEN	45203	0.0312	8	0.0214	30	0.0185	20	0.0284	10	0.0039	12	0.0000	0	0.0084	112	0.0039	10	0.0322	10	0.0550	34	0.0299	23	0.0352	10
N-PBEN	45209	0.0048	21	0.0000	0	0.0001	113	0.0035	23	0.0004	47	0.0269	189	0.0000	0	0.0011	120	0.0070	36	0.0186	62	0.0064	76	0.0085	31
I-PBEN	98043	0.0007	31	0.0000	0	0.0001	113	0.0006	32	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0023	27	0.0000	0	0.0000	0	0.0021	27
C10BEN1	45105	0.0009	100	0.0000	0	0.0000	0	0.0007	100	0.0002	159	0.0000	0	0.0000	0	0.0002	159	0.0000	0	0.0000	0	0.0000	0	0.0000	0
M-XYL	45205	0.0412	11	0.0236	24	0.0290	16	0.0376	10	0.0048	13	0.0000	0	0.0069	76	0.0047	13	0.0311	11	0.0304	25	0.0187	13	0.0315	10
O-XYL	45204	0.0265	9	0.0161	30	0.0144	18	0.0238	10	0.0034	15	0.0000	0	0.0039	189	0.0034	18	0.0252	11	0.0247	23	0.0134	17	0.0254	10
P-XYL	45206	0.0356	14	0.0217	28	0.0252	20	0.0327	14	0.0048	13	0.0000	0	0.0069	76	0.0047	13	0.0311	11	0.0304	25	0.0187	13	0.0315	10
C9BEN2	45104	0.0294	10	0.0090	46	0.0083	34	0.0240	11	0.0033	25	0.0000	0	0.0000	0	0.0032	25	0.0197	15	0.0907	31	0.0197	31	0.0260	15
C10BEN2	45106	0.0002	107	0.0000	0	0.0000	0	0.0002	107	0.0001	159	0.0000	0	0.0000	0	0.0001	159	0.0000	0	0.0000	0	0.0000	0	0.0000	0
123TMBEN	45225	0.0008	89	0.0000	0	0.0000	0	0.0006	90	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
124TMBEN	45208	0.0229	15	0.0120	44	0.0058	35	0.0190	16	0.0026	27	0.0000	0	0.0000	0	0.0025	27	0.0186	19	0.0256	28	0.0057	33	0.0191	18
135TMBEN	45207	0.0073	18	0.0013	136	0.0005	80	0.0056	20	0.0011	28	0.0000	0	0.0000	0	0.0010	28	0.0070	11	0.0185	43	0.0059	22	0.0081	13
C10BEN4	45232	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	189	0.0717	118	0.0000	0	0.0022	118	0.0000	0	0.0000	0	0.0000	0	0.0000	0
STYRENE	45220	0.0055	8	0.0004	124	0.0015	100	0.0042	9	0.0004	45	0.0000	0	0.0000	0	0.0004	45	0.0099	32	0.0147	37	0.0104	28	0.0109	28
INDAN	98044	0.0002	101	0.0007	155	0.0000	155	0.0002	112	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
NAPHTHAL	98046	0.0003	107	0.0000	0	0.0000	0	0.0002	107	0.0003	98	0.0000	0	0.0000	0	0.0003	98	0.0000	0	0.0000	0	0.0000	0	0.0000	0
METHANOL	43301	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.8488	1	0.1495	62	0.2637	60	0.8204	2	0.0000	0	0.0000	0	0.0000	0	0.0000	0
ETHANOL	43302	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
FORMALD	43502	0.0123	29	0.0400	50	0.0169	54	0.0148	37	0.0448	12	0.3303	28	0.1835	47	0.0526	14	0.0369	27	0.1163	46	0.1174	29	0.0142	28
ACETALD	43503	0.0071	17	0.0339	38	0.0125	26	0.0097	18	0.0009	37	0.0207	61	0.0420	69	0.0021	48	0.0114	11	0.0103	46	0.0071	40	0.0032	10
PROPALD	43504	0.0015	42	0.0080	107	0.0010	107	0.0016	43	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	94	0.0000	0	0.0000	0	0.0000	94
C4ALD	43510	0.0004	57	0.0000	0	0.0000	0	0.0003	56	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C5ALD	43512	0.0001	155	0.0000	0	0.0000	0	0.0001	155	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6ALD	98095	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	189	0.0000	0	0.0000	0	0.0005	189	0.0000	0	0.0000	0	0.0000	0	0.0000	0
CROTALD	98156	0.0002	86	0.0017	107	0.0011	107	0.0004	92	0.0001	159	0.0010	159	0.0029	159	0.0002	159	0.0000	0	0.0000	0	0.0000	0	0.0000	0
BENZALD	98157	0.0009	63	0.0042	102	0.0006	106	0.0011	56	0.0000	0	0.0083	189	0.0164	159	0.0003	117	0.0000	0	0.0000	0	0.0000	0	0.0000	0
ACETONE	43551	0.0036	28	0.0337	49	0.0117	39	0.0073	32	0.0020	39	0.1186	46	0.0547	61	0.0052	42	0.0021	15	0.0000	0	0.0000	0	0.0005	16
C4KET	43552	0.0000	0	0.0140	107	0.0002	107	0.0007	107	0.0000	189	0.0000	0	0.0007	189	0.0001	189	0.0000	0	0.0000	0	0.0000	0	0.0000	0
ACROLEIN	43505	0.0017	32	0.0040	85	0.0013	129	0.0018	48	0.0002	82	0.0000	0	0.0000	0	0.0002	83	0.0004	34	0.0000	0	0.0000	0	0.0001	36

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Appendix B

Low Emitting Vehicle Profiles Provided to Professor Russell

California Air Resources Board Low Emitting Vehicle (LEV) Profiles - November 13, 1992

Federal Test Procedure (FTP) weight fractions and mass in grams/mile

All standard deviations (SD) in percent

		--- U. S. National Average Gasoline (RF-A) ---								--------- Phase 2 Gasoline (Phase 2) ---------							
OGID	SAROAD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD
MASS		0.2453	10	0.0100	18	0.0252	24	0.0605	5	0.2254	10	0.0120	31	0.0225	19	0.0547	11
ETHANE	43202	0.0316	16	0.0941	30	0.1252	21	0.0450	13	0.0341	16	0.0435	26	0.1151	20	0.0450	14
PROPANE	43204	0.0018	16	0.0068	34	0.0080	82	0.0030	31	0.0104	97	0.0472	82	0.0110	72	0.0121	80
BUTANE	43212	0.0486	11	0.0559	15	0.0651	24	0.0516	11	0.0096	17	0.0303	32	0.0220	32	0.0131	15
PENTANE	43220	0.0302	11	0.0348	19	0.0303	24	0.0312	11	0.0095	10	0.0326	97	0.0071	26	0.0127	36
HEXANE	43231	0.0266	7	0.0198	93	0.0161	38	0.0260	9	0.0090	8	0.0030	88	0.0028	37	0.0093	8
HEPTANE	43232	0.0148	4	0.0045	57	0.0095	31	0.0142	5	0.0115	7	0.0049	48	0.0071	30	0.0115	7
OCTANE	43233	0.0074	10	0.0023	130	0.0056	40	0.0075	9	0.0051	6	0.0000	0	0.0020	55	0.0048	8
NONANE	43235	0.0030	16	0.0000	0	0.0000	0	0.0025	16	0.0015	27	0.0029	117	0.0002	145	0.0016	29
DECANE	43238	0.0008	39	0.0000	0	0.0007	149	0.0008	43	0.0008	22	0.0011	166	0.0002	145	0.0008	21
UNDECANE	43241	0.0010	24	0.0100	122	0.0000	0	0.0024	87	0.0005	77	0.0000	0	0.0000	0	0.0005	78
2MC3	43214	0.0013	12	0.0025	57	0.0016	36	0.0015	15	0.0034	107	0.0065	35	0.0038	41	0.0039	81
2MC4	98132	0.0442	9	0.0932	27	0.0558	28	0.0495	12	0.0792	8	0.0831	34	0.0886	22	0.0856	5
2MC5	43229	0.0524	8	0.0133	50	0.0371	27	0.0500	8	0.0334	8	0.0137	46	0.0172	28	0.0325	8
3MC5	43230	0.0251	8	0.0084	41	0.0218	22	0.0246	9	0.0150	7	0.0088	60	0.0098	34	0.0152	11
22DMC4	43291	0.0087	31	0.0055	91	0.0100	47	0.0091	31	0.0032	55	0.0014	89	0.0024	60	0.0031	54
23DMC4	98001	0.0178	11	0.0058	47	0.0125	36	0.0172	11	0.0375	18	0.0231	38	0.0143	44	0.0360	16
3MC6	43295	0.0150	10	0.0025	53	0.0122	31	0.0144	9	0.0154	5	0.0053	55	0.0097	28	0.0152	5
24DMC5	43271	0.0002	121	0.0000	0	0.0000	0	0.0002	121	0.0002	78	0.0000	0	0.0000	0	0.0001	78
BRC7PAR	43106	0.0400	7	0.0054	60	0.0323	28	0.0383	6	0.0745	5	0.0305	31	0.0549	24	0.0747	5
23DMC6	98139	0.0053	8	0.0015	130	0.0013	93	0.0049	11	0.0083	7	0.0000	0	0.0063	35	0.0080	9
234TMC5	43279	0.0043	41	0.0013	130	0.0038	51	0.0042	41	0.0064	51	0.0038	80	0.0035	68	0.0061	52
BRC8PAR	43107	0.0450	5	0.0363	62	0.0427	17	0.0474	8	0.0772	6	0.0287	30	0.0666	22	0.0780	6
225TMC6	98033	0.0053	9	0.0045	130	0.0043	59	0.0058	17	0.0098	6	0.0011	117	0.0086	28	0.0097	8
BRC9PAR	43108	0.0070	20	0.0007	130	0.0039	50	0.0065	22	0.0047	12	0.0027	94	0.0025	72	0.0048	16
BRC10PAR	43109	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	79	0.0000	0	0.0003	145	0.0002	82
CYC6	43248	0.0022	9	0.0001	155	0.0008	88	0.0019	11	0.0007	27	0.0035	143	0.0000	179	0.0011	55
MCYC5	43262	0.0095	7	0.0047	70	0.0063	40	0.0091	10	0.0045	10	0.0021	71	0.0009	54	0.0042	12
MCYC6	43261	0.0065	6	0.0057	130	0.0016	64	0.0067	18	0.0029	12	0.0010	127	0.0013	88	0.0028	15
CYC8PAR	43116	0.0074	22	0.0037	83	0.0107	26	0.0082	20	0.0034	26	0.0011	179	0.0054	39	0.0037	19
CYC10PAR	98066	0.0051	30	0.0049	80	0.0033	61	0.0050	28	0.0020	25	0.0024	87	0.0017	103	0.0022	27
ETHENE	43203	0.0519	7	0.0355	30	0.0217	37	0.0490	8	0.0573	14	0.0233	27	0.0220	33	0.0536	13
PROPENE	43205	0.0259	5	0.0121	23	0.0119	41	0.0244	6	0.0367	14	0.0178	26	0.0134	33	0.0345	12
1C4=	43213	0.0042	9	0.0018	49	0.0015	38	0.0039	10	0.0045	19	0.0039	33	0.0017	26	0.0043	16
2MC3=	43215	0.0118	21	0.0080	27	0.0097	40	0.0118	22	0.0364	11	0.0321	43	0.0214	27	0.0367	12
2M1C4=	43225	0.0002	122	0.0000	0	0.0000	0	0.0002	123	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6OLE1	43245	0.0044	43	0.0000	0	0.0021	97	0.0039	44	0.0031	11	0.0020	126	0.0000	0	0.0028	15

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C7OLE1	98005	0.0023	112	0.0003	93	0.0003	155	0.0016	102	0.0002	48	0.0060	142	0.0000	0	0.0005	77
C8OLE1	43265	0.0096	4	0.0039	44	0.0101	31	0.0095	5	0.0241	5	0.0109	30	0.0224	21	0.0247	5
C9OLE1	43267	0.0008	19	0.0010	130	0.0002	130	0.0009	32	0.0008	19	0.0004	117	0.0002	117	0.0008	21
C5OLE2	43226	0.0015	84	0.0000	0	0.0042	155	0.0015	87	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6OLE2	43246	0.0072	27	0.0000	0	0.0257	142	0.0090	48	0.0045	9	0.0012	179	0.0000	0	0.0039	10
C8OLE2	43266	0.0096	4	0.0039	44	0.0101	31	0.0095	5	0.0241	5	0.0109	30	0.0224	21	0.0247	5
C9OLE2	98042	0.0008	19	0.0010	130	0.0002	130	0.0009	32	0.0008	19	0.0004	117	0.0002	117	0.0008	21
13C4==	43218	0.0034	11	0.0011	69	0.0013	64	0.0031	11	0.0028	16	0.0030	39	0.0017	57	0.0029	19
CYC5=	43292	0.0001	155	0.0000	0	0.0014	121	0.0002	136	0.0000	0	0.0005	179	0.0000	0	0.0001	179
ETHYNE	43206	0.0275	47	0.0117	47	0.0009	61	0.0243	49	0.0236	24	0.0124	31	0.0020	80	0.0220	25
BENZENE	45201	0.0490	8	0.0344	62	0.0674	48	0.0535	10	0.0321	8	0.0443	77	0.0433	38	0.0404	21
TOLUENE	45202	0.0744	5	0.0386	29	0.0538	45	0.0732	7	0.0825	4	0.0168	43	0.0373	31	0.0776	4
EBEN	45203	0.0295	11	0.0148	54	0.0145	38	0.0282	11	0.0250	8	0.0458	43	0.0140	38	0.0274	8
N-PBEN	45209	0.0054	39	0.0018	130	0.0026	78	0.0053	37	0.0046	27	0.0029	99	0.0045	99	0.0047	23
I-PBEN	98043	0.0020	34	0.0000	0	0.0000	0	0.0016	28	0.0018	16	0.0000	0	0.0002	145	0.0016	15
M-XYL	45205	0.0357	10	0.0277	29	0.0203	29	0.0349	10	0.0252	6	0.0120	43	0.0096	49	0.0240	7
O-XYL	45204	0.0282	14	0.0173	58	0.0141	28	0.0269	16	0.0195	6	0.0148	53	0.0078	46	0.0189	7
P-XYL	45206	0.0357	10	0.0277	29	0.0203	29	0.0349	10	0.0252	6	0.0120	43	0.0096	49	0.0240	7
C9BEN2	45104	0.0342	24	0.0408	37	0.0238	38	0.0364	25	0.0168	16	0.0403	51	0.0148	49	0.0205	16
124TMBEN	45208	0.0268	28	0.0491	27	0.0156	26	0.0286	26	0.0079	26	0.0231	52	0.0056	60	0.0092	27
135TMBEN	45207	0.0108	18	0.0161	45	0.0129	66	0.0120	21	0.0056	10	0.0093	103	0.0031	89	0.0064	22
STYRENE	45220	0.0064	23	0.0033	88	0.0035	62	0.0064	24	0.0055	17	0.0025	61	0.0044	39	0.0057	17
FORMALD	43502	0.0191	28	0.1613	37	0.1122	64	0.0107	30	0.0401	20	0.2313	31	0.2562	31	0.0247	21
ACETALD	43503	0.0111	9	0.0590	41	0.0153	70	0.0043	18	0.0120	18	0.0356	30	0.0167	40	0.0042	14
ACETONE	43551	0.0020	24	0.0000	0	0.0000	0	0.0005	22	0.0033	36	0.0000	0	0.0000	0	0.0008	35
ACROLEIN	43505	0.0000	155	0.0000	0	0.0000	0	0.0000	155	0.0001	85	0.0000	0	0.0000	0	0.0000	86

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Appendix C

Transitional Low Emitting Vehicle Profiles for the Complete Data Set

California Air Resources Board Transitional Low Emitting Vehicle (TLEV) Profiles - January 14, 1993

Federal Test Procedure (FTP) weight fractions and mass in grams/mile

All standard deviations (SD) in percent

		--- U. S. National Average Gasoline (RF-A) ---								------ 85% Methanol/15% RF-A (M85/RF-A) ------								--------- Phase 2 Gasoline (Phase 2) ---------							
OGID	SAROAD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD
MASS		0.3659	6	0.0266	15	0.0549	10	0.1047	6	1.1006	14	0.0106	28	0.0241	29	0.2396	14	0.3962	4	0.0140	15	0.0386	20	0.0999	4
ETHANE	43202	0.0245	10	0.0841	27	0.0874	20	0.0399	14	0.0013	60	0.0349	87	0.0202	79	0.0026	50	0.0219	5	0.0707	21	0.0887	13	0.0308	8
PROPANE	43204	0.0025	50	0.0061	68	0.0053	30	0.0033	37	0.0001	84	0.0023	69	0.0036	83	0.0002	61	0.0011	18	0.0091	52	0.0051	62	0.0017	17
BUTANE	43212	0.0405	7	0.0430	33	0.0692	20	0.0442	10	0.0064	37	0.0459	107	0.0597	43	0.0094	42	0.0091	11	0.0314	27	0.0160	17	0.0115	10
PENTANE	43220	0.0264	9	0.0202	31	0.0345	18	0.0268	12	0.0019	31	0.0000	0	0.0041	133	0.0019	32	0.0136	19	0.0089	40	0.0161	27	0.0136	20
HEPTANE	43232	0.0119	11	0.0168	33	0.0138	20	0.0129	13	0.0008	50	0.0000	0	0.0000	0	0.0008	50	0.0086	8	0.0053	44	0.0086	12	0.0084	8
OCTANE	43233	0.0061	7	0.0010	79	0.0028	38	0.0050	7	0.0001	133	0.0000	0	0.0000	0	0.0001	133	0.0044	6	0.0008	74	0.0041	21	0.0042	6
NONANE	43235	0.0022	55	0.0000	0	0.0006	116	0.0016	50	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0013	10	0.0000	0	0.0002	45	0.0012	11
DECANE	43238	0.0004	132	0.0013	136	0.0000	0	0.0006	91	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0007	12	0.0006	162	0.0002	91	0.0006	14
UNDECANE	43241	0.0010	38	0.0000	0	0.0000	0	0.0007	38	0.0001	159	0.0000	0	0.0000	0	0.0001	159	0.0004	43	0.0020	116	0.0003	113	0.0005	36
DODECANE	43255	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0003	96	0.0000	0	0.0005	102	0.0004	78
2MC3	43214	0.0057	60	0.0024	48	0.0026	30	0.0049	54	0.0000	77	0.0077	115	0.0046	83	0.0002	90	0.0017	38	0.0078	47	0.0024	25	0.0022	27
2MC4	98132	0.0378	9	0.0481	25	0.0625	18	0.0429	11	0.0037	22	0.0790	74	0.0342	40	0.0058	31	0.0609	8	0.1194	21	0.0889	10	0.0704	6
2MC5	43229	0.0266	17	0.0250	37	0.0364	19	0.0282	18	0.0024	58	0.0000	0	0.0123	103	0.0027	61	0.0294	7	0.0224	34	0.0318	13	0.0297	7
3MC5	43230	0.0154	16	0.0194	33	0.0229	18	0.0172	15	0.0012	58	0.0000	0	0.0000	0	0.0012	58	0.0144	7	0.0121	25	0.0170	13	0.0145	8
22DMC4	43291	0.0076	24	0.0026	88	0.0058	45	0.0069	24	0.0005	68	0.0000	0	0.0000	0	0.0005	68	0.0058	16	0.0037	34	0.0083	19	0.0060	16
23DMC4	98001	0.0115	23	0.0086	41	0.0140	28	0.0117	22	0.0004	101	0.0000	0	0.0000	0	0.0004	101	0.0262	18	0.0123	23	0.0156	12	0.0248	16
2MC6	43275	0.0037	71	0.0027	104	0.0034	100	0.0036	75	0.0003	108	0.0000	0	0.0000	0	0.0002	108	0.0038	36	0.0038	68	0.0041	37	0.0038	36
3MC6	43295	0.0133	9	0.0218	30	0.0198	24	0.0153	11	0.0011	40	0.0000	0	0.0058	133	0.0012	45	0.0117	6	0.0076	35	0.0127	14	0.0116	6
23DMC5	43274	0.0013	100	0.0000	0	0.0000	0	0.0010	100	0.0004	100	0.0000	0	0.0000	0	0.0004	100	0.0094	36	0.0060	46	0.0114	37	0.0094	36
24DMC5	43271	0.0017	64	0.0016	107	0.0012	101	0.0016	66	0.0001	189	0.0000	0	0.0000	0	0.0001	189	0.0056	36	0.0040	39	0.0067	37	0.0056	36
33DMC5	43106	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	37	0.0001	113	0.0006	44	0.0005	36
223TMC4	43106	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	45	0.0007	75	0.0002	60	0.0002	44
BRC7PAR	43106	0.0258	25	0.0372	33	0.0362	26	0.0286	24	0.0024	61	0.0000	0	0.0053	133	0.0024	62	0.0388	23	0.0286	33	0.0504	25	0.0394	23
2MC7	98140	0.0014	73	0.0009	101	0.0014	100	0.0014	77	0.0001	120	0.0000	0	0.0000	0	0.0001	120	0.0023	37	0.0007	91	0.0030	39	0.0023	37
3MC7	43298	0.0020	66	0.0013	103	0.0015	101	0.0019	67	0.0001	145	0.0000	0	0.0000	0	0.0001	145	0.0031	36	0.0017	49	0.0040	36	0.0031	36
4MC7	43297	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0009	36	0.0003	135	0.0010	47	0.0009	37
23DMC6	98139	0.0033	15	0.0018	120	0.0020	40	0.0030	18	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0070	6	0.0059	47	0.0092	10	0.0071	6
24DMC6	43277	0.0012	66	0.0007	101	0.0008	101	0.0011	66	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0036	36	0.0043	59	0.0044	36	0.0037	36
25DMC6	43278	0.0009	66	0.0006	101	0.0007	101	0.0009	67	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0025	36	0.0023	45	0.0030	37	0.0026	36
224TMC5	43276	0.0061	66	0.0125	73	0.0108	66	0.0076	66	0.0018	59	0.0000	0	0.0020	189	0.0018	59	0.0712	7	0.0513	17	0.0999	9	0.0725	7
234TMC5	43279	0.0085	11	0.0104	35	0.0107	22	0.0093	11	0.0011	40	0.0000	0	0.0000	0	0.0011	40	0.0109	19	0.0101	45	0.0136	19	0.0110	19
BRC8PAR	43107	0.0300	23	0.0399	25	0.0367	23	0.0322	22	0.0021	59	0.0000	0	0.0116	76	0.0022	59	0.0191	15	0.0091	36	0.0223	18	0.0191	15
24DMC7	98142	0.0001	101	0.0001	155	0.0001	101	0.0001	101	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	37	0.0000	0	0.0005	48	0.0005	37
225TMC6	98033	0.0037	10	0.0005	106	0.0016	60	0.0030	13	0.0003	71	0.0095	189	0.0000	0	0.0005	83	0.0074	8	0.0030	47	0.0104	9	0.0075	7
BRC9PAR	43108	0.0040	18	0.0063	121	0.0039	86	0.0047	32	0.0000	0	0.0000	0	0.0047	189	0.0003	189	0.0071	16	0.0070	44	0.0095	23	0.0073	15
BRC10PAR	43109	0.0006	107	0.0000	0	0.0000	0	0.0004	107	0.0002	120	0.0000	0	0.0000	0	0.0002	120	0.0019	29	0.0034	70	0.0013	48	0.0020	33
CYC5	43242	0.0010	78	0.0000	0	0.0004	111	0.0009	76	0.0004	93	0.0121	189	0.0007	189	0.0008	103	0.0004	33	0.0017	116	0.0005	53	0.0005	37
CYC6	43248	0.0015	71	0.0115	87	0.0022	114	0.0034	67	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0011	16	0.0022	103	0.0015	51	0.0012	21
MCYC5	43262	0.0074	9	0.0037	67	0.0068	27	0.0071	10	0.0007	50	0.0000	0	0.0073	133	0.0008	59	0.0059	13	0.0085	44	0.0068	22	0.0061	12
MCYC6	43261	0.0052	17	0.0039	58	0.0021	48	0.0046	18	0.0001	133	0.0000	0	0.0000	0	0.0001	133	0.0044	15	0.0027	48	0.0040	24	0.0043	16
13DMCYC5	90064	0.0004	100	0.0011	103	0.0007	105	0.0005	100	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0012	37	0.0003	88	0.0015	39	0.0011	37
ECYC6	43288	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	43	0.0011	81	0.0010	62	0.0006	46
CYC8PAR	43116	0.0072	24	0.0019	67	0.0085	29	0.0067	23	0.0003	73	0.0000	0	0.0000	0	0.0003	73	0.0059	12	0.0104	86	0.0136	46	0.0075	19
CYC10PAR	98066	0.0023	32	0.0009	93	0.0002	88	0.0018	34	0.0002	69	0.0000	0	0.0000	0	0.0002	69	0.0000	0	0.0000	0	0.0000	0	0.0000	0
ETHENE	43203	0.0995	9	0.0303	34	0.0766	26	0.0880	10	0.0084	22	0.0228	108	0.0103	79	0.0091	19	0.0667	7	0.0271	26	0.0352	20	0.0612	6
PROPENE	43205	0.0368	10	0.0078	43	0.0168	17	0.0306	10	0.0045	18	0.0013	77	0.0028	100	0.0044	16	0.0478	5	0.0193	22	0.0233	18	0.0431	5
1C4=	43213	0.0063	12	0.0018	37	0.0036	29	0.0053	11	0.0003	72	0.0007	66	0.0006	74	0.0003	68	0.0061	8	0.0039	29	0.0032	17	0.0057	8
2MC3=	43215	0.0184	20	0.0051	35	0.0096	30	0.0154	18	0.0020	37	0.0005	104	0.0024	84	0.0020	36	0.0489	6	0.0259	17	0.0354	14	0.0459	6
1C5=	43224	0.0015	96	0.0016	155	0.0000	0	0.0014	86	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0009	39	0.0033	109	0.0004	85	0.0012	51
2M1C4=	43225	0.0002	103	0.0000	0	0.0000	0	0.0001	102	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0016	36	0.0014	62	0.0009	46	0.0015	36
3M1C4=	43223	0.0001	104	0.0000	0	0.0000	0	0.0001	104	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0006	37	0.0004	113	0.0002	83	0.0005	40
1C6=	43245	0.0002	101	0.0005	124	0.0002	112	0.0002	105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0003	37	0.0000	0	0.0001	90	0.0003	39

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C6OLE1	43245	0.0022	46	0.0000	0	0.0009	92	0.0018	45	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0026	11	0.0002	162	0.0003	157	0.0022	13
C7OLE1	98005	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0046	159	0.0004	159	0.0001	47	0.0006	151	0.0003	93	0.0001	72
C8OLE1	43265	0.0070	24	0.0173	27	0.0106	25	0.0088	24	0.0007	58	0.0000	0	0.0058	76	0.0008	58	0.0008	36	0.0000	0	0.0005	50	0.0007	36
C9OLE1	43267	0.0005	40	0.0000	0	0.0000	0	0.0003	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0014	23	0.0052	113	0.0009	41	0.0015	30
C-2C4=	43217	0.0001	105	0.0000	0	0.0000	0	0.0001	105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0020	37	0.0003	135	0.0016	49	0.0017	38
T-2C4=	43216	0.0008	88	0.0000	0	0.0000	0	0.0006	88	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0009	53	0.0005	63	0.0009	57	0.0009	49
2M2C4=	43228	0.0019	61	0.0005	155	0.0000	155	0.0015	62	0.0002	120	0.0000	0	0.0000	0	0.0002	120	0.0024	36	0.0014	111	0.0013	47	0.0021	36
C5OLE2	43226	0.0026	35	0.0000	0	0.0000	0	0.0020	35	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0018	36	0.0055	58	0.0016	54	0.0021	37
C6OLE2	43246	0.0035	34	0.0048	155	0.0013	67	0.0032	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0054	8	0.0040	74	0.0016	49	0.0050	10
C7OLE2	98041	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	41	0.0000	0	0.0001	135	0.0004	42
C8OLE2	43266	0.0070	24	0.0173	27	0.0106	25	0.0088	24	0.0007	58	0.0000	0	0.0058	76	0.0008	58	0.0009	38	0.0006	113	0.0006	50	0.0008	38
C9OLE2	98042	0.0005	40	0.0000	0	0.0000	0	0.0003	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0003	30	0.0000	0	0.0001	124	0.0003	30
13C4==	43218	0.0042	20	0.0022	41	0.0001	89	0.0034	19	0.0005	45	0.0000	0	0.0000	0	0.0005	45	0.0057	11	0.0026	39	0.0016	48	0.0049	9
ISOPRENE	43243	0.0008	68	0.0000	0	0.0000	0	0.0006	69	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0014	37	0.0085	63	0.0013	51	0.0019	35
CYC5=	43292	0.0026	63	0.0018	114	0.0009	155	0.0022	62	0.0005	110	0.0000	0	0.0041	133	0.0006	109	0.0015	36	0.0004	123	0.0002	77	0.0012	35
CYC6=	43273	0.0004	101	0.0000	0	0.0000	0	0.0003	101	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	41	0.0000	0	0.0003	80	0.0004	42
ETHYNE	43206	0.0420	16	0.0040	43	0.0009	71	0.0317	18	0.0037	41	0.0022	73	0.0029	82	0.0036	38	0.0357	12	0.0127	29	0.0013	54	0.0300	12
PROPYNE	43209	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	64	0.0015	137	0.0010	61	0.0005	52
1BUTYNE	43219	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	43	0.0054	103	0.0003	104	0.0010	74
BENZENE	45201	0.0616	9	0.0736	26	0.0866	13	0.0683	12	0.0073	16	0.0271	106	0.0982	31	0.0097	19	0.0352	6	0.0217	20	0.0503	13	0.0361	6
TOLUENE	45202	0.0933	4	0.1271	18	0.1025	11	0.1004	5	0.0145	9	0.0203	104	0.0727	33	0.0162	9	0.0846	7	0.0473	19	0.0627	12	0.0807	7
EBEN	45203	0.0312	8	0.0214	30	0.0185	20	0.0284	10	0.0039	12	0.0000	0	0.0084	112	0.0039	10	0.0271	8	0.0289	33	0.0206	22	0.0262	10
N-PBEN	45209	0.0048	21	0.0000	0	0.0001	113	0.0035	23	0.0004	47	0.0269	189	0.0000	0	0.0011	120	0.0044	25	0.0072	69	0.0036	60	0.0046	27
I-PBEN	98043	0.0007	31	0.0000	0	0.0001	113	0.0006	32	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0019	34	0.0000	0	0.0001	161	0.0016	34
S-BBEN	45216	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	53	0.0001	225	0.0001	113	0.0001	53
C10BEN1	45105	0.0009	100	0.0000	0	0.0000	0	0.0007	100	0.0002	159	0.0000	0	0.0000	0	0.0002	159	0.0000	163	0.0000	0	0.0000	0	0.0000	169
C11BEN1	45245	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	41	0.0003	167	0.0000	0	0.0002	50
M-XYL	45205	0.0412	11	0.0236	24	0.0290	16	0.0376	10	0.0048	13	0.0000	0	0.0069	76	0.0047	13	0.0281	7	0.0228	23	0.0169	13	0.0266	8
O-XYL	45204	0.0265	9	0.0161	30	0.0144	18	0.0238	10	0.0034	15	0.0000	0	0.0039	189	0.0034	18	0.0207	9	0.0175	25	0.0127	14	0.0197	10
P-XYL	45206	0.0356	14	0.0217	28	0.0252	20	0.0327	14	0.0048	13	0.0000	0	0.0069	76	0.0047	13	0.0281	7	0.0228	23	0.0169	13	0.0266	8
C9BEN2	45104	0.0294	10	0.0090	46	0.0083	34	0.0240	11	0.0033	25	0.0000	0	0.0000	0	0.0032	25	0.0212	8	0.0519	38	0.0158	26	0.0224	11
C10BEN2	45106	0.0002	107	0.0000	0	0.0000	0	0.0002	107	0.0001	159	0.0000	0	0.0000	0	0.0001	159	0.0034	37	0.0013	119	0.0013	82	0.0029	37
C11BEN2	45245	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	50	0.0000	0	0.0003	113	0.0004	51
123TMBEN	45225	0.0008	89	0.0000	0	0.0000	0	0.0006	90	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	57	0.0005	127	0.0002	76	0.0002	46
124TMBEN	45208	0.0229	15	0.0120	44	0.0058	35	0.0190	16	0.0026	27	0.0000	0	0.0000	0	0.0025	27	0.0136	14	0.0230	23	0.0079	30	0.0136	14
135TMBEN	45207	0.0073	18	0.0013	136	0.0005	80	0.0056	20	0.0011	28	0.0000	0	0.0000	0	0.0010	28	0.0060	8	0.0148	61	0.0045	20	0.0064	12
C10BEN3	45103	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0014	37	0.0006	117	0.0003	109	0.0011	38
C12BEN3	45247	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	57	0.0000	0	0.0000	0	0.0001	57
C10BEN4	45232	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	189	0.0717	118	0.0000	0	0.0022	118	0.0006	42	0.0010	225	0.0003	143	0.0006	55
STYRENE	45220	0.0055	8	0.0004	124	0.0015	100	0.0042	9	0.0004	45	0.0000	0	0.0000	0	0.0004	45	0.0067	21	0.0057	50	0.0068	29	0.0066	21
INDAN	98044	0.0002	101	0.0007	155	0.0000	155	0.0002	112	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	47	0.0000	0	0.0002	76	0.0002	43
NAPHTHAL	98046	0.0003	107	0.0000	0	0.0000	0	0.0002	107	0.0003	98	0.0000	0	0.0000	0	0.0003	98	0.0003	47	0.0018	154	0.0003	102	0.0005	76
METHANOL	43301	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.8488	1	0.1495	62	0.2637	60	0.8204	2	0.0000	0	0.0000	0	0.0000	0	0.0000	0
ETHANOL	43302	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
FORMALD	43502	0.0123	29	0.0400	50	0.0169	54	0.0148	37	0.0448	12	0.3303	28	0.1835	47	0.0526	14	0.0138	12	0.0530	38	0.0283	24	0.0163	13
ACETALD	43503	0.0071	17	0.0339	38	0.0125	26	0.0097	18	0.0009	37	0.0207	61	0.0420	69	0.0021	48	0.0044	10	0.0188	42	0.0059	37	0.0051	15
PROPALD	43504	0.0015	42	0.0080	107	0.0010	107	0.0016	43	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	62	0.0000	0	0.0000	0	0.0001	60
C4ALD	43510	0.0004	57	0.0000	0	0.0000	0	0.0003	56	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C5ALD	43512	0.0001	155	0.0000	0	0.0000	0	0.0001	155	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6ALD	98095	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	189	0.0000	0	0.0000	0	0.0005	189	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C7ALD	98158	0.0000	0	0.0042	102	0.0006	106	0.0005	105	0.0000	0	0.0083	189	0.0000	0	0.0001	189	0.0000	0	0.0000	0	0.0000	0	0.0000	0
CROTALD	98156	0.0002	86	0.0017	107	0.0011	107	0.0004	92	0.0001	159	0.0010	159	0.0029	159	0.0002	159	0.0000	113	0.0000	0	0.0000	0	0.0000	113
BENZALD	98157	0.0009	63	0.0000	0	0.0000	0	0.0006	62	0.0000	0	0.0000	0	0.0164	159	0.0002	159	0.0015	49	0.0129	100	0.0065	117	0.0022	50
MTBE	.	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0158	39	0.0023	89	0.0007	49	0.0127	40
ACETONE	43551	0.0036	28	0.0337	49	0.0117	39	0.0073	32	0.0020	39	0.1186	46	0.0547	61	0.0052	42	0.0035	11	0.0134	54	0.0076	30	0.0045	17
C4KET	43552	0.0000	0	0.0140	107	0.0002	107	0.0007	107	0.0000	189	0.0000	0	0.0007	189	0.0001	189	0.0001	113	0.0000	0	0.0000	0	0.0001	113
ACROLEIN	43505	0.0017	32	0.0040	85	0.0013	129	0.0018	48	0.0002	82	0.0000	0	0.0000	0	0.0002	83	0.0011	30	0.0000	0	0.0000	0	0.0009	28

Appendix D

Low Emitting Vehicle Profiles for the Complete Data Set

California Air Resources Board Low Emitting Vehicle (LEV) Profiles - January 14, 1993

Federal Test Procedure (FTP) weight fractions and mass in grams/mile

All standard deviations (SD) in percent

		--- U. S. National Average Gasoline (RF-A) ---								--------- Phase 2 Gasoline (Phase 2) ---------							
OGID	SAROAD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD
MASS		0.2274	8	0.0095	16	0.0250	19	0.0589	5	0.2113	8	0.0101	23	0.0214	19	0.0549	8
ETHANE	43202	0.0333	11	0.1363	19	0.1490	18	0.0519	13	0.0333	13	0.0540	22	0.1442	25	0.0419	11
PROPANE	43204	0.0020	15	0.0119	26	0.0095	81	0.0034	20	0.0051	94	0.0329	62	0.0110	68	0.0066	69
BUTANE	43212	0.0464	8	0.0712	11	0.0786	15	0.0513	7	0.0105	17	0.0411	28	0.0314	33	0.0158	15
PENTANE	43220	0.0292	8	0.0396	13	0.0354	14	0.0304	7	0.0111	9	0.0207	31	0.0124	25	0.0125	12
HEXANE	43231	0.0258	7	0.0220	60	0.0209	22	0.0253	7	0.0111	17	0.0054	65	0.0090	45	0.0107	21
HEPTANE	43232	0.0144	4	0.0071	41	0.0110	18	0.0138	5	0.0106	10	0.0059	40	0.0063	26	0.0100	11
OCTANE	43233	0.0076	6	0.0011	150	0.0056	27	0.0071	7	0.0051	8	0.0003	139	0.0016	47	0.0044	10
NONANE	43235	0.0029	14	0.0026	150	0.0001	150	0.0025	17	0.0013	26	0.0023	115	0.0002	101	0.0015	40
DECANE	43238	0.0009	26	0.0000	0	0.0009	145	0.0008	29	0.0027	102	0.0037	107	0.0001	109	0.0024	92
UNDECANE	43241	0.0009	20	0.0052	138	0.0000	0	0.0015	81	0.0005	65	0.0001	139	0.0000	0	0.0004	63
2MC3	43214	0.0012	9	0.0025	40	0.0018	23	0.0014	10	0.0013	27	0.0075	35	0.0047	41	0.0023	24
2MC4	98132	0.0444	7	0.0934	22	0.0652	17	0.0493	7	0.0769	8	0.1065	22	0.1082	17	0.0851	6
2MC5	43229	0.0518	7	0.0313	33	0.0474	16	0.0509	5	0.0331	8	0.0227	38	0.0260	22	0.0328	9
3MC5	43230	0.0250	7	0.0164	37	0.0271	14	0.0250	6	0.0164	8	0.0112	50	0.0155	26	0.0161	9
22DMC4	43291	0.0094	25	0.0077	52	0.0119	33	0.0097	24	0.0056	30	0.0022	81	0.0067	53	0.0053	29
23DMC4	98001	0.0181	10	0.0107	37	0.0172	20	0.0178	8	0.0115	12	0.0063	29	0.0071	39	0.0108	12
2MC6	43275	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0011	100	0.0000	0	0.0003	160	0.0008	101
3MC6	43295	0.0155	7	0.0066	42	0.0148	18	0.0150	6	0.0150	7	0.0060	43	0.0106	21	0.0142	8
23DMC5	43274	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0028	100	0.0015	160	0.0040	101	0.0029	100
24DMC5	43271	0.0002	119	0.0000	0	0.0000	0	0.0001	119	0.0018	98	0.0000	0	0.0024	105	0.0017	99
BRC7PAR	43106	0.0420	5	0.0183	42	0.0418	17	0.0411	5	0.0683	13	0.0363	28	0.0591	22	0.0660	13
2MC7	98140	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	106	0.0000	0	0.0000	0	0.0003	106
3MC7	43298	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0007	101	0.0000	0	0.0000	0	0.0005	102
23DMC6	98139	0.0056	7	0.0007	150	0.0032	41	0.0051	9	0.0082	6	0.0003	139	0.0052	35	0.0073	9
24DMC6	43277	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0012	100	0.0000	0	0.0003	160	0.0009	101
25DMC6	43278	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0009	100	0.0000	0	0.0000	0	0.0006	100
224TMC5	43276	0.0411	5	0.0330	31	0.0504	19	0.0419	6	0.0959	5	0.0745	26	0.1047	13	0.0971	5
234TMC5	43279	0.0059	32	0.0016	92	0.0062	39	0.0057	33	0.0118	30	0.0050	75	0.0110	32	0.0113	29
BRC8PAR	43107	0.0263	5	0.0206	66	0.0252	14	0.0267	10	0.0259	15	0.0074	69	0.0191	27	0.0242	15
225TMC6	98033	0.0057	7	0.0023	150	0.0048	33	0.0056	11	0.0095	6	0.0010	108	0.0072	30	0.0086	9
BRC9PAR	43108	0.0073	14	0.0004	150	0.0045	35	0.0065	15	0.0042	15	0.0049	60	0.0038	48	0.0044	17
BRC10PAR	43109	0.0004	93	0.0012	127	0.0002	127	0.0004	94	0.0004	55	0.0000	0	0.0006	73	0.0004	57
CYC5	43242	0.0002	108	0.0000	0	0.0000	0	0.0001	108	0.0000	0	0.0000	0	0.0000	0	0.0000	0
CYC6	43248	0.0022	11	0.0001	100	0.0010	83	0.0019	12	0.0007	23	0.0035	94	0.0001	139	0.0009	41
MCYC5	43262	0.0097	5	0.0062	40	0.0080	23	0.0094	6	0.0051	14	0.0034	37	0.0024	47	0.0048	12
MCYC6	43261	0.0064	5	0.0030	140	0.0032	34	0.0061	12	0.0038	17	0.0018	86	0.0012	57	0.0032	12

13DMCYC5	90064	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	160	0.0000	0	0.0000	0	0.0001	160
CYC7PAR	43115	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	91	0.0000	0	0.0000	0	0.0003	91
CYC8PAR	43116	0.0086	20	0.0051	50	0.0116	15	0.0090	17	0.0042	25	0.0014	90	0.0049	33	0.0042	22
ETHENE	43203	0.0587	10	0.0334	26	0.0281	25	0.0527	9	0.0620	13	0.0246	19	0.0278	26	0.0544	11
PROPENE	43205	0.0284	8	0.0129	18	0.0121	26	0.0252	6	0.0387	12	0.0176	21	0.0155	26	0.0337	10
1C4=	43213	0.0047	10	0.0016	53	0.0015	29	0.0041	9	0.0042	23	0.0037	34	0.0016	25	0.0038	20
2MC3=	43215	0.0122	13	0.0079	22	0.0085	27	0.0115	13	0.0421	12	0.0336	29	0.0265	20	0.0396	11
2M1C4=	43225	0.0002	120	0.0000	0	0.0000	0	0.0002	121	0.0005	91	0.0000	0	0.0001	139	0.0003	89
C6OLE1	43245	0.0038	31	0.0000	0	0.0013	98	0.0032	33	0.0026	17	0.0016	98	0.0000	0	0.0023	20
C7OLE1	98005	0.0012	126	0.0002	102	0.0005	120	0.0009	111	0.0002	39	0.0055	99	0.0001	139	0.0005	53
C9OLE1	43267	0.0009	18	0.0005	150	0.0001	150	0.0008	23	0.0006	21	0.0002	139	0.0000	139	0.0006	20
C-2C4=	43217	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0007	100	0.0000	0	0.0000	0	0.0005	100
T-2C4=	43216	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	106	0.0000	0	0.0000	0	0.0003	106
2M2C4=	43228	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0007	101	0.0000	0	0.0000	0	0.0004	101
C5OLE2	43226	0.0009	92	0.0000	0	0.0028	150	0.0009	94	0.0000	0	0.0006	139	0.0001	139	0.0001	139
C6OLE2	43246	0.0064	20	0.0000	0	0.0013	98	0.0053	21	0.0038	16	0.0010	139	0.0000	0	0.0032	17
C9OLE2	98042	0.0009	18	0.0005	150	0.0001	150	0.0008	23	0.0006	21	0.0002	139	0.0000	139	0.0006	20
13C4==	43218	0.0033	8	0.0017	45	0.0010	52	0.0029	7	0.0035	20	0.0027	37	0.0014	54	0.0031	17
ISOPRENE	43243	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	100	0.0000	0	0.0000	0	0.0003	100
CYC5=	43292	0.0001	150	0.0000	0	0.0017	119	0.0002	133	0.0001	96	0.0011	139	0.0000	0	0.0001	79
ETHYNE	43206	0.0227	39	0.0112	43	0.0008	54	0.0194	42	0.0243	20	0.0157	29	0.0029	55	0.0213	21
BENZENE	45201	0.0534	7	0.0586	33	0.0693	30	0.0578	8	0.0378	10	0.0518	42	0.0514	27	0.0433	13
TOLUENE	45202	0.0779	3	0.0396	24	0.0497	33	0.0722	5	0.0875	4	0.0540	43	0.0518	26	0.0828	7
EBEN	45203	0.0299	7	0.0166	40	0.0131	32	0.0270	8	0.0245	5	0.0400	35	0.0142	38	0.0241	8
N-PBEN	45209	0.0055	24	0.0010	150	0.0016	80	0.0048	25	0.0039	22	0.0076	92	0.0041	110	0.0041	27
I-PBEN	98043	0.0018	24	0.0000	0	0.0000	0	0.0014	20	0.0014	18	0.0000	0	0.0001	139	0.0012	18
C10BEN1	45105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0003	127	0.0000	0	0.0023	160	0.0006	147
M-XYL	45205	0.0367	6	0.0268	26	0.0183	25	0.0338	7	0.0259	4	0.0163	28	0.0124	29	0.0237	5
O-XYL	45204	0.0291	9	0.0227	37	0.0140	22	0.0268	10	0.0196	4	0.0141	35	0.0090	30	0.0180	7
P-XYL	45206	0.0367	6	0.0268	26	0.0183	25	0.0338	7	0.0259	4	0.0163	28	0.0124	29	0.0237	5
C9BEN2	45104	0.0383	17	0.0393	47	0.0234	44	0.0364	19	0.0202	13	0.0535	36	0.0227	48	0.0232	12
123TMBEN	45225	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	160	0.0000	0	0.0000	0	0.0001	160
124TMBEN	45208	0.0275	19	0.0410	32	0.0136	28	0.0267	18	0.0101	14	0.0181	41	0.0054	45	0.0099	15
135TMBEN	45207	0.0105	14	0.0128	53	0.0129	78	0.0104	18	0.0059	8	0.0059	49	0.0041	65	0.0057	12
C10BEN4	45232	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	128	0.0000	0	0.0000	0	0.0001	129
STYRENE	45220	0.0065	15	0.0017	107	0.0028	54	0.0058	16	0.0052	13	0.0025	69	0.0053	32	0.0050	16
FORMALD	43502	0.0065	20	0.0512	39	0.0346	69	0.0107	22	0.0110	17	0.0808	35	0.0795	48	0.0191	20
ACETALD	43503	0.0035	9	0.0285	28	0.0074	35	0.0059	18	0.0038	13	0.0292	42	0.0110	31	0.0061	19
C4ALD	43510	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	126	0.0000	0	0.0000	0	0.0001	126
BENZALD	98157	0.0002	150	0.0000	0	0.0000	0	0.0001	150	0.0006	61	0.0064	119	0.0015	123	0.0012	85
MTBE	.	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0293	14	0.0175	29	0.0113	30	0.0265	14
ACETONE	43551	0.0013	16	0.0056	56	0.0048	57	0.0017	20	0.0027	13	0.0079	86	0.0040	48	0.0031	22
ACROLEIN	43505	0.0000	150	0.0000	0	0.0000	0	0.0000	150	0.0002	56	0.0000	0	0.0000	0	0.0002	57

PROPOSED

State of California
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

Adopted: May 20, 1987
Amended: December 20, 1989
Amended: January 22, 1990
Amended: December 26, 1990
Amended: July 12, 1991
Amended: August *19 12*, 1992
Amended: October 23, 1992
Amended: [*Phase 2 Cert Fuel Item*]
Amended: [ ]

NOTE: The regulatory amendments originally proposed in this rulemaking are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions compared to the version of the test procedures as amended on October 23, 1992. Modifications to the originally noticed text are shown by **bold *italics*** to indicate additions and ~~**bold italics**~~ to indicate deletions.

On August 13, 1992, the Air Resources Board approved amendments to section 9 of these test procedures pertaining to Phase 2 gasoline certification fuel specifications. These amendments have not yet been approved by the Office of Administrative Law. In this document, text added by the rulemaking on Phase 2 gasoline certification specifications is shown by *italics* to indicate additions and [~~*italicized strikeout in brackets*~~] to indicate deletions.

This document incorporates by reference various sections of the Code of Federal Regulations, some with modifications. In numerous instances, this document states that incorporated federal regulations are to be varied in some way. Where the directions introducing the variation are not entirely underlined, the variation is displayed in an underline and ~~strikeout~~ format showing changes from the referenced federal regulation as previously incorporated in the California test procedures. Where the directions introducing the variation are entirely underlined, the federal language which will be modified is underlined and the modifications are displayed in double underline and ~~strikeout~~ to indicate additions to or deletions from the federal language.

~~The numbering convention employed in this document, in order of priority, is: 1.a.1.i.A.~~ Any references within specific sections in the Code of Federal Regulations are denoted in order of priority as: (a)(1)(i)(A) - the same numbering system employed in the Code of Federal Regulations.

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NOTE: The page numbering convention of this document has been changed from previous versions.

Appendices

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CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES

The provisions of Subparts A, ~~and~~ B, and C, Part 86, Title 40, Code of Federal Regulations as set forth in Appendix I, to the extent they pertain to Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, are hereby adopted as the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, with the following exceptions and additions.

1. Applicability

   a. These test procedures are applicable to 1988 and subsequent model gasoline, gaseous, diesel, and, beginning in 1993, ~~methanol~~ alcohol passenger cars, light-duty trucks, and medium-duty vehicles. Procedures specific to transitional low-emission, low-emission, and ultra-low-emission vehicles are applicable to 1992 and subsequent model-year gasoline and diesel, and to 1993 and subsequent model-year alternate fuel and hybrid electric passenger cars, light-duty trucks, and medium-duty vehicles. Procedures specific to zero-emission vehicles are applicable to 1992 and subsequent model-year passenger cars, light-duty trucks and medium-duty vehicles. References to "light-duty trucks" in 40 CFR 86 shall apply both to "light-duty trucks" and "medium-duty vehicles" in these procedures.

   b. Any reference to vehicle sales throughout the United States shall mean vehicle sales in California.

   c. Regulations concerning EPA hearings, EPA inspections, specific language on the Certificate of Conformity, evaporative emissions high-altitude vehicles and testing, particulate and oxides of nitrogen averaging and engine family standards applicable in such averaging, alternative useful life, selective enforcement audit and heavy-duty engines and vehicles shall not be applicable to these procedures, except where specifically noted.

   d. Any reference to gasoline-powered vehicles shall also apply to vehicles powered by gaseous fuels.

   e. Regulations both herein and in Title 40, CFR Part 86, Subparts A, ~~and~~ B, and C, concerning otto-cycle and diesel-cycle vehicles shall be applicable to ~~methanol~~ alcohol vehicles, except where specifically noted otherwise.

   f. Regulations concerning ~~methanol~~ alcohol vehicles shall also be applicable to fuel-flexible vehicles, except where specifically noted otherwise.

g. For engines used in medium-duty vehicles which are not distinctly diesel engines nor derived from such, the Executive Officer shall determine whether the engines shall be subject to diesel or otto-cycle engine regulations, in consideration of the relative similarity of the engines' torque-speed characteristics and vehicle applications with those of otto-cycle and diesel engines.

2. Definitions

a. "Administrator" means the Executive Officer of the Air Resources Board (ARB).

b. "Certificate of Conformity" means Executive Order certifying vehicles for sale in California.

c. "Certification" means certification as defined in Section 39018 of the Health and Safety Code.

d. "Passenger car" means any motor vehicle designed primarily for transportation of persons and having a design capacity of 12 persons or less.

e. "Heavy-duty engine" means an engine which is used to propel a heavy-duty vehicle.

f. "Heavy-duty vehicle" means any motor vehicle having a manufacturer's gross vehicle weight rating greater than 6000 pounds, except passenger cars.

g. "Light-duty truck" means any motor vehicle, rated at 6000 pounds gross vehicle weight or less, which is designed primarily for purposes of transportation of property or is a derivative of such a vehicle, or is available with special features enabling off-street or off-highway operation and use.

h. "Medium-duty vehicle" means any pre-1995 model year heavy-duty vehicle having a manufacturer's gross vehicle weight rating of 8500 pounds or less and any 1995 and subsequent model year heavy-duty vehicle or any 1992 and subsequent model-year low-emission, ultra-low-emission, or zero-emission vehicle having a manufacturer's gross vehicle rating of 14,000 pounds or less.

i. "Gaseous fuels" means liquefied petroleum gas, compressed natural gas, or liquefied natural gas fuels for use in motor vehicles.

j. "Trap oxidizer system" means an emission control system which consists of a trap to collect particulate matter and a mechanism to oxidize the accumulated particulate.

k. "Regeneration" means the process of oxidizing accumulated particulate matter. It may occur continually or periodically.

l. "Periodically regenerating trap oxidizer system" means a trap oxidizer system that utilizes, during normal driving conditions for cleaning the trap, an automated regeneration mode which can be easily detected.

m. "Continually regenerating trap oxidizer system" means a trap oxidizer system that does not utilize an automated regeneration mode during normal driving conditions for cleaning the trap.

n. "Non-regeneration emission test" means a complete emission test which does not include a regeneration.

o. "Regeneration emission test" means a complete emission test which includes a regeneration.

p. "Regeneration interval" means the interval from the start of a regeneration to the start of the next regeneration.

q. "Useful Life" means a period of use denoted by the emission standards to which a given vehicle is certifying. For those light-duty and medium-duty vehicles certified to optional 100,000 mile standards and those 1993 and subsequent vehicles certified to 100,000 mile emission standards, and those transitional low-emission, low-emission, and ultra-low-emission vehicles, including hybrid electric vehicles, certified to 100,000 mile emission standards, the useful life shall be 10 years or 100,000 miles, whichever first occurs. For 1995 and subsequent medium-duty vehicles and medium-duty low-emission and ultra-low emission vehicles certified to 120,000 mile emission standards, the useful life shall be 11 years or 120,000 miles, whichever first occurs. For light-duty and medium-duty vehicles, certified only to 50,000 miles, the useful life shall be 5 years or 50,000 miles, whichever first occurs.

r. "Methanol" means any fuel for motor vehicles and motor vehicle engines that is composed of either commercially available or chemically pure methanol (CH_3OH) and gasoline as specified in section 9.a. (Fuel Specifications) of these procedures. The required fuel blend is based on the types of methanol-fueled vehicle being certified and the particular aspect of the certification procedure being conducted.

s. "Methanol vehicle" means any motor vehicle that is engineered and designed to be operated using methanol as a fuel.

t. "Fuel-Flexible Vehicle (FFV)" means any methanol-fueled or ethanol-fueled motor vehicle that is engineered and designed to be operated using any gasoline-methanol or gasoline-ethanol fuel mixture or blend.

u. "Dedicated Methanol Vehicle" means any methanol-fueled motor vehicle that is engineered and designed to be operated solely on methanol.

v. "Diesel-cycle" means powered by an engine where the primary means of controlling power output is by limiting of the amount of fuel that is injected into the combustion chambers of the engine.

w. "Otto-cycle" means powered by an engine where the primary means of controlling power output is by limiting the amount of air and fuel which can enter the combustion chambers of the engine. Gasoline-fueled engines are otto-cycle engines.

x. "Organic Material Hydrocarbon Equivalent" (or "OMHCE") means the sum of the carbon mass contributions of non-oxygenated hydrocarbons, methanol, and formaldehyde as contained in a gas sample, expressed as gasoline-fueled vehicle hydrocarbons. In the case of exhaust emissions, the hydrogen-to-carbon ratio of the equivalent hydrocarbon is 1.85:1. In the case of diurnal and hot-soak

emissions, the hydrogen-to-carbon ratios of the equivalent hydrocarbons are 2.33:1 and 2.2:1, respectively.

y. "Incomplete vehicle" means any vehicle which does not have the primary load carrying device or container attached. In situations where individual marketing relationships makes the status of the vehicle questionable, the Executive Officer shall determine whether a specific model complies with the definition of incomplete vehicle.

z. "Non-methane organic gas" (or "NMOG") means the sum of non-oxygenated and oxygenated hydrocarbons contained in a gas sample as measured in accordance with the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991 and last amended _____., ~~including, at a minimum, all oxygenated organic gases containing five or fewer carbon atoms (i.e., aldehydes, ketones, alcohols, ethers, etc.), and all known alkanes, alkenes, alkynes, and aromatics containing twelve or fewer carbon atoms. For diesel-fueled vehicles, non-methane organic gas shall mean the sum of all oxygenated organic gases containing five or fewer carbon atoms and all known alkanes, alkenes, alkynes, and aromatics containing twenty-five or fewer carbon atoms. To demonstrate compliance with an NMOG standard, NMOG emissions shall be measured in accordance with the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991.~~

Aa. "Dual-fuel vehicle" means any motor vehicle that is engineered and designed to be capable of operating on gasoline or diesel ~~a petroleum fuel~~ and on compressed natural gas or liquefied petroleum gas ~~another fuel~~, with ~~stored separately~~ fuel tanks for each fuel on-board the vehicle.

Ab. "Transitional low-emission vehicle" or "TLEV" means any vehicle certified to transitional low-emission standards.

Ac. "Low-emission vehicle" or "LEV" means any vehicle certified to low-emission standards.

Ad. "Ultra-low-emission vehicle" or "ULEV" means any vehicle certified to ultra-low emission standards.

Ae. "Zero-emission vehicle" or "ZEV" means any vehicle which is certified by the Executive Officer to produces zero emissions of any criteria pollutants under any and all possible operational modes and conditions. Incorporation of a fuel fired heater shall not preclude a vehicle from being certified as a ZEV provided the fuel fire heater cannot be operated at ambient temperatures above 40 degrees Fahrenheit and the heater is demonstrated to have zero evaporative emissions under any and all possible operational modes and conditions.

Af. "Electric vehicle" means any vehicle which operates solely by use of a battery or battery pack. This definition also includes vehicles which are powered mainly through the use of an electric battery or battery pack, but which use a flywheel that stores energy produced by the electric motor or through regenerative braking to assist in vehicle operation.

Ag. "Series hybrid electric vehicle" means any vehicle which allows power to be delivered to the driven wheels solely by a battery powered electric motor, but which also incorporates the use of a combustion engine to provide power to the battery and/or electric motor.

Ah. "Parallel hybrid electric vehicle" means any vehicle which allows power to be delivered to the driven wheels by either a combustion engine and/or by a battery powered electric motor.

Ai. "Battery assisted combustion engine vehicle" means any vehicle which allows power to be delivered to the driven wheels solely by a combustion engine, but which uses a battery pack to store energy which may be derived through remote charging, regenerative braking, and/or a flywheel energy storage system or other means which will be used by an electric motor to assist in vehicle operation.

Aj. "Hybrid electric vehicle" means any vehicle which is included in the definition of a "series hybrid electric vehicle", a "parallel hybrid electric vehicle", or a "battery assisted combustion engine vehicle".

Ak. "Diesel Engine" means any engine powered with diesel fuel, gaseous fuel, ethanol, or methanol for which diesel engine speed/torque characteristics and vehicle applications are retained.

Al. "Fuel fired heater" means a fuel burning device which creates heat for the purpose of warming the passenger compartment of a vehicle but does not contribute to the propulsion of the vehicle.

Am. "Conventional gasoline" means any certification gasoline which ~~whose specifications are substantially equivalent to gasoline available commercially in the 1989 calendar year, as determined by the Executive Officer~~ meets the specifications of 86.113-90(a), 40 CFR 86, including the specifications of (a)(1)(i) but excluding the specifications of (a)(1)(ii) as amended by Section 9.a.1. of these test procedures. For the purpose of determining the ozone-forming potential of conventional gasoline vehicle exhaust emissions, gasoline meeting the specifications of Appendix VIII, note (9) of these test procedures shall be used.

An. "Reactivity adjustment factor" means a fraction applied to the mass of NMOG emissions from a vehicle powered by a fuel other than conventional gasoline for the purpose of determining a gasoline-equivalent NMOG emission value. The reactivity adjustment factor is defined as the ozone-forming potential of the exhaust from a vehicle powered by a fuel other than conventional gasoline divided by the ozone-forming potential of conventional gasoline vehicle exhaust.

Ao. "Intermediate volume manufacturer" is any vehicle manufacturer with California sales between 3,001 and 35,000 new light- and medium-duty vehicles per model year based on the average number of vehicles sold by the manufacturer each year from 1989 to 1993; however, for manufacturers certifying for the first time in California, model-year sales shall be based on projected California sales.

Ap. "Certification level" means the official exhaust or evaporative emission result from an emission-data vehicle which has been adjusted by the applicable mass deterioration factor and is submitted to the Executive Officer for use in determining compliance with an emission standard for the purpose of certifying a particular engine family. For those engine families which are certified using reactivity adjustment factors developed by the manufacturer pursuant to Appendix VIII of these test procedures, the exhaust NMOG certification level shall include adjustment by the ozone deterioration factor.

Aq. "Ozone deterioration factor" means a factor applied to the mass of NMOG emissions from TLEVs, LEVs, or ULEVs which accounts for changes in the ozone-forming potential of the NMOG emissions from a vehicle as it accumulates mileage.

Ar. "Organic material non-methane hydrocarbon equivalent" (or "OMNMHCE") for methanol-fueled vehicles means the sum of the carbon mass contribution of non-oxygenated hydrocarbons (excluding methane), methanol, and formaldehyde as contained in a gas sample, expressed as gasoline-fueled hydrocarbons. For ethanol-fueled vehicles, "organic material non-methane hydrocarbon equivalent" (or "OMNMHCE") means the sum of carbon mass contribution of non-oxygenated hydrocarbons (excluding methane), methanol, ethanol, formaldehyde and acetaldehyde as contained in a gas sample, expressed as gasoline-fueled hydrocarbons.

As. "Battery pack" means any electrical energy storage device consisting of any number of individual battery modules which is used to propel electric or hybrid electric vehicles.

At. "Type A hybrid electric vehicle" means a hybrid electric vehicle which achieves a minimum range of 60 miles in the All-Electric Range Test, while maintaining minimal speed and time requirements throughout the test and without use of the auxiliary power unit.

Au. "Type B hybrid electric vehicle" means a hybrid electric vehicle which achieves a range of 40 to 59 miles in the All-Electric Range Test, while maintaining minimal speed and time requirements throughout the test and without use of the auxiliary power unit.

Av. "Type C hybrid electric vehicle" means a hybrid electric vehicle which achieves a range of 0 to 39 miles in the All-Electric Range Test, while maintaining minimal speed and time requirements throughout the test and without use of the auxiliary power unit, or which has been designated by the manufacturer as having a range of less than 40 miles without the use of the auxiliary power unit. This definition shall also apply to any hybrid electric vehicle which allows the operator to control the time or mode of operation of the auxiliary power unit either directly or indirectly~~,~~ ***(with the exception that a mechanism which allows the operator only to shut off the auxiliary power unit is permissible for Type A and Type B HEVs)***, to any hybrid electric vehicle which can be operated solely through the use of the auxiliary power unit, to any hybrid electric vehicle which utilizes a climate control system that cannot be operated without using the auxiliary power unit, and all other

types of hybrid electric vehicles, excluding Type A and Type B hybrid electric vehicles.

Aw. "All-Electric Range Test" means a test sequence used to determine the range of an electric vehicle or of a hybrid electric vehicle without the use of its auxiliary power unit. The All-Electric Range Test cycle consists of alternating the Highway Fuel Economy Schedule and the Urban Dynamometer Driving Schedule (see 9.f. of these test procedures).

Ax. "Defeat Device" means an auxiliary emission control device (AECD) that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use, unless (1) such conditions are substantially included in the Federal emission test procedure, (2) the need for the AECD is justified in terms of protecting the vehicle against damage or accident, or (3) the AECD does not go beyond the requirements of engine starting.

Ay. "Element of Design" means any control system (i.e., computer software, electronic control system, emission control system, computer logic), and/or control system calibrations and/or the results of systems interaction, and/or hardware items on a motor vehicle or motor vehicle engine.

Az. "Intermediate Temperature Cold Testing" means testing done pursuant to the driving cycle and testing conditions contained in 40 CFR Part 86 Subpart C, at temperatures between 25°F (-4°C) and 68°F (20°C).

Ba. "Ethanol vehicle" means any motor vehicle that is engineered and designed to be operated using ethanol as a fuel.

Bb. "Dedicated Ethanol Vehicle" means any ethanol-fueled motor vehicle that is engineered and designed to be operated solely on ethanol.

Bc. "Ethanol" means any fuel for motor vehicles and motor vehicle engines that is composed of either commercially available or chemically pure ethanol (CH_3CH_2OH) and gasoline as specified in section 9.a. (Fuel Specifications) of these test procedures. The required fuel blend is based on the type of ethanol-fueled vehicle being certified and the particular aspect of the certification procedure being conducted.

Bd. "Alcohol fuel" means either methanol or ethanol as those terms are defined in these test procedures.

Be. "Methane Reactivity Adjustment Factor" means a factor applied to the mass of methane emissions from natural gas fueled vehicles for the purpose of determining the gasoline equivalent ozone-forming potential of the methane emissions.

Bf. "Natural gas" means either compressed natural gas or liquefied natural gas.

Bg. "Natural gas vehicle" means any motor vehicle that is engineered and designed to be operated using either compressed natural gas or liquefied natural gas.

3. Standards

The following standards represent the maximum projected exhaust emissions for the useful life of the vehicle.

a. The exhaust emissions from new 1988 model passenger cars, light-duty trucks, and medium-duty vehicles shall not exceed:

1988 EXHAUST EMISSIONS STANDARDS(5)(6)
(grams per mile)

Vehicle Type(1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Non-Methane Hydro-carbons(2)	Carbon Monoxide	Oxides of Nitrogen (3)
PC	All	50,000	0.39 (0.41)	7.0	0.4
PC(4)	All	50,000	0.39 (0.41)	7.0	0.7
PC (Option 1)	All	100,000	0.39 (0.41)	7.0	1.0
PC (Option 2)	All	100,000	0.46	8.3	1.0
LDT,MDV	0-3750	50,000	0.39 (0.41)	9.0	0.4
LDT,MDV (4)	0-3750	50,000	0.39 (0.41)	9.0	1.0
LDT,MDV (Option 1)	0-3750	100,000	0.39 (0.41)	9.0	1.0
LDT,MDV (Option 2)	0-3750	100,000	0.46	10.6	1.0
LDT,MDV	3751-5750	50,000	0.50 (0.50)	9.0	1.0
LDT,MDV (Option 1)	3751-5750	100,000	0.50 (0.50)	9.0	1.5
MDV	5751 & larger	50,000	0.60 (0.60)	9.0	1.5
MDV (Option 1)	5751 & larger	100,000	0.60 (0.60)	9.0	2.0

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.

(2) Hydrocarbon standards in parentheses apply to total hydrocarbons. In order to demonstrate compliance with a non-methane hydrocarbon emission standard, hydrocarbon emissions shall be measured in accordance with the "California Non-Methane Hydrocarbon Test Procedures."

(3) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 1.33 times the applicable passenger car standards and 2.00 times the applicable light-duty trucks and medium-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(4) This set of standards for 1988 and later model vehicles is optional. A manufacturer may choose to certify to these optional standards pursuant to the conditions set forth in Section 1960.1.5 of Title 13, California Code of Regulations.

(5) Diesel passenger cars, light-duty trucks, and medium-duty vehicles, except those fueled with methanol, are subject to the following particulate exhaust emission standards: 0.2 g/mi for the 1988 model years. The particulate compliance shall be determined on a 50,000 mile durability vehicle basis.

(6) For gaseous-fueled vehicles the calculation procedures provided in Appendix V shall be used for determining emissions and fuel economy.

b. The exhaust emissions from (i) new 1989 through 1992 model passenger cars and light-duty trucks, except those produced by a small volume manufacturer, (ii) new 1991 through 1994 model passenger cars and light-duty trucks produced by a small volume manufacturer, (iii) new 1989 through 1994 model medium-duty vehicles, except those produced by a small volume manufacturer, and (iv) new 1991 through 1994 model medium-duty vehicles produced by a small volume manufacturer, shall not exceed:

1989 THROUGH 1994 MODEL YEAR
EXHAUST EMISSIONS STANDARDS (5)(6)
(grams per mile)

Vehicle Type(1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Non-Methane Hydro-carbons(2)	Carbon Monoxide	Oxides of Nitrogen (3)(4)
PC	All	50,000	0.39 (0.41)	7.0	0.4
PC(7)	All	50,000	0.39 (0.41)	7.0	0.7
Diesel PC (Option 2)	All	100,000(9)	0.46	8.3	1.0
LDT,MDV	0-3750	50,000	0.39 (0.41)	9.0	0.4
LDT,MDV (7)	0-3750	50,000	0.39 (0.41)	9.0	0.7(8)
~~Diesel LDT, MDV (Option 2)~~	~~0-3750~~	~~100,000(9)~~	~~0.46~~	~~10.6~~	~~1.0~~
LDT,MDV	3751-5750	50,000	0.50 (0.50)	9.0	1.0
LDT,MDV (Option 1)	3751-5750	100,000(9)	0.50 (0.50)	9.0	1.5
MDV	5751 & larger	50,000	0.60 (0.60)	9.0	1.5
MDV (Option 1)	5751 & larger	100,000(9)	0.60 (0.60)	9.0	2.0

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.

(2) Hydrocarbon standards in parentheses apply to total hydrocarbons. In order to demonstrate compliance with a non-methane hydrocarbon emission standard, hydrocarbon emissions shall be measured in accordance with the "California Non-Methane Hydrocarbon Test Procedures". For 1993 through 1994 model methanol-fueled vehicles certifying to these standards, including ~~flexible-fueled~~ fuel-flexible vehicles, "Non-Methane Hydrocarbons" shall mean "Organic Material Hydrocarbon Equivalent" (or "OMHCE").

(3) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 1.33 times the applicable passenger car standards and 2.00 times the applicable light-duty trucks and medium-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(4) The standard for in-use compliance for passenger cars, light-duty trucks and medium-duty vehicles certifying to the 0.4 g/mi NOx standard shall be 0.55 g/mi NOx for 50,000 miles. If the in-use compliance level is above 0.4 g/mi NOx but does not exceed 0.55 g/mi NOx, and based on a review of information derived from a statistically valid and representative sample of vehicles, the Executive Officer determines that a substantial percentage of any class or category of such vehicles exhibits, prior to 50,000 miles or 5 years, whichever occurs first, an identifiable, systematic defect in a component listed in Section 1960.1.5(c)(2), Title 13, California Code of Regulations, which causes a significant increase in emissions above those exhibited by vehicles free of such defects and of the same class or category and having the same period of use and mileage, then the Executive Officer may invoke the enforcement authority under Subchapter 2.5, Title 13, California Code of Regulations, commencing with Section 2111, to require remedial action by the vehicle manufacturer. Such remedial action shall be limited to owner notification and repair or replacement of the defective component. As used in this section, the term "defect" shall not include failures which are the result of abuse, neglect, or improper maintenance. This provision is applicable for the 1989 through 1992 model years only. For small volume manufacturers, this provision is applicable for the 1991 through 1994 model years only.

(5) Diesel passenger cars, light-duty trucks, and medium-duty vehicles certifying to these standards are subject to a particulate exhaust emission standard of 0.08 g/mi for the 1989 and subsequent model years. The particulate compliance shall be determined on a 50,000 mile durability vehicle basis.

(6) For gaseous-fueled vehicles certifying to these standards, the calculation procedures provided in Appendix V shall be used for determining emissions and fuel economy.

(7) This set of standards is optional. A manufacturer may choose to certify to these standards pursuant to the conditions set forth in Section 1960.1.5 of Title 13, California Code of Regulations.

(8) Pursuant to Section 1960.1.5(a)(1)(B), Title 13, California Code of Regulations the optional standard for 1989 model year light-duty trucks and medium-duty vehicles only is 1.0 g/mi NOx.

(9) The optional 100,000 mile certification standards and provisions are not applicable to ~~methanol~~ alcohol vehicles.

c. The exhaust emissions from new 1993 and subsequent model dedicated ~~methanol~~ alcohol vehicles and fuel-flexible vehicles shall meet all the requirements in Sections 3.b., 3.e, and 3.f. of these test procedures with the following modifications and additions:

1993 AND SUBSEQUENT METHANOL-SPECIFIC AND ETHANOL-SPECIFIC EXHAUST EMISSION STANDARDS

Vehicle Type	Loaded Vehicle Weight (lbs.)(3)	Durability Vehicle Basis (mi)	Formaldehyde (mg/mi) Certification	Formaldehyde (mg/mi) In-Use Compliance (2)
PC	All	50,000	15	23 (1993-1995) 15 (1996 and later)
LDT,MDV	0-3750	50,000	15	23 (1993-1995) 15 (1996 and later)
LDT,MDV	3751-5750	50,000	18	27 (1993-1995) 18 (1996 and later)
MDV	5751-8500	50,000	22	33 (1993-1995) 22 (1996 and later)
MDV	8501-10,000	50,000	28	36 (1995) 28 (1996 and later)
MDV	10,001-14,000	50,000	36	45 (1995) 36 (1996 and later)

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.

(2) If the formaldehyde in-use compliance level is above the respective certification level but does not exceed the in-use compliance level, and based on a review of information derived from a statistically valid and representative sample of vehicles, the Executive Officer determines that a substantial percentage of any class or category of such vehicle exhibits, prior to 50,000 miles or 5 years, whichever occurs first, an identifiable, systematic defect in a component listed in Section 1960.1.5(c)(2), Title 13 California Code of Regulations, which causes a significant increase in emissions above those exhibited by vehicles free of such defects and of the same class or category and having the same period of use and mileage, the Executive Officer may invoke the enforcement authority under subchapter 2.5, Title 13, California Code of Regulations, commencing with Section 2111, to require remedial action by the vehicle manufacturer. Such remedial action shall be limited to owner notification and repair or replacement of the defect component. As used in this section, the term "defect" shall not include failures which are the result of abuse, neglect, or improper maintenance.

(3) For 1995 and subsequent model year medium-duty vehicles certifying to the standards and test procedures specified in Section 1960.1 (h)(1), Title 13, California Code of Regulations, "Loaded Vehicle Weight" shall mean "Test Weight", which is the average of the vehicle's curb weight and gross vehicle weight.

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d. The exhaust emission levels from 1992 and subsequent model-year transitional low-emission vehicles, low-emission vehicles, and ultra-low-emission vehicles, including fuel-flexible and dual-fuel vehicles, shall meet all the requirements of Sections 3.g and 3.j of these test procedures with the following additions:

EXHAUST EMISSION STANDARDS
FOR TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES,
AND ULTRA-LOW-EMISSION VEHICLES IN THE
LIGHT-DUTY AND MEDIUM-DUTY VEHICLE WEIGHT CLASSES (5)(6)
["milligrams per mile" (or "mg/mi")]

Vehicle Type (1)	Vehicle Weight (lbs.)(2)	Durability Vehicle Basis (mi)	Vehicle Emission Category(3)	Formaldehyde (mg/mi)(4)
PC and LDT	All 0-3750	50,000	TLEV	15 (23)
			LEV	15 (15)
			ULEV	8 (12)
		100,000	TLEV	18
			LEV	18
			ULEV	11
LDT	3751-5750	50,000	TLEV	18 (27)
			LEV	18 (18)
			ULEV	9 (14)
		100,000	TLEV	23
			LEV	23
			ULEV	13
MDV	0-3750	50,000	LEV	15 (15)
			ULEV	8 (12)
		120,000	LEV	22
			ULEV	12
MDV	3751-5750	50,000	LEV	18 (18)
			ULEV	9 (14)
		120,000	LEV	27
			ULEV	13
MDV	5751-8500	50,000	LEV	22 (22)
			ULEV	11 (17)
		120,000	LEV	32
			ULEV	16
MDV	8501-10,000	50,000	LEV	28 (28)
			ULEV	14 (21)
		120,000	LEV	40
			ULEV	21
MDV	10,001-14,000	50,000	LEV	36 (36)
			ULEV	18 (27)
		120,000	LEV	52
			ULEV	26

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(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.

(2) For light-duty or medium-duty vehicles, Vehicle Weight shall mean "Loaded Vehicle Weight" (or "LVW") or "Test Weight" (or "TW"), respectively.

(3) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(4) The standards in parentheses are intermediate in-use compliance standards for 50,000 miles.

a. For PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles, intermediate in-use compliance standards shall apply to TLEVs through the 1995 model year, and LEVs and ULEVs through the 1998 model year. In-use Gcompliance with standards beyond 50,000 miles shall be waived through the 1995 model year for TLEVs and through the 1998 model year for LEVs and ULEVs.

b. For MDVs from 0-14,000 lbs. TW, including fuel-flexible and dual-fuel vehicles, intermediate in-use compliance standards shall apply to LEVs and ULEVs through the 1999 model year. In-use Gcompliance with standards beyond 50,000 miles shall be waived through the 1999 model year for LEVs and ULEVs.

(5) Manufacturers shall demonstrate compliance with the above standards for formaldehyde at 50 degrees F, according to the procedure specified in Section 11k of these test procedures. Hybrid electric vehicles, natural gas vehicles, and diesel-fueled vehicles shall be exempt from 50 degrees F test requirements. ~~the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, as adopted May 20, 1987, and last amended July 12, 1991.~~

(6) In-use compliance testing shall be limited to PCs and LDTs with fewer than 75,000 miles and MDVs with fewer than 90,000 miles.

e. The exhaust emissions from new 1993 and 1994 model passenger cars and light-duty trucks, except those produced by a small volume manufacturer, shall not exceed:

1993 AND 1994 MODEL-YEAR PASSENGER CAR AND
LIGHT-DUTY TRUCK EXHAUST EMISSIONS STANDARDS (5)(6)(10)
(grams per mile)

Vehicle Type(1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Non-Methane Hydrocarbons (2)(8)(9)	Carbon Monoxide (8)(9)	Oxides of Nitrogen (1)(3)(4)
PC	All	50,000	0.39 (0.25)	7.0 (3.4)	0.4
PC(7)	All	50,000	0.39 (0.25)	7.0 (3.4)	0.7
PC	All	100,000	(0.31)	(4.2)	n/a
Diesel PC (Option 2)	All	100,000	0.46 (0.31)	8.3 (4.2)	1.0
LDT	0-3750	50,000	0.39 (0.25)	9.0 (3.4)	0.4
LDT (7)	0-3750	50,000	0.39 (0.25)	9.0 (3.4)	0.7
LDT	0-3750	100,000	(0.31)	(4.2)	n/a
Diesel LDT (Option 2)	0-3750	100,000	0.46 (0.31)	10.6 (4.2)	1.0
LDT	3751-5750	50,000	0.50 (0.32)	9.0 (4.4)	1.0
LDT	3751-5750	100,000	(0.40)	(5.5)	n/a
Diesel LDT (Option 1)	3751-5750	100,000	0.50 (0.40)	9.0 (5.5)	1.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"n/a" means not applicable.

(2) In order to demonstrate compliance with a non-methane hydrocarbon emission standard, hydrocarbon emissions shall be measured in accordance with the "California Non-Methane Hydrocarbon Test Procedures." For methanol-fueled vehicles certifying to these standards, including fuel-flexible-fueled vehicles when certifying on methanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Hydrocarbon Equivalent" (or "OMHCE"). For alcohol vehicles certifying to the phase-in standards in parenthesis, including fuel-flexible vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(3) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 1.33 times the applicable passenger car standards and 2.00 times the applicable light-duty truck and medium-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(4) The standard for in-use compliance for passenger cars and light-duty trucks certifying to the 0.4 g/mi NOx standard shall be 0.55 g/mi NOx for 50,000 miles. If the in-use compliance level is above 0.4 g/mi NOx but does not exceed 0.55 g/mi NOx, and based on a review of information derived from a statistically valid and representative sample of vehicles, the Executive Officer determines that a substantial percentage of any class or category of such vehicles exhibits, prior to 50,000

miles or 5 years, whichever occurs first, an identifiable, systematic defect in a component listed in Section 1960.1.5(c)(2), Title 13 California Code of Regulations, which causes a significant increase in emissions above those exhibited by vehicles free of such defects and of the same class or category and having the same period of use and mileage, then the Executive Officer may invoke the enforcement authority under subchapter 2.5, Title 13, California Code of Regulations, commencing with Section 2111, to require remedial action by the vehicle manufacturer. Such remedial action shall be limited to owner notification and repair or replacement of the defective component. As used in this section, the term "defect" shall not include failures which are the result of abuse, neglect, or improper maintenance. This provision is applicable for the 1993 model year only.

(5) Diesel passenger cars and light-duty trucks certifying to these standards are subject to a particulate exhaust emission standard of 0.08 g/mi, determined on a 50,000 mile durability vehicle basis.

(6) For gaseous-fueled vehicles certifying to these standards, the calculation procedures provided in Appendix V shall be used for determining emissions and fuel economy.

(7) This set of standards is optional. A manufacturer may choose to certify to these standards pursuant to the conditions set forth in Section 1960.1.5 of Title 13, California Code of Regulations.

(8) The emission standards in parenthesis are phase-in standards. For the 1993 model year, each manufacturer must certify a minimum of 40% of their vehicles to the phase-in standards or to the more stringent standards in Section 3.g of these test procedures. ~~For the 1994 model year, each manufacturer must certify a minimum of 80% of their vehicles to the phase-in standards or to the more stringent standards in Section g of these test procedures. The percentages shall be applied to the~~ manufacturers' total projected sales of California-certified passenger cars and light-duty trucks for the 1993 model year. For 1994 and subsequent model years, manufacturers shall comply with the fleet average requirements specified in Section 3.h. of these test procedures.

(9) The following conditions shall apply to the in-use compliance standards of 1993 and 1994 model-year passenger cars and light-duty trucks only.

(a) The in-use compliance standards for those passenger cars and light-duty trucks certifying to the 0.25 g/mi non-methane hydrocarbon and 3.4 g/mi carbon monoxide standards shall be 0.32 g/mi non-methane hydrocarbon and 5.2 g/mi carbon monoxide for 50,000 miles.

(b) The in-use compliance standards for those light-duty trucks certifying to the 0.32 g/mi non-methane hydrocarbon and 4.4 g/mi carbon monoxide standards shall be 0.41 g/mi non-methane hydrocarbon and 6.7 g/mi carbon monoxide for 50,000 miles.

(c) In-use compliance standards shall be waived beyond 50,000 miles.

(10) All passenger cars and light-duty trucks, except those diesel vehicles certifying to optional 100,000 mile standards, are subject to non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards determined on a 50,000 mile durability basis and non-methane hydrocarbon and carbon monoxide standards determined on a 100,000 mile basis.

f. The exhaust emissions from new 1995 and subsequent model passenger cars and light-duty trucks shall not exceed:

1995 AND SUBSEQUENT MODEL-YEAR PASSENGER CAR AND LIGHT-DUTY TRUCK EXHAUST EMISSIONS STANDARDS (5)(6)(8)(9)(11)
(grams per mile)

Vehicle Type(1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Non-Methane Hydrocarbons (2)(7)	Carbon Monoxide (7)	Oxides of Nitrogen (1)(3)
PC	All	50,000	0.25	3.4	0.4(4)
PC	All	100,000	0.31	4.2	0.6(10)n/a
Diesel PC (Option 2)	All	100,000	0.31	4.2	1.0
LDT	0-3750	50,000	0.25	3.4	0.4(4)
LDT	0-3750	100,000	0.31	4.2	0.6(10)n/a
Diesel LDT (Option 2)	0-3750	100,000	0.31	4.2	1.0
LDT	3751-5750	50,000	0.32	4.4	0.7
LDT	3751-5750	100,000	0.40	5.5	0.97(10)n/a
Diesel LDT (Option 1)	3751-5750	100,000	0.40	5.5	1.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
~~"n/a" means not applicable.~~

(2) In order to demonstrate compliance with a non-methane hydrocarbon emission standard, hydrocarbon emissions shall be measured in accordance with the "California Non-Methane Hydrocarbon Test Procedures." For ~~methanol~~ alcohol-fueled vehicles certifying to these standards, including fuel-flexible-~~fueled~~ vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(3) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 1.33 times the applicable passenger car standards and 2.00 times the applicable light-duty truck standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(4) Small volume manufacturers may choose to certify to an optional 0.7 g/mi NOx standard for the 1995 model year only, pursuant to the conditions set forth in Title 13, California Code of Regulations, Sections 1960.1 (f)(1) and 1960.1.5.

(5) Diesel passenger cars and light-duty trucks certifying to these standards are subject to a ~~particulate exhaust emission~~ standard of 0.08 g/mi, ~~determined on a 50,000 mile~~ durability vehicle basis.

(6) For gaseous-fueled vehicles certifying to these standards, the calculation procedures provided in Appendix V shall be used for determining ~~emissions~~ and fuel economy.

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(7) For all vehicles, except those certifying to optional diesel standards, in-use compliance with the exhaust emission standards shall be limited to vehicles with less than 75,000 miles.

(8) For the 1995 and 1996 model years, all manufacturers, except those certifying to optional diesel standards, are permitted alternative in-use compliance. Alternative in-use compliance is permitted for 60% of a manufacturer's vehicles in the 1995 model year and 20% of a manufacturer's vehicles in the 1996 model year. For the 1995 and 1996 model years, small volume manufacturers only are permitted alternative in-use compliance for 100% of the fleet. The percentages shall be applied to the manufacturers' total projected sales of California-~~certified~~ *-certified* passenger cars and light-duty trucks *~~certified to the emission standards in this Section 3.1 of these test procedures~~* for the model year. "Alternative in-use compliance" shall consist of the following:

a. For all passenger cars and those light-duty trucks from 0-3750 lbs., loaded vehicle weight, except those diesel vehicles certifying to optional 100,000 mile standards, in-use compliance standards shall be 0.32 g/mi non-methane hydrocarbon and 5.2 g/mi carbon monoxide for 50,000 miles.

b. For light-duty trucks from 3751-5750 lbs., loaded vehicle weight, except those diesel light-duty trucks certifying to optional 100,000 mile standards, in-use compliance standards shall be 0.41 g/mi non-methane hydrocarbon and 6.7 g/mi carbon monoxide for 50,000 miles.

c. In-use compliance standards shall be waived beyond 50,000 miles.

(9) All passenger cars and light-duty trucks, except those diesel vehicles certifying to optional standards, are subject to non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards determined on a 50,000 mile durability basis and non-methane hydrocarbon and carbon monoxide standards determined on a 100,000 mile durability basis.

(10) All 1996 and subsequent model-year PCs and LDTs shall comply with the applicable 100,000 mile standards for NOx.

(11) Each manufacturer shall certify PCs or LDTs to the exhaust emission standards of Sections 3.f. and 3.g. of these test procedures, or as Zero-Emission Vehicles, such that the manufacturer's fleet average NMOG values for California-certified PCs and LDTs from 0-3750 lbs. Loaded Vehicle Weight (or "LVW"), and LDTs from 3751-5750 lbs. LVW produced and delivered for sale in California are less than or equal to the requirement for the corresponding Model Year, Vehicle Type, and LVW Class in Section 3.h. of these test procedures.

g. The exhaust emissions from new 1992 and subsequent model-year transitional low-emission vehicles, low-emission vehicles, and ultra-low-emission vehicles shall not exceed:

EXHAUST MASS EMISSION STANDARDS
FOR TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES, AND ULTRA-LOW-EMISSION VEHICLES IN PASSENGER CAR AND LIGHT-DUTY TRUCK VEHICLE CLASSES (6)(7)(8)(9)(10)
["grams per mile" (or "g/mi")]

Vehicle Type (1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Vehicle Emission Category (2)	Non-Methane Organic Gases (3)(4)	Carbon Monoxide	Oxides of Nitrogen (5)
PC and LDT	All 0-3750	50,000	TLEV	0.125 (0.188)	3.4 (3.4)	0.4 (0.4)
			LEV	0.075 (0.100)	3.4 (3.4)	0.2 (0.3)
			ULEV	0.040 (0.058)	1.7 (2.6)	0.2 (0.3)
		100,000	TLEV	0.156	4.2	0.6
			LEV	0.090	4.2	0.3
			ULEV	0.055	2.1	0.3
LDT	3751-5750	50,000	TLEV	0.160 (0.238)	4.4 (4.4)	0.7 (0.7)
			LEV	0.100 (0.128)	4.4 (4.4)	0.4 (0.5)
			ULEV	0.050 (0.075)	2.2 (3.3)	0.4 (0.5)
		100,000	TLEV	0.200	5.5	0.9
			LEV	0.130	5.5	0.5
			ULEV	0.070	2.8	0.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.

(2) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(3) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions. To demonstrate compliance with an NMOG standard, NMOG emissions shall be measured in accordance with the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991. For TLEVs, LEVs, and ULEVs certified to operate on any fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when certifying on any fuel other than conventional gasoline, manufacturers shall multiply the exhaust NMOG certification levels ~~mass emission levels at 50,000 and 100,000 miles~~ by the applicable reactivity adjustment factor set forth in Section 13 of these test procedures, or established by the Executive Officer pursuant to Appendix VIII of these test procedures. In addition, natural gas (NG) vehicles certifying to TLEV, LEV or ULEV standards shall calculate a reactivity-adjusted methane exhaust emission value by multiplying the methane exhaust certification level

by the applicable methane reactivity adjustment factor set forth in section 13 of these test procedures. The product of the exhaust NMOG certification levels ~~mass emission levels~~ and the reactivity adjustment factor shall be compared with the exhaust NMOG mass emission standards established for the particular vehicle emission category and fuel to determine compliance. For NG vehicles, the reactivity-adjusted NMOG value shall be added to the reactivity-adjusted methane value and then compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance.

a. Each manufacturer shall certify PCs or LDTs to meet the exhaust mass emission standards for TLEVs, LEVs, ULEVs, or to the exhaust emission standards of Sections 3.b., 3.e., or 3.f. of these test procedures, or as Zero-Emission Vehicles such that the manufacturer's fleet average NMOG values for California-certified PCs and LDTs from 0-3750 lbs. "Loaded Vehicle Weight" (or "LVW"), and LDTs from 3751-5750 lbs. LVW ~~sold~~ produced and delivered for sale in California are less than or equal to the requirement for the corresponding Model Year, Vehicle Type, and LVW Class in Section 3.h. of these test procedures.

(4) Fuel-flexible and dual-fuel PCs and LDTs from 0-5750 lbs. LVW shall be certified to exhaust mass emission standards for NMOG established for the operation of the vehicle on any available fuel other than ~~conventional~~ gasoline, and ~~conventional~~ gasoline as specified in Section 9.a.1. of these test procedures.

a. For TLEVs, LEVs, and ULEVs, when certifying for operation on a fuel other than ~~conventional~~ gasoline, manufacturers shall multiply the exhaust NMOG ~~mass~~ certification ~~emission~~ levels by the applicable reactivity adjustment factor. In addition to multiplying the exhaust NMOG certification levels by the applicable reactivity adjustment factor, NG vehicles shall multiply the exhaust methane certification level by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. The certification levels for fuel-flexible or dual-fuel vehicles when certifying on gasoline shall not be multiplied by a reactivity adjustment factor.

b. For PCs and LDTs from 0-3750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:

   (i) For TLEVs, 0.25 g/mi and 0.31 g/mi for 50,000 and 100,000 miles, respectively.

   (ii) For LEVs, 0.125 g/mi and 0.156 g/mi for 50,000 and 100,000 miles, respectively.

   (iii) For ULEVs, 0.075 g/mi and 0.090 g/mi for 50,000 and 100,000 miles, respectively.

c. For LDTs from 3751-5750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:

   (i) For TLEVs, 0.32 g/mi and 0.40 g/mi for 50,000 and 100,000 miles, respectively.

   (ii) For LEVs, 0.160 g/mi and 0.200 g/mi for 50,000 and 100,000 miles, respectively.

   (iii) For ULEVs, 0.100 g/mi and 0.130 g/mi for 50,000 and 100,000 miles, respectively.

(5) The maximum projected emissions of "Oxides of Nitrogen" (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR 600

Subpart B) shall not be greater than 1.33 times the applicable light-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) The standards in parentheses are intermediate in-use compliance standards for 50,000 miles. For PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, intermediate ~~in-use~~ compliance standards shall apply to TLEVs through the 1995 model year and to LEVs and ULEVs through the 1998 model year. In-use ~~C~~compliance with standards beyond 50,000 miles shall be waived through the 1995 model year for TLEVs, and through the 1998 model year for LEVs and ULEVs.

a. For TLEVs, LEVs, and ULEVs designed to operate on any fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on any fuel other than conventional gasoline, exhaust NMOG emission results ~~levels~~ shall be multiplied by the reactivity adjustment factor to determine compliance with intermediate in-use compliance standards for NMOG. In addition to multiplying the exhaust NMOG ~~certification level~~ ***emission results*** by the applicable reactivity adjustment factor, NG vehicles shall multiply the exhaust methane ~~certification level~~ ***emission results*** by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value.

b. For fuel-flexible and dual-fuel PCs and LDTs from 0-3750 lbs. LVW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.32 g/mi, 0.188 g/mi and 0.100 g/mi for TLEVs, LEVs and ULEVs, respectively.

c. For fuel-flexible and dual-fuel PCs and LDTs from 3751-5750 lbs. LVW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.41 g/mi, 0.238 g/mi and 0.128 g/mi for TLEVs, LEVs and ULEVs, respectively.

(7) Manufacturers of diesel vehicles shall also certify to particulate standards at 100,000 miles. For all PCs and LDTs from 0-5750 lbs, the particulate standard is 0.08 g/mi, 0.08 g/mi, and 0.04 g/mi for TLEVs, LEVs, and ULEVs, respectively.

(8) Manufacturers shall demonstrate compliance with the above standards for NMOG, carbon monoxide and NOx at 50 degrees F, according to the procedure specified in Section 11k of these test procedures. Hybrid electric vehicles, natural gas, and diesel-fueled vehicles shall be exempt for 50 degrees F test requirements. ~~California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, as Adopted May 20, 1987, Amended: December 20, 1989, Amended: January 22, 1990, Amended: December 26, 1990, Amended: July 12, 1991 and last amended INSERT. For diesel vehicles, compliance with the particulate standard shall also be demonstrated as specified in Section 11k of the foregoing test procedures.~~

(9) ~~In-use compliance testing shall be limited to vehicles with fewer than~~ 75,000 miles.

(10) Deterioration factors for hybrid electric vehicles shall be based on the emissions and mileage accumulation of the auxiliary power unit. For certification purposes only, Type A hybrid electric vehicles shall

demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors), and demonstrating compliance with 100,000 mile emission standards shall not be required. For certification purposes only, Type B hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 100,000 mile emission standards (using 75,000 mile deterioration factors). For certification purposes only, Type C hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 100,000 mile emission standards (using 100,000 mile deterioration factors).

h.. The fleet average non-methane organic gas exhaust mass emission values from the a manufacturer's sales of passenger cars and light-duty trucks produced and delivered for sale in California by a manufacturer each model year shall not exceed:

FLEET AVERAGE NON-METHANE ORGANIC GAS EXHAUST MASS EMISSION REQUIREMENTS FOR LIGHT-DUTY VEHICLE WEIGHT CLASSES (7)(8)(9)
["grams per mile" (or "g/mi")]

Vehicle Type (1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)(7)	Model Year	Fleet Average Non-Methane Organic Gases (2)(3)(4)(5)(6)
PC and LDT	All 0-3750	50,000	1994	0.250
			1995	0.231
			1996	0.225
			1997	0.202
			1998	0.157
			1999	0.113
			2000	0.073
			2001	0.070
			2002	0.068
			2003 and subsequent	0.062
LDT	3751-5750	50,000	1994	0.320
			1995	0.295
			1996	0.287
			1997	0.260
			1998	0.205
			1999	0.150
			2000	0.099
			2001	0.098
			2002	0.095
			2003 and subsequent	0.093

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.

(2) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions.

(3) For the purpose of calculating fleet average NMOG values, vehicles which have no tailpipe emissions but use fuel fired heaters and which are not certified as ZEVs shall be treated as Type A Hybrid Electric Vehicles Ultra-Low-Emission Vehicles (or "Type A HEV ULEVs"). manufacturer may adjust the certification levels of hybrid electric vehicles (or "HEVs") based on the range of the HEV without the use of the engine. For the purpose of calculating the adjusted NMOG emission levels, the following definitions shall apply.
"Type A HEV" shall mean an HEV which achieves a minimum range of 60 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET, 40 CFR Part 600 Subpart B) without the use of an auxiliary engine. Use of vehicle accessories cannot lower the range below 60 miles. This definition shall also apply to vehicles which have no tailpipe emissions, but

use fuel fired heaters, regardless of the operating range of the vehicle.

"Type B HEV" shall mean an HEV which achieves a range of 40 - 59 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET, 40 CFR Part 600 Subpart B) without the use of an auxiliary engine. Use of vehicle accessories cannot lower the range below 40 miles.

"Type C HEV" shall mean an HEV which achieves a range of 0 - 39 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET, 40 CFR Part 600 Subpart B) without the use of an auxiliary engine, an HEV which allows the operators of the vehicle to control the engine time and modes of operation either directly or indirectly, an HEV which can be operated solely through the use of the engine, and all other HEVs excluding "Type A" and "Type B" HEVs.

(4) Each manufacturer's fleet average NMOG value for the total number of PCs and LDTs from 0-3750 lbs. "Loaded Vehicle Weight" (or "LVW") ~~sold~~ produced and delivered for sale in California shall be calculated in units of g/mi NMOG according to the following equation, where the term "Produced" means produced and delivered for sale in California as: [[(No. of Vehicles Certified to the Exhaust Emission Standards in Section 3.b. of these test procedures and Produced ~~Sold~~) x (0.39)] + [(No. of Vehicles Certified to the Exhaust Emission Standards in Section 3.e. of these test procedures and Produced) x (0.25)] + [(No. of Vehicles Certified to the Exhaust Emission Standards in Section 3.f. of these test procedures and Produced ~~Sold~~) x (0.25)] + [(No. of Transitional Low-Emission Vehicles (or "TLEVs") Produced ~~Sold~~ excluding HEVs) x (0.125)] + [(No. of Low-Emission Vehicles (or "LEVs") Produced ~~Sold~~ excluding HEVs) x (0.075)] + [(No. of Ultra-Low-Emission Vehicles (or "ULEVs") Produced ~~Sold~~ excluding HEVs) x (0.040)] + (HEV contribution factor)]/[Total No. of Vehicles Produced ~~Sold~~, Including Zero-Emission Vehicles ("ZEVs") and HEVs].

a. "HEV contribution factor" shall mean the NMOG emission contribution of HEVs to a manufacturer's fleet average NMOG value. The HEV contribution factor shall be calculated in units of g/mi as follows, where the term "Produced" means produced and delivered for sale in California:
HEV contribution factor = {[No. of "Type A HEV" TLEVs Produced ~~Sold~~] x (0.100) + [No. of "Type B HEV" TLEVs Produced ~~Sold~~] x (0.113) + [No. of "Type C HEV" TLEVs Produced ~~Sold~~] x (0.125)} + {[No. of "Type A HEV" LEVs Produced ~~Sold~~] x (0.057) + [No. of "Type B HEV" LEVs Produced ~~Sold~~] x (0.066) + [No. of "Type C HEV" LEVs Produced ~~Sold~~] x (0.075)} + {[No. of "Type A HEV" ULEVs Produced ~~Sold~~] x (0.020) + [No. of "Type B HEV" ULEVs Produced ~~Sold~~] x (0.030) + [No. of "Type C HEV" ULEVs Produced ~~Sold~~] x (0.040)}

b. ZEVs classified as LDTs 3751-5750 lbs. LVW which have been counted toward the ZEV requirement for PCs and LDTs 0-3750 lbs. LVW as specified in note (9) shall be included in the above equation of note (4) ~~calculation may not be included in the calculation of vehicle emission credits for medium-duty vehicles in footnote 12 of Section j of these test procedures~~.

c. Beginning with the 1996 model year, manufacturers that produce and deliver for sale in California LDTs 0-3750 lbs. LVW that are certified to the Tier I exhaust emission standards in 40 CFR

86.094-8 and 86.094-9 shall add the following term to the numerator of the fleet average NMOG equation in note (4) and calculate their fleet average values accordingly:
[(No. of Vehicles Certified to federal Tier I exhaust emission standards and Produced) x (0.25)].

(5) Manufacturers that certify LDTs from 3751-5750 lbs. LVW, shall calculate a fleet average NMOG value in units of g/mi NMOG according to the following equation, where the term "Produced" means produced and delivered for sale in California as: {[(No. of Vehicles Certified to the Exhaust Emission Standards in Section 3.b. of these test procedures and Produced ~~Sold~~ x (0.50)] + [(No. of Vehicles Certified to the Phase-In Exhaust Emission Standards in Section 3.e. of these test procedures and Produced) x (0.32)] + [(No. of Vehicles Certified to the Exhaust Emission Standards in Section 3.f. of these test procedures and Produced ~~Sold~~) x (0.32)] + [(No. of TLEVs Produced ~~Sold~~ excluding HEVs) x (0.160)] + [(No. of LEVs Produced ~~Sold~~ excluding HEVs) x (0.100)] + [(No. of ULEVs Produced ~~Sold~~ excluding HEVs) x (0.050)] + (HEV contribution factor)}/(Total No. of Vehicles Produced ~~Sold~~, Including ZEVs and HEVs).

a. "HEV contribution factor" shall mean the NMOG emission contribution of HEVs to a manufacturer's fleet average NMOG value. The HEV contribution factor shall be calculated in units of g/mi as follows, where the term "Produced" means produced and delivered for sale in California:
HEV contribution factor = {[No. of "Type A HEV" TLEVs Produced ~~Sold~~] x (0.130) + [No. of "Type B HEV" TLEVs Produced ~~Sold~~] x (0.145) + [No. of "Type C HEV" TLEVs Produced ~~Sold~~] x (0.160)} + {[No. of "Type A HEV" LEVs Produced ~~Sold~~] x (0.075) + [No. of "Type B HEV" LEVs Produced ~~Sold~~] x (0.087) + [No. of "Type C HEV" LEVs Produced ~~Sold~~] x (0.100)} + {[No. of "Type A HEV" ULEVs Produced ~~Sold~~] x (0.025) + [No. of "Type B HEV" ULEVs Produced ~~Sold~~] x (0.037) + [No. of "Type C HEV" ULEVs Produced ~~Sold~~] x (0.050)}

b. Only ZEVs which have been certified as LDTs 3751-5750 lbs. LVW and which have not been counted toward the ZEV requirements for PCs and LDTs 0-3750 lbs. LVW as specified in note (9) shall be included in the equation of note (5). ~~included in the above calculation or in the calculation of footnote 4 may not be included in the calculation of vehicle emission credits for medium-duty vehicles in footnote 12 of Section j of these test procedures.~~

c. Beginning with the 1996 model year, manufacturers that produce and deliver for sale in California LDTs 3751-5750 lbs. LVW that are certified to the Tier I exhaust emission standards in 40 CFR 86.094-9 shall add the following term to the numerator of the fleet average NMOG equation in note (5) and calculate their fleet average NMOG values accordingly:
[(No. of Vehicles Certified to federal Tier I exhaust emission standards and Produced and Delivered for Sale in California) x (0.32)]

(6) As used in this subsection 3.h. of these test procedures, the term "small volume ~~manufacturer~~" shall mean any vehicle manufacturer with California ~~sales~~ less than or equal to 3000 new PCs, LDTs, and MDVs ~~light- and medium-duty vehicles~~ per model year based on the average number of vehicles sold by the manufacturer each model year from 1989 to 1991, except as otherwise noted below. For manufacturers certifying

for the first time in California, model-year sales shall be based on projected California sales. In 2000 and subsequent model years, small volume manufacturers shall comply with the fleet average NMOG requirements set forth below.

a. Prior to the model year 2000, compliance with the specified fleet average NMOG requirements shall be waived.

b. In 2000 and subsequent model years, small volume manufacturers shall not exceed a fleet average NMOG value of 0.075 g/mi for PCs and LDTs from 0-3750 lbs. LVW calculated in accordance with note (4) ~~for 50,000 miles~~.

c. In 2000 and subsequent model years, small volume manufacturers shall not exceed a fleet average NMOG value of 0.100 g/mi for LDTs from 3751-5750 lbs. LVW calculated in accordance with note (5) ~~for 50,000 miles~~.

d. If a manufacturer's average California sales exceeds 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the fleet average requirements applicable for larger manufacturers as specified in Section 3.h. of these test procedures beginning with the fourth model year after the last of the three consecutive model years.

e. If a manufacturer's average California sales falls below 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall be treated as a small volume manufacturer and shall be subject to requirements for small volume manufacturers as specified in Section 3.h. of these test procedures beginning with the next model year.

(7) In ~~1992~~ 4 and subsequent model years, manufacturers that achieve fleet average NMOG values lower than the fleet average NMOG requirement for the corresponding model year shall receive credits in units of g/mi NMOG determined as: {[(Fleet Average NMOG Requirement) - (Manufacturer's Fleet Average NMOG Value)] x (Total No. of Vehicles Produced and Delivered for Sale in California ~~Sold~~, Including ZEVs and HEVs)}.

a. Manufacturers with fleet average NMOG values greater than the fleet average requirement for the corresponding model year shall receive debits in units of g/mi NMOG equal to the amount of negative credits determined by the aforementioned equation. For any given model year, the total g/mi NMOG credits or debits earned for PCs and LDTs 0-3750 lbs. LVW and for LDTs 3751-5750 lbs. LVW shall be summed together. The resulting amount shall constitute the g/mi NMOG credits or debits accrued by the manufacturer for the model year.

b. For the 1994 through 1997 model years, manufacturers shall equalize emission debits within three model years and prior to the end of the 1998 model year by earning g/mi NMOG emission credits in an amount equal to their g/mi NMOG debits, or by submitting a commensurate amount of g/mi NMOG credits to the Executive Officer that were earned previously or acquired from another manufacturer. For 1998 and subsequent model years, manufacturers shall equalize emission debits by the end of the following model year. If emission debits are not equalized within the specified time period, the manufacturer shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer which

sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the emission debits are not equalized by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's emission standards shall be determined by dividing the total amount of g/mi NMOG emission debits for the model year by the g/mi NMOG fleet average requirement for PCs and LDTs 0-3750 lbs. LVW applicable for the model year in which the debits were first incurred.

c. The g/mi NMOG emission credits earned in any given model year shall retain full value through the subsequent model year.

d. The g/mi NMOG value of any credits not used to equalize the previous model-year's debit, shall be discounted by 50% at the beginning of second model year after being earned, discounted to 25% of its original value if not used by the beginning of the third model year after being earned, and will have no value if not used by the beginning of the fourth model year after being earned.

e. ~~Any g/mi NMOG emission credits earned by a manufacturer may be applied toward either the fleet average requirement for passenger cars and light-duty trucks from 0-3750 lbs. LVW, or to the fleet average requirement for light-duty trucks from 3751-5750 lbs. LVW, at the manufacturer's discretion.~~

(8) Manufacturers that ~~sell~~ produce and deliver for sale in California vehicles certified to the phase-in ~~complying with~~ the exhaust emission standards in Section 3.e. of these test procedures or vehicles certified to the exhaust emission standards in Sections 3.f. or 3.g. of these test procedures and/or ZEVs in the 1992 and 1993 model years, shall receive emission credits ~~for the sale of these vehicles~~ as determined by the equations in ~~footnotes~~ (4), ~~or~~ (5), ~~depending upon Vehicle Weight Class,~~ and ~~footnote~~ (7).

a. For PCs and LDTs from 0-3750 lbs. LVW, the fleet average NMOG requirement for calculating a manufacturer's emission credits shall be 0.390 and 0.334 g/mi NMOG for vehicles certified in the 1992 and 1993 model years, respectively.

b. For LDTs from 3751-5750 lbs. LVW, the fleet average NMOG requirement for calculating a manufacturer's emission credits shall be 0.500 and 0.428 g/mi NMOG for vehicles certified in the 1992 and 1993 model years, respectively.

c. Emission credits earned prior to the 1994 model year shall be considered as earned in the 1994 model year and discounted in accordance with the schedule specified in ~~footnote~~ (7).

(9) While meeting the fleet average requirements, each manufacturer shall certify, produce, and deliver for sale in California ~~its sales fleet of passenger cars and light-duty trucks from 0-3750 lbs. LVW shall be composed of~~ at least 2% ZEVs each model year from 1998 through 2000, 5% ZEVs in 2001 and 2002, and 10% ZEVs in 2003 and subsequent model years. These percentages shall be applied to the manufacturer's total production of PCs and LDTs 0-3750 lbs. LVW delivered for sale in California.

a. Manufacturers which produce for sale in California more ZEVs than required in a given model year shall earn ZEV credits, which shall have units of g/mi NMOG. The amount of ZEV credits earned shall be equal to the number of ZEVs required to be produced and delivered for sale in California for the model year subtracted from the

number of ZEVs actually produced and delivered for sale in the model year and then multiplied by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for that model year. All ZEV credits earned prior to the 1998 model year shall be treated as if earned in the 1998 model year and shall be discounted in accordance with notes (7)c and (7)d.

a b. A manufacturer may meet the ZEV requirements in any given model year by submitting to the Executive Officer a commensurate amount of ZEV credits. ~~g/mi NMOG emission credits earned exclusively from the sale of ZEVs.~~ These credits may be earned previously by the manufacturer or acquired from another manufacturer. The amount of ZEV credits required to be submitted shall be calculated by subtracting the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year from the number of ZEVs required to be produced by the manufacturer for the model year and then multiplying by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for that model year.

b c. Manufacturers which ~~sell~~ certify, produce, and deliver for sale in California fewer ZEVs than required in a given model year shall make up the deficit by the end of the next model year, ~~by selling an additional number of ZEVs equal to their deficit or~~ by submitting to the Executive Officer a commensurate amount of ZEV credits. ~~g/mi NMOG credits earned exclusively from the sale of ZEVs.~~ The amount of ZEV credits required to be submitted shall be calculated by subtracting the number of ZEVs actually produced and delivered for sale in California by the manufacturer for the model year from the number of ZEVs required to be produced by the manufacturer for the model year and then multiplying by the fleet average requirements for PCs and LDTs 0-3750 lbs. LVW for the model year in which the deficit is incurred.

d. Any manufacturer which fails to produce and deliver for sale in California the required number of ZEVs or submit an appropriate amount of ZEV credits and does not make up ZEV deficits within the specified time period shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the ZEV deficits are not balanced by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's standards shall be calculated according to the following equation: (No. of ZEVs required to be produced and delivered for sale in California for the model year) - (No of ZEVs actually produced and delivered for sale in California for the model year) - [(Amount of ZEV credits submitted for the model year) / (the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for the model year)].

e. ZEVs classified as MDVs or as LDTs 3751-5750 lbs. LVW may be counted toward the ZEV requirement for PCs and LDTs 0-3750 lbs. LVW and included in the calculation of ZEV credits as specified in note (9)a., if the manufacturer so designates.

e f. Small volume manufacturers shall not be required to meet the percentage ZEV requirements. However, small volume manufacturers may earn and market credits for ZEVs they produce and ~~sell~~ deliver for sale in California.

d g. Intermediate volume manufacturers shall not be required to meet the percentage ZEV requirements before the 2003 model year.

i. The exhaust emissions from new 1995 and subsequent model medium-duty vehicles shall not exceed:

1995 AND SUBSEQUENT MODEL-YEAR
MEDIUM-DUTY VEHICLE EXHAUST EMISSIONS STANDARDS (1)(2)(3)(7)(8)
(grams per mile)

Test Weight(lbs.)	Durability Vehicle Basis(mi)	Non-Methane Hydrocarbons(4)	Carbon Monoxide	Oxides of Nitrogen(5)	Particulates (6)
0-3,750	50,000	0.25	3.4	0.4	n/a
0-3,750	120,000	0.36	5.0	0.55	0.08
3,751-5,750	50,000	0.32	4.4	0.7	n/a
3,751-5,750	120,000	0.46	6.4	0.98	0.10
5,751-8,500	50,000	0.39	5.0	1.1	n/a
5,751-8,500	120,000	0.56	7.3	1.53	0.12
8,501-10,000	50,000	0.46	5.5	1.3	n/a
8,501-10,000	120,000	0.66	8.1	1.81	0.12
10,001-14,000	50,000	0.60	7.0	2.0	n/a
10,001-14,000	120,000	0.86	10.3	2.77	0.12

(1) "n/a" means not applicable.
"Test Weight" shall mean the average of the vehicle's curb weight and gross vehicle weight.

(2) Manufacturers have the option of certifying engines used in incomplete and diesel medium-duty vehicles from 8501-14,000 pounds gross vehicle weight to the heavy-duty engine standards and test procedures set forth in Section 1956.8(e), Title 13, California Code of Regulations. Manufacturers certifying incomplete or diesel medium-duty vehicles to the heavy-duty engine standards and test procedures shall specify, in the application for certification, an in-use compliance test procedure, as provided in Sections 2139(c), Title 13, California Code of Regulations.

(3) For the 1995 model year only, manufacturers of medium-duty vehicles may certify a maximum of 50 percent of their vehicles to the applicable 1994 model year standards and test procedures. The percentage shall be based upon each manufacturer's projected sales of California-certified medium-duty vehicles. For the 1995 model year only, small volume manufacturers may certify 100 percent of their vehicles to the applicable 1994 model-year standards and test procedures.

(4) For ~~methanol~~ alcohol-fueled vehicles certifying to these standards, including fuel-flexible-fueled vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(5) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 2.00 times the applicable medium-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) Particulate standards are only applicable for diesel vehicles and shall be determined on a 120,000 mile basis.

(7) In-use compliance testing shall be limited to vehicles with less than 90,000 miles. For the 1995 through 1997 model years, alternative in-use compliance is available for medium-duty vehicle manufacturers. A manufacturer may use alternative in-use compliance for up to 100 percent of its fleet in the 1995 and 1996 model years and up to 50 percent of its fleet in the 1997 model year. Small volume manufacturers only may use alternative in-use compliance for up to 100 percent of their fleet in the 1995 through 1997 model years. The percentages shall be determined only from the manufacturer's projected California sales of medium-duty vehicles. For vehicles certified to the standards and test procedures of this subsection, "alternative in-use compliance" shall consist of an in-use allowance of 25 percent over the applicable 1995 model-year hydrocarbon, carbon monoxide, and oxides of nitrogen 50,000 mile emission standards and a waiver of the emission standards beyond 50,000 miles.

(8) All medium-duty vehicles, except diesel-fueled vehicles and those incomplete and diesel vehicles certifying to heavy-duty engine test procedures, are subject to 50,000 mile and 120,000 mile non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards. Diesel-fueled vehicles shall be subject to 120,000 mile non-methane hydrocarbon, carbon monoxide, oxides of nitrogen, and particulate standards only.

j. The exhaust emission levels from new 1992 and subsequent model-year medium-duty low-emission vehicles and ultra-low-emission vehicles shall not exceed:

EXHAUST EMISSION STANDARDS FOR LOW-EMISSION VEHICLES
AND ULTRA-LOW-EMISSION VEHICLES IN THE
MEDIUM-DUTY VEHICLE WEIGHT CLASS (8)(9)(10)(11)(12)(13)(14)(15)(16)
[grams per mile (or "g/mi")]

Test Weight (lbs.) (1)	Durability Vehicle Basis (mi)	Vehicle Emission Category (2)	Non-Methane Organic Gases (3)(4)	Carbon Monoxide	Oxides of Nitrogen (5)	Particulates (6)(7)
0-3750	50,000	LEV	0.125 (0.188)	3.4 (3.4)	0.4 (0.4)	n/a
		ULEV	0.075 (0.100)	1.7 (2.6)	0.2 (0.3)	n/a
	120,000	LEV	0.180	5.0	0.6	0.08
		ULEV	0.107	2.5	0.3	0.04
3751-5750	50,000	LEV	0.160 (0.238)	4.4 (4.4)	0.7 (0.7)	n/a
		ULEV	0.100 (0.128)	2.2 (3.3)	0.4 (0.5)	n/a
	120,000	LEV	0.230	6.4	1.0	0.10
		ULEV	0.143	3.2	0.5	0.05
5751-8500	50,000	LEV	0.195 (0.293)	5.0 (5.0)	1.1 (1.1)	n/a
		ULEV	0.117 (0.156)	2.5 (3.8)	0.6 (0.8)	n/a
	120,000	LEV	0.280	7.3	1.5	0.12
		ULEV	0.167	3.7	0.8	0.06
8501-10000	50,000	LEV	0.230 (0.345)	5.5 (5.5)	1.3 (1.3)	n/a
		ULEV	0.138 (0.184)	2.8 (4.2)	0.7 (1.0)	n/a
	120,000	LEV	0.330	8.1	1.8	0.12
		ULEV	0.197	4.1	0.9	0.06
10,001-14000	50,000	LEV	0.300 (0.450)	7.0 (7.0)	2.0 (2.0)	n/a
		ULEV	0.180 (0.240)	3.5 (5.3)	1.0 (1.5)	n/a
	120,000	LEV	0.430	10.3	2.8	0.12
		ULEV	0.257	5.2	1.4	0.06

(1) "Test Weight" (or "TW") shall mean the average of the vehicle's curb weight and gross vehicle weight.

(2) "LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(3) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions. To determine compliance with an NMOG standard, NMOG emissions shall be measured in accordance with "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991 and last amended .

a. For LEVs and ULEVs certified to operate on any available fuel other than conventional gasoline, including fuel-flexible or dual-fuel vehicles when certifying on a fuel other than conventional gasoline, manufacturers shall multiply the NMOG exhaust mass ~~emission~~ certification levels at ~~50,000~~ and ~~120,000~~ ~~miles~~ by the applicable reactivity adjustment factor set forth in Section 13 of

these test procedures or established pursuant to Appendix VIII of these test procedures. In addition, NG vehicles certifying to LEV or ULEV standards shall calculate a reactivity-adjusted methane exhaust emission value by multiplying the methane exhaust certification level by the applicable methane reactivity adjustment factor set forth in section 13 of these test procedures. For NG vehicles, the reactivity-adjusted NMOG value shall be added to the reactivity-adjusted methane value and then compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance.

(4) Fuel-flexible and dual-fuel "Medium-Duty Vehicles" (or "MDVs") from 0-14,000 lbs. TW shall be certified to exhaust mass emission standards for NMOG established for the operation of the vehicle on any fuel other than ~~conventional~~ gasoline, and ~~conventional~~ gasoline.

a. For LEVs and ULEVs when certifying on the fuel other than gasoline, manufacturers shall multiply the exhaust NMOG certification ~~mass emission~~ levels at ~~50,000~~ and ~~120,000~~ miles by the applicable reactivity adjustment factor. In addition to multiplying the exhaust NMOG certification levels by the applicable reactivity adjustment factor, NG vehicles shall multiply the exhaust methane certification level by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. When certifying on gasoline, the exhaust NMOG certification levels of fuel-flexible and dual-fuel vehicles shall not be multiplied by a reactivity adjustment factor.

b. For MDVs from 0-3750 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.25 g/mi and 0.36 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.125 g/mi and 0.180 ~~0.190~~ g/mi for 50,000 and 120,000 miles, respectively.

c. For MDVs from 3751-5750 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.32 g/mi and 0.46 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.160 g/mi and 0.230 g/mi for 50,000 and 120,000 miles, respectively.

d. For MDVs from 5751-8500 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.39 g/mi and 0.56 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.195 g/mi and 0.280 g/mi for 50,000 and 120,000 miles, respectively.

e. For MDVs from 8501-10,000 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.46 g/mi and 0.66 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.230 g/mi and 0.330 g/mi for 50,000 and 120,000 miles, respectively.

f. For MDVs from 10,001-14,000 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.60 g/mi and 0.86 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.300 g/mi and 0.430 g/mi for 50,000 and 120,000 miles, respectively.

(5) The maximum projected emissions of "Oxides of Nitrogen" (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall not be greater than 2.00 times the applicable MDV standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) Particulate standards are only applicable for diesel vehicles and shall be determined on a 120,000 mile basis.

(7) "n/a" means not applicable.

(8) Manufacturers have the option of certifying engines used in incomplete and diesel MDVs to the heavy-duty engine standards and test procedures set forth in Section 1956.8(h), Title 13, California Code of Regulations. Manufacturers certifying incomplete or diesel MDVs to the heavy-duty engine standards and test procedures shall specify in the application for certification an in-use compliance procedure as provided in Section 2139(c), Title 13, California Code of Regulations.

(9) The standards in parenthesis are intermediate in-use compliance standards for 50,000 miles. For MDVs from 0-14,000 lbs. TW, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, intermediate in-use compliance standards shall apply to LEVs and ULEVs through the 1999 model year. ~~In-use Ccompliance with standards beyond 50,000 miles shall be waived~~ through the 1999 model year for LEVs and ULEVs.

a. For LEVs and ULEVs designed to operate on any available fuel other than ~~conventional~~ gasoline, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, NMOG exhaust mass emission ~~levels~~ results shall be multiplied by the applicable reactivity adjustment factor. In addition to multiplying the exhaust NMOG ~~certification~~ *mass emission* levels by the applicable reactivity adjustment factor, NG vehicles shall multiply the exhaust methane ~~certification~~ *mass emission* level by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. For fuel-flexible and dual-fuel vehicles when operating on gasoline, NMOG emission results shall not be multiplied by a reactivity adjustment factor.

b. For fuel-flexible and dual-fuel MDVs from 0-3750 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.32 g/mi and 0.188 g/mi for LEVs and ULEVs, respectively.

c. For fuel-flexible and dual-fuel MDVs from 3751-5750 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.41 g/mi and 0.238 g/mi for LEVs and ULEVs, respectively.

d. For fuel-flexible and dual-fuel MDVs from 5751-8500 lbs. TW, intermediate in-use compliance standards for NMOG emissions at

50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.49 g/mi and 0.293 g/mi for LEVs and ULEVs, respectively.

e. For fuel-flexible and dual-fuel MDVs from 8501-10,000 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on conventional gasoline, shall be 0.58 g/mi and 0.345 g/mi for LEVs and ULEVs, respectively.

f. For fuel-flexible and dual-fuel MDVs from 10,001-14,000 lbs. TW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.75 g/mi and 0.450 g/mi for LEVs and ULEVs, respectively.

(10) Each manufacturer's MDV fleet shall be defined as the total number of California certified MDVs from 0-14,000 lbs. TW ~~sold~~ produced and delivered for sale in California.

a. Manufacturers of MDVs shall certify an equivalent of 25% of their MDV fleet sales to LEV standards in the 1998 model year, 50% of their MDV fleet sales to LEV standards in the 1999 model year, 75% of their MDV fleet sales to LEV standards in the 2000 model year, 95% of their MDV fleet sales to LEV standards in the 2001 model year, 90% of their MDV fleet sales to LEV standards in the 2002 model year, and 85% of their MDV fleet sales to LEV standards in the 2003 and subsequent model years.

b. Manufacturers of MDVs shall certify an equivalent of 2% of their MDV fleet sales to ULEV standards in each model year from 1998 to 2000, 5% of their MDV fleet sales to ULEV standards in the 2001 model year, 10% of their MDV fleet sales to ULEV standards in the 2002 model year, and 15% of their MDV fleet sales to ULEV standards in the 2003 and subsequent model years.

c. The percentages shall be applied to the manufacturers' total production sales of California-certified medium-duty vehicles delivered for sale in California.

d. These requirements shall not apply to small volume manufacturers. Small volume manufacturers shall comply with the requirements of note (15) below.

(11) For the purpose of calculating "Vehicle Equivalent Credits" (or "VECs"), vehicles which have no tailpipe emissions but use fuel fired heaters and which are not certified as ZEVs shall be treated as Type A Hybrid Electric Vehicle Ultra-Low-Emission Vehicles (or "Type A HEV ULEVs"). ~~the contribution of hybrid electric vehicles (or "HEVs") will be calculated based on the range of the HEV without the use of the engine. For the purpose of calculating the contribution of HEVs to the VECs, the following definitions shall apply.~~

~~"Type A HEV" shall mean a hybrid electric vehicle (or "HEV") which achieves a minimum range of 60 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET; 40 CFR Part 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 60 miles. This definition shall also apply to vehicles which have no tailpipe emissions, but use fuel fired heaters, regardless of the operating range of the vehicle.~~

~~"Type B HEV" shall mean an HEV which achieves a range of 40 - 59 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET; 40 CFR Part 600~~

~~Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 40 miles. "Type G HEV" shall mean an HEV which achieves a range of 0 - 39 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET, 40 CFR Part 600 Subpart B) without the use of an auxiliary engine, an HEV which allows the operator of the vehicle to control the engine time and modes of operation either directly or indirectly, an HEV which can be operated solely through the use of the engine, and all other HEVs excluding "Type A" and "Type B" HEVs.~~

(12) In 1992 and subsequent model years, manufacturers that produce and deliver for sale in California sell MDVs in excess of the equivalent requirements for LEVs and/or ULEVs, shall receive "Vehicle-Equivalent Credits" (or "VECs") calculated in accordance with the following equation, where the term "Produced" means produced and delivered for sale in California as: {[(No. of LEVs Produced Sold excluding HEVs) + (No. of "Type C HEV" LEVs Produced Sold)] + [(No. of "Type A HEV" LEVs Produced Sold) x (1.2)] + [(No of "Type B HEVs" LEVs Produced Sold) x (1.1)] - (Equivalent No. of LEVs Required to be Produced Sold)} + {(1.4) x [(No. of ULEVs Produced Sold excluding HEVs) + (No. of "Type C HEV" ULEVs Produced Sold)] + [(1.7) x (No. of "Type A HEV" ULEVs Produced Sold)] + [(1.5) x (No. of "Type B HEV" ULEVs Produced Sold)] - [(1.4) x (Equivalent No. of ULEVs Required to be Produced Sold)]} + [(2.0) x (No. of ZEVs Certified and Produced Sold as MDVs)].

a. Manufacturers which fail to produce and deliver for sale in California sell the equivalent quantity of MDVs certified to LEV and/or ULEV exhaust emission standards, shall receive "Vehicle-Equivalent Debits" (or "VEDs") ~~equal to the amount of negative~~ VECs determined by the aforementioned equation.

b. Manufacturers shall equalize emission debits within one model year by earning VECs in an amount equal to their previous model-year's total of VEDs, or by submitting a commensurate amount of VECs to the Executive Officer that were earned previously or acquired from another manufacturer. Any manufacturer which fails to equalize emission debits within the specified time period shall be subject to the Health and Safety Code civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the emission debits are not equalized by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's emission standards shall be equal to the amount of VEDs incurred.

c. The VECs earned in any given model year shall retain full value through the subsequent model year.

d. The value of any VECs not used to equalize the previous model-year's debit, shall be discounted by 50% at the beginning of second model year after being earned, discounted to 25% of its original value if not used by the beginning of the third model year after being earned, and will have no value if not used by the beginning of the fourth model year after being earned.

e. Any VECs earned prior to the 1998 model year shall be treated as earned in the 1998 model year and discounted in accordance with the schedule specified in note (12)(d).

e f. Only ZEVs certified as MDVs ean shall be included in the calculation of VECs.

(13) Manufacturers shall demonstrate compliance with the above standards for NMOG, carbon monoxide, and oxides of nitrogen at 50 degrees F, according to the procedure specified in Section 11k of these test procedures. Hybrid electric, natural gas, and diesel-fueled vehicles are exempt from 50 degrees F test requirements. ~~"California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles as, Adopted: May 20, 1987, and last amended: INSERT".~~ ~~For diesel vehicles, compliance with the particulate standard shall also be demonstrated as specified in Section 11k of the foregoing test procedures.~~

(14) In-use compliance testing shall be limited to vehicles with fewer than 90,000 miles.

(15) Deterioration factors for hybrid electric vehicles shall be based on the emissions and mileage accumulation of the auxiliary power unit. For certification purposes only, Type A hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors), and demonstrating compliance with 120,000 mile emission standards shall not be required. For certification purposes only, Type B hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 120,000 mile emission standards (using 90,000 mile deterioration factors). For certification purposes only, Type C hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 120,000 mile emission standards (using 120,000 mile deterioration factors).

(16) As used in this section 3.j. of these test procedures, the term "small volume manufacturer" shall mean any vehicle manufacturer with California sales less than or equal to 3000 new PCs, LDTs, and MDVs per model year based on the average number of vehicles sold by the manufacturer each model year from 1992 to 1994, except as otherwise noted below. For manufacturers certifying for the first time in California, model-year sales shall be based on projected California sales. In 2001 and subsequent model years, small volume manufacturers shall comply with the requirements set forth below.

a. Prior to the model year 2001, small volume manufacturers shall not be required to certify, produce, or deliver LEVs and ULEVs for sale in California.

b. In 2001 and subsequent model years, small volume manufacturers shall certify, produce, and deliver for sale in California LEVs in a quantity equivalent to 100% of their MDV fleet .

c. If a manufacturer's average California sales exceeds 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the LEV and ULEV requirements applicable for larger manufacturers as specified in Section 3.j of these test procedures beginning with the fourth model year after the last of the three consecutive model years.

e. If a manufacturer's average California sales falls below 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the

manufacturer shall be treated as a small volume manufacturer and shall be subject to requirements for small volume manufacturers as specified in Section 3.j of these test procedures beginning with the next model year.

k. The cold temperature exhaust carbon monoxide emission levels from new 1996 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles shall not exceed:

1996 AND SUBSEQUENT MODEL-YEAR COLD TEMPERATURE CARBON MONOXIDE EXHAUST EMISSIONS STANDARDS FOR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES (1)(2)
(grams per mile)

Vehicle Type	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Carbon Monoxide
Passenger Car	All	50,000	10.0
Light-Duty Truck	0-3750	50,000	10.0
Light-Duty Truck	3751-5750	50,000	12.5
Medium-Duty Vehicle	0-3750	50,000	10.0
Medium-Duty Vehicle	3751-8500 (3)	50,000	12.5

(1) These standards are applicable to vehicles tested in accordance with 40 CFR Part 86 Subpart C, at a nominal temperature of 20°F (-7°C).
(2) Natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles are exempt from these standards.
(3) Medium-duty vehicles with a gross vehicle weight rating greater than 8,500 lbs. are exempt from this standard.

4. **Initial Requirements**

a. Application for Certification

In paragraph 86.088-21, 86.090-21, and 86.091-21, and 86.094-21:

1. Amend subparagraph (b)(1)(i) to read:

(i) Identification and description of the vehicles (or engines) covered by the application and a description (including a list and part numbers of all major emission control system parts and fuel system components) of their engine (vehicles only) emission control system and fuel system components, including if applicable, the turbocharger and intercooler. This shall include a detailed description of each auxiliary emission control device (AECD) to be installed in or on any certification test vehicle (or certification test engine).

2. Amend subparagraph (b)(2) to read:

(2) For 1992 and subsequent model-year TLEVs, LEVs, and ULEVs not certified powered exclusively by on gasoline, projected California sales data and fuel economy data ~~two years~~ 19 months prior to January 1 of the calendar year with the same numerical designation as the model year for which the vehicles are certified ~~the end of the certification process~~, and projected California sales data for all vehicles, regardless of operating fuel or vehicle emission category, sufficient to enable the Executive Officer to select a test fleet representative of the vehicles (or engines) for which certification is requested at the time of certification.

3. Add subparagraph (g) which reads:

(1) For ZEVs and hybrid electric vehicles, the certification application shall include the following:

(i) Identification and description of the vehicle(s) covered by the application.

(ii) Identification of the vehicle weight category to which the vehicle is certifying: PC, LDT 0-3750 lbs. LVW, LDT 3751-5750 lbs. LVW, or MDV (state test weight range), and the curb weight and gross vehicle weight rating of the vehicle.

(iii) Identification and description of the propulsion system for the vehicle.

(iv) Identification and description of the climate control system used on the vehicle.

(v) Projected number of vehicles produced and delivered for sale in California, and projected California sales.

(vi) For electric and hybrid electric vehicles, identification of the energy usage in kilowatt-hours per mile from the point when electricity is introduced from the electrical outlet and the operating range in miles of the vehicle when tested in accordance with the All-Electric Range Test (see section 9.f. of these test procedures).

(vii) If the vehicle is equipped with a fuel fired heater, a description of the control system logic of the fuel fired heater, including an evaluation of the conditions under which the fuel fired heater can be operated and an evaluation of the possible operational modes and conditions under which evaporative emissions can exist. Vehicles which utilize fuel fired heaters which can be operated at ambient temperatures above 40 degrees Fahrenheit or which cannot be demonstrated to have zero evaporative emissions under any and all possible operation modes and conditions shall not be certified as ZEVs.

(viii) All information necessary for proper and safe operation of the vehicle, including information on the safe handling of the battery system, emergency procedures to follow in the event of battery leakage or other malfunctions that may affect the safety of the vehicle operator or laboratory personnel, method for determining battery state-of-charge, battery charging capacity and recharging procedures, and any other relevant information as determined by the Executive Officer.

In paragraph 86.088-21 and 86.090-21:

34. Amend subparagraph (b)(4)(iii)(C)(1) and (C)(2) to read:

(1) A statement of maintenance and procedures consistent with the restrictions imposed under subparagraph 86.085-25(a)(1), necessary to assure that the vehicles (or engines) covered by a certificate of conformity in operation in normal use to conform to the regulations, and a description of the program for training of personnel for such maintenance, and the equipment required.

(2) A statement that the vehicles sold comply with the California high-altitude emission requirements as specified in Section 11.b. (High Altitude Requirements) in these procedures.

b. Required Data

In paragraph 86.085-23, 86.087-23, 86.088-23, and 86.091-23, and 86.094-23:

1. Amend subparagraph (a) by adding the following paragraph which reads:

Zero-emission vehicles (including electric vehicles which do not utilize auxiliary fuel fired heaters) shall be exempt from emission testing and durability requirements. All series hybrid electric vehicle emission testing shall be conducted while operating the vehicle's auxiliary engine continuously over the GVS-75 test cycle (as specified in paragraphs 86.135-90 and 86.137-90) at maximum regulated engine speed and load conditions or other operation to be determined by the Executive Officer as resulting in the worst case emissions. All parallel hybrid electric vehicle emission testing shall be conducted while the vehicle is operating solely through use of its combustion engine over the GVS-75 test cycle (as specified in paragraphs 86.135-90 and 86.137-90), or as close to pure engine operation as is feasible. All battery assisted combustion engine vehicles shall be tested in accordance with the test procedures specified (40 CFR Part 86) for vehicles which operate solely by use of a combustion engine. All hybrid electric vehicles shall be tested in accordance with paragraphs 86.129-80.

2 1. Amend (c)(1) by adding the following two paragraphs which reads:

In the case of electric vehicles (or other zero-emission vehicles) which use fuel fired heaters, the manufacturer shall determine the exhaust emissions per mile produced by the auxiliary fuel fired heater, when certifying electric vehicles (or other zero-emission vehicles) which utilize this type of heater. This shall be accomplished by determining heater emissions per minute when operating at maximum heating capacity, and multiplying that number by 3.6 minutes per mile (the number of minutes in the GVS-75 test cycle divided by the number of miles in the GVS-75 test cycle.) A statement of the standards to which the vehicle complies based on the emissions from the heater shall be required for vehicle certification.

For all TLEVs, LEVs, and ULEVs certifying on a fuel other than conventional gasoline, manufacturers shall multiply the provide a total NMOG exhaust certification level emission value multiplied for each emission-data vehicle by the appropriate reactivity adjustment factor listed in Section 13.a. of these test procedures or established by the Executive Officer pursuant to Appendix VIII of these test procedures in g/mile to demonstrate compliance with the applicable NMOG emission standards. For all TLEVs, LEVs, and ULEVs certifying on natural gas, manufacturers shall multiply the NMOG exhaust certification level for each emission-data vehicle by the appropriate reactivity

adjustment factor listed in Section 13.a. of these test procedures or established by the Executive Officer pursuant to Appendix VIII of these test procedures and add that value to the product of the methane exhaust certification level for each emission-data vehicle and the appropriate methane reactivity adjustment factor listed in Section 13.a. of these test procedures or established by the Executive Officer pursuant to Appendix VIII of these test procedures to demonstrate compliance with the applicable NMOG emission standard. Manufacturers requesting to certify to existing standards utilizing an adjustment factor unique to its vehicle/fuel system must follow the data requirements described in Appendix VIII of these test procedures. A separate formaldehyde exhaust certification level ~~emission value in mg/mile~~ shall also be provided for demonstrating compliance with emission standards for formaldehyde.

c. Test Vehicles and Test Engines; Assigned Deterioration Factors (DFs)

In paragraphs 86.085-24, and 86.090-24, 86.092-24, *86.094.24* and 86.095-24:

1. Amend subparagraph (a)(1) by adding the following additional statement:

(a)(1) The vehicles or engines covered by an application for certification will be divided into groupings of engines which ~~are expected to have similar emission characteristics~~ throughout their useful life. Each group of engines with similar emission characteristics shall be defined as a separate engine family. For 1995 and subsequent model-year vehicles or engines, all engines classified in the same engine family shall be certified to identical exhaust emission standards.

~~1~~ 2. Delete subparagraph (b) (Emission-data vehicle selection provisions)

REPLACE WITH:

(b) Emission-data vehicles shall be selected according to the provisions of Appendix II. Selection shall be based on highest sales volume and will require only two emission-data vehicles for certification testing per engine family. (For fifty-state families, the reference in the federal procedures to configuration or sales shall mean California configurations and sales rather than total family configurations and sales.) The Executive Officer will accept data from California (or fifty-state) configuration vehicles or from federal vehicles which meet the requirements of subparagraph 4.b.4. Federal vehicles may be reconfigured to California versions and tested to show compliance with California emission standards. The Executive Officer will

also allow the manufacturer to reconfigure California vehicles.

2 3. Delete subparagraph (e)(1) (Reduced number of test vehicles)

REPLACE WITH:

(1) Any manufacturer whose projected California annual sales for the model year in which certification is sought is less than a combined total of 3,000 passenger cars, light-duty trucks, medium-duty vehicles, and heavy-duty engines may request a reduction in the number of test vehicles determined in accordance with the foregoing provisions of this paragraph. The Executive Officer may agree to such lesser numbers as he or she determines would meet the objectives of this procedure.

3 4. Delete subparagraph (e)(2) (Assigned deterioration factors)

REPLACE WITH:

(2)(i) Any manufacturer may request to certify engine families using assigned DFs for a combined total of 3,000 projected annual California sales of passenger cars, light-duty trucks, medium-duty vehicles, and heavy-duty engines per manufacturer regardless of total sales.

(2)(ii) Assigned DFs shall be used only where specific mileage accumulation data do not exist (i.e., if a vehicle manufacturer uses an engine/system combination where DFs derived from exhaust emission testing exist, then the assigned factors cannot be used).

Assigned DFs shall be used in lieu of data from durability vehicle(s) only when a manufacturer demonstrates that it has control over design specifications, can provide development data, has in-house testing capabilities including accelerated aging of components/systems, and has evaluation criteria to ensure emission control system (ECS) durability for the vehicle's useful life. The applying manufacturer must demonstrate engine durability and that the emission control system(s) developed or adapted for the particular engine will be durable and comply with the applicable emission standards for the engine's or vehicle's useful life. In evaluating any information provided, all relevant test data and design factors shall be considered, including but not limited to: vehicle application, engine design, catalyst loading and volume, space velocity in the catalyst, engine exhaust gas concentrations and catalyst temperatures for various operating modes, and the durability of any emission control system components which may have been used in other vehicle applications. The assigned DFs shall be applied only to entire families.

If emission control parts from other certified vehicles are utilized, then parameter comparisons of the above data must also be provided including part numbers where applicable. Emission control durability may include special in-house specifications.

(2)(iii) The criteria for evaluating assigned DFs for evaporative families are the same as those for exhaust families. However, in determining evaporative family DFs the "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model ~~Liquefied Petroleum Gas- or Gasoline- or Methanol-Fueled~~ Motor Vehicles" require that an evaporative family DF be determined by averaging DFs obtained from durability vehicle testing and from bench testing. Therefore, if a manufacturer meets the criteria as specified above in (e)(2)(i) and (e)(2)(ii), the Executive Officer may grant assigned DFs for either (or both) the durability vehicle DF or the bench DF.

Assigned DFs for bench test requirements do not depend upon the 3,000 maximum sales limit. The assigned bench DF is applicable only to evaporative emission control systems which are similar to those used by the manufacturer for 1980 or later model-year vehicles and where an evaporative vehicle DF was determined. In evaluating a request for an assigned bench DF, all relevant information shall be considered, including but not limited to: fuel tank capacity, fuel tank temperatures, carburetor bowl "capacity", underhood temperatures, canister capacity and location, and any other comparisons to the certified application.

4 5. Amend subparagraph (f) and (h)(1)(v) by adding the following additional requirement which reads:

The durability or emission data submitted may be from vehicles previously certified by ARB. For 1993 through 1996 model-year passenger cars and light-duty trucks and 1995 through 1997 model-year medium-duty vehicles, the manufacturer shall submit durability data from only California (or fifty-state) configuration vehicles unless the durability data was generated from a vehicle certified by EPA or ARB prior to the 1993 model year (1995 for medium-duty vehicles). For 1997 (1998 for medium-duty vehicles) and subsequent model-year vehicles, durability data shall be submitted from only California (or fifty-state) configuration vehicles. For 1993 and (1995 for medium-duty vehicles) subsequent model-year vehicles, the Executive Officer shall permit the use of federal durability data vehicles if he or she determines that the federal data will adequately represent the durability characteristics of the California configuration. This determination shall be based upon similarity of catalyst location and configuration; similarity of fuel metering system; similarity of major features of emission control system logic and design; and similarity of any other features determined by the Executive Officer to be

likely to affect durability. If data from a federal durability data vehicle is used, the requirements of subparagraph 6.b.5. (durability vehicles must meet emission standards) will refer to the federal emissions standards in effect for the model year for which the durability data was generated.

d. Compliance with the Inspection and Maintenance Program

All 1993 and subsequent model-year emission-data vehicles shall be required to be tail-pipe tested at 4,000 miles and demonstrate compliance with the California Inspection and Maintenance emission standards in place at the time of certification as specified in the "Mandatory Exhaust Emissions Inspection Standards and Test Procedures", Title 16, California Code of Regulations, Section 3340.42. Test vehicles shall undergo preconditioning procedures prior to the tail-pipe test which consist of idle conditions for a minimum period of ten minutes after the thermostat is open. Preconditioning and test procedures shall be conducted at an ambient temperature from 68 to 86 degrees, Fahrenheit. The manufacturer shall, in accordance with good engineering practice, attest that such test vehicles will meet the requirements of this section when preconditioned and tested at ambient temperatures from 35 to 68 degrees Fahrenheit.

5. Maintenance Requirements

a. Maintenance[1]

Delete paragraph 86.090-25.

Delete paragraph 86.088-25.

Delete paragraph 86.087-25.

In paragraph 86.085-25:

1. Amend the title and first sentence of subparagraph (a) to read:

(a) Light-duty vehicles. Paragraph (a) of this section applies to passenger cars, light-duty trucks, and medium-duty vehicles.

2. Amend subparagraph (a)(1) to read:

(1) Scheduled maintenance on the engine, emission control system, and fuel system of durability vehicles shall, unless otherwise provided pursuant to paragraph (a)(5)(iii), be restricted as set forth in the following provisions. If a manufacturer must revise the maintenance schedule, prior approval by the Executive Officer is required. Unscheduled maintenance must not render a durability vehicle nonrepresentative of the production vehicles. The unscheduled maintenance must not be likely to be required in the normal use of the vehicle. Unauthorized or unjustifiable unscheduled maintenance may be cause for disqualification of a durability vehicle.

Manufacturers must submit durability maintenance logs to the Executive Officer. The maintenance logs shall include the mileage where maintenance occurred, the nature of the maintenance, and the name and part numbers of all fuel system and emission control parts involved with the maintenance. Manufacturers of series hybrid electric vehicles and parallel hybrid electric vehicles shall be required to incorporate into the vehicles a separate odometer or other device subject to the approval of the Executive Officer which can accurately gauge the mileage accumulation on the engines which are used in these vehicles.

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1. These requirements are for vehicles certified to the primary 50,000 mile and 100,000 or 120,000 mile standards. Requirements for the vehicles certified to the optional 100,000 mile standards are found in section 10 (Optional 100,000 Mile Certification Procedure) of these procedures.

(i)(A) For otto-cycle vehicles and hybrid electric vehicles which use otto-cycle engines, maintenance shall be restricted to the inspection, replacement, cleaning, adjustment, and/or service of the following items at intervals no more frequent than indicated:

(1) Drive belts on engine accessories (tension adjustment only); (30,000 miles of engine operation).

(2) Valve lash (15,000 miles of engine operation).

(3) Spark plugs (30,000 miles of engine operation).

(4) Air filter (30,000 miles of engine operation).

(5) Exhaust gas sensor (30,000 miles of engine operation). Provided that:

(a) the manufacturer shall equip the vehicle with a maintenance indicator consisting of a light or flag, which shall be preset to activate automatically by illuminating in the case of a light or by covering the odometer in the case of a flag the first time the minimum maintenance interval established during certification testing is reached and which shall remain activated until reset. After resetting, the maintenance indicator shall activate automatically when the minimum maintenance interval, when added to the vehicle mileage at the time of resetting, is again reached and shall again remain activated until reset. When the maintenance indicator consists of a light, it shall also activate automatically in the engine-run key position before engine cranking to indicate that it is functioning. The maintenance indicator shall be located in the instrument panel and shall, when activated, display the words "oxygen sensor" or may display such other words determined by the Executive Officer to be likely to cause the vehicle owner to seek oxygen sensor replacement. The maintenance indicator shall be separate from the malfunction indicator light required by Section 1968, Title 13, California Code of Regulations;

(b) the manufacturer shall provide free replacement of the oxygen sensor, including both parts and labor, and shall reset the maintenance indicator without any charge, the first time the maintenance interval established during certification testing is reached for vehicles certified with scheduled sensor maintenance before 50,000 miles. If the oxygen sensor is replaced pursuant to the warranty provisions of Section 2037, Title 13, California Code of Regulations, before the first maintenance interval is reached, the manufacturer shall also replace the oxygen sensor and reset the maintenance indicator at the mileage point determined by

adding the maintenance interval to the vehicle's mileage at the time of the warranty replacement. If the calculated mileage point for a second oxygen sensor replacement would exceed 50,000 miles, no free second replacement shall be required;

(c) The maintenance indicator shall be resettable. The maintenance instructions required by section 5.b. of these procedures shall provide instructions for the resetting of the maintenance indicator, and shall specify that the maintenance indicator shall be reset each time the oxygen sensor is replaced; and

(d) Notwithstanding the provisions of Section 2037(c), Title 13, California Code of Regulations; the oxygen sensor, including any replacement required pursuant to this section, shall be warranted for the applicable warranty period of the vehicle or engine in accordance with Section 2037(a), Title 13, California Code of Regulations. If such oxygen sensor fails during this period, it shall be replaced by the manufacturer in accordance with Section 2037(d), Title 13, California Code of Regulations.

(6) Choke (cleaning or lubrication only); (30,000 miles of engine operation).

(7) Positive crankcase ventilation valve (50,000 miles of engine operation).

(8) Ignition wires (50,000 miles of engine operation).

(9) In addition, adjustment of the engine idle speed (curb idle and fast idle), valve lash, and engine bolt torque may be performed once during the first 5,000 miles of scheduled driving, provided the manufacturer makes a satisfactory showing that the maintenance will be performed on vehicles in use. For hybrid electric vehicles, these adjustments may only be performed once during the first 5,000 miles of engine operation.

(10) Hybrid electric vehicle battery system (manufacturer's established performance limits). Provided that:

(a) The manufacturer shall equip the vehicle with a maintenance indicator consisting of a light which shall activate automatically by illuminating the first time the minimum performance level is observed for all battery system components. Possible battery system components requiring monitoring are:

i. battery water level
ii. temperature control
iii. pressure control

iv. other parameters critical for determining battery condition

(b) The manufacturer shall equip the vehicle with a useful life indicator for the battery system consisting of a light which shall illuminate the first time the battery system is unable to achieve an all-electric operating range (starting from a full state-of-charge) which is at least 75% of the range determined for the vehicle in the All-Electric Range Test (see section 9.f. of these test procedures) and submitted in the certification application.

(i)(B) For diesel vehicles and hybrid electric vehicles which use diesel engines, maintenance shall be restricted to the following items at intervals no more frequently than every 12,500 miles of engine operation, provided that no maintenance may be performed within 5,000 miles of the final test point:

(1) Adjust low idle speed.

(2) Adjust valve lash if required.

(3) Adjust injector timing.

(4) Adjust governor.

(5) Clean and service injector tips.

(6) Adjust drive belt tension on engine accessories.

(7) Check engine bolt torque and tighten as required.

(ii) Change of engine and transmission oil, change or service of oil filter and, for diesel vehicles only, change or service of fuel filter and air filter, will be allowed at the mileage intervals specified in the manufacturer's maintenance instructions.

(iii) Maintenance shall be conducted in a manner consistent with service instructions and specifications provided by the manufacturer for use by customer service personnel.

3. Delete subparagraph (a)(3) (Service of exhaust gas recirculation system).

4. Delete subparagraph (a)(4) (Service of catalytic converter).

5. Amend subparagraph (a)(5), by adding a new subparagraph (iv) to read:

(iv) When a part has to be replaced while conducting unscheduled maintenance, a similarly aged part shall be used for those parts that affect emissions, unless it is

impractical and unnecessary to age a part and prior approval has been obtained from the Executive Officer for use of the part without aging. In either case, an engineering report on the nature of the problem with the probable cause and corrective action shall be supplied to the Executive Officer.

6. Delete subparagraph (b) (Maintenance of light-duty trucks and heavy-duty engines).

b. Maintenance Instructions

Delete paragraph 86.087-38.

In paragraph 86.085-38:

1. Amend subparagraph (a) to read:

(a) The manufacturer shall furnish or cause to be furnished to the purchaser of each new motor vehicle subject to the standards prescribed in Section 3 of these procedures, written instructions for the maintenance and use of the vehicle by the purchaser as may be reasonable and necessary to assure the proper functioning of emission control systems in normal use. Such instructions shall be consistent with and not require maintenance in excess of the restrictions imposed under subparagraph 86.085-25(a)(1) as amended above, except that the instructions may, subject to approval by the Executive Officer, require additional maintenance for vehicles operated under extreme conditions. In addition, subject to approval by the Executive Officer, the instructions may require inspections necessary to insure safe operation of the vehicle in use.

In addition to any maintenance which may be required pursuant to the preceding paragraph, the instructions may also recommend such inspections, maintenance, and repair as may be reasonable and necessary for the proper functioning of the vehicle and its emission control systems. If the instructions recommend maintenance in addition to that which may be required pursuant to the preceding paragraph, they shall distinguish clearly between required and recommended maintenance.

2. Amend both subparagraphs (c)(1) and (d)(1) to read:

(1) Such instructions shall specify the performance of all scheduled maintenance performed by the manufacturer under subparagraph 86.085-25(a)(1).

c. Submission of Maintenance Instructions

Amend subparagraph 86.079-39(a) to read:

(a) The manufacturer shall provide to the Executive Officer, no later than the time of the submission required by paragraph 86.088-23, *or* 86.091-23, *or 86.094-23,* a copy of the maintenance instructions which the manufacturer proposes to supply to the ultimate purchaser in accordance with subparagraph 86.085-38(a). The Executive Officer will review such instructions to determine whether they are consistent with California requirements, and to determine whether the instructions for required maintenance are consistent with the restrictions imposed under subparagraph 86.085-25(a)(1). The Executive Officer will notify the manufacturer of his or her determinations.

6. Demonstrating Compliance

a. Mileage and Service Accumulation; Emission Measurements

In paragraphs 86.084-26 and 86.090-26:

1. Amend subparagraph (a)(1) to read:

(a)(1) Paragraph (a) of this section applies to light-duty vehicles,except ZEVs which shall be exempt from all mileage and service accumulation, durability-data vehicle, and emission-data vehicle testing requirements.

~~1~~ 2. Amend (a)(2) to read:

The procedure for mileage accumulation shall be the Durability Driving Schedule as specified in Appendix IV to Part 86 of the Code of Federal Regulations. A modified procedure may also be used if approved in advance by the Executive Officer. All passenger cars, light-duty trucks, pre-1995 model year medium-duty vehicles, and 1995 model-year vehicles certified to 1994 model-year emission standards shall accumulate mileage at a measured curb weight which is within 100 pounds of the estimated curb weight. All 1995 and subsequent model-year medium-duty vehicles (except those certified to 1994 model-year emission standards) and all 1992 and subsequent medium-duty LEVs and ULEVs shall accumulate mileage at a loaded weight that is within 100 pounds of the average of the vehicle's curb weight and gross vehicle weight. If the vehicle weight is within 100 pounds of being included in the next higher inertia weight class, the manufacturer may elect to conduct the respective emission tests at the higher weight. All mileage accumulation of ~~series~~ hybrid electric vehicles shall be conducted with the battery pack at the manufacturer's indicated lowest state-of-charge at the beginning of the test cycle. At no time throughout mileage accumulation shall the battery pack be charged using any off-board charging source. ~~utilizing constant operation of the auxiliary engines. Parallel hybrid electric vehicles shall accumulate all mileage while operating with as much use of the combustion engine as is possible.~~

~~2~~ 3. Amend (a)(3)(i) and (a)(3)(ii) (Emission-data vehicle mileage accumulation) by adding the following additional requirement which reads:

The Executive Officer will accept the manufacturer's determination of the mileage at which the engine-system combination is stabilized for emission data testing if ~~(prior to testing) a manufacturer determines that the interval chosen yields emissions performance~~ which is stable and representative of design intent. Sufficient mileage should be accumulated to reduce the possible effects of any emissions variability that is the result of insufficient

vehicle operation. Of primary importance in making this determination is the behavior of the catalyst, EGR valve, trap oxidizer or any other part of the ECS which may have non-linear aging characteristics. In the alternative, the manufacturer may elect to accumulate 4,000 mile +/- 250 mile on each test vehicle within an engine family without making a determination.

3 4. Amend (a)(4)(i) and (a)(4)(ii) (Durability-data vehicle mileage accumulation) by adding the following new subparagraphs (A), (B), (C), and (D) to read:

(A) For otto-cycle and diesel vehicles and battery assisted combustion engine vehicles which use otto-cycle or diesel engines:

(1) Passenger cars, light-duty trucks and medium-duty vehicles certifying to exhaust emissions standards only on a 50,000 mile durability basis and selected by the Executive Officer or elected by the manufacturer under 86.085-24(c)(1), ~~or~~ 86.090-24(c)(1), *86.092-24(c)(1), 86.094-24(c)(1), or 86.095-24(c)(1)* shall be driven, with all emission control systems installed and operating, for 50,000 miles or such lesser distance as the Executive Officer may agree to as meeting the objective of this procedure.

(2) Prior to initiation of mileage accumulation in a durability-data vehicle, manufacturers must establish ~~the mileage test interval for durability-data vehicle~~ testing of the engine family. Once testing has begun on a durability-data vehicle, the durability test interval for that family may not be changed. At a minimum, multiple tests must be performed at 5,000 miles, 50,000 miles, and the final mileage point as long as they meet the requirements of Appendix III. The Executive Officer will accept durability test interval schedules determined by the manufacturer. The testing must provide a DF confidence level equal to or better than the confidence level using the former fixed mileage test and scheduled maintenance intervals. The procedure for making this determination is also given in Appendix III. The mileage intervals between test points must be approximately of equal length. The +/- 250 mile test point tolerance and the requirement that tests be conducted before and after scheduled maintenance is still mandatory. Emission control systems for otto-cycle engines which have step function changes designed into the control system must use the 5,000 mile test interval schedule.

(3) Testing before and after scheduled (or unscheduled) maintenance points must be conducted, and these data

are to be included in the deterioration factor calculation.[2]

The number of tests before and after scheduled maintenance and the mileage intervals between test points should be approximately equal. Durability test interval schedules with multiple testing at test points within 10,000 miles of or at the 50,000 mile and the final mileage test point must be submitted for approval. Multiple testing at maintenance mileage tests points within 10,000 miles of the 50,000 mile and the final mileage test points may be approved if it can be demonstrated by previously generated data that the emission effects of the maintenance are insignificant.

(4) For engine families which are to be certified to the full useful life emission standards, each exhaust emission durability-data vehicle shall be driven with all emission control systems installed and operating, for the full useful life or such lesser distance as the Executive Officer may agree to as meeting the objective of this procedure. Durability tests shall be at every 5,000 miles, from 5,000 miles to the full useful life, however, the above procedures may be used to determine alternate test intervals subject to the following.

For engine families which are to be certified to the full useful life emission standards, durability vehicles may accumulate less than the full useful life if the manufacturer submits other data or information sufficient to demonstrate that the vehicle is capable of meeting the applicable emission standards for the full useful life. At a minimum, 75% of the full useful life shall be accumulated. For the purpose of conducting mileage accumulation on light-duty hybrid electric vehicles, the full useful life of the auxiliary power unit shall be defined as 50,000 miles for a Type A hybrid electric vehicle, 75,000 miles for a Type B hybrid electric vehicle, and 100,000 miles for a Type C hybrid electric vehicle. For medium-duty hybrid electric vehicles, the full useful life of the auxiliary power unit shall be defined as 60,000 miles for a Type A hybrid electric vehicle, 90,000 miles for a Type B hybrid electric vehicle, and 120,000 miles for a Type C hybrid electric vehicle. Alternative durability plans may also be used if the manufacturer provides a demonstration that the alternative plan provides equal or greater confidence that the vehicles

2. Testing before unscheduled maintenance may be omitted with the prior consent of the Executive Officer when testing would be dangerous to a vehicle or an operator.

will comply in-use with the emission standards. The demonstration shall include, but not be limited to, bench test data and engineering data. A manufacturer's in-use emission data may also be used. All alternative durability plans, including the use of durability vehicles which accumulate less than the full useful life are subject to approval in advance by the Executive Officer.

(B) For diesel vehicles equipped with periodically regenerating trap oxidizer systems, at least four regeneration emission tests (see 86.106 through 86.145) shall be made.[3] With the advance approval of the Executive Officer, the manufacturer may install (1) a manual override switch capable of preventing (i.e. delaying until the switch is turned off) the start of the regeneration process and (2) a light which indicates when the system would initiate regeneration if it had no override switch. Upon activation of the override switch the vehicle will be operated on a dynamometer to precondition it for the regeneration emission test in accordance with section 86.132-82 or 86.132-90 and section 9.b. of these procedures. The Urban Dynamometer Driving Schedule (UDDS) which is in progress at the time when the light comes on shall be completed and the vehicle shall proceed to the prescribed soak period followed by testing. With the advance approval of the Executive Officer, the manual override switch will be turned off at some predetermined point in the testing sequence permitting ~~the regeneration process to proceed without further manual~~ interaction. The mileage intervals between test points shall be approximately equal. The first regeneration emission test shall be made at the 5,000 mile point. The regeneration emission tests must provide a deterioration factor confidence level equal to or better than the confidence level achieved by performing regeneration emission tests at the following mileage point: 5,000; 20,000; 35,000; and 50,000. The procedure for making this determination is shown in Appendix IV.

(C) For gasoline-, gaseous-, and ~~methanol~~ alcohol-fueled vehicles, the "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model ~~Liquefied Petroleum Gas- or Gasoline- or Methanol-Fueled~~ Motor Vehicles," as incorporated in Title 13, California Code of Regulations, Section 1976, specify evaporative durability testing at 5,000, 10,000, 20,000, 30,000, 40,000 and 50,000 mile test points. These requirements are also applicable to

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3. Included in Appendix V are the pollutant mass emission calculation procedures for vehicles equipped with periodically regenerating trap oxidizer systems.

hybrid electric vehicles. With the exception of fuel-flexible vehicles, a manufacturer may conduct evaporative testing at test points used for exhaust emission durability testing provided that the same deterioration confidence level for the evaporative emission DF determination is retained (see Appendix III).

(D) For 1993 and 1994 fuel-flexible vehicles which are not certified to TLEV, LEV, or ULEV standards, the test schedule must include exhaust emission tests at 5,000, 10,000, and every 10,000 miles thereafter to the final mileage point using M85 or E85 for methanol and ethanol fuel-flexible vehicles, respectively. Exhaust emission tests shall also be conducted at 5,000 miles, 50,000 miles, and the final mileage point with certification gasoline. For all 1995 and subsequent fuel-flexible vehicles and all 1992 and subsequent fuel-flexible vehicles certifying to TLEV, LEV, or ULEV standards, the test schedule shall include exhaust emission tests at 5,000 miles, 10,000 miles, and every 10,000 miles thereafter to the final mileage point using M85 or E85 and certification gasoline. For all fuel-flexible vehicles, if evaporative emission testing is conducted, exhaust and evaporative emission tests shall also be conducted using M35 or E10, or another approved fuel, at the mileage points where M85 or E85 testing is conducted. The results of these exhaust and evaporative emission tests will be used by the Executive Officer to evaluate the vehicle's emission control deterioration with various fuels (M85, M35, and unleaded gasoline; See Fuel Specifications, Section 9.a. of these procedures). Only the M85 or E85 and certification gasoline exhaust emission results and the M35 or E10 evaporative emission results will be ~~incorporated with other exhaust emission data in determining~~ used to determine applicable exhaust and evaporative emission deterioration factors, respectively, as required in Section 6.b. (Compliance with Emission Standards) of these procedures.

~~(E) For series hybrid electric vehicles and parallel hybrid electric vehicles, the manufacturer shall submit a test schedule to the Executive Officer which reflects the operating mileage of the engine over the full useful life of the vehicle. The test schedule shall include exhaust emission tests at 5,000, 10,000, and every 10,000 miles of engine operation thereafter to the final mileage point corresponding to operating mileage of the engine over the full useful life of the vehicles.~~

~~(F)~~ (E) The Executive Officer may determine under 86.085-24(f), ~~or~~ 86.090-24(f), *86.092-24(f), 86.094-24(f), or 86.095-24(f)* that no testing is required.

~~4~~ 5. Amend subparagraph (a)(5)(i) by adding the following requirement which reads:

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In addition, the emission tests performed on emission-data vehicles and durability-data vehicles shall be non-regeneration emission tests for diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems. For any of these vehicles equipped with continually regenerating trap oxidizer systems, manufacturers may use the provisions applicable to periodically regenerating trap oxidizer systems as an option.

If such an option is elected, all references in these procedures to vehicles equipped with periodically regenerating trap oxidizer systems shall be applicable to the vehicles equipped with continually regenerating trap oxidizer systems.

5 6. Amend subparagraph (a)(8) to read:

(8) Once a manufacturer submits the information required in paragraphs (a)(7) of this section for a durability-data vehicle, the manufacturer shall continue to run the vehicle to 50,000 miles if the family is certified to 50,000 mile emission standards or to the full useful life if it is certified to emission standards beyond 50,000 miles (or to a lesser distance which the Executive Officer may have previously agreed to), and the data from the vehicle will be used in the calculations under 86.088-28, 86.090-28, and 86.091-28. Discontinuation of a durability-data vehicle shall be allowed only with the consent of the Executive Officer.

6 7. Delete subparagraph (b) (Emission-data and durability-data mileage accumulation for light duty trucks).

b. Compliance with Emission Standards

In paragraph 86.088-28, 86.090-28, and 86.091-28:

1. Amend subparagraph (a)(1) to read:

(1) Paragraph (a) of this section applies to ~~light-duty vehicles~~ (passenger cars, light-duty trucks and medium-duty vehicles ~~)~~, except ZEVs.

2. Amend Subparagraph (a)(3) to read:

(3) Since it is expected that emission control efficiency will change with mileage accumulation on a vehicle, the emission level of a vehicle which has accumulated 50,000 miles will be used as the basis for determining compliance with the 50,000 mile emission standards.

3. Amend subparagraph (a)(4)(i) to read:

(i) Separate emission deterioration factors shall be determined from the exhaust emission results of the durability-data vehicle(s) for each engine-system combination. A separate factor shall be established for exhaust HC (non-~~methanol~~ alcohol vehicles, non-TLEVs, non-LEVs, and non-ULEVs), exhaust OMHCE or OMNMHCE (~~methanol~~ alcohol vehicles that are not TLEVs, LEVs, or ULEVs), exhaust NMOG (all TLEVs, LEVs, and ULEVs), exhaust formaldehyde (~~methanol~~ alcohol vehicles, TLEVs, LEVs, and ULEVs), exhaust CO, exhaust NOx, and exhaust particulate (diesel vehicles only) for each engine-system combination. A separate evaporative emission deterioration factor shall be determined for each evaporative emission family-evaporative emission control system combination from the testing conducted by the manufacturer (gasoline- and ~~methanol~~ alcohol-fueled vehicles only).

Separate emission correction factors (diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems only) shall be determined from the exhaust emission results of the durability-data vehicle(s) for each engine-system combination. A separate factor shall be established for exhaust HC (non-~~methanol~~ alcohol vehicles, non-TLEVs, non-LEVs, and non-ULEVs), exhaust OMHCE or OMNMHCE (~~methanol~~ alcohol vehicles that are not TLEVs, LEVs, or ULEVs), exhaust NMOG (TLEVs, LEVs, and ULEVs), exhaust CO, exhaust NOx, and exhaust particulate for each engine-system combination.

4. Delete subparagraph (a)(4)(i)(A)(4) (Outlier test point procedure).

REPLACE WITH:

(4) The manufacturer must use the California outlier identification procedure entitled "Calculation of t-Statistic for Deterioration Data Outlier Test", dated December 17, 1976 and set forth in Appendix VII, to test for irregular data from a durability-data set. If any data point is identified as a statistical outlier, the Executive Officer shall determine, on the basis of an engineering analysis of the causes of the outlier submitted by the manufacturer, whether the outlier is to be rejected. The outlier shall be rejected only if the Executive Officer determines that the outlier does not reflect representative characteristics of the emission control system i.e., the outlier is a result of an emission control system anomaly, test procedure error, or an extraordinary circumstance not expected to recur. ~~Only the identified outlier shall be eliminated; other data at that test point~~ (i.e., data for other pollutants) shall not be eliminated unless the Executive Officer determines, based on the engineering analysis, that they also do not reflect representative characteristics of the emission control system. Where the

manufacturer chooses to apply both the outlier procedure and averaging (as allowed under 86.084-26(b)(6)(i) and 86.090-26(a)(6)(1) to the same data set, the outlier procedure shall be completed prior to applying the averaging procedure. All durability test data, including any outliers and the manufacturer's engineering analysis, shall be submitted with the final application.

5. Amend subparagraph (a)(4)(i)(B) (durability vehicles must meet emissions standards) to read:

(B) All applicable exhaust emission results shall be plotted as a function of the mileage on the system, rounded to the nearest mile, and the best fit straight lines, fitted by the method of least squares, shall be drawn through all these data points. The emission data will be acceptable for use in the calculation of the deterioration factor only if the interpolated 4,000-mile, 50,000-mile, and full useful life points on this line are within the emission standards given in subparagraph 3. or within the federal emission standards if a federal durability data vehicle is approved in accordance with subparagraph 4.b.4., as applicable. For hybrid electric vehicles, the emission data will be acceptable for use in the calculation of the deterioration factor only if the engine mileage points corresponding to the interpolated 4,000 mile, 50,000 mile, and full useful life points of the vehicle on this line are within the emission standards given in subparagraph 3. or within the ~~federal emission standards if a federal durability data~~ vehicle is approved in accordance with subparagraph 4.b.4., as applicable. The engine mileage points shall be determined based on the test schedule submitted to the Executive Officer as required in paragraphs 86.084-26 and 86.090-26. As an exception, the Executive Officer will review the data on a case-by-case basis and may approve its use in those instances where the best fit straight line crosses an applicable standard but no data point exceeds the standard or when the best fit straight line crosses the applicable standard at the 4,000-mile point but the 5,000-mile actual test point and the 50,000 mile and full useful life interpolated points are both below the standards. A multiplicative exhaust emission deterioration factor shall be calculated for each engine system combination as follows:

(1) For engine families certified to 50,000 mile emissions standards:

$Factor_1$ = Exhaust emissions interpolated to 50,000 miles divided by exhaust emissions interpolated to 4,000 miles.

(2) For engine families certified to full useful life emissions standards beyond 50,000 miles:

$Factor_2$ = Exhaust emissions interpolated to the full useful life divided by exhaust emissions interpolated to 4,000 miles.

6. Add subparagraph (a)(4)(i)(D) to read:

(D) The regeneration exhaust emission data (diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems only) from the tests required under 86.084-26(a)(4) or 86.090-26(a)(4) shall be used to determine the regeneration exhaust emissions interpolated to the 50,000-mile point. The regeneration exhaust emission results shall be plotted as a function of the mileage on the system, rounded to the nearest mile, and the best fit straight lines, fitted by the method of least squares, shall be drawn through all these data points. The interpolated 50,000-mile point of this line shall be used to calculate the multiplicative exhaust emission correction factor for each engine-system combination as follows:

$$\text{Factor} = 1 + \frac{R-1}{4505} n$$

where, R = the ratio of the regeneration exhaust emissions interpolated to 50,000 miles to the non-regeneration exhaust emissions interpolated to 50,000 miles.

n = the number of complete regenerations which occur during the durability test.

These interpolated values shall be carried out to a minimum of four places to the right of the decimal point before dividing one by the other to determine the correction factor. The results shall be rounded to three places to the right of the decimal point in accordance with ASTM E 29-67. For applicability to gaseous emission standards under the 100,000 mile option, R will be determined based upon projected 100,000 mile emissions.

7. Amend subparagraph (a)(4)(ii)(A) to read:

(A) The official exhaust emission test results for each emission-data vehicle at the 4,000 mile test point shall be multiplied by the appropriate deterioration factor, and correction factor (diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems only): Provided: that if a deterioration factor as computed in paragraph (a)(4)(i)(B) of this section or a correction factor as computed in paragraph (a)(4)(i)(D) of this section is less than one, that deterioration factor or correction factor shall be one for the purposes of this paragraph.

8. Amend subparagraph (a)(4)(iii) to read:

(iii) The emissions to compare with the standard (or the family particulate emission limit, as appropriate) shall be the adjusted emissions of paragraphs (a)(4)(ii)(A) and (B) of this section for each emission-data vehicle. Before any emission value is compared with the standard (or the family particulate limit, as appropriate), it shall be rounded, in accordance with ASTM E29-67 to ~~two~~ one significant figures beyond the number of significant figures contained in the standard (or the family particulate emission limit, as appropriate). The rounded emission values may not exceed the standard (or the family particulate emission limit, as appropriate). Fleet average NMOG value calculations shall be rounded, in accordance with ASTM E29-67, to four significant figures before comparing with fleet average NMOG requirements.

~~8~~ 9. Delete subparagraph (b) (Compliance provisions for light-duty trucks).

c. Prohibition of Defeat Devices

In paragraph 86.094-16:

1. Amend subparagraph (a) to read:

No new passenger car, light-duty truck, or medium-duty vehicle shall be equipped with a defeat device.

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7. Small-Volume Manufacturer's Certification Procedures

a. In paragraphs 86.084-14, and 86.088-14 86.090-14, 86.092-14, and 86.095-14:

1. Amend subparagraph (b)(1) to read:

(1) The optional small-volume manufacturers certification procedures apply to light-duty vehicles (passenger cars, light-duty trucks, and medium-duty vehicles), produced by manufacturers with California sales (for the model year in which certification is sought) of fewer than 3,000 units (PC, LDT and MDV combined). The optional small-volume manufacturers certification procedures shall not apply to hybrid electric vehicles. All hybrid electric vehicle manufacturers shall be subject to the certification requirements established for hybrid electric vehicles.

2. Delete subparagraphs (b)(2) through (b)(5) (Determining aggregated sales; aggregated sales provisions for small volume manufacturers).

2 3. Amend subparagraph (c)(4) to read:

(4) A small-volume manufacturer shall include in its records all of the information that ARB requires in 86.088-21, *86.090-21,* or 86.091-21, or 86.094-21, including the modifications noted in Section 4.a. of these test procedures. This information will be considered part of the manufacturer's application for certification and must be submitted to the Executive Officer.

4. Delete subparagraph (c)(7)(i)(A) (Worst-case selection of emission-data vehicles).

5. Amend subparagraph (c)(11)(ii)(D)(1) to show the 3,000 total vehicle sales limit applicable to California for determining a small-volume manufacturer.

8. Alternative Procedures for Notification of Additions and Changes

a. Amend subparagraph 86.082-34(a) by adding the following additional requirements which read:

A manufacturer must notify the Executive Officer within 10 working days of making an addition of a vehicle to a certified engine family or a change in a vehicle previously covered by certification.

The manufacturer shall also submit, upon request of the Executive Officer, the following items:

(1) service bulletin.
(2) driveability statement.
(3) test log.
(4) maintenance log.

All running changes and field fixes which do not adversely affect the system durability are deemed approved unless disapproved by the Executive Officer within 30 days of the receipt of the running change or field fix request. A change not specifically identified in the manufacturer's application must also be reported to the Executive Officer if the change may adversely affect engine or emission control system durability. Examples of such changes include any change that could affect durability, thermal characteristics, deposit formation, or exhaust product composition i.e., combustion chamber design, cylinder head material, camshaft profile, computer modifications, turbocharger, intercooler wastegate characteristics, and transmission or torque converter specifications. Running changes and field fixes meeting the definitions contained in Appendix VI shall be automatically deemed approved by the Executive Officer, as long as the conditions set forth in Appendix VI are satisfied.

The manufacturer is required to update and submit to the Executive Officer the "supplemental data sheet" for all running changes and field fixes implemented with the change notification. The manufacturer shall submit, on a monthly basis, by engine family, a list of running changes/field fixes giving the document number date submitted and a brief description of the change.

9. Test Requirements

a. Fuel Specifications

In paragraph 86.113-90, 86.113-91, and 86.113-94:

1. Add subparagraphs (a)(1)(i) *and (ii)* which read[*s*]:

(i) For 1992-*1994* [*and subsequent*] model-year Otto-cycle vehicles, gasoline having the specifications listed below may be used in exhaust and evaporative emission testing as an option to the specifications referred to in subparagraph (a)(1). If a manufacturer elects to utilize this option, both exhaust and evaporative emission testing shall be conducted by the manufacturer with gasoline having the specifications listed below, and the Executive Officer shall conduct exhaust and evaporative emission testing with gasoline having the specifications listed below.

Research Octane, minimum	93
Sensitivity, minimum	7.5
Lead (organic), maximum, g/US gal	0.050
Distillation Range	
IBP, degrees F	75-100
10 pct. point, degrees F	120-140
50 pct. point, degrees F	200-230
90 pct. point, degrees F	300-325
EP, maximum, degrees F	415
Sulfur, maximum weight pct.	0.03
Phosphorous, maximum, g/US gal	0.005
RVP, psi	7.5-8.0
Hydrocarbon composition	
Olefins, maximum pct.	10
Aromatics, maximum pct.	35
Saturates	remainder

(ii) For 1993-1994 model-year Otto-cycle TLEVs, LEVs, and ULEVs and for all 1995 and subsequent model-year Otto-cycle vehicles, gasoline having the specifications listed below may be used in exhaust and evaporative emission testing as an option to the specifications referred to in subparagraph (a)(1). If a manufacturer elects to utilize this option, both exhaust and evaporative emission testing shall be conducted by the manufacturer with gasoline having the specifications listed below, and the Executive Officer shall conduct exhaust and evaporative emission testing with gasoline having the specifications listed below.

Fuel Property a/	Limit	Test Method b/
Octane, (R+M)/2 (min)	91	D 2699-88, D 2700-88
Sensitivity (min)	7.5	D 2699-88, D 2700-88
Lead, g/gal (max) (No lead added)	0-0.01	Title 13 CCR 2253.4(c)
Distillation Range, degrees F		Title 13 CCR 2263 c/
10 pct. point,	130-150	
50 pct. point,	200-210 d/	
90 pct. point,	290-300 e/	
EP, maximum	390	
Residue, vol% (max)	2.0	
Sulfur, ppm by wt.	30-40	Title 13 CCR 2263
Phosphorous, g/gal (max)	0.005	Title 13 CCR 2253.4(c)
RVP, psi	6.7-7.0	Title 13 CCR 2263
Olefins, vol %	4.0-6.0	Title 13 CCR 2263
Total Aromatic Hydrocarbons, vol %	22-25	Title 13 CCR 2263
Benzene, vol %	0.8-1.0 f/	Title 13 CCR 2263
Multi-Substituted Alkyl Aromatic Hydrocarbons, vol %	12-14	g/
MTBE, vol %	10.8-11.2	Title 13 CCR 2263
Additives	Sufficient to meet requirements of Title 13, Section 2257, of California Code of Regulations	
Copper Corrosion	No. 1	D 130-88
~~Gum, Washed, mg/100 ml (max)~~	~~3.0~~	~~D 381-86~~
Oxidation Stability, minutes (min)	1000	D 525-88
Specific Gravity	Report h/	
Heat of Combustion	Report h/	
Carbon, wt%	Report h/	
Hydrogen, wt%	Report h/	

a/ The gasoline must be blended from typical refinery feedstocks.

b/ ASTM specification unless otherwise noted. A test method other than that specified may be used following a determination by the Executive Officer that the other method produces results equivalent to the results with the specified method.

c/ Although Title 13 CCR Section 2263 refers to the temperatures of the 50 and 90 percent points, this procedure can be extended to the 10 percent and end point temperatures, and to the determination of the residue content.

d/ The range for interlaboratory testing is 195-215 degrees Fahrenheit.

e/ The range for interlaboratory testing is 285-305 degrees Fahrenheit.

f/ The range for interlaboratory testing is 0.7-1.1 percent by volume.

g/ "Detailed Hydrocarbon Analysis of Petroleum Hydrocarbon Distillates, Reformates, and Gasoline by Single Column High Efficiency (Capillary) Column Gas Chromatography," by Neil Johansen, 1992, Boulder, CO.

h/ The fuel producer should report this fuel property to the fuel purchaser. Any generally accepted test method may be used and shall be identified in the report.

3. Delete subparagraph (a)(4) (Alternative methanol test fuels for otto-cycle vehicles).

4. Amend subparagraph (a)(5) to read:

(5) The specification range of the fuels to be used under paragraph (a)(2) of this section shall be reported in accordance with 86.090-21(b)(3) or 86.091-21(b)(3).

5. Amend subparagraph (b)(2) to read:

(2) Except as noted below, petroleum fuel for diesel vehicles meeting the specifications referenced in 86.113-90(b)(2), or substantially equivalent specifications approved by the Executive Officer, shall be used in exhaust emission testing. The grade of petroleum fuel recommended by the engine manufacturer, commercially designated as "Type 2-D" grade diesel shall be used. For 1993 and subsequent model-year diesel vehicles, petroleum fuel meeting the specifications of 86.113-94(b)(2) may be used in exhaust emission testing as an option to the specifications in 86.113-90(b)(2). For 1995 and subsequent model-year diesel-fueled vehicles, the petroleum fuel used in exhaust emission testing may meet the specifications of the general reference fuel in Section 2256(g)(3), Title 13, California Code of Regulations, or substantially equivalent specifications approved by the Executive Officer as an option to the specifications in 86.113-90(b)(2) or 86.113-94(b)(2).

6. Amend subparagraph (b)(3) to read:

(3) Except as noted below, petroleum fuel for diesel vehicles meeting the following specifications, or substantially equivalent specifications approved by the Executive Officer shall be used in service accumulation. The grade of diesel fuel recommended by the engine manufacturer, commercially designated as "Type 2-D" grade diesel fuel, shall be used. For 1993 and subsequent model-year diesel-fueled vehicles, petroleum fuel meeting the specifications of 86.113-94(b)(3) may be used in service accumulation. For 1995 and subsequent model-year diesel-fueled vehicles, diesel fuel representative of commercial diesel fuel which will be generally available through retail outlets shall be used in service accumulation.

7. Delete subparagraph (b)(4) (Methanol test fuel for diesel vehicles).

8. Delete subparagraph (b)(5) (Alternative methanol test fuels for diesel vehicles).

9. Amend subparagraph (b)(6) to read:

(6) The specification range of the fuels to be used under paragraphs (b)(2) and (b)(3) of this section shall be

reported in accordance with 86.090-21(b)(3) or 86.091-21(b)(3).

10. Replace subparagraph (d) with:

(d) Methanol-Gasoline Fuel Specifications for 1993 Model-Year Vehicles.

Various methanol-gasoline fuel blends will be used according to the type of methanol-fueled vehicle being certified and the particular aspect of the certification procedure being conducted, as specified below. Gasoline used for blending fuel for use in mileage accumulation shall be representative of commercial regular unleaded gasoline which will be generally available through retail outlets. Gasoline used for blending fuel for use in emission testing shall conform with the unleaded gasoline specification noted in paragraph (a) above.

Fuel additives and ignition improvers intended for use in methanol test fuels shall be subject to the approval of the Executive Officer. In order for such approval to be granted, a manufacturer must demonstrate that emissions will not be adversely affected by the use of the fuel additive or ignition improver.

(1) Otto-cycle methanol vehicles and hybrid electric vehicles which use otto-cycle methanol engines

Mileage-accumulation fuel: For methanol vehicles and hybrid electric vehicles which use otto-cycle methanol engines a methanol-gasoline blend composed of 85-percent methanol which is representative of commercially available methanol and 15-percent unleaded gasoline as noted above.

Emission-testing fuel: For vehicles certifying on methanol, a methanol-gasoline blend composed of 85 percent chemical grade methanol and 15-percent unleaded gasoline as noted above.

(2) Methanol-fueled diesel vehicles and hybrid electric vehicles which use methanol-fueled diesel engines.

Mileage-accumulation fuel: For methanol vehicles and hybrid electric vehicles which use methanol-fueled diesel engines, commercially available methanol fuel.

Emission-testing fuel: chemical grade methanol.

(3) Fuel-flexible vehicles

Mileage-accumulation fuel: For both durability-data vehicles and emission-data vehicles, mileage accumulation shall be conducted with one fuel. For

Mileage-accumulation fuel: For both durability-data vehicles and emission-data vehicles, mileage accumulation shall be conducted with one fuel. For vehicles designed to operate on methanol, a methanol-gasoline blend composed of 85-percent methanol and 15-percent unleaded gasoline both of which are representative of commercially available fuels shall be used. Alternative mileage accumulation fuels and procedures may be used if demonstrated to result in equivalent or more severe deterioration of the vehicle's emission control system, subject to the prior approval of the Executive Officer.

Emission-test fuel: Case (1) For ~~regular~~ exhaust only emission testing of emission-data vehicles, a methanol-gasoline blend composed of 85-percent chemical grade methanol and 15-percent unleaded gasoline (M85), and unleaded gasoline shall be used. For evaporative emission testing, a blend of 35-percent chemical grade methanol and 65-percent unleaded gasoline (M35) shall be used.

Case (2) For the testing required under 6.a.4.(D) ~~3.(D).~~ of these procedures (of durability-data vehicles), exhaust ~~emission tests~~ (exhaust OMHCE or OMNMHCE for non-TLEVs, non-LEVs, and non-ULEVs, exhaust NMOG for TLEVs, LEVs, and ULEVs, exhaust formaldehyde, exhaust CO, and exhaust NOx) and evaporative emission tests (evaporative OMHCE) shall be conducted at the specified mileage intervals and with the specified fuels using 85-percent chemical grade methanol and 15-percent unleaded gasoline (M85), unleaded gasoline, and/or 35-percent chemical grade methanol and 65-percent unleaded gasoline (M35), as applicable. ~~In addition, complete sets of emission tests shall be conducted at 5,000 miles, 50,000 miles and the final mileage point with unleaded gasoline.~~

For both Case (1) and (2), alternative methanol-gasoline blends may be used in place of M35 if demonstrated to result in equivalent or higher evaporative emissions, subject to the prior approval of the Executive Officer.

(4) Other methanol fuels may be used for testing and service accumulation provided: (i) they are commercially available; (ii) information, acceptable to the Executive Officer, is provided to show that only the designated fuel would be used in customer service; (iii) use of a fuel listed in this section would not have a detrimental effect on emissions or durability; (iv) written approval from the Executive Officer of the fuel specifications must be provided prior to the start of testing.

(5) The specification of the fuels to be used under paragraphs (d)(1), (d)(2), and (d)(3) of this section shall be reported in accordance with 86.090-21(b)~~9~~(3), ~~or~~ 86.091-21(b)(3), *or 86.094-21(b)(3).*

(6) The specifications set forth in subparagraph (e) may be used as an option for 1993 model-year vehicles.

11. Add new subparagraph (e) to read:

(e) ~~Methanol~~Alcohol-Gasoline Fuel Specifications for 1994 and Subsequent Model-Year Vehicles.

Various ~~methanol~~ alcohol-gasoline fuel blends will be used according to the type of ~~methanol~~alcohol-fueled vehicle being certified and the particular aspect of the certification procedure being conducted, as specified below.

Fuel additives and ignition improvers intended for use in ~~methanol~~ alcohol test fuels shall be subject to the approval of the Executive Officer. In order for such approval to be granted, a manufacturer must demonstrate that emissions will not be adversely affected by the use of the fuel additive or ignition improver.

(1) Otto-cycle ~~methanol~~ alcohol vehicles and hybrid electric vehicles which use otto-cycle ~~methanol~~ alcohol engines

Mileage-accumulation fuel: For methanol, ~~vehicles~~ ethanol and hybrid electric vehicles which use otto-cycle methanol or ethanol engines, fuel which meets the specifications listed in Title 13, CCR, Section 2292.1, ~~or~~ 2292.2, 2292.3 or 2292.4, as applicable.

Emission-testing fuel: For methanol, ethanol and hybrid electric vehicles which use otto-cycle methanol or ethanol engines, fuel which meets the specifications listed in Title 13, CCR, Section 2292.1, ~~or~~ 2292.2, 2292.3 or 2292.4, as modified by the following:

The fuel specification for Title 13, CCR, Section 2292.1 shall be modified to: a) require methanol content at 98.0 +/- 0.5 volume percent; b) require ethanol content at 1.0 +/- 0.1 volume percent; c) require certification gasoline conforming with specifications noted in paragraph ~~(a)~~ section 9.a.1. of these test procedures at 1.0 +/- 0.1 volume percent.

The fuel specification for Title 13, CCR, Section 2292.3 shall be modified to: a) require ethanol content at 98.0 +/- 0.5 volume percent; b) require methanol content at 1.0 +/- 0.1 volume percent; c) require certification gasoline conforming with specifications.

certification gasoline conforming with specifications noted in section 9.a.1. of these test procedures at 1.0 +/- 0.1 volume percent.

The fuel specification for Title 13, CCR, Section 2292.2 and 2292.4 shall be modified to require certification gasoline conforming with specifications noted in ~~paragraph (a)~~ section 9.a.1. of these test procedures as the hydrocarbon fraction. The vapor pressure specification for the emission-testing fuel shall be adjusted to 8.0 - 8.5 psi., using common blending components from the gasoline stream.

(2) ~~Methanol~~ Alcohol-fueled diesel vehicles and hybrid electric vehicles which use ~~methanol~~ alcohol-fueled diesel engines

Mileage-accumulation fuel: For methanol, ~~vehicles~~ ethanol and hybrid electric vehicles which use ~~methanol~~ alcohol-fueled diesel engines, fuel which meets the specifications listed in Title 13, CCR, Section 2292.1, ~~or~~ 2292.2, 2292.3 or 2292.4, as applicable.

Emission-testing fuel: For methanol, ethanol and hybrid electric vehicles which use otto-cycle ~~methanol~~ alcohol engines, fuel which meets the specifications listed in Title 13, CCR, Section 2292.1, ~~or~~ 2292.2, 2292.3 or 2292.4, as modified by the following:

The fuel specification for Title 13, CCR, Section 2292.1 shall be modified to: a) require methanol content at 98.0 +/- 0.5 volume percent; b) require ethanol content at 1.0 +/- 0.1 volume percent; c) require certification gasoline as noted in ~~paragraph (a)~~ section 9.a.1. of these test procedures at 1.0 +/- 0.1 volume percent.

The fuel specification for Title 13, CCR, Section 2292.3 shall be modified to require ethanol content at 98.0 +/- 0.5 volume percent and require certification gasoline conforming with specifications noted in section 9.a.1. of these test procedures at 1.0 +/- 0.1 volume percent.

The fuel specification for Title 13, CCR, Section 2292.2 and 2292.4 shall be modified to require certification gasoline conforming with specifications noted in ~~paragraph (a)~~ section 9.a.1. of these test procedures as the hydrocarbon fraction. The vapor pressure specification for the emission-testing fuel shall be adjusted to 8.0 - 8.5 psi., using common blending components from the gasoline stream.

(3) Fuel-flexible vehicles

Mileage-accumulation fuel: For both durability-data vehicles and emission-data vehicles, mileage accumulation shall be conducted with one fuel. For vehicles designed to operate on methanol, a fuel that meets the specifications listed in Title 13, CCR, Section 2292.2 shall be used. For vehicles designed to operate on ethanol, a fuel that meets the specifications listed in Title 13, CCR, Section 2292.4 shall be used. Alternative mileage accumulation fuels and procedures may be used if demonstrated to result in equivalent or more severe deterioration of the vehicle's emission control system, subject to the prior approval of the Executive Officer.

Emission-test fuel: Case (1) For ~~regular~~ exhaust only emission testing of emission-data vehicles, fuel that meets the specifications listed in Title 13, CCR, Section 2292.2 or 2292.4. For evaporative emission testing, a blend of fuel that meets the specifications listed in Title 13, CCR, Section 2292.2 or 2292.4 and gasoline meeting the specifications of section 9.a.1. of these test procedures such that the final blend is composed of either 35 volume percent methanol (plus or minus 1 volume percent of total blend) for methanol-fueled vehicles or 10 volume percent ethanol (plus or minus 1 volume percent of total blend) for ethanol-fueled vehicles shall be used.

~~Case (2) For the testing required under 6.a.4.(D) 3.(D).~~ of these procedures (of durability-data vehicles), exhaust emission tests (exhaust OMHCE or OMNMHCE for non-TLEVs, non-LEVs, and non-ULEVs, exhaust NMOG for TLEVs, LEVs, and ULEVs, exhaust formaldehyde, exhaust CO, and exhaust NOx) and evaporative emission tests (evaporative OMHCE) shall be conducted at the specified mileage intervals using: (i) emission testing fuel that meets the specifications listed in subparagraph (e)(1) of section 9.a.11. of ~~this~~ these test procedures and (ii) a blend of fuel produced by combining emission-testing fuel that meets the specifications in subparagraph (e)(1) of section 9.a.11. of these test procedures and certification gasoline described in paragraph ~~(a)~~ section 9.a.1. of these test procedures such that the final fuel is either 35 volume percent methanol (plus or minus 1 volume percent of total blend) and 65 volume percent certification gasoline for methanol-fueled vehicles or 10 volume percent ethanol (plus or minus 1 volume percent of total blend) and 90 volume percent certification gasoline for ethanol-fueled vehicles. ~~In addition, complete sets of emission tests shall be conducted at 5,000 miles, 50,000 miles and the final mileage point with commercially available unleaded gasoline.~~

For both Case (1) and (2), alternative alcohol-gasoline blends may be used in place of M35 or E10 if demonstrated to result in equivalent or higher evaporative emissions, subject to the prior approval of the Executive Officer.

(4) The specification of the fuels to be used under paragraphs (e)(1), (e)(2), (e)(3) and (e)(4) of this section shall be reported in accordance with 86.090-21(b)(3) or 86.091-21(b)(3).

12. Add new subparagraph (f) to read:

(f) Gaseous Fuel Specifications for 1988 Through 1993 Model Year Vehicles.

(1) Gaseous fuels representative of commercial gaseous fuels which will be generally available through retail outlets in California or liquid petroleum gas having the ASTM D1835 or NGPA HD-5 specification shall be used in service accumulation.

(2) Liquid petroleum gas having the ASTM D1835 or NGPA HD-5 specification shall be used for exhaust and evaporative emission testing.

(3) Natural gas representative of commercial natural gas which will be generally available through retail outlets in California shall be used for exhaust emission testing.

(4) Written approval from the Administrator of the fuel specifications must be provided prior to the start of testing.

(5) For dedicated gaseous- and dual-fueled vehicles and for hybrid electric vehicles which use gaseous-fueled engines, the mileage accumulation fuel for both durability-data vehicles and emission-data vehicles shall be conducted with one fuel. For vehicles designed to operate on natural gas, natural gas which meets the requirements of (3) shall be used. For vehicles designed to operate on liquefied petroleum gas, liquefied petroleum gas which meets the requirements of (2) shall be used.

(6) The specifications set forth in subparagraph (g) may be used as an option for 1993-model year vehicles.

(7) Alternative mileage-accumulation fuels and test procedures may be used if demonstrated to result in equivalent or more severe deterioration of the vehicle's emission control system, subject to the prior approval of the Executive Officer.

(8) Alternative emission-test fuels may be used if demonstrated to result in equivalent or higher exhaust

emissions, subject to the prior approval of the Executive Officer.

13. Add new subparagraph (g) to read:

(g) Gaseous Fuel Specifications for 1994 and Subsequent Model Year Vehicles.

(1) Dedicated gaseous- and dual-fueled vehicles and hybrid electric vehicles which use liquefied petroleum gas

Mileage accumulation fuel: Liquefied petroleum gas meeting the specifications listed in Title 13, CCR, Section 2292.6 shall be used in service accumulation.

Emission-test fuel: Liquefied petroleum gas meeting the specifications listed in Title 13, CCR, Section 2292.6 shall be used for exhaust and evaporative emission testing with the following exceptions: a) propane content limited to 93.5 +/- 1.0 volume percent; b) propene content limited to 3.8 +/- 0.5 volume percent; c) butane and heavier components limited to 1.9 +/- 0.3 volume percent.

(2) Dedicated gaseous- and dual-fueled vehicles and hybrid electric vehicles which use natural gas

Mileage accumulation fuel: Natural gas meeting the specifications listed in Title 13, CCR, Section 2292.5 shall be used in service accumulation.

Emission-test fuel: Natural gas meeting the specifications listed in Title 13, CCR, Section 2292.5 as modified by the following: a) methane content limited to 90.0 +/- 1.0 mole percent; b) ethane content limited to 4.0 +/- 0.5 mole percent; c) C_3 and higher hydrocarbon content at 2.0 +/- 0.3 mole percent; d) oxygen content at 0.5 +/- 0.1 mole percent; e) inert gases (sum of CO_2 and H_2) content at 3.5 +/- 0.5 mole percent.

b. Road Load Power Test Weight

In paragraph 86.129-80 and 86.129-94:

1. Amend subparagraph (a) to add:

ROAD LOAD POWER TEST WEIGHT AND INERTIA WEIGHT CLASS DETERMINATION

ROAD LOAD POWER AT 50 mi/hr-LIGHT DUTY TRUCKS	LOADED WEIGHT (POUNDS)[5]	EQUIVALENT TEST WEIGHT (POUNDS)	INERTIA WEIGHT CLASS (POUNDS)
	10001 to 10250	10000	10000
	10251 to 10750	10500	10500
	10751 to 11250	11000	11000
	11251 to 11750	11500	11500
	11751 to 12250	12000	12000
	12251 to 12750	12500	12500
	12751 to 13250	13000	13000
	13251 to 13750	13500	13500
	13751 to 14000	14000	14000

[5] For 1995 and subsequent medium-duty vehicles, "Loaded Weight" shall be the average of the vehicle's curb weight and gross vehicle weight.

2. Add subparagraph (d) to read:

(d) Power absorption unit adjustment- medium-duty vehicles.

(1) The power absorption unit shall be adjusted to reproduce road load power at 50 mph true speed. The dynamometer power absorption shall take into account the dynamometer friction, as discussed in paragraph 86.118-78.

(2) The dynamometer road load setting is determined from the loaded test weight, the reference frontal area, vehicle protuberances, and an aerodynamic drag coefficient as determined appropriate by the Executive Officer. The vehicle manufacturer shall submit the procedure by which the aerodynamic drag coefficient was determined in the test vehicle information section in the certification application. The dynamometer road load setting shall be determined by the following equation.

(i) For medium-duty vehicles to be tested on twin or single, large roll dynamometers.

$$Hp = (0.00182)V((0.015)(W)+(0.0375)(Cd)(A)(V^2)/(32.2ft/s^2))+P$$

where:

Hp=the dynamometer power absorber setting at 50 mph (horsepower).
0.00182=conversion factor to horsepower.
V=velocity in feet/sec.
0.015=coefficient of rolling resistance.
W=loaded vehicle weight in pounds.
0.0375=air density in lbm/cubic ft.
Cd=aerodynamic drag coefficient

A=reference frontal area in square ft.
32.2 ft/s^2=gravitational acceleration
P=protuberance power (horsepower)

(ii) The protuberance power, P shall be determined per subparagraph 86.129-80 (c)(2)(i).

(iii) The dynamometer power absorber setting for medium-duty vehicles shall be rounded to the nearest 0.1 horsepower.

(3) The road load power calculated above shall be used or the vehicle manufacturer may determine the road load power by an alternate procedure requested by the manufacturer and approved in advance by the Executive Officer.

(4) Where it is expected that more than 33 percent of a vehicle line within an engine-system combination will be equipped with air conditioning, per subparagraph 86.090-24(g)(2), 86.092-24(g)(2), *86.094-24(g)(2)*, or 86.095-24(g)(2), the road load power as determined in paragraph (d) (2) or (3) of this section shall be increased by 10 percent up to a maximum increment of 1.4 horsepower, for testing all test vehicles of that vehicle line within that engine-system combination if those vehicles are intended to be offered with air conditioning in production. This power increment shall be added to the indicated dynamometer power absorption setting prior to rounding off this value.

(5) For electric and hybrid electric vehicle lines where it is expected that more than 33 percent of a vehicle line will be equipped with air conditioning, per subparagraph 86.090-24(g)(2), 86.092-24(g)(2), *86.094-24(g)(2)*, or 86.095-24(g)(2), which derives power from the battery pack, the road load shall be increased by the incremental horsepower required to operate the air conditioning unit. The incremental increase shall be determined by recording the difference in energy required for a hybrid electric vehicle under all-electric power to complete the running loss test fuel tank temperature profile test sequence without air conditioning and the same vehicle tested over the running loss test fuel tank temperature profile test sequence with the air conditioning set to the "NORMAL" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed over the time period needed to perform the test sequence, and converting this value into units of horsepower. Vehicles equipped with automatic temperature controlled air conditioning systems shall be operated in "AUTOMATIC" temperature and fan modes with the system set at 72 degrees Fahrenheit. The running loss test fuel tank temperature profile test sequence is found in the "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles" as incorporated by reference in section 1976, Title 13, CCR.

c. Test Sequence; General Requirements

Amend paragraph 86.130-78 to read:

The test sequence shown in figure B78-10 shows the steps encountered as the test vehicle undergoes the procedures subsequently described to determine conformity with the standards set forth. Ambient temperature levels shall not be less than 68 degrees F (20 degrees C) nor more than 86 degrees F (30 degrees C) ... For purposes of determining conformity with 50 degrees F test requirements, the procedures set forth in Section 11k of these test procedures shall apply. For all hybrid electric vehicles and all 1995 and subsequent model-year vehicles certifying to running loss and useful life evaporative emission standards, the test sequence specified in "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles" as incorporated by reference in section 1976, Title 13, CCR shall apply.

d. Vehicle Preconditioning

In paragraphs 86.132-82 and 86.132-90:

1. Amend subparagraph (a)(2) to read:

(2) Within one hour of being fueled the vehicle shall be placed, either by being driven or pushed, on a dynamometer and operated through one Urban Dynamometer Driving Schedule (UDDS) test procedure, see 86.115 and Appendix I of the federal procedures.

The UDDS performed prior to a non-regeneration emission test shall not contain a regeneration (diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems only). A gasoline fueled test vehicle may not be used to set dynamometer horsepower.

2. Amend subparagraph (a)(3) to read:

(3) For those unusual circumstances where additional preconditioning is desired by the manufacturer, such preconditioning may be allowed with the advance approval of the Executive Officer. The Executive Officer may also choose to conduct or require the conduct of additional preconditioning to insure that the evaporative emission control system is stabilized in the case of otto-cycle engines, or to insure that the exhaust system is stabilized in the case of diesel engines. The additional preconditioning shall consist of an initial one hour minimum soak and, one, two, or three driving cycles of the UDDS (or more in the case of a diesel vehicle equipped with a periodically regenerating trap oxidizer system, which is being preconditioned for a regeneration emission test), as described in paragraph (a)(2) of this section, each followed by a soak of at least one hour with engine off, engine compartment cover closed and cooling

fan off. The vehicle may be driven off the dynamometer following each UDDS for the soak period.

3. For all hybrid electric vehicles and all 1995 and subsequent model-year vehicles subject to running loss and useful life evaporative emission standards, the preconditioning sequence specified in "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles" as incorporated by reference in section 1976, Title 13, CCR shall apply.

e. Regeneration Recording Requirements

Amend paragraph 86.142-82 by adding the following subparagraph (r) which reads:

(r) The manufacturer shall record in the durability-data vehicle log book, the number of regenerations which occur during the 50,000 mile durability test of each diesel passenger car, light-duty truck and medium-duty vehicle equipped with a periodically regenerating trap oxidizer system. The manufacturer shall include, for each regeneration: the date and time of the start of regeneration, the duration of the regeneration, and the accumulated mileage at the start and the end of regeneration. The number of regenerations will be used in the calculation of the correction factor in 40 CFR Part 86, Section 28.

Amend paragraph 86.142-90 by adding the following subparagraph (s) which reads:

(s) The manufacturer shall record in the durability-data vehicle log book, the number of regenerations which occur during the 50,000 mile durability test of each diesel passenger car, light-duty truck and medium-duty vehicle equipped with a periodically regenerating trap oxidizer system. The manufacturer shall include, for each regeneration: the date and time of the start of regeneration, the duration of the regeneration, and the accumulated mileage at the start and the end of regeneration. The number of regenerations will be used in the calculation of the correction factor in 40 CFR Part 86, Section 28.

f. All-Electric Range Test Requirements

All 1993 and subsequent ZEVs and Type A and Type B hybrid electric vehicles shall be subject to the All-Electric Range Test specified below for the purpose of determining the energy efficiency and operating range of a ZEV or of a hybrid electric vehicle operating without the use of its auxiliary power unit. For hybrid electric vehicles, the manufacturer may elect to conduct the All-Electric Range Test prior to vehicle preconditioning in the exhaust and evaporative emission test sequence specified in "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles" as incorporated by reference in section 1976, Title 13, CCR.

(1) Cold soak. The vehicle shall be stored at an ambient temperature not less than 68 degrees F (20 degrees C) and not more than 86 degrees F (30 degrees C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state-of-charge.

(2) Driving schedule. At the end of the cold soak period, the vehicle shall be placed, either driven or pushed, onto a dynamometer and operated through a Highway Fuel Economy Driving Schedule, found in Part 600, Appendix I of the CFR, followed immediately by an Urban Dynamometer Driving Schedule, found in Part 600, Appendix I of the CFR, followed by another Highway Fuel Economy Driving Schedule and an Urban Dynamometer Driving Schedule. This sequence of driving schedules shall be repeated until the vehicle is no longer able to maintain within 5 miles per hour of the speed requirements or within 2 seconds of the time requirements of the driving schedules in the case of a ZEV, or unable to maintain within 5 miles per hour of the speed requirements or within 2 seconds of the time requirement of the driving schedules without the use of the auxiliary power unit in the case of a hybrid electric vehicle.

(3) Recording requirements. Once the vehicle is no longer able to maintain the speed and time requirements specified in (2) above, or once the auxiliary power unit turns on, in the case of a hybrid electric vehicle, the accumulated mileage and energy usage of the vehicle from the point where electricity is introduced from the electrical outlet shall be recorded, and the vehicle shall be brought to an immediate stop, thereby concluding the All-Electric Range Test.

(4) Regenerative breaking. Regenerative braking systems may be utilized during the range test. The braking level, if adjustable, shall be set according to the manufacturer's specifications prior to the commencement of the test. The driving schedule speed and time tolerances specified in (2) shall not be exceeded due to the operation of the regenerative braking system.

g. Calculations: exhaust emissions

Amend paragraph 86.144-94 by adding the following subparagraph (b)(10) which reads:

(10) Organic material non-methane hydrocarbon equivalent mass for ethanol vehicles:

$$OMNMHCE_{mass} = NMHC_{mass} + (13.8756/32.042) \times (CH_3OH)_{mass} + (13.8756/46.064) \times (CH_3CH_2OH)_{mass} + (13.8756/30.0262) \times (HCHO)_{mass} + (13.8756/44.048) \times (CH_3CHO)_{mass}$$

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10. Optional 100,000 Mile Certification Procedure

The following provisions and alternate emission standards shown in section (3) of these procedures shall apply to any engine ~~section~~ family certified to the optional 100,000 mile certification standards.[4]

a. General Guidelines for Implementation

1. Designation

The manufacturer shall designate in the preliminary application for certification those engine families that will be certified to the 100,000 mile procedures. In order to allow the manufacturer as much flexibility as possible, the manufacturer may at any time designate additional engine families or remove any designated engine family. Families originally intended for 50,000 mile certification may be designated as 100,000 mile families after the start of durability testing and vice versa. The Executive Officer must be notified within ten working days of any such changes. Manufacturers are cautioned that any engine family certified to the 100,000 mile certification procedure must comply with the allowable maintenance provisions of section 10.b in these procedures during the engine mileage accumulation.

2. Mileage Accumulation

All durability vehicles must be run to at least 50,000 miles for established emission control systems. ~~;~~ early termination of mileage accumulation may be requested by the manufacturer if sufficient evidence as described below is provided to satisfy the Executive Officer that further testing is unnecessary.

Testing beyond 50,000 miles must be conducted in accordance with the certification test procedures applicable prior to 50,000 miles. Exhaust emissions tests shall be performed at every 5,000 mile interval starting with the 55,000 mile point and ending with the 100,000 mile point, and before and after all scheduled maintenance.

The Executive Officer may, upon request by the manufacturer waive any exhaust emission testing beyond 50,000 miles, if he or she finds that (1) the extrapolated 100,000 mile points and interpolated 4,000 mile points on the least squares lines comply with the line crossing provisions of section 10.b. of

4. The additional criteria outlined in Section 6.a. (Mileage and Service Accumulation: Emission Measurements) shall be used to determine the durability-data testing schedule and the emission-data 4,000 mile test point.

the procedures, and (2) the system and engine designs, on the basis of previous engineering experience, would not be expected to exceed the applicable standards after 100,000 miles. For example, a diesel vehicle that shows a flat deterioration curve (D.F. = 1.0) for the first 50,000 miles and which is not equipped with any add-on emission control system (such as EGR) may be eligible for such a waiver. The Executive Officer will evaluate each request on a case-by-case basis. The manufacturer must submit its request to the Executive Officer to stop testing within ten working days after the last emission test.

If a durability vehicle accumulates less than 100,000 miles the manufacturer shall submit evidence that the engine is capable of meeting the applicable emission standards for 100,000 miles. Such evidence shall include engineering data on piston rings, piston, valves, cylinder head, fuel system ignition system, etc., as applicable.

Any decision to stop mileage accumulation before 100,000 miles does not relieve the manufacturer from its warranty and recall obligations.

For the last 50,000 miles, the Executive Officer may, upon the request of the manufacturer, allow driving schedules different from the standard AMA driving cycle for accelerated mileage accumulation and a reduced test frequency. The evaluation of alternate test programs will be based on the type of emission control system involved and the characteristic of the cumulative emission control system deterioration.

3. Scheduled Maintenance

A vehicle manufacturer who initially intends to certify a vehicle to the 50,000 mile procedure may not change to the 100,000 mile option after mileage accumulation unless the manufacturer starts initial mileage accumulation using, for each maintenance item, the most stringent maintenance schedule of either the 100,000 mile option or the 50,000 mile certification requirements.

4. Unscheduled Maintenance

The Executive Officer will follow the provisions of section 5.a of these procedures, in evaluating any manufacturer's request for unscheduled maintenance. Manufacturers shall obtain the Executive Officer's approval before performing any unscheduled emission control component/system maintenance. In all cases, the degree of system degradation must not be improved by any inspection or repairs. Emission tests must be

performed before and after all unscheduled maintenance and be used in the DF calculation.[5]

5. Evaporative Compliance Criteria

If a manufacturer conducts evaporative emission testing (gasoline- and ~~methanol~~ alcohol-fueled vehicles only) in conjunction with exhaust durability testing, the vehicle manufacturer is required to show compliance with the evaporative emission standard for 50,000 miles. If the manufacturer wishes to conduct testing beyond 50,000 miles, all data must be submitted to the Executive Officer. The Executive Officer will not use any evaporative emission standard. However, the manufacturer must warrant the evaporative emission control system for 10 years or 100,000 miles.

b. Specific Guidelines for Compliance

Each exhaust emission durability data vehicle shall be driven, with all emission control systems installed and operating, for 100,000 miles or such lesser distance as the Executive Officer may agree to as meeting the objectives of this procedure. Emission tests performed on emission-data vehicles and durability-data vehicles (for determination of the deterioration factors) shall be non-regeneration emission tests for diesel passenger cars, light-duty trucks and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems. Compliance with the emission standards shall be established as follows:

1. The linear regression line for all pollutants shall be established by use of all required data from tests of the durability vehicle at every 5,000 mile interval from 5,000 to 100,000 miles. The requirements in subparagraph 86.088-28(a)(4)(i)(B), 86.090-28(a)(4)(i)(B), and 86.091-28(a)(4)(i)(B) (durability vehicles must meet emissions standards) refer, for each pollutant, to the California 100,000 mile emission standards.

2. Compliance with the hydrocarbon and carbon monoxide standards shall be determined as follows:

   i. For Option 1:

      A. The interpolated 4,000 and 50,000 mile points on the linear regression line in section b.1. shall not exceed the appropriate hydrocarbon and carbon monoxide standards, except as in B. below.

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5. Testing before unscheduled maintenance may be omitted with the prior consent of the Executive Officer when testing would be dangerous to a vehicle or an operator.

B. The linear regression line in section b.1. may exceed the standard provided that no data point exceeds the standard.

C. The hydrocarbon and carbon monoxide data from the 4,000 mile test point of the emission data vehicle shall be multiplied by the deterioration factor computed by dividing the interpolated 50,000 mile point by the interpolated 4,000 mile point, and the appropriate exhaust emission correction factor (diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems only). These values shall not exceed the appropriate hydrocarbon and carbon monoxide standards.

ii. For Option 2:

A. The interpolated 4,000 and 100,000 mile points on the linear regression line in section b.1. shall not exceed the appropriate hydrocarbon and carbon monoxide standards, except as in B. below.

B. The linear regression line in section b.1. may exceed the standard provided that no data point exceeds the standard.

C. The hydrocarbon and carbon monoxide data from the 4,000 mile test point of the emission data vehicle shall be multiplied by the deterioration factor computed by dividing the interpolated 100,000 mile point by the interpolated 4,000 mile point, and the appropriate exhaust emission correction factor (diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems only). These values shall not exceed the appropriate 100,000 mile hydrocarbon and carbon monoxide standards.

3. Compliance with the oxides of nitrogen standard for Options 1 and 2 shall be determined as follows:

i. the interpolated 4,000 and 100,000 mile points on the linear regression line in section b.1. shall not exceed the appropriate 100,000 mile oxides of nitrogen standard, except as in ii. below.

ii. the linear regression line in section b.1. may exceed the standard provided that no data point exceeds the standard.

iii. the oxides of nitrogen data from the 4,000 mile test point of the emission data vehicle shall be multiplied by the deterioration factor computed by dividing the interpolated 100,000 mile point by the interpolated 4,000 mile point, and the appropriate exhaust emission

correction factor (diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems only). These values shall not exceed the appropriate 100,000 mile oxides of nitrogen standard.

4. Compliance with the particulate standard for options 1 and 2 shall be determined as follows:

   i. the interpolated 4,000 and 50,000 mile points on the linear regression line in section b.1. shall not exceed the appropriate particulate, except as in ii. below.

   ii. the linear regression line in section b.1. may exceed the standard provided that no data point exceeds the standard.

   iii. the particulate data from the 4,000 mile test point of the emission data vehicle shall be multiplied by the deterioration factor computed by dividing the interpolated 50,000 mile point by the interpolated 4,000 mile point, and the appropriate exhaust emission correction factor (diesel passenger cars, light-duty trucks, and medium-duty vehicles equipped with periodically regenerating trap oxidizer systems only). These values shall not exceed the appropriate particulate standard.

5. All references in these test procedures to "useful life", 5 years, and 50,000 miles shall mean "total life", 10 years, and 100,000 miles, respectively, except in section 10.b.2.

c. Maintenance

Only the following scheduled maintenance shall be allowed under subparagraph 86.085-25 (a)(1)(i).

1. 25(a)(1)(i) Option 1. For 1988 model otto-cycle or diesel vehicles, and 1989 and later model otto-cycle or diesel light-duty trucks and medium-duty vehicles 3751 L.V.W. and greater, and 1993 and subsequent diesel light-duty trucks and medium-duty vehicles 3751 L.V.W. and greater, maintenance shall be restricted to the inspection, replacement, cleaning, adjustment, and/or service of the following items at intervals no more frequent than indicated.

   (1) Drive bent tension on engine accessories (30,000 miles).
   (2) Valve lash (15,000 miles).
   (3) Spark plugs (30,000 miles).
   (4) Air filter (30,000 miles).
   (5) Exhaust gas sensor (30,000 miles): Provided that:

   (a) the manufacturer shall equip the vehicle with a maintenance indicator consisting of a light or flag, which shall be preset to activate automatically by illuminating in

the case of a light or by covering the odometer in the case of a flag the first time the minimum maintenance interval established during certification testing is reached and which shall remain activated until reset. After resetting, the maintenance indicator shall activate automatically when the minimum maintenance interval, when added to the vehicle mileage at the time of resetting, is again reached and shall again remain activated until reset. When the maintenance indicator consists of a light, it shall also activate automatically in the engine-run key position before engine cranking to indicate that it is functioning. The maintenance indicator shall be located on the instrument panel and shall, when activated, display the words "oxygen sensor" or may display such other words determined by the Executive Officer to be likely to cause the vehicle owner to seek oxygen sensor replacement. The maintenance indicator shall be separate from the malfunction indicator light required by Section 1968, Title 13, California Code of Regulations;

(b) the manufacturer shall provide free replacement of the oxygen sensor, including both parts and labor, and shall reset the maintenance indicator without any charge, the first time the maintenance interval established during certification testing is reached for vehicles certified with scheduled sensor maintenance before 50,000 miles. If the oxygen sensor is replaced pursuant to the warranty provisions of Section 2037, Title 13, California Code of Regulations, before the first maintenance interval is reached, the manufacturer shall ~~also replace the oxygen sensor and reset the maintenance~~ indicator at the oxygen sensor and reset the maintenance indicator at the mileage point determined by adding the maintenance interval to the vehicle's mileage at the time of the warranty replacement. If the calculated mileage point for a second oxygen sensor replacement would exceed 50,000 miles, no free second replacement shall be required;

(c) the maintenance indicator shall be resettable. The maintenance instructions required by paragraph 5.b. of these procedures shall provide instructions for the resetting of the maintenance indicator, and shall specify that the maintenance indicator shall be reset each time the oxygen sensor is replaced; and

(d) notwithstanding the provisions of Section 2037(c), Title 13, California Code of Regulations, the oxygen sensor, including any replacement required pursuant to this section, shall be warranted for the applicable warranty period of the vehicle or engine in accordance with Section 2037(a), Title 13, California Code of Regulations. If such oxygen sensor fails during this period, it shall be replaced by the manufacturer in accordance with Section 2037(d), Title 13, California Code of Regulations.

(6) Choke, cleaning or lubrication only (30,000 miles).
(7) Idle speed (30,000 miles).

(8) Fuel Filter (30,000 miles).
(9) Injection timing (30,000 miles).

Option 2. For 1981-1988 and later model otto-cycle vehicles or 1988 and later diesel vehicles, maintenance shall be restricted to the inspection, replacement, cleaning, adjustment, and/or service of the following items at intervals no more frequent than indicated:

(1) Drive belt tension on engine accessories (30,000 miles).
(2) Valve lash (15,000 miles).
(3) Spark plugs (30,000 miles).
(4) Air filter (30,000 miles).
(5) Fuel Filter (30,000 miles).
(6) Idle speed (30,000 miles).
(7) Injection timing (30,000 miles).

2. In addition, adjustment of the engine idle speed (curb idle and fast idle), valve lash, and engine bolt torque may be performed once during the first 5,000 miles of scheduled driving, provided the manufacturer makes a satisfactory showing that the maintenance will be performed on vehicles in use.

d. The manufacturer shall agree to apply to vehicles certified under this paragraph the provision of Section 43204 of the California Health and Safety Code for a period of ten years or 100,000 miles, whichever first occurs.

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11. Additional Requirements

a. In order to qualify for the alternative durability program, in addition to the requirements of paragraph 86.085-13, the algorithm requirements of Appendix III shall be met and only the first 50,000 miles (or 100,000 miles, as applicable) of data or its equivalent shall be used.

b. For otto-cycle vehicles or hybrid electric vehicles which use otto-cycle engines, evidence shall be supplied showing that the air/fuel metering system or secondary air injection system is capable of providing sufficient oxygen to theoretically allow enough oxidation to attain the CO emission standards at barometric pressures equivalent to those expected at altitudes ranging from sea level to 6000 feet elevations.

A vehicle will be deemed in compliance with the above requirement if the manufacturer demonstrates that the tailpipe air/fuel ratio (TAFR) is, at elevations up to 6000 feet, stoichiometric or leaner in each of several driving modes. However, if a vehicle operates in a given driving mode at sea level with a TAFR richer than stoichiometric, then for that particular driving mode the manufacturer is only required to show that the TAFR is, at elevations up to 6000 feet, no richer than the TAFR at sea level. The driving modes selected for testing shall be representative of the full range of normal driving conditions, and shall include the following three steady-state modes: idle, 30 mph road load cruise, 50 mph road load cruise. Assuming the use of dry air and indolene fuel (hydrogen to carbon atom ratio of 1.85), a TAFR of 14.6 shall be considered a stoichiometric ratio. The vehicle manufacturer may correct this value for different fuels and/or humidity, subject to approval by the Executive Officer.

For fuel injected vehicles or hybrid electric vehicles which use fuel-injected engines, compliance may be demonstrated upon a showing by the manufacturer that the fuel injection system distributes fuel based on air mass flow, rather than volume flow, and is therefore self-compensating. All submitted test proposals will be evaluated on their acceptability by the Executive Officer.

As an alternative to the demonstration described above, a manufacturer may demonstrate compliance by testing California vehicle configurations as part of its federal high altitude certification requirements. Engine families which meet all the applicable California low altitude emission standards when tested at the EPA test elevation are deemed to be in compliance.

Exemptions to the high altitude provisions as allowed by the federal government in 86.087-8, 86.088-9, 86.090-8, 86.090-9, and 86.091-9 shall not be approved.

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c. The exhaust emissions shall be measured from all exhaust emission data vehicles tested in accordance with the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600, Subpart B). The oxides of nitrogen emissions measured during such tests shall be multiplied by the oxides of nitrogen deterioration factor computed in accordance with paragraph 86.088-28, 86.090-28, and 86.091-28, and then rounded and compared with the standard as set forth in section 3 preceding. All data obtained pursuant to this paragraph shall be reported in accordance with procedures applicable to other exhaust emissions data required pursuant to these procedures. ***Hybrid electric vehicles shall be tested with the battery state-of-charge set such that one of the following two conditions is satisfied: (1) the state-of-charge is at the lowest level allowed by the control unit of the auxiliary power unit; or (2) the state-of-charge is set such that auxiliary power unit operation will be at its maximum level at the beginning and throughout the emission test.***

In the event that one or more of the manufacturer's emission data vehicles fail the HWFET standard listed in section 3, the manufacturer may submit to the Executive Officer engineering data or other evidence showing that the system is capable of complying with the standard. If the Executive Officer finds, on the basis of an engineering evaluation, that the system can comply with the HWFET standard, he or she may accept the information supplied by the manufacturer in lieu of vehicle test data.

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d. Labeling required pursuant to paragraph 86.088-35, 86.090-35, and 86.091-35, 86.084-35, and 86.095-35, and Section 1965, Chapter 3, Title 13 of the California Code of Regulations shall conform with the requirements specified in the "California Motor Vehicle Emission Control Label Specifications."

e. The manufacturer shall submit to the Executive Officer a statement that those vehicles for which certification is requested have driveability and performance characteristics which satisfy that manufacturer's customary driveability and performance requirements for vehicles sold in the United States. This statement shall be based on driveability data and other evidence showing compliance with the manufacturer's performance criteria. This statement shall be supplied with the manufacturer's final application for certification, and with all running changes for which emission testing is required.

If the Executive Officer has evidence to show that in-use vehicles demonstrate poor performance that could result in wide-spread tampering with the emission control systems, he or she may request all driveability data and other evidence used by the manufacturer to justify the performance statement.

f. For all vehicles subject to the provisions of Section 1968, Title 13, California Code of Regulations, the manufacturer shall submit with its application for certification a description of the malfunction and diagnostic system to be installed on the vehicles. (The vehicles shall not be certified unless the Executive Officer finds that the malfunction and diagnostic system complies with the requirements of Section 1968).

g. The provisions of the incorporated federal test procedures which allow manufacturers to omit methanol and formaldehyde emission testing of 1990 through 1994 methanol-fueled vehicles shall not be applicable in California.

h. The following requirements shall apply to methanol and ethanol fuel-flexible vehicles which are not certified to TLEV, LEV, or ULEV emission standards:
The emission testing required under 6.a.24.(D) (Fuel-flexible vehicle special emission testing) shall be made part of the regular certification program and submitted to the Executive Officer for review. Certification for methanol-fueled vehicles shall be denied unless the exhaust emission values resulting from testing with 35-percent methanol and 65-percent ~~unleaded~~ certification gasoline, or another approved methanol-gasoline blend, at the required mileage intervals, and with ~~unleaded~~ certification gasoline at 5,000 miles, 50,000 miles and the final mileage point, comply with the applicable standards. Certification for ethanol-fueled vehicles shall be denied unless the exhaust emission values resulting from testing with 10-percent ethanol and 90-percent certification gasoline, or another approved ethanol-gasoline blend, at the required mileage intervals, and with certification gasoline at 5,000 miles, 50,000 miles and the final mileage point, comply with the applicable standards.

i. Certification, if granted, is effective only for the vehicle/engine family described in the original manufacturer's certification application. Modifications by a secondary manufacturer to vehicles/engines shall be deemed not to increase emissions above the standards under which those vehicles/engines were certified and to be within the original certification if such modifications do not: (1) increase vehicle weight more than 10 percent above the curb weight, increase frontal area more than 10 percent, or result in a combination increase of weight plus frontal area of more than 14 percent; or (2) include changes in axle ratio, tire size, or tire type resulting in changes in the drive train ratio of more than 5 percent; or (3) include any modification to the emission control system. No originally certified vehicle/engine which is modified by a secondary manufacturer ~~in a manner described~~ in items (1) through (3) of the preceding sentence may be sold to an ultimate purchaser, offered or delivered for sale to an ultimate purchaser, or registered in California unless the modified vehicle/engine is certified by the state board in accordance with applicable

test procedures to meet emission standards for the model year for which the vehicle/engine was originally certified.

For the purposes of this subsection, "secondary manufacturer" means any person, other than the original manufacturer, who modifies a new motor vehicle prior to sale to the ultimate purchaser.

j. A statement must be supplied that the production vehicles shall be in all material respects the same as those for which certification is granted.

k. Following a 12 to 36 hour cold soak at a nominal temperature of 50 degrees F, emissions of NMOG ~~(multiplied by the reactivity adjustment factor for fuels other than conventional gasoline)~~, CO, and NOx, and formaldehyde measured on the Federal Test Procedure (40 CFR Part 86), conducted at a nominal test temperature of 50 degrees F, shall not exceed the above standards for vehicles of the same emission category and vehicle type subject to a cold soak and emission test at 68 to 86 degrees F. For all TLEVs, emissions of NMOG and formaldehyde at 50 degrees F shall not exceed the 50,000 mile certification standard multiplied by a factor of ~~1.75~~ *2.00*. For all LEVs, emissions of NMOG and formaldehyde at 50 degrees F shall not exceed the 50,000 mile certification standard multiplied by a factor of 1.75. For all ULEVs, emissions of NMOG and formaldehyde at 50 degrees F shall not exceed the 50,000 mile certification standard multiplied by a factor of 1.0. Emissions of NMOG shall be multiplied by a reactivity adjustment factor, if any, prior to comparing with the 50,000 certification standard multiplied by the specified factor.

The test vehicles shall not be subject to a diurnal heat build prior to the cold start exhaust test or evaporative emission testing. ~~For diesel vehicles, compliance with the particulate standard applicable to the corresponding vehicle emission category and vehicle type shall also be demonstrated.~~

i. For the 50 degrees F emission test, the nominal preconditioning, soak, and test temperatures shall be maintained within 3 degrees F of the nominal temperature on an average basis and within 5 degrees F of the nominal temperature on a continuous basis. The temperature shall be sampled at least once every 15 seconds during the preconditioning and test periods and at least once each 5 minutes during the soak period. A continuous strip chart recording of the temperature with these minimum time resolutions is an acceptable alternative to employing a data acquisition system.

ii. The test site temperature shall be measured at the inlet of the vehicle cooling fan used for testing.

iii. The test vehicle may be fueled before the preconditioning procedure in a fueling area maintained within a temperature range of 68 to 86 degrees F. The preconditioning shall be conducted at a nominal temperature of 50 degrees F. The requirement to saturate the evaporative control canister(s) shall not apply.

iv. If a soak area remote from the test site is used, the vehicle may pass through an area maintained within a temperature range of 68 to 86 degrees F during a time interval not to exceed 10 minutes. In such cases, the vehicle shall be restabilized to 50 degrees F by soaking the vehicle in the nominal 50 degrees F test area for six times as long as the exposure time to the higher temperature area, prior to starting the emission test.

v. The vehicle shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution.

Manufacturers shall demonstrate compliance with this requirement each year by testing at least three PC or LDT and three MDV emission data and/or engineering development vehicles (with at least 4000 miles) which are representative of the array of technologies available in that model year. Only TLEVs, LEVs, and ULEVs are to be considered for testing at 50 degrees F. It is not necessary to apply deterioration factors (DFs) to the 50 degrees F test results to comply with this requirement. Testing at 50 degrees F shall not be required for fuel-flexible and dual-fuel vehicles when operating on gasoline, natural gas, hybrid electric, and diesel-fueled vehicles shall also be exempt from 50 degrees F testing.

The following schedule outlines the parameters to be considered for vehicle selection:

1. Fuel control system (e.g., multiport fuel injection, throttle body electronic fuel injection, sequential multiport electronic fuel injection, etc.)
2. Catalyst system (e.g., electrically heated catalyst, close-coupled catalyst, underfloor catalyst, etc.)
3. Control system type (e.g., mass-air flow, speed density, etc.)
4. Vehicle category (e.g., TLEV, LEV, ULEV)
5. Fuel type (e.g., gasoline, methanol, GNG, etc.)

The same engine family shall not be selected in the succeeding two years unless the manufacturer produces fewer than three engine families. If the manufacturer produces more than three TLEV, LEV, or ULEV engine families per model year, the Executive Officer may request 50 degrees F testing of specific engine families. If the manufacturer provides a list of the TLEV, LEV, and ULEV engine families that it will certify for a model year and provides a description of the technologies used

on each engine family (including the information in items 1 through 5 of the vehicle selection parameters listed above), the Executive Officer shall select the engine families subject to 50 degrees F testing within a 30 day period after receiving such a list and description. The Executive Officer may revise the engine families selected after the 30 day period if the information provided by the manufacturer does not accurately reflect the engine families actually certified by the manufacturer.

l. For each engine family certified to TLEV, LEV, or ULEV standards, manufacturers shall submit with the certification application, an engineering evaluation demonstrating that a discontinuity in emissions of non-methane organic gases, carbon monoxide, oxides of nitrogen and formaldehyde measured on the Federal Test Procedure (40 CFR Part 86) does not occur in the temperature range of 20 to 86 degrees F. For diesel vehicles, the engineering evaluation shall also include particulate emissions.

~~m. The Executive Officer may approve, upon submission of supporting data by a manufacturer, an alternative procedure for conducting assembly line quality audit testing for those vehicles certified to non-methane organic gas (NMOG) and formaldehyde (HCHO) standards. In order to use this alternative procedure, the manufacturer shall establish during certification testing the ratio of measured NMOG and HCHO exhaust emissions to measured NMHC exhaust emissions for each certification test data vehicle for the applicable engine family. The average of the individual test ratios of measured NMOG and HCHO emissions to measured NMHC emissions for the family shall be calculated and submitted in the application for certification. Following approval of the application for certification, the manufacturer may conduct quality audit testing on the engine family and measure NMHC exhaust emissions rather than NMOG and HCHO exhaust emissions. The measured NMHC exhaust emissions shall be multiplied by the NMOG to NMHC and HCHO to NMHC ratios submitted in the application for certification for the engine family to determine the equivalent NMOG and equivalent HCHO exhaust emission values for the quality audit test vehicle. The equivalent NMOG exhaust emission values shall be used in place of the measured NMOG exhaust emission value in determining the reactivity adjusted exhaust NMOG emission results. The equivalent reactivity adjusted NMOG and equivalent HCHO exhaust emission values shall be compared to the NMOG and HCHO exhaust emission standard applicable to the vehicle emission category (TLEV, LEV, or ULEV) in which the engine family was certified.~~

12. **Identification of New Clean Fuels to be Used in Certification Testing.**

Any person may petition the state board to establish by regulation certification testing specifications for a new clean fuel for which specifications are not specifically set forth in paragraph 86.113-90 as amended herein. Prior to adopting such specifications, the state board shall consider the relative cost-effectiveness of use of the fuel in reducing emissions compared to the use of other fuels. Whenever the state board adopts specifications for a new clean fuel for certification testing, it shall also establish by regulation specifications for the fuel as it is sold commercially to the public.

(a) If the proposed new clean fuel may be used to fuel existing motor vehicles other than low-emission vehicles certified on the primary designated clean fuel, the state board shall not establish certification specifications for the fuel unless the petitioner has demonstrated both of the following:

(1) Use of the new clean fuel in such existing motor vehicles would not increase emissions of NMOG (on a reactivity-adjusted basis), NOx, CO, and the potential risk ~~assecation~~ associated with toxic air contaminants as determined pursuant to the procedures set forth in "California Test Procedures for Evaluating the Emission Impacts of Substitute Fuels or New Clean Fuels" as adopted July 12, 1991. In the case of fuel-flexible vehicles or dual-fuel vehicles which were not certified on the new clean fuel but are capable of being operated on it, emissions during operation with the new clean fuel shall not increase compared to emissions during vehicle operation on gasoline.

(2) Use of the new clean fuel in such existing motor vehicles would not result in increased deterioration of the vehicle and would not void the warranties of any such vehicles.

(b) Whenever the state board designates a new clean fuel pursuant to this section, the state board shall also establish by regulation required specifications for the new clean fuel.

13. Reactivity Adjustment Factors

For the purpose of complying with the NMOG exhaust emission standards in Section 1960.1, Title 13, California Code of Regulations, the mass of NMOG emissions from a vehicle certified to operate on a fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operated on a fuel other than conventional gasoline, shall be multiplied by the reactivity adjustment factor applicable to the vehicle emission control technology category and fuel. The product of the NMOG mass emission value and the reactivity adjustment factor shall be compared to the NMOG exhaust emission standards to determine compliance with the standards. In addition to the above requirements, vehicles operating on natural gas shall add to the product of the NMOG mass emission value and the reactivity adjustment factor, the product of the methane mass emission value and the methane reactivity adjustment factor. This result shall be compared to the NMOG exhaust emission standards to determine compliance with the standards for natural gas-fueled vehicles.

a. The following reactivity adjustment factors have been established pursuant to the criteria in Appendix VIII of these test procedures:

1. Passenger cars and light-duty trucks 0-5750 lbs. LVW

Vehicle Emission Control Technology Category	Fuel	Reactivity Adjustment Factor
1993 and subsequent model-year TLEVs	85% methanol, 15% gasoline blends	0.41
1993 ~~and subsequent~~ through 1997 model-year TLEVs	gasoline meeting the specifications of section 9.a.1.(ii) of these test procedures ~~1/00~~	0.98
1993 ~~and subsequent~~ through 1997 model-year TLEVs	gasoline meeting the specifications of section 9.a.1.(ii) of these test procedures ~~0/95~~	0.94

2. NG passenger cars and light-duty trucks 0-5750 lbs. LVW

Vehicle Emission Control Technology Category	Methane Reactivity Adjustment Factor
1993 and subsequent model-year TLEVs	0.0043
1993 and subsequent model-year LEVs	0.00457

b. The Executive Officer may establish by executive order new reactivity adjustment factors pursuant to Appendix VIII of these test procedures in addition to those listed in Section 13.a. The Executive Officer shall notify manufacturers in writing of the new reactivity adjustment factors within 30 days of their establishment.

c. The Executive Officer may revise any reactivity adjustment factor listed in Section 13.a. or established by the Executive Officer pursuant to Appendix VIII of these test procedures if he or she determines that the revised reactivity adjustment factor is more representative of the ozone-forming potential of vehicle NMOG emissions based on the best available scientific knowledge and sound engineering judgment. The Executive Officer shall notify manufacturers in writing of any such reactivity adjustment factor at least 3 years prior to January 1 of the calendar year which has the same numerical designation as the model year for which the revised reactivity adjustment factor first becomes effective. However, manufacturers may use the revised reactivity adjustment factor in certifying any new engine family whose certification application is submitted following such notification, if they so choose. Manufacturers may also continue to use the original reactivity adjustment factor for any existing engine family previously certified with that reactivity adjustment factor until a new durability-data vehicle is tested for that engine family.

d. Manufacturers may request the use of a unique reactivity adjustment factor for a specific vehicle emission control technology category and fuel. The Executive Officer shall approve such requests in accordance with the conditions and procedures of Appendix VIII of these test procedures. For the purpose of calculating the reactivity adjustment factor as specified in Appendix VIII, the 'g ozone potential per g NMOG' value for the vehicle emission control technology category and fuel system for which the manufacturer is requesting the use of a unique reactivity adjustment factor shall be divided by the 'g ozone potential per g NMOG' value for a ~~conventional gasoline-fueled vehicle established for the vehicle~~ emission control technology category. The following 'g ozone potential per g NMOG' values for conventional gasoline-fueled vehicle emission control technology categories have been established:

1. Passenger cars and light-duty trucks 0-5750 lbs. LVW

Vehicle Emission Control Technology Category	'g ozone potential per g NMOG' for conventional gasoline
All TLEVs	3.42
All LEVs	~~3.25~~ *3.13*

14. Cold Temperature Test Procedure.

a. General Applicability

In paragraph 86.201-94:

1. Amend subparagraph (a) to read:

(a) This subpart describes procedures for determining the cold temperature carbon monoxide (CO) emissions from ~~1994~~ 1996 and later model year new ~~gasoline-fueled light-duty vehicles and~~ passenger cars, light-duty trucks, and medium-duty vehicles (excluding natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles).

b. Equipment Required; Overview

In paragraph 86.206.94:

1. Amend subparagraph (a) to read:

(a) This subpart contains procedures for exhaust emission tests on ~~gasoline-fueled light-duty vehicles and~~ passenger cars, light-duty trucks, and medium-duty vehicles (excluding natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles). Equipment required and specifications are as follows:

2. Amend subparagraph (a)(1) to read:

(a)(1) Exhaust emission tests. Exhaust from ~~gasoline-fueled~~ vehicles (excluding natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles) is tested for gaseous emissions using the Constant Volume Sampler (CVS) concept (Section 86.209). Equipment necessary and specifications appear in 40 CFR Part 86, Sections 86.208 through 86.214.

3. Amend subparagraph (a)(2) to read:

(a)(2) Fuel, analytical gas, and driving schedule specifications. Fuel specifications for exhaust emission testing for gasoline-fueled vehicles are specified in 40 CFR Part 86, Section 86.213. Fuel specifications for exhaust emission testing for alcohol-fueled vehicles and liquefied petroleum gas vehicles are specified in Section 9.a. of these Test Procedures. Analytical gases are specified in 40 CFR Part 86, Section 86.214. The EPA Urban Dynamometer Driving Schedule (UDDS) for use in ~~gasoline-fueled~~ emission tests is specified in 40 CFR Part 86, Section 86.215 and Appendix I.

APPENDIX I

List of Sections of Subparts A, and B, and C, Part 86, Title 40, Code of Federal Regulations, Incorporated by Reference

This Appendix sets forth the sections of Subparts A, and B, and C, Part 86, Title 40, Code of Federal Regulations, as adopted or amended by the U.S. Environmental Protection Agency (EPA) on the date listed for each section, which are incorporated by reference in "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.

Subpart A - General Provisions for Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles, Light-Duty Trucks, and Heavy-Duty Engines, and for 1985 and Later Model Year New Gasoline-Fueled and Methanol-Fueled Heavy-Duty Vehicles.

86.085-1 General applicability. July 7, 1986.
86.090-1 General applicability. April 11, 1989.
86.082-2 Definitions. November 2, 1982.
86.084-2 Definitions. December 10, 1984.
86.085-2 Definitions. November 26, 1983.
86.088-2 Definitions. March 15, 1985.
86.090-2 Definitions. April 11, 1989.
86.078-3 Abbreviations. January 21, 1980.
86.090-3 Abbreviations. April 11, 1989.
86.084-4 Section numbering; construction. September 25, 1980.
86.084-5 General standards; increase in emissions; unsafe conditions. November 2, 1982.
86.090-5 General standards; increase in emissions; unsafe conditions. April 11, 1989.
86.078-7 Maintenance of records; submitted information; right of entry. November 1, 1982.
86.087-8 Emission standards for 1987 light-duty vehicles. January 24, 1984.
86.090-8 Emission standards for 1990 and later model year light-duty vehicles. April 11, 1989.
86.088-9 Emission standards for *1987 1988 and later* model *year* light-duty trucks. *April 11, 1989/ October 31, 1988.*
~~86.090-9 Emission standards for 1990 and later model year light-duty trucks. April 11, 1989.~~
~~86.091-9 Emission standards for 1991 and later model year light-duty trucks. April 11, 1989.~~
86.080-12 Alternative certification procedures. April 17, 1980.
86.085-13 Alternative durability program. May 19, 1983.
86.084-14 Small-volume manufacturers certification procedures. January 31, 1985.
86.090-14 Small-volume manufacturer certification procedures. April 11, 1989.
86.092-14 Small-volume manufacturer certification procedures. February 28, 1990.
86.095-14 Small-volume manufacturer certification procedures. June 5, 1991.
86.094-16 Prohibition of defeat devices. July 17, 1992.
86.085-20 Incomplete vehicles. January 12, 1983.
86.088-21 Application for certification. March 15, 1985.

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86.090-21 Application for certification. April 11, 1989.
86.091-21 Application for certification. April 11, 1989.
86.094-21 Application for certification. July 17, 1992.
86.085-22 Approval of application for certification; test fleet selection, etc. July 7, 1986.
86.090-22 Approval of application for certification; test fleet selection, etc. April 11, 1989.
86.094-22 Approval of application for certification; test fleet selection, etc. July 17, 1992.
86.088-23 Required data. July 19, 1985.
86.090-23 Required data. April 11, 1989.
86.091-23 Required data. ~~April 11, 1989~~ July 26, 1990.
86.094-23 Required data. June 5, 1991.
86.085-24 Test vehicles and engines. January 31, 1985.
86.090-24 Test vehicles and engines. April 11, 1989.
86.092-24 Test vehicles and engines. July 26, 1990.
86.094-24 Test vehicles and engines. July 17, 1992.
86.095-24 Test vehicles and engines. July 17, 1992.
86.085-25 Maintenance. July 7, 1986.
~~86.087-25 Maintenance. July 7, 1986.~~ ***86.087-25 Maintenance. July 7, 1986.***
~~86.088-25 Maintenance. July 7, 1986.~~ ***86.088-25 Maintenance. July 7, 1986.***
~~86.090-25 Maintenance. April 11, 1989.~~ ***86.090-25 Maintenance. April 11, 1989.***
86.084-26 Mileage and service accumulation; emission measurements. July 7, 1986.
86.090-26 Mileage and service accumulation; emission requirements. April 11, ~~1989~~.
86.085-27 Special test procedures. January 12, 1983.
86.090-27 Special test procedures. April 11, 1989.
86.088-28 Compliance with emission standards. July 7, 1986.
86.090-28 Compliance with emission standards. April 11, 1989.
86.091-28 Compliance with emission standards. ~~April 11, 1989~~ July 17, 1992.
86.088-29 Testing by the Administrator. March 15, 1985.
86.090-29 Testing by the Administrator. April 11, 1989.
86.091-29 Testing by the Administrator. April 11, 1989.
86.088-30 Certification. January 24, 1984.
86.090-30 Certification. ~~April 11, 1989.~~ July 26, 1990.
86.091-30 Certification. July 26, 1990.
86.094-30 Certification. June 5, 1991.
86.095-30 Certification. June 5, 1991.
86.079-31 Separate certification. September 8, 1977.
86.079-32 Addition of a vehicle or engine after certification. September 8, 1977.
86.079-33 Changes to a vehicles or engine covered by certification. September 8, 1977.
86.082-34 Alternative procedures for notification of addition and changes. November 2, 1982.
86.088-35 Labeling. March 15, 1985.
86.090-35 Labeling. April 11, 1989.
86.091-35 Labeling. April 11, 1989.
86.094-35 Labeling. July 17, 1992.
86.095-35 Labeling. July 17, 1992.
86.079-36 Submission of vehicle identification numbers. November 14, 1978.
86.085-37 Production vehicles and engines. January 12, 1983.

86.085-38 Maintenance instructions. November 16, 1983.
86.087-38 Maintenance instructions. July 7, 1986.
86.079-39 Submission of maintenance instructions. September 8, 1977.
86.084-40 Automatic expiration of reporting and record keeping requirements. September 25, 1980.

Subpart B-Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles and New Light-Duty Trucks; Test Procedures.

86.101 General applicability. June 28, 1977.
86.102 Definitions. March 5, 1980.
86.103 Abbreviations. March 5, 1980.
86.104 Section numbering, construction. April 11, 1989.
86.105 Introduction; structure of subpart. April 11, 1989.
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86.130-78 Test sequence; general requirements. June 28, 1977.
86.131-78 Vehicle preparation. June 28, 1977.
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86.137-82 Dynamometer test run, gaseous and particulate emissions. March 5, 1980.
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86.226-94	Calibration of other equipment. July 17, 1992.
86.227-94	Test procedures; overview. July 17, 1992.
86.228-94	Transmissions. July 17, 1992.
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APPENDIX II

Exhaust Emission-Data Vehicle Selection Criteria For
Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles

I. Selection of Exhaust Emission-Data Vehicles (see flow diagram on page II-4)

A. Item 1 of the attached emission-data vehicle selection worksheet (page II-5) shall be prepared with the highest projected sales engine displacement-system combination first and the remainder in order of decreasing projected sales volume.

B. For engine families with a single engine displacement-exhaust emission control system combination representing 70 percent or more of the projected sales.

1. The first vehicle selection will be determined as follows:

a. The engine displacement-exhaust emission control system combination shall be the one with the highest projected sales. (Item 1, on worksheet.)

b. Using the data entered in Item 2 of the worksheet and the formula shown below, the equivalent test weight of the vehicle is determined from the calculated sales weighted equivalent test weight for that engine displacement-exhaust emission control system combination.

Sales Weighted Test Weight

Determine the sales weighted test weight as follows:

T_i = Test weight of i'th class

S_i = Sales volume of i'th class

N = Number of test weight classes

SWTW = Sales Weighted Test Weight

$$SWTW = \frac{\sum_{i=1}^{N} S_i T_i}{\sum_{i=1}^{N} S_i}$$

Select the equivalent test weight that includes the calculated SWTW. If the SWTW is exactly between two equivalent test weights, select the higher equivalent test weight. Similarly, if there are no vehicles with the desired displacement-exhaust emission control system combination in the same equivalent test weight that includes the calculated SWTW, the next higher equivalent test weight that contains such a vehicle will be specified.

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c. The transmission will be the class with the highest sales for the engine displacement-exhaust emission control system combination (Item 3, worksheet). If the highest sales transmission class is not available in the equivalent test weight determined in (b), above, the next higher equivalent test weight with the highest sales transmission class will be selected. If manual transmissions are the highest selling class, the transmission configuration with the highest sales should generally be selected (Item 4, worksheet). If the manufacturer wishes to test a vehicle with an M-4 transmission both as an M-4 vehicle and an M-3 vehicle, use of the vehicle with an M-4 transmission will be allowed provided the first three gear ratios are identical in both transmissions. Similarly, use of an M-5 will be allowed to represent both an M-5 vehicle and an M-4 vehicle, providing the first four gear ratios are identical in both transmissions.

d. The highest selling engine code within the engine displacement-exhaust emission control system-equivalent test weight-transmission class combination will be specified (Item 5, worksheet).

e. The highest selling body style within the engine displacement-exhaust emission control system-equivalent test weight-transmission class-engine code combination will be specified (Item 6, worksheet.)

f. The N/V ratio will be the standard ratio (standard tire and axle ratio combination) for the vehicle selected (Item 7, worksheet).

g. Standard or optional equipment that can reasonably be expected to influence emissions (Item 8, worksheet) and is expected to be installed on more than 33 percent of the vehicles in the car line within the engine-system combination shall be specified (and the full estimated weight of those items should be included in the curb weight computation) unless an item is not available on the particular vehicle specified. Other standard or optional equipment expected to be installed on more than 33 percent of the vehicles in the car line within the engine-system combination shall have their full estimated weight included in the curb weight computation and be included in the specified vehicle's weight. Overdrive units are considered transmission configurations and not items of optional equipment. The weight of an overdrive unit should be included in the curb weight computation of vehicles with such units. (In other words, the weight of overdrive units should not be disregarded when car line sales of such items are 33 percent or less.)

2. The second vehicle will be determined as follows.

a. The transmission class, from Item 3 of worksheet, with the second highest sales will be specified if this transmission class has projected sales of more than 30 percent of the engine displacement-exhaust emission control system combination. The equivalent test weight, engine code body style, N/V ratio, and optional equipment specified for the second vehicle are determined by criteria in Section 1.

b. If the second transmission class does not meet the criteria of 2.a. above, the second vehicle will be the worst case vehicle selected from the family.

c. For engine families with multiple displacement-emission control system combinations, the first vehicle selection will be highest sales combination, and the second vehicle selection will be second highest sales combination. Other vehicle configuration details will be as in Section B.1.b. through B.1.g.

d. An exception to the two maximum emission-data vehicles may occur for engine families with vehicles in multiple standard classifications, i.e., loaded vehicle weight classifications for light-duty trucks and/or medium-duty vehicles. The first vehicle selection will be determined as above in B.1. in the highest sales loaded vehicle weight classification, and the subsequent vehicle selection(s) will be a worst case vehicle(s) in the other loaded vehicle weight classification(s).

C. For determining cold temperature CO exhaust emission compliance for each engine family, the Executive Officer shall select for testing the vehicle expected to emit the highest emissions from the vehicles selected in accordance with sections I.A. and I.B. of this Appendix. The selected vehicle shall be tested by the manufacturer in accordance with the test procedures in Subpart C, Part 86, Title 40, Code of Federal Regulations or with alternative procedures requested by the manufacturer and approved in advance by the Executive Officer.

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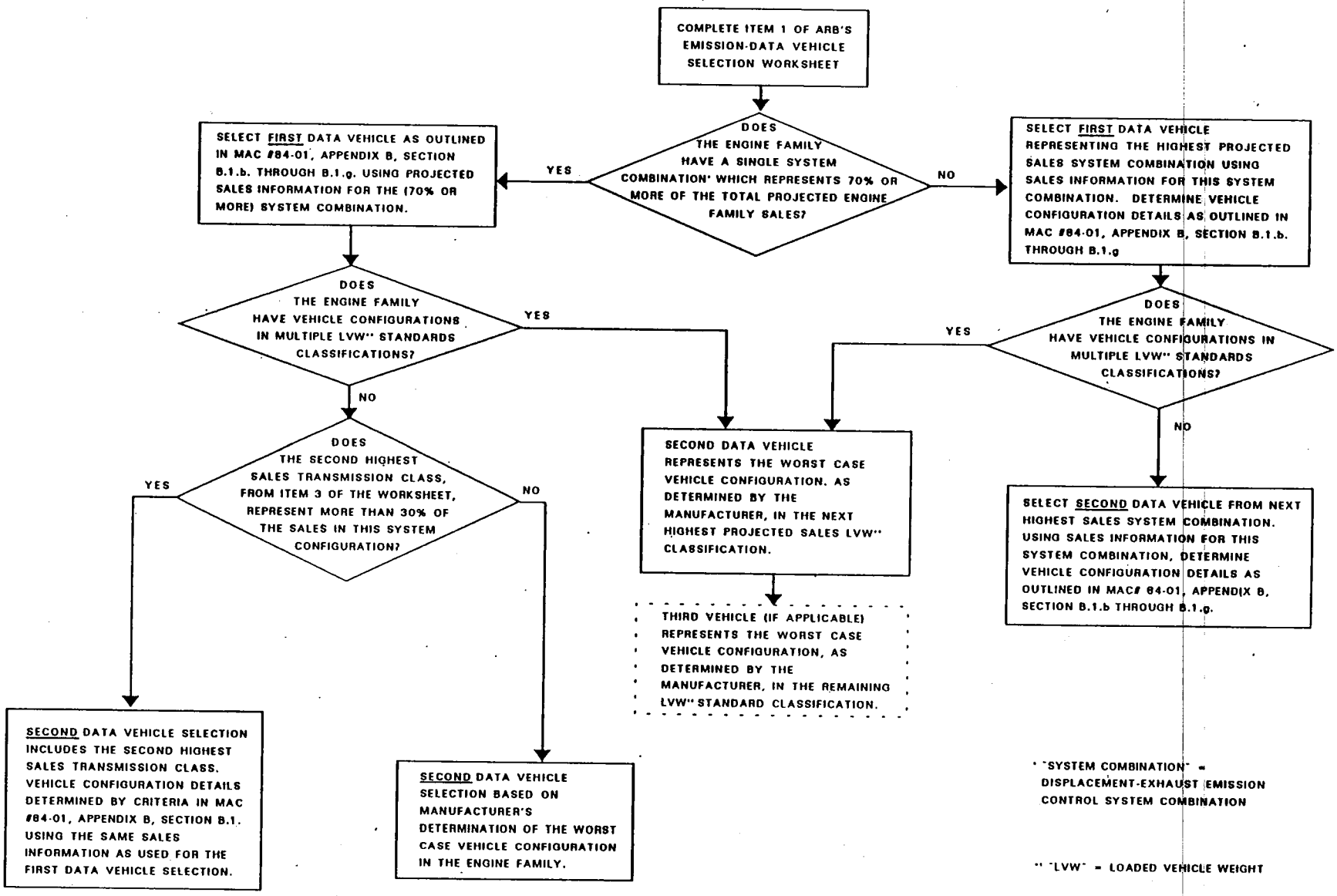
FLOW DIAGRAMS FOR SELECTING ARB
PC, LDT AND MDV EXHAUST EMISSION-DATA VEHICLES



* "SYSTEM COMBINATION" = DISPLACEMENT-EXHAUST EMISSION CONTROL SYSTEM COMBINATION

** "LVW" = LOADED VEHICLE WEIGHT

Emission-Data Vehicle Selection Worksheet

Manufacturer _____ Date _____

Engine Family _____

1. Engine Displacement	Emission Control System	Unit	Percent	Cumulative%
a) _____	_____	____	_____	_____
b) _____	_____	____	_____	_____
c) _____	_____	____	_____	_____
d) _____	_____	____	_____	_____

2. Sales Weighted Test Weight

Total projected sales _____

Test Weight - lb.	Sales Volume
a) _____	_____
b) _____	_____
c) _____	_____
d) _____	_____

Calculated SWTW _____ lbs. Equivalent Test Weight _____ lbs.

3. Transmission Selection

Class	Sales Volumes	Percentage Sales	High Sales
a) _____	_____	_____	_____
b) _____	_____	_____	_____

4. Transmission Configuration

Configuration	Sales Volumes	High Sales
a) _____	_____	_____
b) _____	_____	_____
c) _____	_____	_____

5. Engine Code (within 1, 2, 3, and 4 above)	Sales Volumes	High Sales
a)		
b)		
c)		
d)		

6. Body Style (within 1, 2, 3, 4, and 5 above)	Sales Volumes	High Sales
a)		
b)		
c)		
d)		
e)		
f)		

7. STD Axle_____ STD N/V_____.

8. Options over 33 percent

9. Second and Subsequent Selections Vehicles

a) High Sales Engine Displacement-Exhaust Emission Control System_____

b) Second-Highest Selling Transmission Class_____

Designated Second and Subsequent Selections Vehicles

Disp.	Eng. Code	Evap. Code	Model	Trans.	ETW	Axle	N/V

APPENDIX III

Determination of Acceptable Durability Test Schedule*

A manufacturer may determine mileage test intervals for durability-data vehicles subject to the conditions specified in 40 CFR 86.084-26 or 86.09088-26. The following procedure shall be used to determine if the schedule is acceptable to the Executive Officer.

1. Select exhaust system mileage test points and maintenance mileage test points for proposed (prop) schedule.

2. Calculate the sums of the squares corrected to the mean of the system mileages at the proposed test points:

$$A_{prop} = \frac{[\Sigma(X_p)^2 - ((\Sigma X_p)^2/N)_{p\,prop}]}{}$$

Where:

X = Individual mileages at which the vehicle will be tested.

N = Total number of tests (including before and after maintenance tests).

(Subscript "p" refers to proposed test schedule).

3. Determine exhaust system mileage test points and maintenance mileage test points based on testing at five thousand mile intervals from 5,000 miles through the final testing point and maintenance mileage test points selected for the proposed schedule in section 1. This schedule will be designated as the standard (std) test schedule.

4. Calculate the sums of squares corrected to the mean of the standard schedule.

$$B_{std} = \frac{[\Sigma(X_s)^2 - ((\Sigma X_s)^2/N)_{s\,std}]}{}$$

* For diesel vehicles equipped with periodically regenerating trap oxidizer systems (or those with continuously regenerating trap oxidizer systems elected to be certified to the provisions of diesel vehicles with periodically regenerating trap oxidizer systems), additional test schedule requirements for regeneration tests must be met as outlined in subparagraphs 6.a.4.(B) and 6.b.7.(D) ~~6.a.2. and 6.b.3.~~ in these procedures.

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Where:

X = Individual mileages at which the vehicle will be tested.

N = Total number of tests (including before and after maintenance).

(Subscript "s" refers to standard test schedule).

5. Refer to Table I and determine t_p at $(N_p-2)_{prop}$ degrees of freedom and t_s at $(N_s-2)_{std}$.

If $\left(A_{prop}\right)^{1/2} \geq \frac{t_p}{t_s} \times \left(B_{std}\right)^{1/2}$

the proposed plan is acceptable.

Table I

Degrees of freedom N-2	t
1	6.314
2	2.920
3	2.353
4	2.132
5	2.015
6	1.943
7	1.895
8	1.860
9	1.833
10	1.812
11	1.796
12	1.782
13	1.771
14	1.761
15	1.753
16	1.746
17	1.740
18	1.734
19	1.729
20	1.725
21	1.721
22	1.717
23	1.714
24	1.711
25	1.708

APPENDIX IV

Procedure for Determining An Acceptable Exhaust Regeneration Durability-Data Test Schedule for Diesel Cycle Vehicles, Equipped with Periodically Regenerating Traps Oxidizer Systems.

1. Select exhaust system mileage test points for proposed (prop) schedule.

2. Calculate the sums of the squares corrected to the mean of the system mileages at the proposed test points:

$$A_{prop} = [\Sigma(X_p)^2 - ((\Sigma X_p)^2/N)_{p\,prop}]$$

Where:

X = Individual mileages at which the vehicle will be tested.

N = Total number of tests (including before and after maintenance tests).

(Subscript "p" refers to proposed test schedule).

3. The exhaust system mileage tests points at 5,000, 20,000, 35,000 and 50,000 miles will be designated as the standard (std) test schedule.

4. Calculate the sums of square corrected to the mean of the standard tests schedule.

$$B_{std} = [\Sigma(X_s)^2 - ((\Sigma X_s)^2/N)_{s\,std}]$$

Where:

X = Individual mileages at which the vehicle will be tested.

N = Total number of regeneration emission tests.

(Subscript "s" refers to standard test schedule)

5. Refer to Table I and determine t_p at $(N_p-2)_{prop}$ degrees of freedom and t_s at $(N_s-2)_{std}$ degrees of freedom.

If $\left(A_{prop}\right)^{1/2} > \frac{t_p}{t_s} \times \left(B_{std}\right)^{1/2}$

the proposed plan is acceptable.

Table I

Degrees of freedom N-2	t
1	6.314
2	2.920
3	2.353
4	2.132
5	2.015
6	1.943
7	1.895
8	1.860
9	1.833
10	1.812
11	1.796
12	1.782
13	1.771
14	1.761
15	1.753

APPENDIX V

Pollutant Mass Emissions Calculation Procedure for Gaseous-Fueled Vehicles and for Vehicles Equipped with Periodically Regenerating Trap Oxidizer Systems *

I. Gaseous-Fueled Vehicle Pollutant Mass Emission Calculation Procedure

For 1988 through 1990 model-year gaseous-fueled vehicles, Tthese calculation procedures are to be used in lieu of those in subparagraph 86.144-878, and 86.144-90 Part 86, Title 40, Code of Federal Regulations (CFR) when calculating the mass emissions from vehicles fueled with either liquefied petroleum gas or compressed natural gas. This calculation procedure is based on the "Positive Displacement Pump- Constant Volume Sampler (PDP-CVS)" exhaust sampling system. For 1991 and subsequent model-year gaseous-fueled vehicles, the calculation procedures specified in "California Non-Methane Hydrocarbon Test Procedures" shall apply to all vehicles certified to the emission standards of section 3.b., 3.e. and 3.f. of these test procedures. For all TLEVs, LEVs, and ULEVs, the calculation procedures specified in "California Non-Methane Organic Gas Test Procedures" shall apply.

The reported test results shall be computed by use of the following formulas:

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 1:2.658 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.

* These calculation procedures are based on the Federal CVS-1975 Test Procedure.

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$CO_{2_{mass}}$	=	Carbon dioxide emissions, in grams per test phase.
$Density_{CO}$	=	Density of carbon monoxide is 32.97 g/ft^3 at 68°F and 760 mm. Hg pressure.
Density CO_2	=	Density of carbon dioxide is 51.81 g/ft^3 68°F and 760 mm. Hg pressure.
$Density_{HC}$	=	Density of hydrocarbons is 18.64 g/ft^3 for natural gas and 17.28 g/ft^3 for LPG assuming an average carbon to hydrogen ratio of 1:3.802 for natural gas and 1:2.658 for LPG, at 68°F and 760 mm Hg pressure.
$Density_{NO_2}$	=	Density of oxides of nitrogen is 54.16 9/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.
$NO_{x_{conc}}$	=	Oxides of nitrogen concentration of the dilute exhaust sample corrected for background, in ppm.
NO_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 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 ($528^{o}R$ 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 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 test phase.

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

D_{ct} = The measured driving distance from the "transient" phase of the cold start test, in miles.

D_{ht} = The measured distance from the "transient" phase of the hot start test, in miles.

D_s = The measured driving distance from the "stabilized" phase of the cold start test, in miles.

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

(a) The mass emissions of each pollutant in grams per mile is

$$Y_{wm} = 0.43\,((Y_{ct} + Y_s)/(D_{ct} + D_s)) + 0.57\,((Y_{ht} + Y_s)/(D_h + D_s))$$

(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:

$$NOx_{mass} = V_{mix} \times Density_{NO} \times {}_2K_H \times (NOx_{conc}/1{,}000{,}000)$$

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:

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

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

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

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

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

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

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

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

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

$$H = \frac{(43.478R\ )\ (P_d)}{P_B - \frac{P_d \times R_a}{1}}$$

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

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

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II. Pollutant Mass Emissions Calculation Procedure for Vehicles Equipped with Periodically Regenerating Trap Oxidizer Systems

Exhaust Emissions

Amend subparagraph 86.144-88(a) in Part 86, Title 40, Code of Federal Regulations (CFR) to read:

The final reported test results shall be computed by the use of the following formula:

(a) For light-duty vehicles and light-duty trucks:

$$Ywm = 0.43\ ((Yct + Ys)/(Dct + Ds)) + 0.57\ ((Yht + Ys)/(Dht + Ds))$$

For purposes of adjusting emissions for regeneration:

$$Re = ((Yr1 - Yct) + (Yr2 - Ys) + (Yr3 - Yht))/(Dct + Ds + Dht)$$

$$Yr = Ywm^{*} + Re$$

Where:

Ywm = Weighted mass emissions of each pollutant, i.e., HC, CO, NOx or CO_2, in grams per vehicle mile.*

Yct = Mass emissions as calculated from the "transient" phase of the cold start test, in grams per test phase.

Yht = Mass emissions as calculated from the "transient" phase of the hot start test in grams per test phase.

Ys = Mass emissions as calculated from the "stabilized" phase of the cold start test, in grams per test phase.

Dct = The measured driving distance from the "transient" phase of the cold start test, in miles.

Dht = The measured distance from the "transient" phase of the hot start test, in miles.

Ds = The measured driving distance from the "stabilized" phase of the cold start test, in miles.

Yr = Regeneration emission test.

Re = Mass emissions of each pollutant attributable to regeneration in grams per mile.

* Ywm is derived using the emission data from a test with no regeneration.

Yr1 = Mass emissions, during a regeneration emission test, as calculated from the "transient" phase of the cold start test, in grams per test phase.

Yr2 = Mass emissions, during a regeneration emission test, as calculated from the "stabilized" phase of the cold start test, in grams per test phase.

Yr3 = Mass emissions, during a regeneration emission test, as calculated from the "transient" phase of the hot start test in grams per test phase.

Particulate Emissions

Amend subparagraph 86.145-82(a) in Part 86, Title 40, Code of Federal Regulations (CFR) to read:

(a) The final reported test results for the mass particulate (Mp) in grams/mile shall be computed as follows.

For purposes of adjusting emissions for regeneration:

$$Mp = 0.43(Mp1 + Mp2)/(Dct + Ds) + 0.57\ (Mp3 + Mp2/(Dht + Ds)$$

$$Re = ((Mpr1 - Mp1) + (Mpr2 - Mp2) + (Mpr3 - Mp3))/(Dct+Ds+Dht)$$

$$Mpr = Mp^{*} + Re$$

Where:

(1) Mp1 = Mass of particulate determined from the "transient" phase of the cold start test, in grams per test phase. (See 86.110-82(c)(1) and 86.110-88(d)(1) for determination.)

(2) Mp2 = Mass of particulate determined from the "stabilized" phase of the cold start test, in grams per test phase. (See 86.110-82(c)(1) and 86.110-88(d)(1) for determination.)

(3) Mp3 = Mass of particulate determined from the "transient" phase of the hot start test, in grams per test phase. (See 86.110-82(c)(1) and 86.110-88(d)(1) for determination.)

(4) Dct = The measured driving distance from the "transient" phase of the cold start test, in miles.

(5) Ds = The measured driving distance from the "stabilized" phase of the cold start test, in miles.

(6) Dht = The measured driving distance from the "transient" phase of the hot start test, in miles.

(7) Mpr = Regeneration emission test

(8) Re = Mass of particulate attributable to regeneration in grams/mile.

* Mp is derived using the emission data from a test with no regeneration.

(9) Mpr1 = Mass of particulate determined, during a regeneration emission test, from the "transient" phase of the cold start test in grams per test phase.
(See 86.110-82(c)(1) and 86.110-88(d)(1) for determination.)

(10) Mpr2 = Mass of particulate determined, during a regeneration emission test, from "stabilized" phase of the cold start test, in grams per test phase.
(See 86.110-82(c)(1) and 86.110-88(d)(1) for determination.)

(11) Mpr3 = Mass of particulate determined, during a regeneration emission test, from the "transient" phase of the hot start test, in grams per test phase.
(See 86.110-82(c)(1) and 86.110-88(d)(1) for determination.)

III. Fuel Economy Calculations for Gaseous Fuels Based on the Cold Start CVS-1975 Federal Test Procedure

Assume the fuel meets HD-5 specifications (95% C_3H_8, 5% nC_4H_{10}, by volume)

1. Physical constants of Propane and Normal Butane

Component	Mol. Wt.	Sp. Gr.	Liquid Density lb/gal @ 60°F	Liquid Density of HD-5 lb/gal at 60°F
C_3H_8	44.094	0.508	4.235 x (0.95)	= 4.0233
nC_4H_{10}	58.12	0.584	4.868 x (0.05)	= .2434
				4.2667

2. Density of the HD-5 fuel

(0.95 X 4.235) + (0.05 X 4.868) = 4.267 lb/gal @ 60°F

3. Molecular Weights

Species	Mol. Wt.
C	12.01115
H	1.00797
O	15.9994
CO	28.01055
CO_2	44.00995
*$CH_{2.658}$	14.6903

*Average ratio of Hydrogen to carbon atoms in HD-5 fuel.

C_3H_8 $\frac{8}{3}$ = 2.666 x 0.95 (% propane) = 2.533

nC_4H_{10} $\frac{10}{4}$ = 2.5 x 0.05 (% Butane) = $\frac{.125}{2.658}$

4. Weight of Carbon in:

CO = wt. of CO x (12.01115/28.01055) = wt CO x (0.429)

CO_2 = wt. of CO_2 x (12.01115/44.00995) wt CO_2 x (0.273)

$CH_{2.658}$ = wt. of $CH_{2.658}$ x (12.01115/14.6903) = wt $CH_{2.658}$ x (0.818)

5. Wt. of Carbon per gallon of LPG

wt. of carbon = 4.2667 lbs/gal x 453.59 gms/lb x 0.818 = 1583 grams C/gal HD-5

6. Fuel economy:

$$\frac{\text{grams C/gal}}{\text{grams C in exhaust/mi}} = \text{miles/gal.}$$

$$\text{LPG} = \frac{1583 \text{ gms C/gal}}{(0.818)(HC) + (0.429)(CO) + (0.273)(CO_2)}$$

HC = CVS HC in grams/mile
CO = CVS CO in grams/mile
CO_2 = CVS CO_2 in grams/mile

$$\text{For gasoline} = \frac{2421}{(0.866)\ HC + (0.429)\ CO + (0.273)\ CO_2}$$

$$\text{For Natural Gas} = \frac{1535}{(0.759)\ HC + (0.429)\ CO + (0.273)\ CO_2}$$

APPENDIX VI

Blanket Approval of Running Changes and Field Fixes

Running changes and field fixes meeting the following definitions shall be granted automatic or "blanket" approval by the Executive Officer provided that notification of changes listed in paragraph 1. below are received by the ARB at least five working days before implementation, and notification of changes listed in 2. through 13. below are received by the ARB within two working days after implementation. Such automatic approvals shall be effective when they are a proved by EPA.

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

1. The addition of new models to an engine family where the new models differ from previously certified models only in model name and curb weight (same inertia weight class), and where the exhaust, evaporative and fill pipe emission control system specifications do not change.

2. Changes in axle ratio, tire size or tire type, providing that changes to the N/V ratio and/or load horsepower are within 5% of the originally certified values. This includes re-classification of base and optional axle ratios or tires.

3. The deletion of models or vehicle configurations.

4. Changes in fuel tank capacity of less than 10 percent of the originally certified capacity, providing there is no other modification of the evaporative emission control system.

5. Changes to the fuel filler system leaded fuel nozzle restrictor, where EPA preemption is involved.

6. Advance certification of models in the next higher inertia weight class, for use if needed later.

7. Changes in tailpipe length of less than ten inches.

8. The following changes involving spark plugs:

   a. The addition of resistor-type spark plugs if nonresistor spark plugs are standard, or vice-versa, providing the secondary circuit resistance changes less than 5 percent.

   b. The addition of alternate heat ranges within one range of the originally certified spark plugs.

   c. The change of spark plug gap within 15 percent of originally certified spark plug gap.

9. Changes to component part numbers when there are no changes in the materials used or to the performance specifications (e.g. distributor advance curves, carburetor flow curves, fuel pump supply pressure, etc.). These changes may be the result of parts consolidation, changes in supplier, addition/deletion of peripheral items such as brackets, and minor dimensional changes where the durability and performance are not affected.

10. Changes in the crankcase emission control system where EPA preemption is involved, excluding revisions that could have an interaction effect on exhaust emissions (e.g., PCV purge flow changes).

11. Changes submitted under the alternate or concurrent notification procedure in 40 CFR 86 which would otherwise qualify for automatic or "blanket" status.

12. Changes in the physical location of a vacuum hose connection with no change in the relationship between vacuum, speed, load, or any other vacuum-related parameter, provided that the changes do not render the vacuum hose routing diagram unrepresentative.

13. Changes in exhaust system cross sectional area, if this area equals or exceeds the minimum area in the system.

APPENDIX VII

Calculation of t-Statistic for Deterioration Data Outlier Test

Residual normal deviates to indicate outliers are used routinely and usefully in analyzing regression data, but suffer theoretical deficiencies if statistical significance tests are required. Consequently, the procedure for testing for outliers outlined by Snedecor and Cochran, 6th ed., Statistical Methods, pp. 157-158, will be used. The method will be described generally, then by appropriate formulae, and finally a numerical example will be given.

Linearity is assumed (as in the rest of the deterioration factor calculation procedure), and each contaminant is treated separately. The procedure is as follows:

Calculate the deterioration factor regression as usual, and determine the largest residual in absolute value. Then recalculate the regression with the suspected outlier omitted. From the new regression line calculate the residual at the deleted point, denoted as $(y_i - y_i')$. Obtain a statistic by dividing $(y_i - y_i')$ by the square root of the estimated variance of $(y_i - y_i')$. Find the tailed probability, p, from the t-distribution corresponding to the quotient (double-tailed), with n-3 degrees of freedom, with n the original sample size.

This probability, p, assumes the suspected outlier is randomly selected, which is not true. Therefore, the outlier will be rejected only if $1-(1-p)^n \leq .05$.

The procedure will be repeated for each contaminant individually until the above procedure indicates no outliers are present.

When an outlier is found, the vehicle test-log will be examined. If an unusual vehicle malfunction is indicated, data for all contaminants at that test-point will be rejected; otherwise, only the identified outlier will be omitted in calculating the deterioration factor.

Procedure for the calculation of the t-Statistic for Deterioration Data Outlier Test.

Given a set of n points, $(x_1, y_1), (x_2, y_2)\ldots(x_n, y_n)$.

where

x_i is the mileage of the ith data point.
y_i is the emission of the ith data point.

Assume model:

$$y = \alpha + \beta(x - \bar{x}) + \epsilon$$

I.

i) Calculate the regression line,

$$\hat{y} = a + b\,(x - \bar{x})$$

ii) Suppose the absolute value of the ith residual $(y_i - \hat{y}_i)$ is the largest.

II.

i) Calculate the regression line with the ith point deleted.

$$\hat{y}' = a' + b'\,(x - \bar{x})$$

ii) Let $t = (y_i - \hat{y}_i')$ $\quad \hat{var}\,(y_i - \hat{y}_i')$

where y_i is the observed suspected outlier.

$\hat{y}_i'$ is the predicted value with the suspected outlier deleted.

$$\hat{var}\,(y_i - \hat{y}_i') = S^2\left(1 + \frac{1}{n-1} + \frac{(x_i - \bar{x})^2}{\sum_{\substack{j=1 \\ j\neq i}} (x_j - \bar{x})^2}\right)$$

($\bar{x}$ is calculated without the suspected outlier)

$$S^2 = \sum_{\substack{j=1 \\ j\neq i}}^{n} (y_j - \hat{y}_j)^2/n-3$$

iii) Find p from the t-statistic table

where

$p = \text{prob}(|t(n-3)| \geq t)$
$t(n-3)$ is a t-distributed variable with n-3 degrees of freedom.

iv) y_i is an outlier if $1-(1-p)^n < .05$

06705

Example:

x	y	$\hat{y}$	$y-\hat{y}$
8	59	56.14	2.86
6	58	58.17	-0.17
11	56	53.10	2.90
-22	53	41.96	11.04
14	50	50.06	-0.06
17	45	47.03	-2.03
18	43	46.01	-3.01
24	42	39.94	2.06
19	39	45.00	-6.00
23	38	40.95	-2.95
26	30	37.91	-7.91
40	27	23.73	3.27

Assume model:

$$y = \alpha + \beta(x - \bar{x}) + \epsilon$$

$$\hat{y} = 45 - 1.013\ (x - \bar{x})$$

Suspected outlier

Suspected point out of regression:

$$\hat{y}' = 44.273 - 1.053\ (x - \bar{x})$$

$$\hat{y}_i' = 44.273 - 1.053\ (22 - 18.727) = 40.827$$

$$y_i - \hat{y}_i' = 12.173$$

$$\hat{var}(y_i - \hat{y}_i') = S^2 \left(1 + \frac{1}{11} + \frac{10.711}{914.182}\right)$$

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APPENDIX VIII

Procedure for Determining Vehicle Emission Control Technology Category/Fuel Reactivity Adjustment Factors

The following procedure shall be used by the Executive Officer to establish the reactivity adjustment factor for exhaust emissions of non-methane organic gases (NMOG) and establish the 'methane reactivity adjustment factor' for exhaust methane emissions from natural gas vehicles, for the purpose of certifying a vehicle of specific emission control technology category and fuel for sale in California. The NMOG emissions results from Transitional Low-Emission Vehicles (TLEVs), Low-Emission Vehicles (LEVs), and Ultra-Low-Emission Vehicles (ULEVs) designed to operate on any available fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than conventional gasoline, shall be numerically-adjusted to establish a NMOG exhaust mass emission value equivalent, in terms of ozone-forming potential, to the NMOG exhaust mass emissions from conventional gasoline-fueled vehicles of the same vehicle emission control technology category.

(1) The Executive Officer shall determine the representative speciated NMOG exhaust emission profiles for all light- and medium-duty conventional gasoline-fueled TLEVs, LEVs, and ULEVs according to the following conditions.

a. All testing will be conducted using a specified gasoline blend representative of commercial gasoline and having the specifications listed in (9).

b. The sSpeciated NMOG profiles shall be calculated obtained from a statistically valid number of TLEVs, LEVs, and ULEVs.

c. The speciated NMOG profiles shall identify and quantify, in units of g/mile or mg/mile, as many constituents as possible in accordance with the procedures specified in "California Non-Methane Organic Gas Test Procedures.", such that a minimum of 95% of the total g/mile of NMOG emissions measured is identified, and shall be provided in units of g/mile or mg/mile.

d. The speciated NMOG profile shall include at a minimum, the g/mile NMOG emission values of all oxygenated organic gases containing five or fewer carbon atoms (i.e., aldehydes, ketones, alcohols, ethers, etc.), and all known alkanes, alkenes, alkynes and aromatics containing twelve or fewer carbon atoms.

(2) The 'g ozone potential per mile' of each NMOG identified in the speciated profile shall be determined by multiplying the 'g/mile NMOG' emission value of the constituent NMOG by its maximum incremental reactivity given in step (10) (9).

(3) The 'total g ozone potential per mile' of NMOG exhaust emissions from the vehicle/fuel system shall be the sum of all the constituent NMOG 'g ozone potential per mile' values calculated in step (2).

(4) The 'g ozone potential per g NMOG' for the vehicle/fuel system shall be determined by dividing the 'total g ozone potential per mile' value calculated in step (3) by the 'total g/mile of NMOG emissions'.

(5) For light- and medium-duty candidate vehicle/fuel systems not powered by conventional gasoline, the Executive Officer shall establish 'reactivity adjustment factors' calculated from exhaust emission profiles derived according to the same conditions specified in parts b, e, and c d of step (1).

(6) The 'g ozone potential per g NMOG' for candidate vehicle/fuel systems not powered by conventional gasoline shall be determined according to steps (2), (3), and (4).

(7) (a) The candidate vehicle/fuel 'reactivity adjustment factor' shall be determined by dividing the 'g ozone potential per g NMOG' calculated in step (6) by the 'g ozone potential per g NMOG' value for the vehicle in the same emission control technology category operated on the specified conventional gasoline blend. The 'g ozone potential per g NMOG' values for conventional gasoline vehicles are listed in Section 13.d. of these test procedures or shall be established by the Executive Officer pursuant to Appendix VIII of these test procedures. For candidate vehicle/fuel systems powered by methanol or liquified petroleum gas, the quotient calculated above shall be multiplied by 1.1. The resulting value shall constitute the 'reactivity adjustment factor' for the methanol or liquified petroleum gas-powered vehicle/fuel system.

(b) For candidate vehicle/fuel systems operating on natural gas, a 'methane reactivity adjustment factor' shall be calculated by dividing the maximum incremental reactivity value for methane given in (10) by the 'g ozone potential per g NMOG' value for the vehicle in the same emission control technology category operated on conventional gasoline as listed in Section 13.d. of these test procedures or established by the Executive Officer pursuant to Appendix VIII of these test procedures.

(8) The Executive Officer shall assign a reactivity adjustment factor unique to a specific engine family at the request of a vehicle manufacturer provided that each of the following occurs:

a. The manufacturer submits speciated NMOG exhaust emission profiles to the Executive Officer obtained from emission testing a minimum of four different vehicles representative of vehicles that will be certified in the engine family. The test vehicles shall include the official emission-data vehicle(s) for the engine family, and the mileage accumulation of each vehicle shall be at or greater than 4000 miles. One speciated profile shall be submitted for each test vehicle. Emission levels of each constituent NMOG shall be measured according to the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991. For the emission-data vehicle(s), the speciated profile(s) shall be obtained from the same test used to obtain the official exhaust emission test results for the emission-data vehicle at the 4,000 mile test point. The manufacturer shall calculate 'g ozone potential per g NMOG' values for each speciated NMOG exhaust emission profile in accordance with the procedures specified in steps (2), (3), and (4) above. By using these 'g ozone potential per g NMOG' values, the manufacturer shall calculate an 'undeteriorated reactivity adjustment factor' for each test vehicle in accordance with the procedure for calculating the 'reactivity adjustment factor' specified in step

c. The speciated profiles, mean 'undeteriorated reactivity adjustment factor' for the engine family, and 'reactivity ozone deterioration factor' are provided to the Executive Officer with the certification application for the engine family.

(9) Gasoline meeting the specifications listed below shall be used to determine the 'g ozone potential per g NMOG' of conventional gasoline:

Fuel Property	Limit
Sulfur, ppm by weight	300 +/- 50
Benzene, volume percent	1.6 +/- 0.3
Reid vapor pressure, psi	8.7 +/- 0.3
Distillation, D-86 degrees F	
10%	115-135
50%, maximum	240
90%	323-333
EP, maximum	420
Hydrocarbon Type, volume percent	
Total Aromatics	32 +/- 3.0
Multi-substituted alkyl aromatics	21 +/- 3.0
Olefins	12 +/- 3.0
Saturates	remainder

(The test methods used for each fuel property shall be the same as the test method for the identical fuel property listed in section 9.a.(1) of these test procedures.)

(10) Table of The maximum incremental reactivities to be used in step (2) are provided in the table below. ÷ Any manufacturer which intends to use the table shall submit to the Executive Officer a list which provides the specific organic gases measured by the manufacturer and the maximum incremental reactivity value assigned to each organic gas prior to or with the submittal of a request for the use of a reactivity adjustment factor unique to a specific engine family. The Executive Officer may deny such requests if he or she determines that the maximum incremental reactivity value assignments are made incorrectly.

Maximum Incremental Reactivity (MIR) Values
(Units: grams ozone/gram organic gas)

Organic Gas Name	MIR
Methane	0.0148
Ethane	0.25
Propane	0.48
n-Butane	1.02
n-Pentane	1.04
n-Hexane	0.98
n-Heptane	0.81
n-Octane	0.61
n-Nonane	0.54
n-Decane	0.47

(7) above. An 'undeteriorated reactivity adjustment factor' for the engine family shall be calculated by taking the arithmetic mean of the 'undeteriorated reactivity adjustment factor' obtained for each test vehicle. The 95 percent upper confidence bound (95% UCB) shall be calculated according to the equation:

$$95\%\ UCB = RAF_m + 1.96 \times [\sum_{i=1}^{n}(RAF_i - RAF_m)^2 / (n-1)]^{1/2}$$

where RAF_m = mean 'undeteriorated reactivity adjustment factor' calculated for the engine family
RAF_i = 'undeteriorated reactivity adjustment factor' calculated for the ith test vehicle
n = number of test vehicles

The 95 percent upper confidence bound of the 'undeteriorated reactivity adjustment factor' for the engine family shall be less than or equal to 115 percent of the engine family 'undeteriorated reactivity adjustment factor.'

b. The manufacturer submits an 'reactivity ozone deterioration factor' for the 'undeteriorated reactivity adjustment factor' calculated for the engine family. To determine the 'reactivity ozone deterioration factor', the manufacturer shall perform two tests at each mileage interval for one or more durability vehicle(s) tested in accordance with the procedures and conditions specified in Sections 6 and 10 of these California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles for calculating mass deterioration factors. The Executive Officer shall approve the use of other mileage intervals and procedures if the manufacturer can demonstrate that equivalently representative 'reactivity ozone deterioration factors' are obtained. One speciated profile shall be submitted for each test. Emission levels of each constituent NMOG shall be measured according to the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991. A mean g/mi NMOG mass value and a mean 'g ozone per g NMOG' value shall be calculated by taking the arithmetic mean of each measurement from the speciated profiles. These results shall be multiplied together to obtain a mean 'total g ozone potential per mile' value at each mileage interval. A mean 'undeteriorated reactivity adjustment ozone deterioration factor' shall be calculated in accordance with the procedures in Sections 6, 10, and Appendix VIII of these California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles except that the mean 'undeteriorated reactivity adjustment factor' 'total g ozone potential per mile' value determined at each mileage interval shall be used in place of measured mass emissions. If the 'reactivity ozone deterioration factor' is determined to be less than 1.00, the 'reactivity ozone deterioration factor' shall be assigned a value of 1.00. The 'reactivity ozone deterioration factor' shall be multiplied by the product of the official exhaust NMOG mass emission results at the 4000 mile test point and the mean 'undeteriorated reactivity adjustment factor' for the engine family to obtain the NMOG certification levels 'reactivity adjustment factor' used to determine compliance with the NMOG emission standards.

n-Undecane	0.42
n-Dodecane	0.38
n-Tridecane	0.35
n-Tetradecane	0.32
n-Pentadecane	0.29
2-Methylpropane	1.21
2-Methylbutane	1.38
2,2-Dimethylpropane	0.37
Branched C5 Alkanes	1.38
2-Methylpentane	1.53
3-Methylpentane	1.52
2,2-Dimethylbutane	0.82
2,3-Dimethylbutane	1.07
Branched C6 Alkanes	1.53
2-Methylhexane	1.08
3-Methylhexane	1.40
2,3-Dimethylpentane	1.51
2,4-Dimethylpentane	1.78
3,3-Dimethylpentane	0.71
2,2,3-Trimethylbutane	1.32
Branched C7 Alkanes	1.40
2-Methylheptane	0.96
3-Methylheptane	0.99
4-Methylheptane	1.20
2,3-Dimethylhexane	1.32
2,4-Dimethylhexane	1.50
2,5-Dimethylhexane	1.63
2,2,4-Trimethylpentane	0.93
2,3,4-Trimethylpentane	1.60
Branched C8 Alkanes	1.20
4-Ethylheptane	1.14
2,4-Dimethylheptane	1.34
2,2,5-Trimethylhexane	0.97
Branched C9 Alkanes	1.14
4-Propylheptane	1.01
Branched C10 Alkanes	1.01
Branched C11 Alkanes	1.17
Branched C12 Alkanes	1.23
Branched C13 Alkanes	0.96
Branched C14 Alkanes	0.76
Branched C15 Alkanes	0.70
Cyclopentane	2.38
Cyclohexane	1.28
Methylcyclopentane	2.82
C6 Cycloalkanes	1.28
Methylcyclohexane	1.85
Ethylcyclopentane	2.31
1,3-Dimethylcyclopentane	2.55
C7 Cycloalkanes	1.85
Ethylcyclohexane	1.94
C8 Cycloalkanes	1.94
C9 Cycloalkanes	2.30
C10 Cycloalkanes	1.78
C11 Cycloalkanes	1.91
C12 Cycloalkanes	1.68
C13 Cycloalkanes	1.42

C14 Cycloalkanes	1.22
C15 Cycloalkanes	1.07
Ethene	7.29
Propene	9.40
1-Butene	8.91
2-Methylpropene	5.31
1-Pentene	6.22
2-Methyl-1-Butene	4.90
3-Methyl-1-Butene	6.22
1-Hexene	4.42
C6 Terminal Alkenes	4.42
C7 Terminal Alkenes	3.48
C8 Terminal Alkenes	2.69
C9 Terminal Alkenes	2.23
C10 Terminal Alkenes	1.91
C11 Terminal Alkenes	1.67
C12 Terminal Alkenes	1.52
C13 Terminal Alkenes	1.36
cis-2-Butene	9.94
trans-2-Butene	9.94
2-Methyl-2-Butene	6.41
C5 Internal Alkenes	8.80
C6 Internal Alkenes	6.69
C7 Internal Alkenes	5.53
C8 Internal Alkenes	5.29
C9 Internal Alkenes	4.58
C10 Internal Alkenes	4.05
C11 Internal Alkenes	3.63
C12 Internal Alkenes	3.32
C13 Internal Alkenes	3.03
1,3-Butadiene	10.89
2-Methyl-1,3-Butadiene	9.08
Cyclopentene	7.66
Cyclohexene	5.67
a-Pinene	3.28
b-Pinene	4.41
Ethyne	0.50
Propyne	4.10
1-Butyne	9.24
Benzene	0.42
Toluene	2.73
Ethylbenzene	2.70
n-Propylbenzene	2.12
Isopropylbenzene	2.24
s-Butylbenzene	1.89
C10 Monoalkyl Benzenes	1.87
C11 Monoalkyl Benzenes	1.70
C12 Monoalkyl Benzenes	1.55
m-Xylene	8.16
o-Xylene	6.46
p-Xylene	6.60
C9 Dialkyl Benzenes	7.20
C10 Dialkyl Benzenes	6.45
C11 Dialkyl Benzenes	5.84
C12 Dialkyl Benzenes	5.34
1,2,3-Trimethylbenzene	8.85

1,2,4-Trimethylbenzene	8.83
1,3,5-Trimethylbenzene	10.12
C10 Trialkyl Benzenes	9.07
C11 Trialkyl Benzenes	8.21
C12 Trialkyl Benzenes	7.50
C10 Tetraalkyl Benzenes	9.07
Styrene	2.22
Indan	1.06
Tetralin	0.95
Naphthalene	1.18
Methyl Naphthalenes	3.27
2,3-Dimethylnaphthalene	5.13
Phenol	1.13
Cresols	2.31
Methanol	0.56
Ethanol	1.34
n-Propyl Alcohol	2.26
Isopropyl Alcohol	0.54
n-Butyl Alcohol	2.69
Isobutyl Alcohol	1.92
t-Butyl Alcohol	0.42
Formaldehyde	7.15
Acetaldehyde	5.52
Propionaldehyde	6.53
C4 Aldehydes	5.26
C5 Aldehydes	4.41
C6 Aldehydes	3.79
C7 Aldehydes	3.32
Crotonaldehyde	5.42
Benzaldehyde	-0.55
Methyl t-Butyl Ether	0.62
Ethyl t-Butyl Ether	1.98
Acetone	0.56
C4 Ketones	1.18
Acrolein	6.77

NMOG Constituent	Maximum Incremental Reactivity (g O / g NMOG)
ALKANES	
Normal Alkanes	
Methane	0.0148
Ethane	0.25
Propane	0.48
n-Butane	1.02
n-Pentane	1.04
n-Hexane	0.98
n-Heptane	0.81
n-Octane	0.61
n-Nonane	0.54
n-Decane	0.47
n-Undecane	0.42
n-Dodecane	0.38
n-Tridecane	0.35
n-Tetradecane	0.32
n-Pentadecane	0.29
Branched Alkanes	
2-Methylpropane	1.21
2,2-Dimethylpropane	0.37
2-Methylbutane	1.38
2,2-Dimethylbutane	0.82
2,3-Dimethylbutane	1.07
2-Methylpentane	1.53
3-Methylpentane	1.52
2,2,3-Trimethylbutane	1.32
2,2-Dimethylpentane	1.40
2,3-Dimethylpentane	1.61
2,4-Dimethylpentane	1.78
3,3-Dimethylpentane	0.71
2-Methylhexane	1.08
3-Methylhexane	1.40
2,2,4-Trimethylpentane	0.93
2,3,3-Trimethylpentane	1.20
2,3,4-Trimethylpentane	1.60
Branched Alkanes	
2,2-Dimethylhexane	1.20
2,3-Dimethylhexane	1.32
2,4-Dimethylhexane	1.60
2,5-Dimethylhexane	1.63
3,3-Dimethylhexane	1.20
2-Methylheptane	0.96
3-Methylheptane	0.99
4-Methylheptane	1.20
2,4-Dimethylheptane	1.34
2,2,5-Trimethylhexane	0.97
Other Branched C9H20 Alkanes	1.14
Branched C10H22 Alkanes	1.01
Branched C11 Alkanes	1.17
Branched C12 Alkanes	1.23
Cyclo Alkanes	
Cyclopentane	2.38
Methylcyclopentane	2.82
Cyclohexane	1.28
t-1,2-Dimethylcyclopentane	1.85
1,3-Dimethylcyclopentanes	2.55
Methylcyclohexane	1.85
Ethylcyclopentane	2.31
Ethylmethylcyclopentane	1.94
1c,2t-3-Trimethylcyclopentane	1.94
1,2,4-Trimethylcyclopentane	1.94
Dimethylcyclohexanes	1.94
Ethylcyclohexane	1.94
Ethylmethylcyclohexane	2.30
Trimethylcyclohexane	2.30
C10 Cycloalkanes	1.78
C11 Cycloalkanes	1.91
C12 Cycloalkanes	1.68

NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)
ALKENES			
Ethene	7.29	Propadiene	7.29
Propene	9.40	1,3-Butadiene	10.89
1-Butene	8.91	2-Methyl-1,3-Butadiene	9.08
2-Butenes	9.94	Cyclopentadiene	7.66
2-Methylpropene	5.31	Cyclopentene	7.66
1-Pentene	6.22	1-Methylcyclopentene	6.67
2-Pentenes	8.80	3-Methylcyclopentene	6.67
2-Methyl-1-Butene	4.90	Cyclohexene	6.67
3-Methyl-1-Butene	6.22	a-Pinene	3.28
2-Methyl-2-Butene	6.41	b-Pinene	4.41
1-Hexene	4.42		
2-Hexenes	6.69		
3-Hexenes	6.69		
Methyl-1-Pentenes	4.42	ALKYNES	
Methyl-2-Pentenes	6.69		
3,3-Dimethyl-1-Butene	4.42	Ethyne	0.50
1-Heptene	3.48	Propyne	4.10
2-Heptenes	5.53	1-Butyne	9.24
3-Heptenes	5.53	2-Butyne	9.24
3-Ethyl-2-Pentenes	5.53		
2,3-Ditemthyl-2-Pentene	5.53		
3-Methyl-1-Hexene	3.48		
2-Methyl-2-Hexenes	5.53		
4-Methyl-2-Hexene	5.53		
2-Methyl-3-Hexene	5.53		
3-Methyl-3-Hexenes	5.53		
1-Octene	2.69		
2-Octenes	5.29		
3-Octenes	5.29		
4-Octenes	5.29		
2,4,4-Trimethyl-1-Pentene	2.69		
2,4,4-Trimethyl-2-Pentene	5.29		
1-Nonene	2.23		

NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)
AROMATIC HYDROCARBONS	
Benzene	0.42
Toluene	2.73
Ethylbenzene	2.70
o-Xylene	6.46
m-Xylene	8.16
p-Xylene	6.60
n-Propylbenzene	2.12
i-Propylbenzene	2.24
Methylethylbenzenes	7.20
1,2,3-Trimethylbenzene	8.86
1,2,4-Trimethylbenzene	8.83
1,3,5-Trimethylbenzene	10.12
n-Butylbenzene	1.87
s-Butylbenzene	1.89
Diethylbenzenes	6.46
1-Methyl-2-Propylbenzene	6.46
1-Methyl-3-Propylbenzene	6.46
C10 Trialkyl Benzenes	9.07
Tetramethylbenzenes	9.07
C11 Monoalkyl Benzenes	1.70
1-Methyl-4-Isobutylbenzene	5.84
C11 Dialkyl Benzenes	5.84
C11 Trialkyl Benzenes	8.21
C12 Monoalkyl Benzenes	1.56
C12 Dialkyl Benzenes	5.34
C12 Trialkyl Benzenes	7.50
Indan (C_9H_{10})	1.06
Methyl Indan	1.06
Naphthalene	1.18
Tetralin	0.96
Methyl Naphthalenes	3.27
2,3-Dimethyl Naphthalene	5.13
Styrene	2.22
AROMATIC OXYGENATES	
Phenol	1.13
Cresols	2.31
Benzaldehyde	-0.66
p-Tolualdehyde	3.32

NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)
OXYGENATES	
Alcohols	
Methanol	0.56
Ethanol	1.34
n-Propyl Alcohol	2.26
Isopropyl Alcohol	0.64
n-Butyl Alcohol	2.69
Isobutyl Alcohol	1.92
t-Butyl Alcohol	0.42
Aldehydes	
Formaldehyde	7.15
Acetaldehyde	6.52
Propionaldehyde	6.63
Acrolein	6.77
n-Butyraldehyde	6.26
Crotonaldehyde	6.42
Pentanaldehyde	4.41
Hexanaldehyde	3.79
C7 Aldehydes	3.32
Ethers	
Methyl t-Butyl Ether	0.62
Ethyl t-Butyl Ether	1.98
Ketones	
Acetone	0.56
Butanone	1.18

PROPOSED

State of California
AIR RESOURCES BOARD

CALIFORNIA ASSEMBLY-LINE TEST PROCEDURES FOR 1983 AND SUBSEQUENT MODEL-YEAR PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES

Adopted:	November 24, 1981
Amended:	March 9, 1983
Amended:	May 25, 1983
Amended:	August 21, 1984
Amended:	_____

Note: The regulatory amendments originally proposed in this rulemaking are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions from existing regulations. Modifications to the originally noticed text are designated by ***bold italics*** and ~~***bold italics***~~ to represent additions and deletions, respectively.

State of California
AIR RESOURCES BOARD

CALIFORNIA ASSEMBLY-LINE TEST PROCEDURES FOR 1983 AND SUBSEQUENT MODEL-YEAR PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES

A. GENERAL PROVISIONS

1. APPLICABILITY

These test procedures, adopted pursuant to Section 43210 of the California Health and Safety Code (H & SC), are applicable to vehicle manufacturers of 1983 and subsequent model-year liquefied petroleum gas, compressed or liquefied natural gas, methanol, hybrid electric, gasoline, and diesel-powered passenger cars, light-duty trucks, and medium-duty vehicles having an engine displacement of 50 cubic inches (820 cubic centimeters) or greater, except motorcycles, including all Transitional Low-Emission Vehicles (TLEVs), Low-Emission Vehicles (LEVs), and Ultra-Low-Emission Vehicles (ULEVs), subject to registration and manufactured for sale in California.

2. COMPLIANCE

The procedures specify two types of tests: (1) an inspection test to be applied to every vehicle before sale; and (2) a quality-audit test according to the "CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1981 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES" or "CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES", as applicable. Demonstration of compliance with cold temperature carbon monoxide standards shall be exempt from quality-audit testing. A vehicle is in compliance with these assembly-line standards and test procedures when that vehicle is in compliance with the inspection test requirements and that vehicle's engine family is in compliance with the quality-audit test requirements. Since quality-audit evaluations occur less frequently than the inspection tests, a vehicle which passes the inspection test may be presumed to be in compliance with the full assembly-line procedures pending meeting the quality-audit evaluation of that vehicle's engine family.

3. ACCESS

Air Resources Board (ARB) personnel and mobile laboratories shall have access to vehicle assembly plants, distribution facilities, and test facilities for the purpose of vehicle selection, testing, and observation. Scheduling of access shall be arranged with the designated manufacturer's representative and shall not unreasonably disturb normal operations.

4. VARIATIONS AND EXEMPTIONS

Variations from these procedures which produce substantially equivalent results may be authorized by the Executive Officer. In extraordinary circumstances where compliance with these procedures is not possible or practicable, a manufacturer may appeal to the Air Resources Board for a temporary exemption.

5. COMMUNICATIONS

All reports required by these procedures shall be sent to:

Chief, Mobile Source Division
California Air Resources Board
9528 Telstar Avenue
El Monte, CA 91731

Two copies of the report shall be submitted.

B. INSPECTION TEST PROCEDURES -- 1983 AND 1984 MODEL-YEAR VEHICLES

This inspection test shall be performed on all 1983 and 1984 model-year passenger cars, light-duty trucks and medium-duty vehicles subject to these test procedures.

1. INSPECTION TEST PROCEDURES

(a) Functional Test

Functional test of the engine components and control systems which affect emissions shall be made prior to the steady-state emissions tests. If a vehicle fails one or more functional tests, it must be repaired and pass a functional retest before it can be emissions tested.

A list of the items to be functionally checked and a procedure for performing these checks shall be maintained by the manufacturer and may be requested for review at any time after production start-up by the chief, Mobile Source Division. When requested, the manufacturer has up to 30 days to submit a copy of these procedures. Within 60 days of receipt, the Chief, Mobile Source Division, may require revisions.

(b) Steady-State Emissions Test

The vehicle engine shall be adjusted to the manufacturer's specifications for delivery to the customer prior to the steady-state emissions test. This test shall consist of a determination of hydrocarbon (HC) and carbon monoxide (CO) exhaust concentrations with the engine operating in a normal idle condition. All tests, including those of control limit test vehicles, shall be conducted as follows:

(1) Vehicles shall be tested in the normal "warmed-up" operating temperature range, i.e., after the choke is fully open and the engine is at curb idle speed, but before thermal override devices are actuated to prevent overheating. The test may be performed in any transmission gear; however the same gear shall be used for control limit test vehicles and production vehicles. For each engine family, the idle test may be performed without the air injection system (AIR) instead of with AIR, provided that the control limit vehicles are tested both with and without AIR. The requirements of section B (3)(g) must be met with AIR. The control limit test vehicles and all production vehicles should be warmed -up and tested in the same manner.

(2) The sampling probes of the analytical system shall be inserted into the exhaust outlets far enough to avoid dilution with the outside air. When this is not possible, a tailpipe extension shall be used.

(3) A vehicle which fails a steady-state emissions test shall be retested or repaired and shall pass on retest prior to sale.

2. EVALUATION

Any vehicle tested by the steady-state emissions test showing emissions less than the control limits established for its engine family or subgroup and which had previously passed the functional tests will be considered to be in compliance with the inspection test requirements.

3. CONTROL LIMITS

The control limits for each engine family or subgroup at the start of a model year will be determined as follows:

(a) Measure the emissions from the first 100 vehicles of each engine family or subgroup tested by the steady-state assembly-line inspection test.

(b) Determine the mean emission level and standard deviation for each pollutant (HC and CO).

(c) The control limit for each pollutant is the sum of the mean plus two times the standard deviation for that pollutant.

(d) Until the first control limits are established, the manufacturer shall use temporary control limits based on the first ten tests. These ten vehicles are deemed to meet the control lim$s so established.

(e) (i) For control systems that do not use catalytic converters -- If the HC control limit value is determined in subparagraph (c) is less than 100 ppm, the HC control value may be increased by up to 50 ppm, not to exceed 100 ppm. If the CO control limit determined in

subparagraph (c) is less than 1.0 percent, the CO control limit may be increased by up to 0.5 percent, not to exceed 1.0 percent.

(ii) For control systems that use catalytic converters -- If the HC control limit value determined in subparagraph (c) is less than 50 ppm, the control limit value may be increased by up to 30 ppm, not to exceed 50 ppm.

If the CO control limit determined in subparagraph (c) is less than 0.5 percent, the CO control limit may be increased by up to 0.3 percent, not to exceed 0.5 percent.

(f) Idle control limit values may be rounded to the nearest 10 ppm HC and 0.1 percent CO in conformance to ASTM E29-67, except where this would result in a zero value.

(g) The maximum allowable steady-state control limits for HC and CO are those values used as the idle mode standard shown in Title 13, California Administrative Code (C.A.C.) Section 2176 for the applicable model-year or, where applicable model-year standards are not yet adopted, the latest previous model-year values in effect at the time the vehicle is manufactured. An exemption to this requirement will be granted providing the manufacturer submits emission data with each quarterly report listed in one of the following options:

(1) Submit with each quarterly assembly-line report HC and CO emission values measured at engine idle speed for each quality audit vehicle tested and the computed mean and standard deviation of HC and CO emission results for the total number of vehicles tested, by engine family. Measurements of HC and CO shall be conducted immediately following completion of the dynamometer run and vehicles shall be in a state described under B.1 (b)(1) above. If less than 30 vehicles were quality-audit tested during the reporting quarter, the computation of the means and standard deviations are not required.

(2) Submit quarterly HC and CO emission values measured at engine idle speed for a minimum of 30 vehicles in the engine family or sub-group immediately after these vehicles have complied with the assembly-line inspection procedures and have either been run-in a distance of 50 miles (on the road or dynamometer) or after other appropriate engine break-in has been performed and the engine is operating at a fully warmed-up condition as described in b.1 (b)(1) above. In addition to emission results of individual vehicles, the mean and standard deviation shall be computed and submitted.

(3) The manufacturer may propose other methods to achieve results equivalent to the two operations above. These emission data shall be obtained from stabilized vehicles which have emission control systems with no defects and are properly adjusted to manufacturer's specifications.

(h) Control limits with AIR operating shall be calculated and reported for information purposes for those engine families that are tested without AIR in operation.

Control limit values shall be recalculated for each production quarter based on the measured emissions from at least 100 vehicles produced during the last half of the preceeding quarter of production for each engine family or subgroup tested by the steady-state emissions test. When production levels do not permit compliance with the above, data from vehicles produced during the first half of the preceeding quarter may be used. If the quarterly production of any engine family is less than 100 vehicles, the manufacturer shall use the test results from all vehicles produced during that quarter in determining the control limit values for the next quarter.

The Executive officer shall be notified within one week if control limit values are recalculated following running changes which affect idle emissions levels. The new control limit values and the date they first went into effect shall be part of the notification.

All testing, reports, evaluations, etc., shall be by engine family except when the Executive Officer has approved a breakdown by subgroups (e.g., different carburetors, engine displacements, control systems, transmissions, and inertia weights), by assembly plant, or both.

Note:

Data from any vehicle indicating gross engine malfunction, and/or failure or disconnection of any emission control component, shall be excluded from that used for generating control limits. Retest data on vehicles exceeding the control limits shall not be used in determining control limits for subsequent quarters.

4. REPORTS

Reports shall be submitted to the Air Resources Board within 45 calendar days of the end of each calendar quarter and within 45 calendar days of the end of the manufacturer's model production year. Results for two different model-years shall not be combined statistically.

The report shall include:

(a) The temporary quarterly control limit values obtained for the first quarter of production.

(b) The mean and standard deviation of the steady-state emissions test used to determine the quarterly control limits.

(c) The steady-state control limit values for the next quarter's production.

(d) From a representative sample of vehicles approved by the Executive Officer, the number and percentage of vehicles:

(1) failing the test

(2) repaired or adjusted

All HC values should be stated as hexane equivalents for NDIR measurement and ppm carbon if a flame ionization detector is used. The hexane equivalent conversion value shall be supplied for each different model of flame ionization detector used and for each engine family.

C. INSPECTION TEST PROCEDURES -- 1985 AND SUBSEQUENT MODEL-YEAR VEHICLES

This Inspection Test shall be performed on all 1985 and subsequent model-year passenger cars, light-duty trucks and medium-duty vehicles subject to these Test Procedures. However, for 1985 model-year vehicles only, the Inspection Test Procedures set forth in Section B. of these Test Procedures may be performed in lieu of the Inspection Test Procedures set forth in this Section C. In such a case, a manufacturer may change to the Procedures set forth in this Section C. at the start of any calendar quarter in which the manufacturer starts performing the Inspection Test set forth in this Section C.

1. INSPECTION TEST PROCEDURES

Functional tests of the emission control components and systems used on the vehicle shall be conducted in accordance with a plan approved by the Executive Officer. At least 90 days prior to the start of production, the manufacturer shall submit to the Executive Officer a plan for functional testing which lists the emission control components and systems to be tested and specifies the testing procedures to be used. Appendix B sets forth typical types of components and systems for inclusion in the functional test plan. If an on-board emission control diagnostic system of any type, either completely self-contained or requiring external peripheral equipment, is installed on a vehicle, it must be included in the components to be functionally tested and the on-board diagnostic system must be used in functionally testing the vehicle emission control system. In appropriate instances, functional tests may be conducted during the vehicle assembly process before the end of the assembly line. For components which cannot practically be functionally checked on every vehicle, a statistically valid sampling test may be used as the functional tests. The Executive Officer shall approve the plan unless he or she determines that the tests are not designated for the appropriate control components and systems or that the tests will be inadequate to reasonably assure that the components and systems are correctly installed and are functioning properly. The manufacturer may at any time submit proposed changes to the plan for functional testing. Once a plan is approved, for subsequent model-years, a manufacturer must submit a plan only if changes are made to the emission control components or systems on the vehicle, or to the proposed functional

test. In the case of such changes, only the portion of the plan covering the changed components or systems, or changes in tests, must be submitted for approval. In order for a vehicle to satisfy the inspection test requirements, each of the emission control components and systems identified in the approved plan for testing must be found, pursuant to the specified approved test, to be correctly installed and functioning properly.

2. EVALUATION

Any vehicle which passes the approved functional test will be considered to be in compliance with the inspection test requirements.

3. REPORTING

Each manufacturer shall submit quarterly a statement that the functional tests included in the approved test plan have been conducted on all vehicles produced for sale in California. The statement shall be signed by an official of the manufacturer who has verified the accuracy of the statement and shall accompany the assembly-line quality audit test report for each production quarter.

D. QUALITY-AUDIT TEST PROCEDURES

1. VEHICLE SAMPLE SELECTION

The vehicle manufacturer shall randomly select vehicles from each engine family for quality-audit testing. Each selected vehicle for quality-audit testing must pass the inspection test, be equipped with emission control systems certified by the ARB, and be representative of the manufacturer's California sales. The procedure for randomly selecting vehicles must be submitted to the Chief, Mobile Source Division, El Monte, CA prior to production.

A continuous sample rate shall be chosen by the manufacturer to provide a sample which is representative of the total production. The manufacturer shall select a sample rate which he or she determines will be satisfactory for use by the ARB in determining the number of vehicles in the entire population of a particular engine family which do not meet Board-established emission standards by extrapolation from the percentage of the sample not meeting the standards. The results from the sample may be extrapolated to the entire population subject to the provisions relating to vehicle exclusion contained in paragraph 3 which follows. The sample rate so chosen shall not be less than 2.0 percent except for fuel-flexible and dual-fuel vehicles where the sample rate chosen shall not be less than 1.0 percent. The manufacturer shall notify the Executive Officer of any change to the sample rate. The date of such change shall be reported in accordance with paragraph 6 which follows.

A vehicle manufacturer may use, as an alternate to the above vehicle selection procedure, the optional procedure outlined in Appendix A.

Four-wheel drive vehicles which can be manually shifted to a two-wheel drive mode will be tested in the normal on-highway two-wheel drive mode of operation. If full-time four-wheel drive vehicles are selected, substitutions may be made with comparable two-wheel drive vehicles of the same engine family. If comparable two-wheel drive vehicles are not available, selected full-time four-wheel vehicles will be tested after having the front wheels temporarily disengaged or the front end of the vehicle elevated.

The Executive Officer may, upon notice to the manufacturer, require the sample rate to be increased to a maximum of ten percent of production (not to exceed 30 additional vehicles) of the calendar quarterly production of any engine family by invoking Section 2110, Chapter 3, Title 13 of the C.A.C.

2. VEHICLE PREPARATION AND PRECONDITIONING

(a) After the inspection tests, no emissions tests may be performed on a quality-audit vehicle prior to the first quality-audit test, except where such tests are run on all vehicles manufactured for sale in California.

(b) The vehicle shall begin the test sequence as received from the inspection test, except for mileage accumulation or engine run-in. The schedule for mileage accumulation or engine run-in and any changes to the schedule must be submitted to the Executive Officer with each quarterly report. This schedule must be adhered to for all quality-audit testing ~~within an engine family and subgroup or engine family and assembly plant as~~ appropriate.

(c)(1) For vehicles which are certified to the running loss and useful life standards for evaporative emissions contained in Title 13, California Code of Regulations, Section 1976(b)(1), and the incorporated "California Evaporative Emissions Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles," last amended November 20, 1991, the vehicle preparation and preconditioning procedure shall be conducted in accordance with the evaporative emissions test procedures contained in section 4.g.i., "Test Procedure, General Requirements," subsections A.-F., as codified in subsections 4.g.ii.(c), 4.g.ii.(d), and 4.g.iii., with the exception that: (1) the cold soak prior to the preconditioning, and the fuel drain and fuel fill following the vehicle preconditioning, as described in subsections 4.g.i.B. and 4.g.i.C., respectively, may be omitted at the discretion of the manufacturer and (2) the vehicle canister loading procedure contained in subsection 4.g.iii. shall be conducted using one of the following options:

(i) The vehicle canister loading procedure shall be conducted in accordance with subsections 4.g.iii.C. and 4.g.iii.D., ***except that prior to the canister loading, the canister shall be cycled no less than 2 times using the method specified in subsection 4.c.iii, utilizing the fuel used in normal operation, in order to place a heel on the canister.***

Alternative methods of loading the original canister may be used, provided such a method is approved in advance by the Executive Officer on the basis of achieving canister loading comparable to the prescribed method.

OR

(ii) The vehicle canister loading procedure described in subsections 4.g.iii.C. and 4.g.iii.D. shall be employed for a canister which is loaded separate from the vehicle, and then attached prior to the exhaust tests, with the original canister disabled. Such a canister loaded separate from the vehicle shall be identical in nominal working bed capacity, charcoal bed volume and configuration to the original canister present on the vehicle. The loading procedure for this canister shall be as described in subsections 4.g.iii.C. and 4.g.iii.D., except ~~that~~ *for the following: (1)* the rate of butane loading shall not exceed 40 grams/hour, *and (2) prior to the loading, the canister shall be cycled at least 2 times according to the method specified in subsection 4.c.iii, utilizing the fuel used in normal operation. If the canister has been cycled for use in a previous exhaust test, this step may be omitted.* An alternative to this option (ii) may be used provided such a method is approved in advance by the Executive Officer on the basis of whether the flow of vapor from the canister to the engine is comparable to the prescribed method.

OR

(iii) Data shall be submitted to the Executive Officer demonstrating ~~that there does not exist a measurable difference~~ the difference or lack of difference in exhaust emissions, for ~~both~~ hydrocarbons, ~~and~~ OMHCE *and carbon monoxide*, between vehicles possessing a canister(s) loaded in accordance with subsections 4.g.iii.C. and 4.g.iii.D. *and cycled no less than 2 times according to the method specified in subsection 4.c.iii utilizing the fuel used in normal operation,* and vehicles possessing an unloaded canister(s). For the purposes of this section, the preparation and preconditioning of vehicles with an unloaded canister shall be conducted in an identical manner as described in 2.(c)(1) of this procedure for vehicles equipped with a loaded canister, except that canister loading requirements contained in subsections 4.g.iii.C. and 4.g.iii.D. shall be omitted.

A test plan for generation of such data shall be submitted to the Executive Officer for approval prior to testing. Such testing shall involve a minimum of ten (10) vehicles for each engine family chosen to use this option, tested both with loaded and unloaded canisters. This testing shall be conducted during the first calendar quarter of production for a given model-year in order to properly apply the results to each quality-audit vehicle which is tested. Such testing shall establish a measured exhaust emissions difference for each vehicle, for hydrocarbons, OMHCE, and carbon monoxide. For each pollutant these differences shall be averaged to generate average exhaust emissions differences (referred to below as D). These differences shall be applied, as an additive factor, to the applicable exhaust emissions results of each quality-audit vehicle that is not tested with a canister

loaded in accordance with 2.(c)(1)(i) or 2.(c)(1)(ii). Compliance with the applicable exhaust emission standards shall be based on the sum of D and the measured quality-audit emission data for each vehicle. However, in no case shall this additive factor be applied when its value is less than zero.

(c)(2) For all other vehicles, the following procedure shall apply. A new carbon canister may be installed on the vehicle at the start of the test sequence. The test sequence shall consist of one Urban Dynamometer Driving Schedule (UDDS) test procedure, followed by a cold soak and constant volume sample (CVS) test. The federal test procedure requirement, consisting of heating the fuel before the CVS test, is to be omitted. The manufacturer may request permission to use an alternate preconditioning procedure provided the manufacturer demonstrates that it will not affect the loading of the carbon canister when compared with the UDDS.

(d) Except as provided in paragraph D.2.(f) below, no vehicle selected for quality-audit testing shall be repaired or adjusted after passing the inspection test, except for a vehicle that: (1) is not testable, e.g., cannot be started, transmission or brakes lock-up; (2) is not reasonably operative, e.g., some transmission gears not functioning; (3) is unsafe to test; or (4) would be damaged by testing.

(e) If a vehicle is shipped to a remote facility for quality-audit testing, correction of damage or maladjustment, which is found to have resulted from shipment of the vehicle, is permitted only after the initial test of the vehicle, except as provided in paragraph (d) above.

All adjustments or repairs performed on vehicles prior to each test shall be reported to the Executive Officer by inclusion in the quarterly report. The vehicle condition and symptoms and reason(s) for each repair or adjustment shall be listed. In the event a retest is performed, application may be made to the Executive Officer for permission to substitute the after-repair test results for the original test results. The Executive Officer will either affirm or deny the application. When requested by the manufacturer, no more than ten days after the production quarter, response from the Executive Officer will be within ten working days.

(f) If a vehicle is shipped to a remote facility for quality-audit testing, no pre-delivery type inspection, adjustment, or repair of vehicles selected for quality-audit is allowed, except as follows: if subsequent to shipping from the assembly-line, the manufacturer performs the particular inspection and correction of damage or maladjustment at designated preparation facility locations for all vehicles produced and the manufacturer's written specific inspections and corrections will be allowed prior to testing quality-audit vehicles.

(g) If the emission test results of a vehicle are determined to be invalid by the manufacturer, the vehicle must be retested. Emission results from all tests shall be reported. A detailed report on the reasons for each invalid test shall be included in the quarterly report.

3. STANDARDS AND TEST PROCEDURES

The emission standards and the exhaust sampling analytical procedures shall be those described in the "CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1981 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES" or in "CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES", as applicable, for, ~~to~~ vehicles tested for exhaust emissions only, with exceptions or additions as shown in paragraph D.2.

4. EVALUATION

The evaluation shall be performed on sample sizes containing 30 or more vehicles. If a sample size for a particular production quarter is less than 30 vehicles, the data from that quarter shall be combined with all the data from each successive quarter until data from at least 30 vehicles have been quality-audit tested is included in the quarterly evaluation. If the sample size for the last final quarter's production for a model year does not contain at least 30 vehicles, the data from the last final quarter shall be combined with all the data from each preceding quarter until the sample size contains at least 30 vehicles. For an engine family which contains both light-duty trucks and medium-duty vehicles, all references in this test procedure to engine family shall mean light-duty truck subgroup or medium-duty vehicle subgroup.

Based upon additional information submitted by a manufacturer, the Executive Officer may allow rejection of any data from vehicles if they are considered to be not representative of production.

For each production quarter, if 30 or more vehicles are tested, the ARB shall consider that probable cause exists for finding a violation by any engine family if the average emissions of any pollutant, after multiplying the emission data of each vehicle by the appropriate certification deterioration factor (DF), exceed the applicable year exhaust emission standards, when rounded to the same number of significant digits as the standard.

The Executive Officer may invoke Section 2109, Chapter 3, Title 13 of the ~~G-A-G-~~ C.C.R, if probable cause is found for a full or combined production quarter. The Executive Officer may invoke Section 2110, Chapter 3, Title 13 of the ~~G-A-G-~~ C.C.R, if probable cause is found for a short start-up production period (less than a full calendar quarter), for the first 30 vehicles quality-audit tested during any production quarter or from the start of production, or for vehicles evaluated in accordance with the monthly evaluation required by paragraph 6 below. In addition, the ARB may seek statutory penalties pursuant to H & SC Sections 43211 and 43212 at the end of each full or combined calendar quarter of production. If the Executive Officer invokes ~~G-A-G-~~ C.C.R Section 2109 or 2110, an evaluation will be made on vehicles produced subsequent to the invocation of a plan

adopted pursuant to Section 2109 or 2110 as long as the sample size contains at least 30 vehicles.

If more than 1.0 percent (at least 2 vehicles) of the sample within an engine family has projected emissions which exceed the applicable standards by more than 2.33 standard deviations at the time of any evaluation of that family's average emissions, within 30 working days, the manufacturer shall submit: (a) an analysis of the projected average emissions for each engine code/transmission type/inertia weight combination within that family: (b) an engineering evaluation of the cause of failure for each vehicle which exceeded the standard by more than 2.33 standard deviations; (c) the manufacturer's opinion as to the nature of the problem; and (d) any corrective action proposed by the manufacturer.

The Executive Officer shall review the report, and may require that the proposed corrective action be taken. If, after review of the report, the Executive Officer finds the proposed corrective action inadequate, the Executive Officer may invoke Section 2109 or 2110, as appropriate.

5. ~~NON-METHANE (NMHC) OR TOTAL~~ HYDROCARBON (THC) MEASUREMENTS

(a) For an engine family certified to ~~the~~ non-methane hydrocarbon (NMHC) standard~~s~~, the manufacturer shall measure the NMHC content which shall be multiplied by the NMHC DF.

(b) For an engine family certified to ~~the~~ total hydrocarbon (THC) standard~~s~~, the measured THC values shall be multiplied by the THC DF.

(c) For an engine family certified to organic material hydrocarbon equivalent (OMHCE) or organic material non-methane hydrocarbon equivalent (OMNMHCE) standards, the manufacturer shall measure the OMHCE or OMNMHCE content which shall be multiplied by the OMHCE or OMNMHCE DF. As an alternative to measuring the OMHCE or OMNMHCE content, the Executive Officer may approve, upon submission of supporting data by a manufacturer, the use of OMHCE or OMNMHCE to NMHC ratios. To request the use of OMHCE or OMNMHCE to NMHC ratios, the manufacturer shall establish during certification testing the ratio of measured OMHCE or OMNMHCE exhaust emissions to measured NMHC exhaust emissions for each certification test data vehicle for the applicable engine family. The average of the individual test ratios of measured OMHCE or OMNMHCE to NMHC emissions for the engine family shall be submitted to the Executive Officer in the application for certification. Following approval of the application for certification, the manufacturer may conduct quality-audit testing on the engine family by measuring NMHC exhaust emissions rather than OMHCE or OMNMHCE exhaust emissions. The measured NMHC exhaust emissions shall be multiplied by the OMHCE or OMNMHCE to NMHC ratio submitted in the application for certification for the engine family to determine the equivalent OMHCE or OMNMHCE exhaust emission values for the quality audit test vehicle. The equivalent OMHCE or OMNMHCE exhaust emission values shall be compared to the OMHCE or OMNMHCE exhaust emission standard applicable to the engine family.

(d) For an engine family certified to non-methane organic gas (NMOG) standards, the manufacturer shall measure the NMOG content which shall be multiplied by the NMOG DF and the reactivity adjustment factor and ozone DF, if applicable. As an alternative to measuring the NMOG content, the Executive Officer may approve, upon submission of supporting data by a manufacturer, the use of NMOG to NMHC ratios. To request the use of NMOG to NMHC ratios, the manufacturer shall establish during certification testing the ratio of measured NMOG exhaust emissions to measured NMHC exhaust emissions for each certification test data vehicle for the applicable engine family. The average of the individual test ratios of measured NMOG to NMHC emissions for the engine family shall be submitted to the Executive Officer in the application for certification. Following approval of the application for certification, the manufacturer may conduct quality-audit testing on the engine family by measuring NMHC exhaust emissions rather than NMOG exhaust emissions. The measured NMHC exhaust emissions shall be multiplied by the NMOG to NMHC ratio submitted in the application for certification for the engine family to determine the equivalent NMOG exhaust emission values for the quality audit test vehicle. The equivalent NMOG exhaust emission value shall be used in place of the measured NMOG exhaust emission value in determining the reactivity adjusted exhaust NMOG results. The equivalent reactivity adjusted NMOG exhaust emission values shall be compared to the NMOG exhaust emission standard applicable to the vehicle emission category (TLEV, LEV, or ULEV) in which the engine family was certified.

(e) For fuel-flexible vehicles certified to either organic material non-methane hydrocarbon equivalent (OMNMHCE) or non-methane organic gas (NMOG) standards, the manufacturer may request from the Executive Officer the use of a methanol (M85) exhaust emission to gasoline NMHC exhaust emission ratio which shall be established during certification testing for each certification test data vehicle for the applicable engine family. The average of the individual test ratios of measured M85 NMOG to gasoline NMHC emissions for the engine family shall be submitted to the Executive Officer in the application for certification. Following approval of the application for certification, the manufacturer may conduct quality-audit testing on the engine family by measuring gasoline NMHC exhaust emissions rather than M85 NMOG exhaust emissions. The measured gasoline NMHC exhaust emissions shall be multiplied by the M85 NMOG to gasoline NMHC ratio submitted in the application for certification for the engine family to determine the equivalent NMOG exhaust emission values for the quality audit test vehicle. The equivalent NMOG exhaust emission value shall be used in place of the measured NMOG exhaust emission value in determining the reactivity adjusted exhaust NMOG results. The equivalent reactivity adjusted NMOG exhaust emission values shall be compared to the NMOG exhaust emission standard applicable to the vehicle emission category (TLEV, LEV, or ULEV) in which the engine family was certified. Manufacturers which choose this option shall test the full two percent of the vehicles selected for quality-audit testing.

(f) For 1993 and 1994 model-year vehicles, the manufacturer has the option of using the fuel meeting the specifications set forth in Section 9.a(1), 9.a(1)(i), or 9.a(1)(ii) of the California Exhaust Emission

Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles for purposes of quality audit testing. All 1995 and subsequent conventional and low-emission vehicles which certify with fuel meeting the specifications set forth in Section 9.a(1) of the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles must use that fuel for purposes of quality audit testing. All 1995 and subsequent conventional and low-emission vehicles which certify with fuel meeting the specifications set forth in Section 9.a(ii) of the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles must use that fuel for purposes of quality audit testing.

6. FORMALDEHYDE (HCHO) MEASUREMENTS

For an engine family certified to HCHO standards, the manufacturer shall measure the HCHO content which shall be multiplied by the HCHO DF. As an alternative to measuring the HCHO content, the Executive Officer may approve, upon submission of supporting data by a manufacturer, the use of HCHO to NMHC ratios. To request the use of HCHO to NMHC ratios, the manufacturer shall establish during certification testing the ratio of measured HCHO exhaust emissions to measured NMHC exhaust emissions for each certification test data vehicle for the applicable engine family. The average of the individual test ratios of measured HCHO to NMHC emissions for the engine family shall be submitted to the Executive Officer in the application for certification. Following approval of the application for certification, the manufacturer may conduct quality-audit testing on the engine family by measuring NMHC exhaust emissions rather than HCHO exhaust emissions. The measured NMHC exhaust emissions shall be multiplied by the HCHO to NMHC ratio submitted in the application for certification for the engine family to determine the equivalent HCHO exhaust emission values for the quality audit test vehicle. The equivalent HCHO exhaust emission values shall be compared to the HCHO exhaust emission standard applicable to the engine family.

6 7. REPORTS

Each vehicle manufacturer shall submit a report to the ARB within 45 calendar days after the end of each calendar quarter and 45 calendar days after the end of the production year. More frequent reports may be required if the Executive Officer invokes G~~.~~A~~.~~G~~.~~ C.C.R. Section 2109 or 2110, Chapter 3, Title 13. Each vehicle manufacturer shall review the test results of the first 30 test vehicles of each engine family for each calendar quarter of production or from the start of production, and the quarter's cumulative test results of each engine family at the end of each month. If the sample size is 30 or more vehicles, the Chief, Mobile Source Division, shall be notified in writing within ten working days whenever an engine family exceeds an emission standard.

The quarterly report shall include the following:

(a) The total production and sample size for each engine family, and the total number of vehicles certified to TLEV, LEV, ULEV or zero-emission vehicle (ZEV) standards and produced and delivered for sale in California in each of the following vehicle classifications: 1) passenger cars and light-duty trucks 0-3750 lbs. loaded vehicle weight, 2) light-duty trucks 3751-5750 lbs. loaded vehicle weight, and 3) medium-duty vehicles.

(b) A description of each test vehicle ((i.e., date of test, engine family, engine size, vehicle identification number, fuel system (e.g., number of venturi, fuel injection, etc.), transmission type, test weight used, dynamometer power absorber setting in horsepower, engine code or calibration number, and test location)).

(c) The CVS exhaust emission data and carbon dioxide data for each test vehicle. For methanol vehicles not certified as TLEVs, LEVs, or ULEVs, OMHCE or OMNMHCE data shall be substituted for NMHC or THC data, and formaldehyde (HCHO) data shall also be submitted. For vehicles certified as TLEVs, LEVs, or ULEVs, NMOG data shall be substituted for NMHC or THC data, and HCHO data shall also be submitted.

The data reported shall be rounded to one significant figure beyond the number of significant figures in the applicable standard. DF's shall be stated, then applied to the data. The data reported after the DF's are applied shall be rounded using the "rounding off method" specified in ASTM: E29-67 to the number of places to the right of the decimal point indicated below. ~~follows for all~~ in accordance with the emission standards to which the vehicles was certified:

THC, NMHC, OMHCE or OMNMHCE	NMOG	CO	NOx	HCHO	CO_2
.XXX	.XXXX	.XX	.XX or .XXX	.XXXX	.X

(d) The retest emissions data, as described in paragraph (c) above, for any vehicle failing the initial test, and description of the corrective measures taken, including specific components replaced or adjusted.

(e) A statistical analysis of the quality-audit test results for each engine family stating:

(1) Number of vehicles tested.

(2) Average emissions and standard deviations of the sample for HC or OMHCE or OMNMHCE or NMOG, as applicable, CO, and NOx, and HCHO, as applicable, both before and after applying DF's, reactivity adjustment factors, and ozone DF's, as applicable. In the latter case, the individual test points shall be multiplied by the DF's, reactivity adjustment factors, and ozone DF's, as applicable, prior to computing the average and standard deviation. The average emissions and standard deviation of the sample for carbon dioxide shall also be listed.

(3) The applicable exhaust emission standards to be met by listing specific options selected, designating when 100,000 mile standards apply, and designation where NMHC, ~~or~~ THC, OMHCE, OMNMHCE, or NMOG standards apply.

(f) Every aborted test and reason for abort shall be reported.

(g) If both four-wheel and two-wheel drive vehicles are included in a light-duty truck engine family under 4,000 pounds inertia weight, the quality-audit test data from four-wheel drive vehicles shall be distinguished from and summarized separately from two-wheel drive vehicles.

(h) The final report shall include the date of the end of the manufacturer's model production year for each engine family.

(i) If vehicles from different model-years are produced in any production quarter, separate reports shall be submitted for each model-year.

(j) For federally certified light-duty vehicles produced under the provisions of H & SC 43102(b), the emissions data and other information required in the quarterly reports shall be included in a separate section of the report. Where such federally certified light-duty vehicles are in the same engine family as medium-duty vehicles, all data from these medium-duty vehicles shall be deleted from the separate section. The separate section shall include the statistical summary required by Section (e)(2). The separate section of the report shall also include identical data for California engine families used for offsetting emissions of federally certified light-duty vehicles.

~~7~~ 8. SPECIAL REQUIREMENTS FOR SMALL VOLUME MANUFACTURERS

The following requirements apply only to those vehicle manufacturers who were granted relief by the Executive Officer under Title 13, C.A.C., Section 1960.4, Special Standards for 1982 and Subsequent Model Passenger Cars and 1983 and Subsequent Model Light-Duty Trucks and Medium-Duty Vehicles, 0-3999 Pound Equivalent Inertia Weight.

The requirements listed below are to be followed as supplemental to and when contrary to other requirements specified in part D. "Quality-Audit test Procedures", Sections "4. Evaluation", and "6. Reports". These requirements are listed to implement, define, and clarify the Board requirements of C.A.C. Section 1960.4.

(a) Additional Reporting Requirements for NOx Emissions

(1) The cumulative average of NOx emissions from the entire quality-audit light-duty trucks (LDT) plus medium-duty vehicles (MDV) 0-3999 lbs. equivalent inertia weight, shall be reported both before and after applying DF's for the 1983 model-year to:

(i) All 1983 models tested during each calendar quarter.

(ii) All 1983 models tested to date by the end of each calendar quarter.

(iii) All 1983 models tested to date by December 31, 1982, by June 30, 1983, and by December 31, 1983.

(2) The combined averages from the entire passenger car (PC) line and, separately, LDT and MDV lines, 0-3999 lbs. equivalent inertia weight, shall be reported both before and after applying DF's for:

(i) All 1983 model PC's tested during each calendar quarter.

(ii) All 1984 model PC's and, separately, LDT's plus MDV's tested during each calendar quarter.

(iii) All 1985 model LDT's plus MDV's tested during each calendar quarter.

(3) Subgroups

The NOx emission results shall be averaged and reported by engine family subgroup in each regular quarterly assembly-line report.

(b) Semi-Annual Evaluations

Joint ARB - manufacturer evaluations will be made each six months to determine compliance with the 0.7 gm/mi NOx production level based on test results by engine families separately for 1983 and 1984 model PC's and 1984 and 1985 model LDT's plus MDV's tested and on a cumulative basis for 1983 model LDT's plus MDV's. The first evaluation will be made based on averaged NOx test data accumulated through December 31, 1982. Subsequent evaluations will be made semiannually for data accumulated through each June 30 and December 31 periods until December 31, 1984 for PC's and December 31, 1985, for LDT's plus MDV's model year productions.

If the NOx value exceeds the 0.7 gm/mi level, but the manufacturer shows that unanticipated technical problems caused the 0.7 gm/mi NOx production average to be exceeded, then appropriate relief will be made available. The relief will be made provided the manufacturer shows reasonable effort was made and will continue to be made towards meeting the 0.7 gm/mi NOx levels for future production periods. This includes incorporating into production improved technology as soon as it becomes available.

After the evaluation, the Executive Officer can revoke Section 2109, Title 13 of the ~~G.A.G.~~ C.C.R, if combined test results exceed the 0.7 gm/mi NOx level separately for 1983 and 1984 model PC's and 1984 and 1985 model LDT's plus MDV's, and on a cumulative basis for 1983 model LDT's plus MDV's provided that the manufacturer has not taken appropriate action.

DEFINITIONS

The definitions in Section 1900 (b), Chapter 3, Title 13 of the California ~~Administrative~~ Code <u>Code of Regulations</u>, shall apply with the following additions:

1. Calendar Quarter is defined as those three month period of time which start on the first days of January, April, July and October.

2. First or Final Calendar Quarter Production is defined as the calendar quarter in which the production of an engine family begins or ends.

3. End of Assembly-Line is defined as that place where the final inspection test or quality-audit test is performed.

4. Assembly-Line Tests are those tests or inspections which are performed on or at the end of the assembly-line.

5. Assembly-Line Quality Audit-Test is defined as the test performed on a minimum sample of 2.0 percent (or other approved sample) of the production vehicles for sale in California.

6. Assembly-Line Inspection Tests are those tests performed pursuant to Sections B or C of these procedures.

7. Functional Test is defined as a type of test or inspection which is performed on engines or vehicles to detect if the emission control system is operating properly.

8. Gross Engine Malfunction is defined as one yielding an emission value greater than the sum of the mean plus three (3) times the standard deviation. This definition shall apply only for determination of control limits.

APPENDIX A

Alternate Quality-Audit Vehicle Selection Criteria

This appendix sets forth the alternative procedure for selection of Quality-Audit vehicles. It includes the flow diagram in Figure A-1.

1. Vehicles shall be randomly selected at a rate of 2.0 percent of engine family production at the beginning of production. When test results of 30 vehicles have been accumulated, an evaluation as indicated below shall be made.

2. Calculate the family mean and standard deviation of each pollutant (HC, CO, NOx). Identify vehicles which have emission levels greater than three standard deviations above the mean. Eliminate these emission data points and recalculate the mean and standard deviation. Continue the calculation until there are no values greater than three standard deviations above the mean. Count the number of these data points greater than the standard (outliers). If the number of outliers is equal to or less than the allowable number in Table A-1 for each pollutant, the engine family is eligible to continue to a second evaluation shown in paragraph 3 below. Otherwise, sampling must continue at a rate of 2.0 percent of production for the rest of the month.

3. If the allowable outlier criteria is met, the family mean, standard deviation, and sample size determined for each contaminant before excluding any outliers, is substituted in the following expression:

$$\frac{(\text{emission standard} - \text{mean})\ ((N^{1/2}))}{(\text{standard deviation})}$$

If the expression is greater than C in Table A-2 below, and the manufacturer reasonably estimates that the quarterly engine family production will exceed 5,000 vehicles, the sampling rate for the remaining portion of the calendar month following the date of selection of the last of the 30 vehicles shall be 30 per month, applied on a prorated basis. If the expression is greater than C in Table A-2 below, and the manufacturer reasonably estimates that the quarterly engine family production will be 5,000 vehicles or less, the sampling rate for the remaining portion of the calendar month following the date of selection of the last of the 30 vehicles shall be 17 per month, applied on a prorated basis. If the expression is equal to or less than C in Table A-2, the sampling rate shall continue to be

2.0 percent of production for the remaining portion of the month in which selection of the 30 vehicles is completed. The value of C is a function of the coefficient of variation (standard deviation/mean). The coefficient of variation and "C" shall be rounded to the number of decimal places shown in Table A-2.

Table A-1

Sample Size	Allowable Outliers	Sample size	Allowable Outliers
1- 32	1	430-478	11
33- 68	2	479-528	12
69-107	3	529-578	13
108-149	4	579-629	14
150-193	5	630-680	15
194-238	6	681-731	16
239-285	7	732-783	17
286-332	8	784-835	18
333-380	9	836-887	19
381-429	10	888-939	20

Table A-2

Coefficient of Variation	C
0.1	0.5
0.2	1.2
0.3	1.8
0.4	2.5
0.5	3.1
0.6	3.8
0.7	4.4
0.8	5.1
0.9	5.7

4. For each remaining calendar month in the quarter, both mathematical procedures set forth in paragraph 2 and 3 shall be repeated at the end of the preceding month, using all of the test data accumulated in the quarter. The sampling rate for each remaining calendar month in the quarter shall be 30 vehicles per month, 17 vehicles per month, or 2.0 percent of the production as determined under the standards in paragraph 3.

5. At the end of the quarter, all of the data accumulated during the quarter is evaluated, and the compliance of the family with emission standards is determined.

6. For each subsequent quarter, the preceding sample selection method shall be followed. The sample rate determination for the first month of each subsequent quarter shall be based on the accumulated data from the previous quarter. The sample rate for the succeeding months of the quarter shall be determined as previously set forth.

7. If the start of production does not coincide with the first of a quarter, the sequence for sample rate determination shall be followed, but references to remaining calendar months may not be appropriate.

8. Where a manufacturer has sampled vehicles at a rate of 17 per month following a reasonable estimate that the quarterly engine family production will be 5,000 vehicles or less, and subsequently determines, or reasonably should determine based on information available to the manufacturer, that the quarterly engine family production will exceed 5,000 vehicles, the manufacturer shall increase the sampling rate for the quarter such that the requirements of paragraph 3 applicable to families reasonably estimated to exceed a quarterly production of 5,000 vehicles are satisfied.

FIGURE A-1

FIRST QUARTER OF PROD.

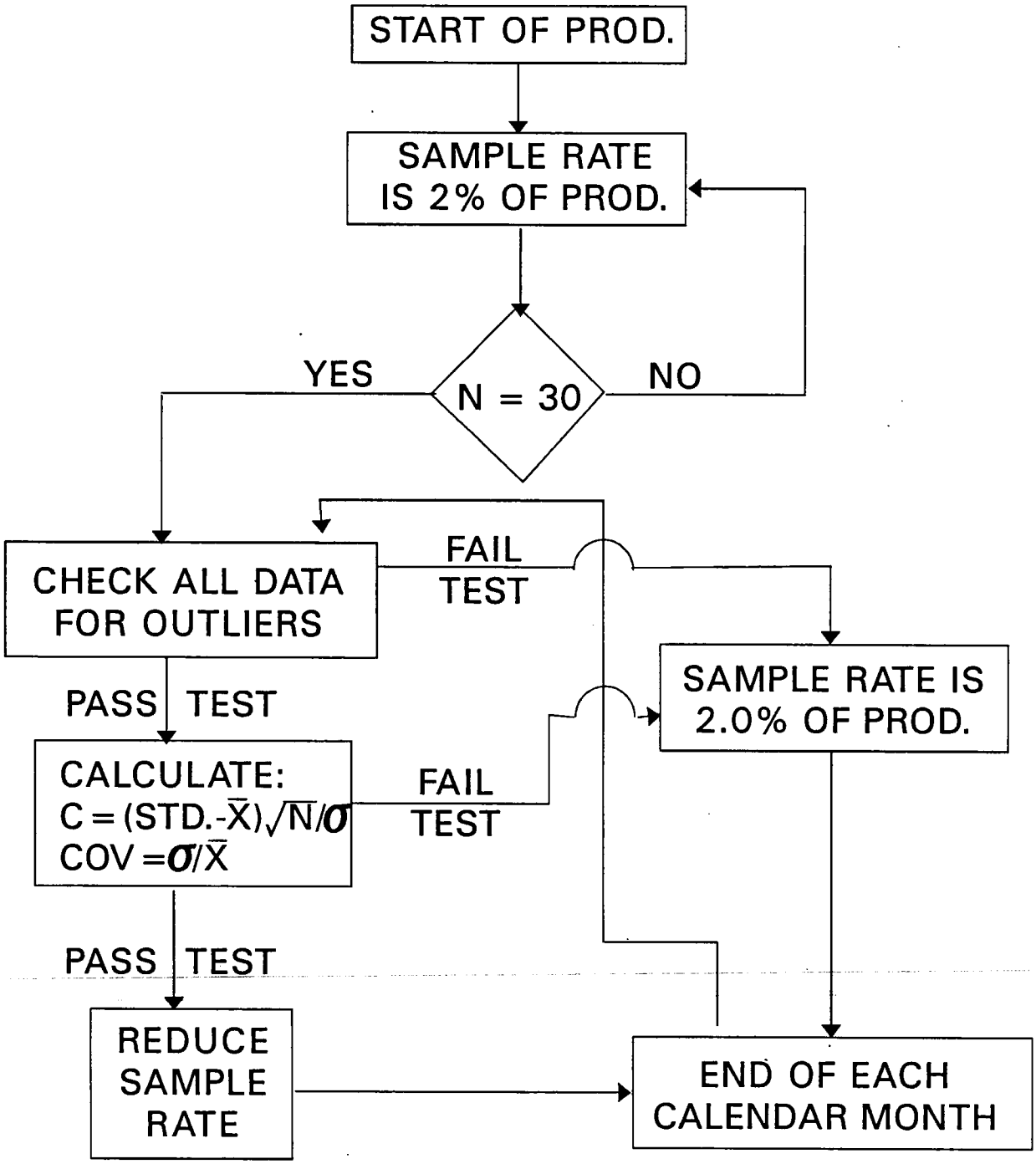

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FIGURE A-1

SUBSEQUENT QUARTERS

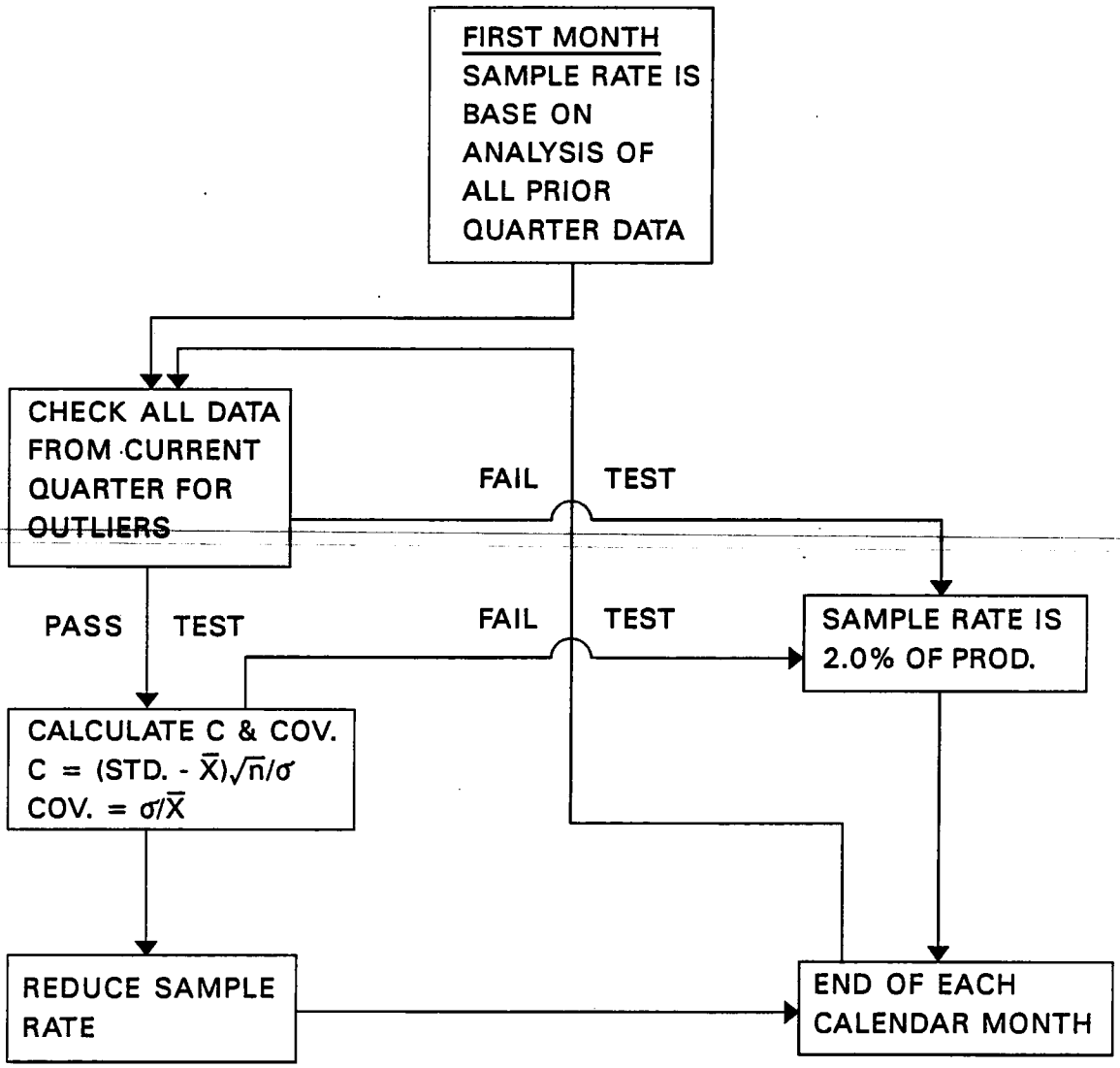

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FIGURE A-1

OUTLIER CALCULATION PROCEDURE

1. CALCULATE THE MEAN AND STANDARD DEVIATION FOR EACH POLLUTANT WITH DF APPLIED.

2. CALCULATE THE MEAN PLUS THREE STANDARD DEVIATIONS.

3. IDENTIFY ALL EMISSION DATA GREATER THAN X + 3σ STANDARD DEVIATIONS.

4. REMOVE THE OUTLIERS FROM THE DATA AND RECALCULATE THE MEAN AND STANDARD DEVIATION.

5. REPEAT STEPS 2, 3, 8, 4.

6. REPEAT STEPS 2, 8, 3

7. IDENTIFY ALL OUTLIERS THAT EXCEED APPLICABLE CERTIFICATION STANDARD AND COUNT THE NUMBER.

8. COMPARE THE NUMBER OF OUTLIERS WITH THE MAXIMUM ALLOWED BY THE OUTLIER TABLE. IF THE NUMBER OF OUTLIERS EXCEEDS THE MAXIMUM, SAMPLE RATE IS 2.0% OF PRODUCTION. IF THE NUMBER IS LESS THAN THE MAXIMUM ALLOWED, CALCULATE "C".

APPENDIX B

Air/Fuel Control System
Carburetor or Fuel Injection System
Air Injection Pump
Air Injection Control Valves
Positive Crankcase Ventilation
EGR Control System Components
Controlled Air Intake System
Distributor
Ignition Coil & Wires
Ignition Control Module
Electronic (Computer) Control System
On-Board Diagnostic System
Emissions Related Hoses, Tubing, Clamps, Belts, Fittings, Wiring, Connectors, Sensors and Switches.
Oxygen Sensor
Coolant Temperature Sensor
Catalyst
Diesel Particulate Control System
Exhaust Gas Recirculation
Choke
Air Diverter Valve
Vacuum Hose Connections

PROPOSED

State of California
AIR RESOURCES BOARD

CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 1978 AND SUBSEQUENT MODEL MOTOR VEHICLES

ADOPTED: April 16, 1975
AMENDED: May 14, 1975
AMENDED: March 31, 1976
AMENDED: October 5, 1976
AMENDED: November 23, 1976
AMENDED: June 8, 1977
AMENDED: December 19, 1977
AMENDED: October 12, 1979
AMENDED: April 23, 1980
AMENDED: June 26, 1980
AMENDED: June 8, 1981
AMENDED: March 9, 1983
AMENDED: October 30, 1985
AMENDED: January 22, 1990
AMENDED: May 15, 1990; effective July 15, 1990
AMENDED: November 20, 1991; effective January 16, 1992
AMENDED: _____

Note: The regulatory amendments originally proposed in this rulemaking are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions from existing regulations. Modifications to the originally noticed text are designated by ***bold italics*** and ~~***bold italics***~~ to represent additions and deletions, respectively.

CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES
FOR 1978 AND SUBSEQUENT MODEL MOTOR VEHICLES

The provisions of Title 40, Code of Federal Regulations (CFR), Part 86, Subparts A and B, as they pertain to evaporative emission standards and test procedures and as they were amended or adopted as of July 1, 1989 are hereby adopted as the California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles, with the following exceptions and additions:

1. These standards and test procedures are applicable to all new 1978 and subsequent model gasoline-fueled, 1983 and subsequent model liquefied petroleum gas (LPG)-fueled, and 1993 and subsequent model ~~methanol~~ alcohol-fueled passenger cars, light-duty trucks, medium-duty vehicles, heavy-duty vehicles, hybrid electric vehicles, and motorcycles. These standards and test procedures do not apply to motor vehicles which are exempt from exhaust emission certification or petroleum-fueled diesel vehicles or hybrid electric vehicles that have sealed fuel systems which can be demonstrated to have no evaporative emissions.

a. The evaporative emission standards for vehicles subject to these procedures, except motorcycles, are:

Class of Vehicle	Model Year	Hydrocarbons or OMHCE (1) Diurnal + Hot Soak (grams per test) 50K miles	Hydrocarbons or OMHCE (1) Diurnal + Hot Soak (grams per test) Useful Life(2)	Running Loss (grams/mile) Useful life(2)
Passenger Car Light-Duty Trucks Medium-Duty Vehicles Heavy-Duty Vehicles	1978 and 1979	6.0		
Passenger Car Light-Duty Trucks Medium-Duty Vehicles Heavy-Duty Vehicles	1980 - 1994	2.0		
Passenger Car Light-Duty Trucks Medium-Duty Vehicles (6,000 - 8,500 lbs. GVWR) (8,501 - 14,000 lbs. GVWR) (4) Heavy-Duty Vehicles (over 14,000 lbs. GVWR)	1995 and subsequent (3)		2.0	0.05

Hybrid Electric Passenger Car Hybrid Electric Light-Duty Trucks Hybrid Electric Medium-Duty Vehicles	1993 and subsequent (5)	2.0	0.05

(1) The applicable evaporative emission standards for ~~methanol~~ alcohol vehicles are expressed as organic material hydrocarbon equivalent (OMHCE). These evaporative standards are effective in the 1993 model year.

(2) For purposes of this paragraph, "useful life" shall have the same meaning as provided in section 2112, Title 13, California Code of Regulations. Approval of vehicles which are not exhaust emission tested using a chassis dynamometer pursuant to section 1960.1, Title 13, California Code of Regulations shall be based on an engineering evaluation of the system and data submitted by the applicant.

(3) The running loss and useful life diurnal plus hot soak evaporative emission standards (hereinafter "running loss and useful life standards") shall be phased in beginning with the 1995 model year. Each manufacturer, except small volume manufacturers, shall certify the specified percent of passenger cars and of light-duty trucks, medium-duty vehicles and heavy-duty vehicles to the ~~running loss and useful life standards according to the following~~ schedule:

Model Year	Number of Vehicles Certified to Running Loss and Useful Life Standards*
1995	10 percent
1996	30 percent
1997	50 percent

* The number of motor vehicles in each vehicle type required to be certified to the running loss and useful life standards shall be determined by applying the specified percentage to the manufacturer's projected California model-year sales of passenger cars and of light-duty trucks, medium-duty vehicles and heavy-duty vehicles.

Beginning with the 1998 model year, all motor vehicles subject to the running loss and useful life standards, including those produced by small volume manufacturers, shall be certified to the specified standards.

All 1995 through 1997 model-year motor vehicles which are not subject to running loss and useful life standards pursuant to the

phase-in schedule shall comply with the 50,000-mile standards in effect for 1980 through 1994 model-year vehicles.

(4) Compliance with the evaporative emission standards for complete vehicles in this weight range shall be based on the Sealed Housing for Evaporative Determination (SHED) conducted in accordance with the procedures set forth in Title 40, Code of Federal Regulations, sections 86.130-78 through 86.143-90 as they existed July 1, 1989.

(5) The running loss and useful life diurnal plus hot soak evaporative emission standards (hereinafter "running loss and useful life standards") for all hybrid electric vehicles shall be effective in the 1993 and subsequent model years.

b. Evaporative emission standards for gasoline-fueled motorcycles are:

Motorcycle Class	Model Year	Hydrocarbons (grams per test)
Class I and Class II (50-279 cc)	1983 - 1984	6.0
	1985 and subsequent	2.0
Class III (280 cc and greater)	1984 - 1985	6.0
	1986 and subsequent	2.0
Class III (280cc and greater) (Optional Standard for Small-Volume Manufacturers)	1986 - 1988	6.0

2. The definitions in section 1900, Title 13, California Code of Regulations, and in the applicable model-year California exhaust emission standards and test procedures, are hereby incorporated into this test procedure by reference.

3. Approval of medium-duty vehicles shall be based on the same standards and test procedures as light-duty trucks. In selecting medium-duty test vehicles, the Executive Officer shall consider the availability of test data from comparably equipped light-duty vehicles and the size of medium-duty vehicles as it relates to the practicability of evaporative emission testing.

4. For all motor vehicles subject to these test procedures, except complete medium-duty vehicles 8,501 to 14,000 lbs GVWR (see footnote 4 to Table 1.a. above), heavy-duty vehicles over 14,000 lbs GVWR (see paragraph 5. below) and motorcycles (see paragraphs 7. and 8. below)

Demonstration of system durability and determination of an evaporative emission (diurnal and hot soak) and running loss emission deterioration factor (DF) for each evaporative emission engine family shall be based on tests of representative vehicles and/or systems. For purposes of evaporative emission durability testing, a representative vehicle is

one which, with the possible exception of the engine and drive train, was built at least three months prior to the commencement of evaporative emission testing, or is one which the manufacturer demonstrates has stabilized non-fuel-related evaporative emissions.

a. For 1978 model evaporative emission engine families which require durability testing for exhaust emissions certification, either

i. Evaporative emission testing shall be conducted on all durability vehicles at the 5,000, 10,000, 20,000, 30,000, 40,000, and 50,000 mile test points. Testing may be performed at more frequent intervals with advance written approval from the Executive Officer. The results of all valid evaporative emission tests within each evaporative emission engine family shall be plotted as a function of mileage, and a least-squares-fit straight line shall be drawn through the data. The evaporative emission DF is defined as the interpolated 50,000 mile value on that line minus the interpolated 4,000 mile value on that line, but in no case shall the factor be less than zero. The interpolated 4,000 and 50,000 mile points on this line must be within the standards of paragraph 1. of these test procedures or the data will not be acceptable for use in the calculation of a DF, unless no applicable data point exceeded the standard.

OR

ii. The manufacturer shall propose in his preliminary application for certification a method for durability testing and for determination of a DF for each evaporative emission engine family. The 4,000 and 50,000 mile test points (or their equivalent) used in determining the DF must be within the standards of paragraph 1. or data will not be acceptable for use in the calculation of a DF. The Executive Officer shall review the method, and shall approve it if it meets the following requirements:

A. The method must cycle and test the complete evaporative emission control system for the equivalent of at least 50,000 miles of typical customer use.

B. The method must reflect the flow of liquid and gaseous fuel through the evaporative emission control system, and the exposure (both peak and cyclical) to heat, vibration, and ozone expected through 50,000 miles of typical customer use.

C. The method must have the specifications for acceptable system performance, including maximum allowable leakage after 50,000 miles of typical customer use.

No evaporative emission control system durability testing shall be required for 1978 model-year vehicles which do not require exhaust emission control system durability testing, unless the Executive Officer determines that durability performance is likely to be significantly inferior to 1977 model-year systems.

b. For 1979 through 1994 evaporative emission engine families and 1995 and subsequent evaporative emission engine families which are not subject to the running loss and useful life standards specified in paragraph 1. of this test procedure, both paragraphs 4.a.i. and 4.a.ii. shall apply to all families selected for exhaust emission durability testing, and paragraph 4.a.ii. shall apply to those evaporative emission engine families which are not subject to testing for exhaust emission durability. The DFs determined under paragraph 4.a.i., if any, shall be averaged with the DFs determined under paragraph 4.a.ii. to determine a single evaporative emission deterioration factor for each evaporative emission engine family.

c. Engine families subject to the running loss and useful life standards specified in paragraph 1. of this test procedure shall demonstrate compliance with durability requirements using one of the following:

i. Evaporative emission testing shall be conducted on all durability vehicles at 5,000 and 10,000 miles, and at every 10,000 mile test point interval thereafter to the applicable final test point. Testing may be performed at more frequent intervals with advance written approval from the Executive Officer. Compliance with the running loss and evaporative emission standards shall be demonstrated as follows: The results of all valid evaporative emission and running loss emission tests within each evaporative emission engine family shall be plotted as a function of mileage, and a least-squares-fit straight line shall be drawn through the data. The evaporative emission and running loss emission DFs shall be defined as the interpolated value at the applicable useful life mileage on that line, minus the interpolated 4,000 mile value on that line, but in no case shall the factor be less than zero. The interpolated 4,000 and 100,000 mile points (for passenger cars and light-duty trucks), or 4,000 and 120,000 mile points (for medium-duty vehicles and heavy-duty vehicles) on this line must be within the standards of paragraph 1. or the data will not be acceptable for use in the calculation of a DF, unless no applicable data point exceeded the standard.

OR

ii. At least one evaporative emission test shall be conducted on all passenger car and light-duty truck durability vehicles at 5,000, 40,000, 70,000, and 100,000 mile test points. At

least one evaporative emission test shall be conducted on all medium-duty durability vehicles at 5,000, 40,000, 70,000, 90,000, and 120,000 mile test points. With prior written approval from the Executive Officer, manufacturers may terminate evaporative emissions testing at the mileage corresponding to 75 percent of the vehicle's useful life if no significant vehicle maintenance or emissions change are observed. Testing may be performed at more frequent intervals also with advance written approval from the Executive Officer. Compliance with the running loss and evaporative emission standards shall be demonstrated as follows: The results of all valid evaporative emission tests within each evaporative emission engine family shall be plotted as a function of mileage, and a least-squares-fit straight line shall be drawn through the data. The evaporative emission and running loss emission DFs are defined as the interpolated value at the useful life mileage on that line minus the interpolated 4,000 mile value on that line, but in no case shall the factor be less than zero. The interpolated 4,000 and 100,000 mile points (for passenger cars and light-duty trucks) or 4,000 and 120,000 mile points (for medium-duty vehicles) must be within the standards of paragraph 1. or the data will not be acceptable for use in the calculation of a DF, unless no applicable data point exceeded the standard.

OR

iii. The manufacturer shall propose in its preliminary application for certification a method for durability testing and for determination of evaporative emission and running loss emission DFs for each evaporative emission engine family. The 4,000, and 100,000 or 120,000 "useful life" mile test points (or their equivalent) used in determining a DF must be within the standards of paragraph 1. or data will not be acceptable for use in the calculation of a DF. The Executive Officer shall review the method, and shall approve it if it meets the following requirements:

A. The method must cycle and test the complete evaporative emission control system for the equivalent of the applicable vehicle useful life (i.e., 100,000 or 120,000 miles) of typical customer use.

B. The method must reflect the flow of liquid and gaseous fuel through the evaporative emission control system, and the exposure (both peak and cyclical) to heat, vibration, and ozone expected based on typical customer use through the applicable useful life.

C. The method must have the specifications for acceptable system performance, including maximum allowable leakage

based on typical customer use through the applicable vehicle useful life.

For 1995 and subsequent model evaporative emission engine families subject to the running loss and useful life evaporative emission standards specified in paragraph 1. of this test procedure, except hybrid electric vehicles, either paragraphs 4.c.i and 4.c.iii., or paragraphs 4.c.ii. and 4.c.iii. shall apply to all families selected for exhaust emission durability testing, and paragraph 4.c.iii. shall apply to those evaporative emission engine families which are not subject to testing for exhaust emission durability. For all 1993 and subsequent model hybrid electric vehicles subject to the running loss and useful life evaporative emission emission standards specified in paragraph 1. of this test procedure, paragraphs 4.c.i. and 4.c.iii. shall apply to all families selected for exhaust emission durability testing, and paragraph 4.c.iii. shall apply to those evaporative emission engine families which are not subject to testing for exhaust emission durability. The DFs determined under paragraph 4.c.i. or 4.c.ii., if any, shall be averaged with the DFs determined under paragraph 4.c.iii. to determine a single evaporative emission deterioration factor for each evaporative emission engine family.

d. Instrumentation

The instrumentation necessary to perform evaporative emission testing is described in 40 CFR 86.107-90. For 1993 and subsequent model hybrid electric vehicles and 1995 and subsequent model motor vehicles subject to running loss and useful life evaporative emission standards, the following language is applicable in lieu of §86.107-90(a)(1):

i. Diurnal Evaporative Emissions Measurement Enclosure

A. The diurnal evaporative emissions measurement enclosure shall be equipped with an internal blower or blowers coupled with an air temperature management system (typically air to water heat exchangers and associated programmable temperature controls) to provide for air mixing and temperature control. The blower(s) shall be sized to provide a nominal total flow rate within a range of 0.3 to 0.6 ft^3/min per ft^3 of the nominal SHED volume (V_n). The inlets and outlets of the air circulation blower(s) shall be configured to provide a well dispersed air circulation pattern that produces effective internal mixing and avoids significant temperature or hydrocarbon stratification. The discharge and intake air diffusers in the enclosure shall be configured and adjusted to eliminate localized high air velocities which could produce non-representative heat transfer rates between the vehicle fuel tank(s) and the air in the enclosure. The

enclosure temperature shall be taken with thermocouples located 3 feet above the floor of the approximate mid-length of each side wall of the enclosure and within 3 to 12 inches of each side wall. The temperature conditioning system shall be capable of controlling the internal enclosure air temperature to follow the prescribed temperature versus time cycle as specified in 40 CFR 86.133-90 within an instantaneous tolerance of ± 3.0°F of the nominal temperature versus time profile throughout the test, and an average tolerance of ± 2.0°F over the duration of the test. The control system shall be tuned to provide a smooth temperature pattern which has a minimum of overshoot, hunting, and instability about the desired long term temperature profile.

B. The variable volume SHED enclosure shall be of sufficient size to contain the test vehicle with personnel access space. It shall use materials on its interior surfaces which do not adsorb or desorb hydrocarbons or ~~*alcohol methanol*~~ *or ethanol* (if the enclosure is used for ~~methanol~~ alcohol-fueled vehicles). The enclosure shall be insulated to enable the test temperature profile to be achieved with a heating/cooling system which has maximum surface temperatures in the enclosure no greater than 25.0°F above the maximum diurnal temperature specification, and minimum surface temperatures in the enclosure no less than 25.0°F below the minimum diurnal temperature specification. The enclosure shall be equipped with a pressure transducer with an accuracy and precision of ± 0.1 inches H_2O. The enclosure shall be constructed with a minimum number of seams and joints which provide potential leakage paths. Particular attention shall be given to sealing and gasketing of such seams and joints to prevent leakage.

C. The variable volume SHED enclosure shall be equipped with features which provide for the effective SHED volume to expand and contract in response to both the temperature changes of the air mass in the SHED enclosure, and any fluctuations in the ambient barometric pressure during the duration of the test. The enclosure shall have the capability of latching or otherwise constraining the enclosed volume to a known, fixed value which shall be termed the nominal SHED volume (V_n). The nominal SHED volume shall be determined by measuring all pertinent dimensions of the enclosure in its latched configuration, including internal fixtures, to an accuracy of ± 1/8 inch (0.5 cm) and calculating the net enclosure nominal volume to the nearest 1 ft^3. The latching system shall provide a fixed volume with an accuracy and repeatability of

$0.005xV_D$. Two potential means of providing the volume accommodation capabilities are a moveable ceiling which is joined to the enclosure walls with a flexure; or a flexible bag or bags of Tedlar or other suitable materials which are installed in the SHED enclosure and provided with flowpaths which communicate with the ambient air outside the enclosure. By moving air into and out of the bag(s), the contained volume can be adjusted dynamically. The total enclosure volume accommodation shall be sufficient to balance the volume changes produced by the difference between the extreme enclosure temperatures and the ambient laboratory temperature with the addition of a superimposed barometric pressure change of 0.8 in. Hg. A minimum total volume accommodation range of $\pm$ $0.07xV_D$ shall be used. The action of the enclosure volume accommodation system shall limit the differential between the enclosure internal pressure and the external ambient barometric pressure to a maximum value of $\pm$ 2.0 inches H_2O.

D. An online computer system or stripchart recorder shall be used to record the following parameters during the diurnal evaporative emissions test sequence:

-SHED enclosure internal air temperature

-Diurnal ambient air temperature specified profile as defined in §86.133-90

-Vehicle fuel tank liquid temperature

-SHED enclosure internal pressure

-SHED enclosure temperature control system surface temperature(s)

-FID output voltage recording the following parameters for each sample analysis:

-zero gas and span gas adjustments

-zero gas reading

-SHED sample reading

-zero gas and span gas readings

The data recording system shall have a time resolution of 30 seconds and shall provide a permanent record in either magnetic, electronic or paper media of the above parameters for the duration of the test.

Other equipment configurations may be used if approved in advance by the Executive Officer. The Executive Officer shall approve alternative equipment configurations if the manufacturer demonstrates that the equipment will yield test results equivalent to those resulting from use of the specified equipment.

ii. Running Loss Measurement Facility

A. For all types of running loss measurement test facilities, the following shall apply:

I. The measurement of vehicle running loss fuel vapor emissions shall be conducted in a test facility which is maintained at a nominal ambient temperature of 105.0°F. Manufacturers have the option to perform running loss testing in either an enclosure incorporating atmospheric sampling equipment, or in a cell utilizing point source sampling equipment. Confirmatory testing or in-use compliance testing may be conducted by the Executive Officer using either sampling procedure. The test facility shall have space for personnel access to all sides of the vehicle and shall be equipped with the following test equipment:

-A chassis dynamometer which meets the requirements of 40 CFR 86.108-79.

-A fuel tank temperature management system which meets the requirements specified in ii.A.III. of this paragraph.

-A running loss fuel vapor hydrocarbon analyzer which meets the requirements specified in §86.107-90(a)(2).

-A running loss test data recording system which meets the requirements specified in ii.A.IV. of this paragraph.

II. All types of running loss test facilities shall be configured to provide an internal ambient temperature of 105°F ± 5°F maximum and ± 2°F on average throughout the running loss test sequence. This shall be accomplished by any one or combination of the following techniques:

-Using the test facility without artificial cooling and relying on the residual heat in the test vehicle for temperature achievement.

-Adding insulation to the test facility walls.

-Using the test facility artificial cooling system (if so equipped) with the setpoint of the cooling system adjusted to a value not lower than 105.0°F, where the cooling system setpoint refers to the internal test facility air temperature.

-Using a full range test facility temperature management system with heating and cooling capabilities.

III. Cell/enclosure temperature management shall be conducted at the inlet of the vehicle cooling fan. The vehicle cooling fan shall be a road speed modulated fan which is controlled to a discharge velocity which matches the dynamometer roll speed throughout the driving cycle. The fan outlet shall airflow discharge to both the vehicle radiator air inlet(s) and the vehicle underbody.

The fuel tank temperature management system shall be configured and operated to control the fuel tank temperature profile of the test vehicle during the running loss test sequence. The use of a discrete fuel tank temperature management system is not required provided that the existing temperature and airflow conditions in the test facility are sufficient to match the on-road fuel tank liquid (T_{liq}) temperature profile of the test vehicle within a tolerance of ± 3.0°F throughout the running loss driving cycle, and the fuel tank vapor (T_{vap}) temperature profile of the test vehicle within a tolerance of ± 3.0°F during the final 120 second idle period of the test. The system shall provide a ducted air flow directed at the vehicle fuel tank which can be adjusted in flow rate and/or temperature of the discharge air to manage the fuel tank temperature. The system shall monitor the vehicle fuel tank temperature sensors located in the tank according to the specifications in paragraph 4.f. (§86.129-80(d)(1)) during the running loss drive cycle. The measured temperature shall be compared to a reference on-road profile for the same platform/ powertrain/fuel tank combination developed according to the procedures in §86.129-80(c). The system shall adjust the discharge flow and/or temperature of the outlet duct to maintain the tank liquid temperature profile within ± 3.0°F of the reference on-road profile throughout the test. Additionally, the

vapor temperature during the final 120 second idle period shall match the reference on-road vapor temperature within ± 3.0°F. The system shall provide a discharge airflow not to exceed 6000 cfm. The temperature of the air supplied to the outlet duct shall be within a range of 70°F to 160°F for systems which utilize artificial heating and/or cooling of the air supply to the outlet duct. This requirement does not apply to systems which recirculate air from inside the test cell without temperature conditioning the airflow. The control system shall be tuned and operated to provide a smooth and continuous fuel tank temperature profile which is representative of the on-road temperature profile.

IV. An on-line computer system or strip-chart recorder shall be used to record the following parameters during the running loss test sequence:

-Cell/enclosure ambient temperature

-Vehicle fuel tank liquid (T_{liq}) and vapor space (T_{vap}) temperatures

-Vehicle coolant temperature

-Vehicle fuel tank headspace pressure

-Reference on-road fuel tank temperature profile developed according to paragraph 4.f. (§86.129-80(d))

-Dynamometer rear roll speed

-FID output voltage recording the following parameters for each sample analysis:

-zero gas and span gas adjustments

-zero gas reading

-dilute sample bag reading

-dilution air sample bag reading

-zero gas and span gas readings

B. If an enclosure, or atmospheric sampling, running loss facility is used, the following requirements (in addition to those in subparagraph A. above) shall also be applicable:

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I. The enclosure shall be readily sealable and rectangular in shape. When sealed, the enclosure shall be gas tight in accordance with 40 CFR 86.117-90. Interior surfaces shall be impermeable and non-reactive to hydrocarbons and to *alcohol* ~~methanol~~ *or ethanol* (if the enclosure is used for ~~methanol~~ alcohol-fueled vehicles). One surface should be of flexible, impermeable, and non-reactive material to allow for minor volume changes, resulting from temperature changes.

II. In the event an artificial cooling or heating system is used, the surface temperature of the heat exchanging elements shall be within a range of 70.0°F to 125.0°F.

C. If a point source running loss measurement facility (cell) is used, the following requirements (in addition to those in subparagraph A. above) shall also be applicable:

I. The running loss vapor vent collection system shall be configured to collect all running loss emissions from each of the discrete point sources which function as vehicle fuel system vapor vents, and transport the collected vapor emissions to a CFV or PDP based dilution and measurement system. The collection system shall consist of a collector at each vehicle vapor vent, lengths of heated sample line connecting each collector to the inlet of the heated sample pump, and lengths of heated sample line connecting the outlet of the heated sample pump to the inlet of the running loss fuel vapor sampling system. Up to 3 feet of unheated line connecting each of the vapor collectors to the heated sample lines shall be allowed. Each heated sample pump and its associated sample lines shall be maintained at a temperature between 175.0°F and 200.0°F to prevent condensation of fuel vapor in the sample lines. The heated sample pump(s) and its associated flow controls shall be configured and operated to draw a flow of ambient air into each collector at a flow rate of at least 40 standard cubic feet per hour (SCFH). The flow controls on each heated sampling system shall include an indicating flow meter which provides an alarm output to the data recording system if the flow rate drops below 40 SCFH by more than 5 percent. The collector inlet for each discrete vapor vent shall be placed in proximity to the vent as necessary to capture any fuel vapor emissions without significantly affecting flow or pressure of

the normal action of the vent. The collector inlets shall be designed to interface with the configuration and orientation of each specific vapor vent. For vapor vents which terminate in a tube or hose barb, a short length of tubing of an inside diameter larger throughout its length than the inside diameter of the vent outlet, may be used to extend the vent into the mouth of the collector as illustrated in Figure 21. For those vapor vent designs which are not compatible with such collector configurations, the vehicle manufacturer shall supply a collector which is configured to interface with the vapor vent design, and which terminates in a fitting approved by the Executive Officer. The Executive Officer shall approve the fitting if the manufacturer demonstrates that it is capable of capturing all vapor emitted from the vent.

II. The running loss fuel vapor sampling system shall be a CFV or PDP based dilution and measurement system which further dilutes the running loss fuel vapors collected by the vapor vent collection system(s) with ambient air, collects continuously proportional samples of the diluted running loss vapors and dilution air in sample bags, and ~~measures the total dilute flow through the sampling~~ system over each test interval. In practice, the system shall be configured and operated in a manner which is directly analogous to an exhaust emissions constant volume sampling system, except that the input flow to the system is the flow from the running loss vapor vent collection system(s) instead of vehicle exhaust flow. The system shall be configured and operated to meet the following requirements:

(1) The running loss fuel vapor sampling system shall be designed to measure the true mass of fuel vapor emissions collected by the running loss vapor vent collection system from the specified fuel vapor vents. The total volume of the mixture of running loss emissions and dilution air shall be measured, and a continuously proportioned sample of volume shall be collected for analysis. Mass emissions shall be determined from the sample concentration and total flow over the test period.

(2) The PDP-CVS shall consist of a dilution air filter and mixing assembly, heat exchanger,

positive displacement pump, sampling system, and associated valves, pressure and temperature sensors. The PDP-CVS shall conform to the following requirements:

The gas mixture temperature, measured at a point immediately ahead of the positive displacement pump, shall be within ± 10°F of the designed operating temperature at the start of the test. The gas mixture temperature variation from its value at the start of the test shall be limited to ± 10°F during the entire test. The temperature measuring system shall have an accuracy and precision of ± 2°F.

The pressure gauges shall have an accuracy and precision of ± 1.6 inches of water (± 0.4 kPa).

The flow capacity of the CVS shall not exceed 350 CFM (0.165 m^3/s).

Sample collection bags for dilution air and running loss fuel vapor samples shall be sufficient size so as not to impede sample flow.

(3) The CFV sample system shall consist of a dilution air filter and mixing assembly, a sampling venturi, a critical flow venturi, a sampling system and assorted valves, and pressure and temperature sensors. The CFV sample system shall conform to the following requirements:

-The temperature measuring system shall have an accuracy and precision of ± 2°F and a response time of 0.100 seconds of 62.5 percent of a temperature change (as measured in hot silicone oil).

-The pressure measuring system shall have an accuracy and precision of ± 1.6 inches of water (0.4 kPa).

-The flow capacity of the CVS shall not exceed 350 CFM (0.165 m^3/s).

-Sample collection bags for dilution air and running loss fuel vapor samples shall be of sufficient size so as not to impede sample flow.

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III. The on-line computer system or strip-chart recorder specified in ii.A.IV. of this paragraph shall be used to record the following additional parameters during the running loss test sequence:

-CFV (if used) inlet temperature and pressure

-PDP (if used) inlet temperature and pressure and differential pressure

-Running loss vapor vent collection system low flow alarm(s)

Other equipment configurations may be used if approved in advance by the Executive Officer. The Executive Officer shall approve alternate equipment configurations if the manufacturer demonstrates that the equipment will yield test results equivalent to those resulting from use of the specified equipment.

iii. Hot Soak Evaporative Emissions Measurement Enclosure

The enclosure shall be readily sealable, rectangular in shape, with space for personnel access to all sides of the vehicle. When sealed, the enclosure shall be gas tight in accordance with §86.117-90. Interior surfaces shall be impermeable and non-reactive to hydrocarbon and to ~~methanol~~ *alcohol* ~~or ethanol~~ (if the enclosure is used for ~~methanol~~ alcohol-fueled vehicles). One surface shall be of flexible, impermeable and non-reactive material to allow for minor volume changes, resulting from temperature changes. The enclosure shall be configured to provide an internal enclosure ambient temperature of 105°F ± 5°F maximum and ± 2°F on average during the test time interval from 5 minutes after the enclosure is closed and sealed until the end of the one hour hot soak interval. The enclosure temperature shall be taken with thermocouples located 3 feet above the floor of the approximate mid-length of each side wall of the enclosure and within 3 to 12 inches of each side wall. This shall be accomplished by any one or combination of the following techniques:

-Using the enclosure without artificial cooling and relying on the residual heat in the test vehicle for temperature achievement.

-Adding insulation to the enclosure walls.

-Using the enclosure artificial cooling system (if so equipped) with the setpoint of the cooling system adjusted to a value not lower than 105.0°F, where the

cooling system setpoint refers to the internal enclosure air temperature.

-Using a full range enclosure temperature management system with heating and cooling capabilities.

In the event an artificial cooling or heating system is used, the surface temperature of the heat exchanging elements shall be within a range of 70.0°F to 125.0°F.

For 1995 through 1997 vehicles subject to running loss and useful life evaporative emission standards, and 1998 and subsequent motor vehicles, except petroleum-fueled diesel vehicles, electric vehicles, and motorcycles, omit §86.107-90(a)(4).

e. Calibrations

Evaporative emission enclosure calibrations are specified in 40 CFR 86.117-90. For all 1993 and subsequent model hybrid electric vehicles and 1995 and subsequent model motor vehicles subject to running loss and useful life evaporative emission standards, section 86.117-90 is amended to include an additional subsection (which shall be cited herein as subsection (e) of §86.117-90), to read:

(e)(1) Diurnal evaporative emission enclosure. The diurnal evaporative emission measurement enclosure calibration consists of the following parts: initial and periodic determination of enclosure background emissions, initial determination of enclosure volume, and periodic hydrocarbon retention check and calibration.

(i) The initial and periodic determination of enclosure background emissions shall be conducted according to the procedures specified in §86.117-90(a)(1) through (a)(6). The SHED enclosure shall be maintained at a nominal temperature of 105.0°F throughout the four hour period. Variable volume SHED enclosures may be operated in either the latched volume configuration, or with the variable volume feature active. The allowable enclosure background emissions as calculated according to §86.117-90(a)(7) shall not be greater than 0.05 grams in 4 hours. The enclosure may be sealed and the mixing fan operated for a period of up to 12 hours before the initial HC concentration reading (C_{HCi}) is taken and the four hour background measurement period begins.

(ii) The initial determination of enclosure internal volume shall be performed according to the procedures specified in §86.117-90(b)(1) through (b)(3).

(iii) The hydrocarbon measurement and retention check shall evaluate the accuracy of enclosure HC mass measurements and the ability of the enclosure to retain trapped HC. The check shall be conducted over a 24 hour period with all of the normally functioning subsystems of the enclosure active. A known mass of propane shall be injected into the SHED enclosure and an initial SHED enclosure mass measurement shall be made. The enclosure shall be subjected to the temperature cycling specified in paragraph g.x.G. of these procedures (revising §86.133-90(1)) for a 24 hour period. A final SHED enclosure mass measurement shall be made. The following procedure shall be performed prior to the introduction of the enclosure into service, following any modifications or repairs to the enclosure that may impact the integrity of this enclosure, and on at least a quarterly basis otherwise:

(A) Zero and span the hydrocarbon analyzer.

(B) Purge the enclosure until a stable enclosure HC level is attained.

(C) Turn on the enclosure air mixing and temperature control system and adjust it for an initial temperature of 105.0°F and a programmed temperature profile covering one cycle from 65.0°F to 105.0°F over a 24 hour period according to the profile specified in §86.133-90. Close the enclosure door. On variable volume SHED enclosures, latch the enclosure to the nominal volume position.

(D) When the enclosure temperature stabilizes at 105.0°F ± 3.0°F seal the enclosure; measure the enclosure background HC concentration (C_{HCe1}) and the temperature (T_i) and pressure (P_i) in the enclosure.

(E) Inject into the enclosure a known quantity of propane of between 4 to 8 grams. The injection method shall use a critical flow orifice to meter the propane at a measured temperature and pressure for a measured time period. Techniques which provide equivalent resolution (± 0.2 percent) of the injected mass are also acceptable. Allow the enclosure internal HC concentration to mix and stabilize for up to 300 seconds. Measure the enclosure HC concentration after mixing (C_{HCe2}). On variable volume SHED enclosures, unlatch the enclosure from the nominal volume configuration to accommodate temperature and barometric pressure changes. Start the temperature cycling function of the enclosure air mixing and temperature control system. These steps shall be completed within 900 seconds of sealing the enclosure.

(F) Calculate the initial recovered HC mass (M_{HCe1}) according to the following formula:

$$M_{HCe1} = (3.05 \times V_n \times 10^{-4} \times P_i \times (C_{HCe2} - C_{HCe1}))/T_i$$

where:

V_n is the enclosure nominal volume (ft^3)

P_i is the enclosure initial pressure (inches Hg absolute)

C_{HCen} is the enclosure HC concentration at event n (ppm C)

T_i is the enclosure initial temperature (^oR)

If the recovered mass agrees with the injected mass within 2.0 percent, continue the test for the 24 hour temperature cycling period. If the recovered mass differs from the injected mass by greater than 2.0 percent, repeat the enclosure concentration measurement in step (E) and recalculate the initial recovered mass (M_{HCe1}). If the recovered mass based on the latest concentration measurement agrees within 2.0 percent of the injected mass, continue the test for the 24 hour temperature cycling period and substitute this second enclosure concentration measurement for C_{HCe2} in all subsequent calculations. In order to be a valid calibration, the final measurement of C_{HCe2} shall be completed within the 900 second time limit outlined above. If the discrepancy persists, the test shall be terminated and the cause of the difference determined, followed by the correction of the problems(s) and the restart of the test.

(G) At the completion of the 24 hour temperature cycling period measure the final enclosure HC concentration (C_{HCe3}). Calculate the final recovered HC mass (M_{HCe2}) as follows:

$$M_{HCe2} = [3.05 \times V_n \times 10^{-4} \times P_i \times (C_{HCe3} - C_{HCe1})]/T_i$$

where:

V_n is the enclosure nominal volume (ft^3)

P_i is the enclosure initial pressure (inches Hg absolute)

C_{HCe3} is the enclosure HC concentration at the end of the 24 hour time period (ppm C)

T_i is the enclosure initial temperature (^oR)

(H) If the calculated final recovered HC mass for variable volume SHED enclosures is not within 3 percent of the

initial enclosure mass, then action shall be required to correct the error to the acceptable level.

(e)(2) The running loss equipment shall be calibrated as follows:

(i) The chassis dynamometer shall be calibrated according to the requirements of 40 CFR 86.118-78. The calibration shall be conducted at a typical ambient temperature of 75°F ± 5°F.

(ii) The running loss hydrocarbon analyzer shall be calibrated according to the requirements of 40 CFR 86.121-90.

(iii) If a point source facility is used, the running loss fuel vapor sampling system shall be calibrated according to the requirements of 40 CFR 86.119-90, with the additional requirement that the CVS System Verification at 40 CFR 86.119-90(c) be conducted by injecting the known quantity of propane into the inlet of the most frequently used fuel vapor vent collector configured to collect vapors from the vent of the evaporative emission vapor storage canister. This procedure shall be conducted in the running loss test cell with the collector installed in a vehicle in the normal test configuration, except that the vent hose from the vehicle evaporative emission canister shall be routed to a ventilation outlet to avoid unrepresentative background HC concentration levels. The propane injection shall be conducted by injecting approximately 4 grams of propane into the collector while the vehicle is operated over one Urban Dynamometer Driving Schedule (UDDS) test procedure, as described in 40 CFR 86.115-78 and Appendix I. The propane injection shall be conducted at a typical ambient temperature of 75°F ± 5°F. In this manner, the ability of the running loss vapor collection system to effectively capture and measure a representative quantity of HC vapor under realistic test conditions will be verified. In the event the running loss test is conducted using the SHED enclosure measurement technique, a propane injection recovery test shall be conducted, with a test vehicle being driven over one UDDS cycle in the enclosure during the propane injection test. The vehicle used shall be configured and operated under conditions which ensure that its own running loss contribution is negligible, by using fuel of the lowest available volatility (7.0 psi RVP), maintaining the tank temperature at low levels (<100°F), and routing the canister vent to the outside of the SHED enclosure.

(iv) Diurnal and hot soak enclosure hydrocarbon analyzer. The hydrocarbon analyzers used for measuring the diurnal and hot soak samples shall be calibrated according to the requirements of §86.121-90.

(v) Other equipment. Other test equipment including temperature and pressure sensors and the associated amplifiers and recorders, flow measurement devices, and other instruments shall be calibrated and operated according to the manufacturer's specifications and recommendations, and good engineering practice.

f. Road Load Power, Test Weight, Inertia Weight Class, and Running Loss Fuel Tank Temperature Profile Determination

For all 1993 and subsequent model hybrid electric vehicles and 1995 and subsequent model motor vehicles subject to running loss and useful life evaporative emission standards, §86.129-80 is amended to include an additional subsection (which shall be cited herein as subsection (d) of §86.129-80), to read:

(d) Determination of running loss test fuel tank temperature profile

The manufacturer shall establish for each combination of vehicle platform/powertrain/fuel tank submitted for certification a representative profile of fuel tank liquid and vapor temperature versus time to be used as the target temperature profile for the running loss evaporative emissions test drive cycle. The profile shall be established by driving the vehicle on-road over the same driving schedule as is used for the running loss evaporative emissions test according to the following sequence:

(1) The vehicle to be used for the fuel tank temperature profile determination shall be equipped with at least 2 thermocouples installed so as to provide a representative bulk liquid average fuel temperature. The specific placement of the thermocouples shall take into account the tank configuration and orientation and shall be along the major axis of the tank. The thermocouples shall not be placed within internal reservoirs or other locations which are thermally isolated from the bulk volume of the fuel. The thermocouples shall be placed at a vertical depth equivalent to the mid-volume of the liquid fuel at a fill level of 40 percent of nominal tank capacity. A third thermocouple shall be installed in the approximate center of the vapor space of the fuel tank. A pressure transducer with a minimum precision and accuracy of $\pm$ 1.0 inches H_2O shall be connected to the vapor space of the fuel tank. A means of conveniently draining the fuel tank shall be provided. The vehicle shall be equipped with a driver's aid which shall be configured to provide the test driver with the desired UDDS vehicle speed versus time trace as defined in Part 86, Appendix I, and the actual vehicle speed. Vehicle coolant temperature shall be monitored to ensure adequate vehicle coolant air to the

radiator intake(s). A computer, data logger, or strip chart data recorder shall record the following parameters during the test run:

-Desired speed

-Actual speed

-Average liquid fuel temperature (T_{liq})

-Vapor space temperature (T_{vap})

-Vapor space pressure

The data recording system shall provide a time resolution of 1 second, and an accuracy of ± 1 MPH, ± 2.0°F, and + 1.0 inches H_2O. The temperature and pressure signals may be recorded at intervals of up to 30 seconds.

(2) The temperature profile determination shall be conducted during ambient conditions which include:

-ambient temperature above 95°F and increasing or stable (± 2°F)

-sunny or mostly sunny with a maximum cloud cover of 25 percent

-wind conditions calm to light with maximum sustained wind speed of 15 MPH

-road surface temperature at least 20°F above ambient

The track temperature shall be measured with an embedded sensor, a portable temperature probe, or an infrared pyrometer which can provide an accuracy of ± 2.0°F. The test shall be conducted on a track or other restricted access facility so that the speed versus time schedule can be maintained without undue safety risks.

Tank pressure shall not exceed 10 inches of water at any time during the temperature profile determination unless a pressurized system is used and the manufacturer demonstrates that vapor would not be vented to the atmosphere if the fuel cap was removed at the end of the running loss fuel tank temperature profile determination.

(3) The vehicle fuel tank shall be drained and filled to 40 percent of the nominal tank capacity with fuel meeting the requirements of paragraph 4.i. of these procedures. The vehicle shall be moved to the location where the driving cycle is to be conducted. It may be driven a maximum

distance of 5.0 miles, longer distances shall require that the vehicle be transported by other means. The vehicle shall be parked for a minimum of 12 hours in an open area on a surface that is representative of the test road. The orientation of the front of the vehicle during parking (N, SW, etc.) shall be documented. Once the 12 hour minimum parking time has been achieved and the ambient temperature and weather conditions and track surface temperature are within the allowable ranges the vehicle engine shall be started. The vehicle air conditioning system (if so equipped) shall be set to the "NORMAL" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed. Vehicles equipped with automatic temperature controlled air conditioning systems shall be operated in "AUTOMATIC" temperature and fan modes with the system set at 72°F. The vehicle may be operated at minimum throttle for periods up to 60 seconds prior to beginning the first UDDS cycle in order to move from the parking location onto the road surface. The driver's aid shall be started and the vehicle operated over three sequential UDDS cycles with the transmission operated in the same manner as specified in 40 CFR 86.128-79. The end of each UDDS cycle shall be followed by an idle period of 120 seconds during which the engine shall remain on with the vehicle in the same transmission range and clutch (if so equipped) actuation mode as during the UDDS idle periods. The data recording system shall provide a record of the required parameters over the entire sequence from the initiation of the first UDDS cycle to the end of the third 120 second idle period. Following the completion of the test, the data recording system and driver's aid shall be turned off.

(4) In addition to the vehicle data recording, the following parameters shall be documented for the running loss test fuel tank temperature determination:

-Date and time of vehicle fueling

-Odometer reading at vehicle fueling

-Date and time vehicle was parked and parking location and orientation

-Odometer reading at parking

-Date and time engine was started

-Time of initiation of first UDDS cycle

-Time of completion of third 120 second idle period

-Ambient temperature and track surface temperature at initiation of first UDDS cycle (T_{amb1} and T_{sur1})

-Ambient temperature and track surface temperature at completion of third 120 second idle period (T_{amb2} and T_{sur2})

(5) The three UDDS cycle driving traces shall be verified to meet the speed tolerance requirements of 40 CFR 86.115-78 (b). The following temperature conditions shall be verified:

$(T_{amb1}) \geq 95.0^{o}F$

$(T_{amb2}) \geq (T_{amb1} - 2.0^{o}F)$

$(T_{sur1} - T_{amb1}) \geq 20.0^{o}F$

$(T_{sur2} - T_{amb2}) \geq 20.0^{o}F$

Failure to comply with any of these requirements shall result in a void test, and require that the entire test procedure be repeated beginning with the fuel drain specified in (d)(3) of this subparagraph. If all of these requirements are met, the following calculations shall be performed:

$$T_{corr} = 105.0 - [(T_{amb1} + T_{amb2})/2]$$

The individual tank liquid (T_{liq}) and vapor space (T_{vap}) temperatures recorded during the test run shall be adjusted by arithmetically adding the temperature correction (T_{corr}) adjustment calculated above to each liquid and vapor temperature data point. This step may be omitted if the calculated absolute value of T_{corr} is less than $2.0^{o}F$. Other methodologies for developing corrected liquid and vapor space temperature profiles are acceptable if approved in advance by the Executive Officer. The Executive Officer shall approve an alternate method if the manufacturer demonstrates equivalence to data collected at $105^{o}F$.

g. Test Procedure

For all 1993 and subsequent model hybrid electric vehicles and 1995 and subsequent model motor vehicles subject to running loss and useful life evaporative emission standards, the exhaust emission test sequence described in 40 CFR 86.130 through 86.140 shall be performed with the following modifications:

i. General Requirements.

The following language shall be applicable in lieu of §86.130-78:

The test sequence shown in Figure ~~1~~2 (Figure 3 for hybrid electric vehicles) describes the steps encountered as the vehicle undergoes the procedures to determine conformity with the standards set forth. During the exhaust portion of the test procedure, i.e., from "START" to the completion of the "HOT START EXHAUST TEST," ambient temperature levels encountered by the test vehicle shall not be less than 68°F nor more than 86°F. The temperatures monitored during testing shall be representative of those experienced by the test vehicle. The test vehicle shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution. The test sequence shown in Figure ~~1~~2 (and Figure 3 for hybrid electric vehicles) is briefly described as follows:

A. The fuel tank shall be drained and filled to the prescribed tank fuel volume, as specified in 40 CFR 86.082-2, in preparation for the vehicle preconditioning.

B. The vehicle preconditioning shall be performed in accordance with 40 CFR 86.132-90, except that following the vehicle fueling step at §86.132-90(a)(1) a soak period of 12 to 36 hours shall be provided to allow the vehicle to stabilize to ambient temperature prior to the preconditioning drive. For hybrid electric vehicles only, the manufacturer may elect to perform the All-Electric Range Test pursuant to §9.f. of the "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 §1960.1(k) of Title 13, CCR prior to vehicle preconditioning.

C. Following the vehicle preconditioning drive, the fuel tank shall be drained and then filled to 40 percent capacity.

D. The vehicle shall be allowed to soak for 12 to 36 hours prior to the exhaust emissions test.

E. During the 12 to 36 hour soak specified in subparagraph D. above, the vehicle's canister shall be purged with a volume of air equivalent to 300 canister charcoal bed volumes at a flow rate of 48 SCFH (22.7 slpm). For hybrid electric vehicles, the battery pack shall be discharged to or just below the state-of-charge at which operation of the auxiliary power unit will be initiated by the vehicle's control strategy/ the state

of charge that satisfies one of the following two conditions: (1) the state of charge is at the lowest level allowed by the control unit of the auxiliary power unit, or (2) the state of charge is set such that auxiliary power unit operation will be at its maximum level at the beginning and through the emission test.

F. The canister shall then be loaded to saturation using a butane-nitrogen mixture.

G. Perform exhaust emission tests in accordance with procedures as provided in section 1960.1(k)~~(i)~~, Title 13, California Code of Regulations, and these procedures.

H. Upon completion of the hot start test, the vehicle shall be parked in a temperature controlled area to stabilize the fuel temperature at 105°F. Artificial cooling or heating of the fuel tank may be induced if a one hour soak is not sufficient to achieve a fuel temperature of 105°F. The initial fuel temperature for the running loss test may be less than 105°F if the manufacturer is able to provide data demonstrating that a lower initial temperature reflects the maximum fuel temperature achieved by a stabilized vehicle during a 105°F day.

I. A running loss test shall be performed after the fuel ~~tank is stabilized at 105°F. The fuel tank temperature~~ shall be controlled using a specified tank temperature profile for that vehicle during the test. The temperature profile shall be achieved either using temperature controllers or by an air management system that would simulate airflow conditions under the vehicle during driving.

J. The hot soak enclosure test shall then be performed at a SHED ambient temperature of 105°F.

K. Upon completion of the hot soak enclosure test, fuel temperature shall be heated or cooled to a temperature of 65°F.

L. A 72-hour diurnal test shall be performed in a variable temperature SHED. For hybrid electric vehicles, the manufacturer shall perform additional 24-hour diurnal test increments as necessary to ensure that the auxiliary power unit will be operated to purge the evaporative emission canister during the test sequence noted in M. below.

M/ For hybrid electric vehicles/ the manufacturer shall perform testing of the evaporative emission control system and evaporative emission control purge system during the final 24/hour diurnal test cycle as specified in 4/x/K/ of these test procedures/

ii. Vehicle Preparation

Amend 40 CFR 86.131-90 to read:

(a) Prepare the fuel tank(s) for recording the temperature of the prescribed test fuel and fuel vapor according to the requirements of paragraph 4.f. (§86.129-80(d)(1)).

(b) The vehicle shall be equipped with a pressure transducer to monitor the fuel tank headspace pressure during the test. The transducer shall have an accuracy and precision of ± 1.0 inches water.

(c) Provide additional fittings and adapters, as required, to accommodate a fuel drain at the lowest point possible in the fuel tank(s) as installed on the vehicle.

(d) Provide valving or other means to allow purging and loading of the evaporative emission canister(s). Special care shall be taken during this step not to alter normal functions of the fuel vapor system components.

iii. Vehicle Preconditioning

Amend paragraph 86.132-90 by adding the following subparagraph (a)(2)(i) which reads:

(i) For hybrid electric vehicles, the battery pack shall be discharged to or just below the state-of-charge at which operation of the auxiliary power unit will be initiated by the vehicle's control strategy. One Urban Dynamometer Driving Schedule (UDDS) shall be used for preconditioning. ***If the auxiliary power unit is capable of being manually activated (which would cause the vehicle to be classified as a Type C HEV), the auxiliary power unit shall be activated at the beginning and throughout the emission test.***

The following language shall be applicable in lieu of §86.132-90(a)(4):

The Executive Officer may also choose to conduct or require the performance of optional or additional preconditioning to ensure that the evaporative emission control system is subjected to conditions typical of normal driving. The optional preconditioning shall consist of no less than 20 and

no more than 50 miles of on-road mileage accumulation under typical driving conditions.

The following language shall be applicable in lieu of §86.132-90(b):

A. Within five minutes of completion of preconditioning, the vehicle shall be driven off the dynamometer to a work area.

B. The fuel tank(s) of the prepared vehicle shall be drained and refilled with the applicable test fuel, as specified in paragraph 4.i. of these procedures, to the prescribed tank fuel volume, defined in §86.082-2.

C. Following the fuel drain and fill described in subparagraph B. above, the test vehicle shall be allowed to soak for a period of not less than 12 or more than 36 hours prior to the exhaust emissions test. During the soak period, the canister shall be connected to a pump or compressor, purged with air, then loaded with butane as described in D. below.

D. The evaporative emissions storage canister(s) shall be preloaded with an amount of butane equivalent to 1.5 times the nominal working capacity. The nominal working capacity of a carbon canister shall be determined by each manufacturer for each evaporative emissions engine family. This determination shall be based on the average capacity of no less than five canisters which are in a stabilized condition each having been cycled no less than 10 times and no more than 100 times according to the method specified in paragraph 4.c.iii. of this test procedure, utilizing the fuel used in normal operation. The following procedure shall be used to preload the canister:

   I. Prepare the evaporative emission canister(s) for the canister purging and loading operation. Special care shall be taken during this step so that the normal functions of the fuel system components or the normal pressure relationships in the system are not disturbed. The canister purge shall be performed with ambient air of controlled humidity to 75 ± 10 grains per pound of dry air. This may be accomplished by purging the canister in a room which is conditioned to this level of absolute humidity. The flow rate of the purge air shall be maintained at a nominal flow rate of 48 SCFH (22.7 slpm), and the duration shall be determined to provide a total purge volume flow

through the canister equivalent to 300 canister charcoal bed volume exchanges.

II. The evaporative emission canister(s) shall then be loaded with an amount of commercial grade butane vapors equivalent to 1.5 times the nominal working capacity. Canister loading shall not be less than 1.5 times the nominal canister capacity. The canister shall be loaded with a mixture composed of 50 percent butane and 50 percent nitrogen by volume. The rate of butane loading shall not exceed 15 $\pm$ 2 grams of butane per hour into the canister. Either a Critical Flow Orifice (CFO) butane injection device or a gravimetric method shall be used to fulfill the requirements of this step. The time of completion of the canister(s) loading activity shall be recorded. Manufacturers shall disclose to the Executive Officer their canister loading procedure. The protocol may not allow for the removal of the canister during loading, or for the replacement of components. In addition, manufacturers shall demonstrate that the procedure does not unduly disturb the components of the evaporative system.

III. Reconnect the evaporative emission canister(s).

iv. Dynamometer procedure.

To be conducted according to 40 CFR 86.135-90.

v. Engine starting and restarting.

To be conducted according to 40 CFR 86.136-90.

vi. Dynamometer test run, gaseous and particulate emissions.

To be conducted according to 40 CFR 86.137-90.

vii. Vehicle Fuel Tank Temperature Stabilization

Immediately after the hot transient exhaust emission test, the vehicle shall be soaked in a temperature controlled area for a maximum of one hour until the fuel temperature is stabilized at 105°F. This is a preparatory step for the running loss test. Cooling or heating of the fuel tank may be induced if the one hour soak is not sufficient to bring the fuel tank to 105°F. The vehicle fuel temperature stabilization step may be omitted on vehicles whose tank fuel temperature is already at 105°F upon completion of the exhaust emission test.

The initial fuel temperature for the running loss test may be less than 105°F if the manufacturer is able to provide data justifying a lower initial temperature. The fuel temperature shall reflect the maximum fuel temperature achieved by a stabilized vehicle during a 105°F day.

The vehicle air conditioning system (if so equipped) shall be set to the "NORMAL" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed. Vehicles equipped with automatic temperature controlled air conditioning systems shall be operated in "AUTOMATIC" temperature and fan modes with the system set at 72°F.

viii. Running Loss Test

After the fuel temperature is stabilized at 105°F or at the temperature specified by the manufacturer, the running loss test shall be performed. During the test, the running loss measurement enclosure (§86.107-90(a)(1)) shall be maintained at 105°F ± 5°F maximum and within ± 2°F on average throughout the running loss test sequence.

A. If running loss testing is conducted using an enclosure which incorporates atmospheric sampling equipment, the manufacturer shall perform the following steps for each test:

I. Place the drive wheels of the vehicle on the dynamometer without starting the engine.

II. Attach the exhaust tube to the vehicle tailpipe(s).

III. The test vehicle windows and the luggage compartments shall be closed.

IV. The fuel tank temperature sensor and the ambient temperature sensor shall be connected to the temperature recording system and, if required, to the air management and temperature controllers. Vehicle coolant temperature shall be monitored to ensure adequate vehicle coolant air to the radiator intake(s). The temperature recording system and the hydrocarbon emission data recording system shall be started.

V. Close and seal enclosure doors.

VI. Analyze enclosure atmosphere for hydrocarbons at the beginning of each Phase of the test (i.e., each UDDS and 120 second idle) and record. This is the background hydrocarbon concentration and is herein denoted as $C_{HCa(n)}$ for each Phase of the test.

VII. The vehicle shall be driven through three UDDS test procedures. The end of each UDDS cycle shall be followed by an idle period of 120 seconds during which the engine shall remain on with the vehicle in the same transmission range and clutch (if so equipped) actuation mode as during the UDDS idle periods. The fuel tank liquid temperature during the dynamometer drive shall be controlled within ± 3.0°F of the fuel tank temperature profile obtained on the road according to the procedures in paragraph 4.f. (§86.129-80(d)) for the same vehicle platform/ powertrain/fuel tank configuration. The fuel tank vapor temperature during the final 120 second idle period shall agree with the corresponding vapor temperature from the on-road profile within ± 3.0°F. The fuel tank temperatures shall be monitored at a frequency of at least once every 15 seconds.

VIII. Tank pressure shall not exceed 10 inches of water at any time during the running loss test unless a pressurized system is used and the manufacturer demonstrates that vapor would not be vented to the atmosphere if the fuel cap was removed at the end of the test. No pressure checks of the evaporative system shall be allowed. If the manufacturer suspects faulty or malfunctioning instrumentation, a repair of the test instrumentation may be performed. Under no circumstances will any changes/repairs to the evaporative emissions control system be allowed.

IX. The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the end of each Phase of the test.

X. Analyze the enclosure atmosphere for hydrocarbons following each Phase. This is the sample hydrocarbon concentration and is herein denoted as $C_{HCs(n)}$ for each Phase of the test. The sample hydrocarbon concentration for a particular Phase of the test shall serve as the background concentration for the next Phase of the test. The running loss test ends with completion of the final 120 second idle and occurs 75 ± 2 minutes after the test begins. The elapsed time of this analysis shall be recorded.

XI. The test vehicle windows and luggage compartment shall be opened. This is a preparatory step for the hot soak evaporative emission test.

XII. The technician may now leave the enclosure through one of the enclosure doors. The enclosure door shall be open no longer than necessary for the technician to leave.

XIII. If background emissions adversely affect test accuracy, a manufacturer may submit data to the Executive Officer demonstrating the problem. If, based on the information provided by the manufacturer, the Executive Officer determines that background emissions do adversely affect test accuracy, the manufacturer shall submit for Executive Officer approval some means to compensate for the problem. The Executive Officer shall approve the use of correction factors to minimize the effects of the problem if supported by experimental data submitted by the manufacturer.

B. If running loss testing is conducted using a cell which incorporates point source sampling equipment, the manufacturer shall perform the following steps for each test:

I. The running loss test shall be conducted in a test cell meeting the specifications of §86.107-90 (a)(1). Ambient temperature in the running loss test cell shall be maintained at 105 ± 5°F maximum and within ± 2°F on average throughout the running loss test sequence. The ambient test cell temperature shall be measured in the vicinity of the vehicle cooling fan, and it shall be monitored at a frequency of at least once every 15 seconds. The vehicle running loss collection system and underbody cooling apparatus (if applicable) shall be positioned and connected. The vehicle shall be allowed to re-stabilize until the liquid fuel tank temperature is within ± 3.0°F of the initial liquid fuel temperature calculated according to paragraph 4.f. (§86.129-80(d)(5)) before the running loss test may proceed.

II. The vehicle cooling fan shall be positioned as described in 40 CFR 86.135-90(b). During the running loss test, the cover of the vehicle engine compartment shall be closed, windows closed, and air conditioning system (if so equipped) shall be operated according to the requirements of paragraph 4.f. (§86.129-80 (d)(3)). Vehicle coolant temperature shall be monitored to ensure adequate vehicle coolant air to the radiator intake(s).

III. The vehicle shall be operated on the dynamometer over three UDDS schedules. Idle periods of 120 seconds shall be added to the end of each of the UDDS driving schedules. For hybrid electric vehicles, if the vehicle is unable to maintain the UDDS trace, the vehicle shall be operated at wide open throttle.

IV. The fuel tank liquid temperature during the dynamometer drive shall be controlled within ± 3.0°F of the fuel tank liquid temperature profile obtained on the road according to the procedures in paragraph 4.f. (§86.129-80(d)) for the same vehicle platform/powertrain/fuel tank configuration. The fuel tank vapor temperature during the final 120 second idle period shall agree with the corresponding vapor temperature from the on-road profile within ± 3.0°F. The fuel tank temperatures shall be monitored at a frequency of at least once every 15 seconds.

V. After the test vehicle is positioned on the dynamometer, the running loss vapor vent collection system shall be properly positioned at the specified fuel vapor vents of the vehicle's fuel system, if not already positioned. The typical vapor vents for current fuel systems are the vents of the evaporative emission canister(s) and the tank pressure relief vent typically integrated into the fuel tank cap as depicted in Figure 21. Other designated places, if any, where fuel vapor can escape, shall also be included.

VI. The running loss vapor vent collection system shall be connected to the PDP-CVS or CFV bag collection system.

VII. The temperature of the collection system until it enters the main dilution airstream shall be maintained between 175°F to 200°F throughout the test to prevent fuel vapor condensation.

VIII. The sample bags shall be analyzed within 20 minutes of their respective sample collection phases, as described in §86.137-90(b)(15).

C. Manufacturers may use an alternative running loss test procedure if it provides an equivalent demonstration of compliance. However, confirmatory testing or in-use compliance testing may be conducted by the Executive Officer using either the running loss measurement enclosure incorporating atmospheric sampling equipment

or point source sampling equipment as specified in §86.107-90(a)(1), and the procedure as outlined in either paragraph 4.g.viii.A. or 4.g.viii.B. of this test procedure.

D/ For hybrid electric vehicles/ the manufacturer shall record the weight of the evaporative emission canister at the conclusion of the running loss test procedures/

ix. Hot-soak test.

Amend 40 CFR 86.138-90 as follows:

Revise the first paragraph of this section to read: The hot soak evaporative emission test shall be conducted immediately following the running loss test. The hot soak test shall be performed at an average ambient temperature of 105°F ± 5.0°F maximum and ± 2.0°F on average.

A. Omit §86.138-90(a),(e), and (f).

B. Revise §86.138-90(i) to read: If hot soak testing is not conducted in the same enclosure as running loss testing, the hot soak enclosure doors shall be closed and sealed within five minutes of engine shutdown following the running loss test. If running loss and hot soak testing is conducted in the same enclosure, the hot soak test shall commence immediately after the completion of the running loss test.

C. Add section (p) to read: If background emissions adversely affect test accuracy, a manufacturer may submit data to the Executive Officer demonstrating the problem. If, based on the information provided by the manufacturer, the Executive Officer determines that background emissions do adversely affect test accuracy, the manufacturer shall submit for Executive Officer approval some means to compensate for the problem. The Executive Officer shall approve the use of correction factors to minimize the effects of the problem if supported by experimental data submitted by the manufacturer.

x. Diurnal breathing loss test.

A 72-hour diurnal test shall be performed in a variable temperature SHED, described in paragraph 4.d.i. of this test procedure. The test consists of three 24-hour cycles. For purposes of this diurnal breathing loss test, all references to methanol shall be applicable to ethanol.

Revise 40 CFR 86.133-90 to read as follows:

A. Revise section (a)(1) to read: Upon completion of the hot soak test, the start of the diurnal breathing loss test shall follow within 24 hours. The diurnal breathing loss test shall consist of three 24-hour test cycles. For hybrid electric vehicles, the manufacturer shall perform additional 24-hour diurnal test cycles as necessary to ensure that the auxiliary power unit will be operated to purge the evaporative emission control canister during the test sequence specified in 4.1.1.(k) of this test procedure.

B. Omit section (f)

C. Revise section (i) to read: The diurnal breathing loss test shall commence with a fuel temperature of 65°F. The fuel may be artificially cooled or heated to the starting diurnal temperature.

D. Revise section (j) to read: When the fuel temperature recording system reaches at least 63°F, immediately:

E. Revise section (k) to read: When the fuel temperature recording system reaches 65°F ± 2°F, immediately:

F. Revise section (k)(3) to read: Start diurnal heat build and record time. This commences the 24 hour ± 2 minute test cycle.

G. Revise section (l) to read: For each 24-hour cycle of the diurnal breathing loss test, the ambient temperature in the SHED enclosure shall be changed in real time as specified in the following table:

Hour	Temperature (°F)	Hour	Temperature (°F)
0	65.0	12	104.2
1	66.6	13	101.1
2	72.6	14	95.3
3	80.3	15	88.8
4	86.1	16	84.4
5	90.6	17	80.8
6	94.6	18	77.8
7	98.1	19	75.3
8	101.2	20	72.0
9	103.4	21	70.0
10	104.9	22	68.2
11	105.0	23	66.5
		24	65.0

H. Revise section (n) to read: The end of the first 24-hour cycle of the diurnal test occurs 24 hours ± 2 minutes after the heat build begins, paragraph (j)(2).

Analyze the enclosure atmosphere for hydrocarbons and record. This is the final hydrocarbon concentration, C_{HCf} in §86.143-90, for this test cycle. The time (or elapsed time) of this analysis shall be recorded. The procedure, commencing with paragraph (k)(1) shall be repeated until three consecutive 24-hour tests are completed. For hybrid electric vehicles, additional 24-hour tests may be required to ensure that the auxiliary power unit will be operated to purge the evaporative emission control canister during the test sequence specified in 4.1.1.K. The data from the test cycle yielding the highest diurnal hydrocarbon mass shall be used in evaporative emissions calculations as required by §86.143-90.

I. Revise section (q) to read: Upon completion of the final 24-hour test cycle, and after the final ethanol sample has been collected, the heat source shall be turned off and the enclosure doors unsealed and opened.

J. Add section (t) to read: If background emissions adversely affect test accuracy, a manufacturer may submit data to the Executive Officer demonstrating the problem. If, based on the information provided by the manufacturer, the Executive Officer determines that background emissions do adversely affect test accuracy, the manufacturer shall submit for Executive Officer approval some means to compensate for the problem. The Executive Officer shall approve the use of correction factors to minimize the effects of the problem if supported by experimental data submitted by the manufacturer.

K. Add section (u) to read: For all hybrid electric vehicles, testing of the evaporative emission control system and evaporative emission purge emission testing shall occur after the final 24-hour diurnal test cycle to ensure proper operation of the evaporative emission control system and to collect exhaust emissions due to any purging operation. The testing shall be conducted in accordance with the following procedure:

1. Prior to evaporative purge system testing, the hybrid electric vehicle battery pack shall be charged to 100% state-of-charge (SOC).

2. After completing the required number of 24-hour diurnal periods (at least 3), evaporative purge testing shall begin within 24 hours of the final diurnal period.

3/ With exhaust collection instrumentation in place/ the ignition shall be turned ON// and the vehicle shall be driven over repeat CVS/72 driving schedules/ The CVS/72 driving schedule shall be repeated until the APU has automatically shut off/ Emission sampling of hydrocarbons shall begin at APU ignition and terminate when the APU has automatically shut off/

4/ Evaporative purge emissions shall be calculated by dividing the total emissions by the product of the time required to completely purge the evaporative emission canister and 20 mph (the average speed of the CVS/72 test schedule)/ This calculation will produce a grams/mile value for hydrocarbons which will then be divided by the number of 24/hour diurnals certified to (at least 3)/ For methanol vehicles/ the manufacturer shall first convert the hydrocarbon emissions into an OMHCE value/ The following equation provides a summary of this procedure/

Evaporative Emission Level = Hydrocarbon or OMHCE emissions (grams) / APU ON Time (sec)x(1 hour/3600 sec)x(20 mph) / Certified number of 24/hour diurnals

= grams / mile / day

5/ To determine if the evaporative emission canister has been completely purged/ the manufacturer shall record the weight of the canister at the conclusion of the repeat CVS/72 test schedules/ The evaporative emission canister shall be considered to be completely purged if the weight of the canister is increased by no more than 5 percent of the nominal working capacity compared to the weight of the canister recorded after the completion of the running loss test procedure/

The results of the evaporative emission control system purge test shall be added to the official running loss emission results of the vehicle for hydrocarbons or OMHCE and submitted in the application for certification of the vehicle/ The sum of the evaporative emission control system purge test and the official running loss emission results of the vehicle shall be compared with the running loss emission standard to determine compliance with the running loss emission standard/

K. *Add section (u) to read: The manufacturer shall specify the working capacity of the evaporative emission control canister, and shall specify the number of 24-hour diurnals that can elapse before the APU will activate solely for the purposes of purging the canister of hydrocarbon vapor.*

L. *Add section (v) to read: In order to determine that the working capacity of the canister is sufficient to store the hydrocarbon vapor generated over the manufacturer specified number of days between auxiliary power unit activation events for the purposes of purging the evaporative canister, the evaporative canister shall be weighed after completion of the 72-hour diurnal period. The weight of the vapor contained in the canister shall not exceed the working capacity of the canister multiplied by three days and divided by the manufacturer specified number of days between auxiliary power unit activation events.*

M. *Add section (w) to read: The manufacturer shall specify the time interval of auxiliary power unit operation necessary to purge the evaporative emission control canister, and shall submit an engineering analysis to demonstrate that the canister will be purged to within five percent of its working capacity over the time interval.*

xi. Calculations; evaporative emissions.

For purposes of this section, all references to methanol shall also be applicable to ethanol.

Revise 40 CFR 86.143-90 as follows:

A. Revise section (a) to read: The calculation of the net hydrocarbon plus methanol (organic material hydrocarbon equivalent) mass change in the enclosure is used to determine the diurnal, hot soak, and running loss mass emissions. The mass changes are calculated from initial and final hydrocarbon and methanol concentrations in ppm carbon, initial and final enclosure ambient temperatures, initial and final barometric pressures, and net enclosure volume using the following equations:

B. Revise section (a)(2) to read:

(2) For hydrocarbons:

(a) Hot soak HC mass. The hot soak enclosure mass is determined as:

$$M_{HChs} = [2.95 \times (V_n - 50) \times 10^{-4} \times P_i \times (C_{HCe2} - C_{HCe1})]/T_i$$

where: M_{HChs} is the hot soak HC mass emissions (grams)

V_n is the enclosure nominal volume (ft^3).

P_i is the initial barometric pressure (inches Hg)

C_{HCe2} is the final enclosure concentration (ppm C)

C_{HCe1} is the initial enclosure concentration (ppm C)

T_i is the initial enclosure temperature (^oR)

(b) Running loss HC mass. The running loss HC mass per distance traveled is defined as:

$$M_{HCrlt} = (M_{HCrl(1)} + M_{HCrl(2)} + M_{HCrl(3)})/(D_{rl(1)} + D_{rl(2)} + D_{rl(3)})$$

where: M_{HCrlt} is the total running loss HC mass per distance traveled (grams HC per mile)

$M_{HCrl(n)}$ is the running loss HC mass for Phase n of the test (grams HC)

$D_{rl(n)}$ is the actual distance traveled over the driving cycle for Phase n of the test (miles)

and: $$M_{HCrl(n)} = (C_{HCs(n)} - C_{HCa(n)}) \times 17.10 \times V_{mix} \times 10^{-6}$$

where: $C_{HCs(n)}$ is the sample bag HC concentration for Phase n of the test (ppm C)

$C_{HCa(n)}$ is the background bag concentration for Phase n of the test (ppm C)

17.10 is the density of butane divided by 4 ($grams/ft^3$)

V_{mix} is the total dilute CVS volume (std. ft^3)

and: V_{mix} is calculated per §86.144-90

(c) Diurnal mass. The HC mass for each of the three diurnals is defined for a variable volume SHED enclosure as:

$$M_{HCd} = [2.98 \times (V_n - 50) \times 10^{-4} \times P_i \times (C_{HCe2} - C_{HCe1})]/T_i$$

where: M_{HCd} is the diurnal HC mass emissions (grams)

V_n is the enclosure nominal volume (ft^3)

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P_i is the initial barometric pressure (inches Hg)

C_{HCe2} is the final enclosure concentration (ppm C)

C_{HCe1} is the initial enclosure concentration (ppm C)

T_i is the initial enclosure temperature (^oR)

C. Revise section (b) to read: The final evaporative emission test results reported shall be computed by summing the evaporative emission result determined for the hot soak test and the highest 24-hour result determined for the diurnal breathing loss test. The final reported result for the running loss test shall be computed by dividing the sum of the three masses by the total miles traveled over the three Phases of the test.

h. For 1983 and subsequent model-year LPG-fueled motor vehicles, the introduction of 40 percent by volume of chilled fuel and the heating of the fuel tank under the diurnal part of the evaporative test procedures shall be eliminated.

i. Evaporative emission test fuel shall be the fuel specified for exhaust emission testing in the applicable exhaust emission test procedures.

~~The maximum Reid Vapor Pressure of gasoline used for testing and~~ in service accumulation shall be consistent with the fuel specification applicable to vehicles in California.

Fuel additives and ignition improvers intended for use in methanol test fuels shall be subject to the approval of the Executive Officer. In order for such approval to be granted, a manufacturer must demonstrate that vehicle performance will be adversely affected without the use of the fuel additive.

5. Approval of heavy-duty vehicles, excluding medium-duty vehicles from 6,000 to 8,500 lbs GVWR and complete medium-duty vehicles 14,000 lbs GVWR or less, shall be based on an engineering evaluation of the system and data submitted by the applicant. Such evaluation may include successful public usage on light-duty or medium-duty vehicles, adequate capacity of storage containers, routing of lines to prevent siphoning, and other emissions-related factors deemed appropriate by the Executive Officer. For LPG systems, this engineering evaluation shall include: emissions from pressure relief valves, carburetion systems and other sources of leakage; emissions due to fuel system wear and aging; and evaporative emission test data from light-duty or medium-duty vehicles with comparable fuel systems.

6. For the 1980 model year, the measured evaporative emissions from all test vehicles, except vehicles tested pursuant to paragraph 4. above and motorcycles, shall be corrected for background emissions by

subtracting 1.0 gram per test. This correction for background emissions may be extended to include the 1981 model year, on a case-by-case basis, if the Executive Officer finds that a manufacturer has had insufficient lead-time to comply with the April 23, 1980 amendment to this procedure.

7. For the purposes of these test procedures, the following references in 40 CFR, Part 86, Subpart B, to light-duty vehicle evaporative testing shall also apply to motorcycles: §§86.117-78, 86.117-90, 86.121-82, and 86.121-90. In addition, 40 CFR, Part 86, Subparts E, F, and other cited sections of Subpart B are incorporated into this test procedure by reference.

8. Certification of a motorcycle evaporative emission control system requires that the manufacturer demonstrate the durability of each evaporative emission control system family.

   a. The motorcycle manufacturer can satisfy the vehicle durability testing requirement by performing an evaporative emission test at each scheduled exhaust emission test (§86.427-78) during the motorcycle exhaust emissions certification test (§86.425-78) for each evaporative emission family. The minimum mileage accumulated shall be the total distance (one-half the useful life distance), although the manufacturer may choose to extend the durability test to the useful life distance (§86.436-78). The displacement classes and test distances are shown below:

Displacement Class	Engine Displacement Range (CC)	Total Test Distance (km)	Useful Life Distance (km)
I	50-169	6,000	12,000
II	170-279	9,000	18,000
III	280 and greater	15,000	30,000

      i. All durability vehicles shall be built at least one month before the evaporative emissions test, or the manufacturer must demonstrate that the non-fuel related evaporative emissions have stabilized.

      ii. Testing at more frequent intervals than the scheduled exhaust emissions tests may be performed only when authorized in writing by the Executive Officer.

      iii. The DF (deterioration factor) shall be determined by calculating a least-squares linear regression of the evaporative emissions data with respect to mileage. The DF is defined as the extrapolated (from the regression) value at the useful life distance minus the interpolated value at the total test distance, where these distances are taken from the table in paragraph 8.a.

iv. The extrapolated useful life and total test distance emissions shall be less than the applicable evaporative emission standards of paragraph 1. or the data will not be acceptable for use in the calculation of a DF and demonstration of compliance.

v. Motorcycle manufacturers may use the ARB Component Bench Test Procedures or propose in their application a method for durability bench testing and determination of a DF for each evaporative emission engine family. The Executive Officer shall review the method, and shall approve it if it is similar to the requirements specified in paragraph 4.a.ii. Any reference to 4,000 miles and 50,000 miles in paragraph 4.a.ii. shall mean total test distance and useful life distance, respectively, as defined in paragraph 8.a. for the appropriate engine displacement class.

vi. The DF determined under paragraph 8.a.iii. shall be averaged with the DF determined under paragraph 8.a.v. to determine a single evaporative emission DF for each evaporative emission engine family. For those motorcycles which do not require exhaust emission control system durability testing, the evaporative emission control system DF shall be determined under paragraph 8.a.v. only. Compliance with the standard shall be demonstrated by performing an evaporative emission test on a stabilized motorcycle. The motorcycle shall have ~~accumulated at least the minimum test distance. The~~ extrapolated useful life distance emissions after applying the bench test-derived DF shall be less than the applicable evaporative emission standards of paragraph 1.

vii. (A) Manufacturers of Class III motorcycles may elect to use an assigned evaporative emission control system DF, provided they meet the following requirements:

- Annual California motorcycle sales do not exceed 500 units, and

- The evaporative emission control system has been previously certified to meet the emission standards specified in these procedures, or the manufacturer provides test data from previous certification demonstrating that the system complies with the durability requirements set forth in this paragraph.

(B) Manufacturers of Class III motorcycles using an assigned evaporative emission control system DF pursuant to subparagraph 8.a.vii.A. may submit a written request for a waiver of evaporative emission testing. The waiver shall be granted if the Executive Officer determines that the motorcycles will comply with the

evaporative emission standard. The determination shall be based on the performance of the evaporative emission control system on other motorcycles, the capacity of vapor storage containers, the routing of lines to prevent siphoning, and other emission-related factors determined by the Executive Officer to be relevant to evaluation of the waiver request.

(C) Nothing in this paragraph shall be construed as an exemption from the exhaust emission standards and test procedures applicable pursuant to section 1958, Title 13, California Code of Regulations, or paragraph 8.c.ii. of these procedures.

viii. The emission label (§86.413-78) shall identify the evaporative emission family.

ix. Preconditioning shall be performed in accordance with §86.532-78. The provisions of §86.132-78 which prohibit abnormal loading of the evaporative emission control system during fueling and setting the dynamometer horsepower using a test vehicle shall be observed. Additional preconditioning (§86.132-82(a)(3) and §86.132-90(a)(3)) may be allowed by the Executive Officer under unusual circumstances.

b. Instrumentation

The instrumentation necessary to perform the motorcycle evaporative emission test is described in 40 CFR 86.107-78 and 86.107-90, with the following changes:

i. Revise section (a)(4) to read: Tank fuel heating system. The tank fuel heating system shall consist of two separate heat sources with two temperature controllers. A typical heat source is a pair of heating strips. Other sources may be used as required by circumstances and the Executive Officer may allow manufacturers to provide the heating apparatus for compliance testing. The temperature controllers may be manual, such as variable transformers, or they may be automated. Since vapor and fuel temperature are to be controlled independently, an automatic controller is recommended for the fuel. The heating system must not cause hot spots on the tank wetted surface which could cause local overheating of the fuel or vapor. Heating strips for the fuel, if used, should be located as low as practicable on the tank and should cover at least 10 percent of the wetted surface. The centerline of the fuel heating strips, if used, shall be below 30 percent of the fuel depth as measured from the bottom of the fuel tank and approximately parallel to the fuel level in the tank. The centerline of the vapor heating strips, if used, should be located at the approximate height of the center of the vapor volume. The temperature

controller must be capable of controlling the fuel and vapor temperatures to the diurnal heating profile within the specified tolerance.

ii. Revise section (a)(5) (Temperature Recording System) to read: In addition to the specifications in this section, the vapor temperature in the fuel tank shall be measured. When the fuel or vapor temperature sensors cannot be located in the fuel tank to measure the temperature of the prescribed test fuel or vapor at the approximate mid-volume, sensors shall be located at the approximate mid-volume of each fuel or vapor containing cavity. The average of the readings from these sensors shall constitute the fuel or vapor temperature. The fuel and vapor temperature sensors shall be located at least one inch away from any heated tank surface. The Executive Officer may approve alternate sensor locations where the specifications above cannot be met or where tank symmetry provides redundant measurements.

iii. Calibration shall be performed in accordance with 40 CFR 86.516-78 or 86.516-90.

c. Test Procedure

i. The motorcycle exhaust emission test sequence is described in 40 CFR 86.530-78 through 86.540-78. The Sealed Housing ~~Evaporative Determination (SHED) test shall be accomplished~~ by performing the diurnal portion of the SHED test (§86.133-78 except subsections a(1), k, and p; §86.133-90 except subsections a(1), l, and s; and neglecting references to windows and luggage compartments in these sections) after preconditioning and soak but prior to the "cold" start test. The fuel will be cooled to below 30°C after the diurnal test. The "cold" and "hot" start exhaust emission tests shall then be run. The motorcycle will then be returned for the hot soak portion of the SHED test. This general sequence is shown in Figure E78-10, under §86.130-78. The specified time limits shall be followed with the exception of soak times which are specified in §86.532-78 for motorcycles.

Running loss tests, when necessary, will be performed in accordance with §86.134-78, except references to §§86.135-82 through 86.137-82 and §§86.135-90 through 86.137-90 shall mean §§86.535-78 through 86.537-78.

ii. Manufacturers of Class III motorcycles with annual California sales of less than 500 units using an assigned evaporative emission control system DF pursuant to paragraph 8.a.vii. shall measure and report to the Executive Officer exhaust emissions from the CVS test between the diurnal and the hot soak tests even if the test is being conducted for evaporative emissions only. The exhaust emission levels

projected for the motorcycle's useful life utilizing the exhaust emission deterioration factor determined during previous federal or California certification testing shall not exceed the standards set forth in section 1958, Title 13, California Code of Regulations.

iii. The fuel and vapor temperatures for the diurnal portion of the evaporative emission test shall conform to the following functions within $\pm$ 1.7°C with the tank filled to 50 percent $\pm$ 2.5 of its actual capacity, and with the motorcycle resting on its center kickstand (or a similar support) in the vertical position.

$$T_f = (1/3)\ t + 15.5^{\circ}C$$

$$T_V = (1/3)\ t + 21.0^{\circ}C$$

Where: T_f = fuel temperature, °C

T_V = vapor temperature, °C

t = time since the start of the diurnal temperature rise, minutes.

The test duration shall be 60 $\pm$ 2 minutes, giving a fuel and vapor temperature rise of 20°C. The final fuel temperature shall be 35.5°C $\pm$ .5°C.

An initial vapor temperature up to 5°C above 21°C may be used. For this condition, the vapor shall not be heated at the beginning of the diurnal test. When the fuel temperature has been raised to 5.5°C below the vapor temperature by following the T_f function, the remainder of the vapor heating profile shall be followed.

iv. An alternate temperature rise for the diurnal test may be approved by the Executive Officer. If a manufacturer has information which shows that a particular fuel tank design will change the temperature rise significantly from the function above, the manufacturer may present the information to the Executive Officer for evaluation and consideration.

v. The hot soak evaporative emission test shall be performed immediately following the "hot" start exhaust emission test. This test is described in §§86.138-78 and 86.138-90, except for §§86.138-78(d) and 86.138-90(e) which are revised to require that the motorcycle be pushed with the engine off rather than driven at minimum throttle from the dynamometer to the SHED.

vi. Calculations shall be performed in accordance with §86.143-78 or 86.143-90, except the standard volume for a motorcycle shall be 5 ft^3 instead of 50 ft^3.

d. Motorcycle manufacturers with annual sales of less than 2,000 units for the three displacement classes in California are not required to submit the information specified by these test procedures to the Executive Officer. However, all information required by these test procedures must be retained on file and be made available upon request to the Executive Officer for inspection. These manufacturers shall submit the following information for evaporative emission certification:

i. A brief description of the vehicles to be covered by the Executive Order. (The manufacturer's sales data book or advertising, including specifications, will satisfy this requirement for most manufacturers.)

ii. A statement signed by an authorized representative of the manufacturer stating "The vehicles described herein have been tested in accordance with the provisions of the 'California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles', and on the basis of those tests, are in conformance with the aforementioned standards and test procedures."

9. ~~The evaporative emissions for LPG systems shall be calculated in~~ accordance with §86.143-78 or 86.143-90 except that a H/C ratio of 2.658 shall be used for both the diurnal and hot soak emissions.

Definitions:

Motorcycle Evaporative Emission Family: The group of motorcycle models which meet the criteria of EPA's MSAPC Advisory Circular No. 59, section D.

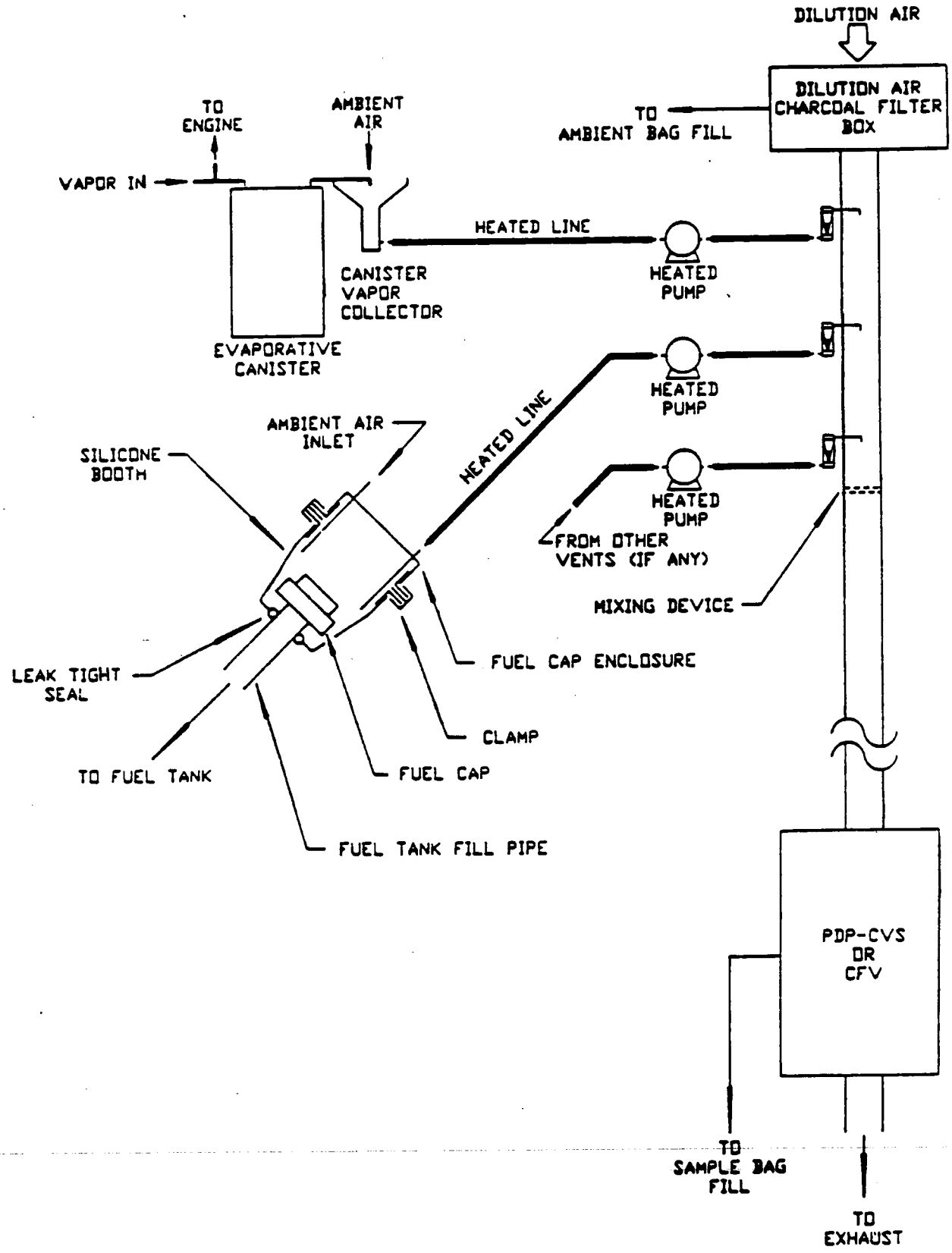

Figure 1. Running Loss Vapor Vent Collection System

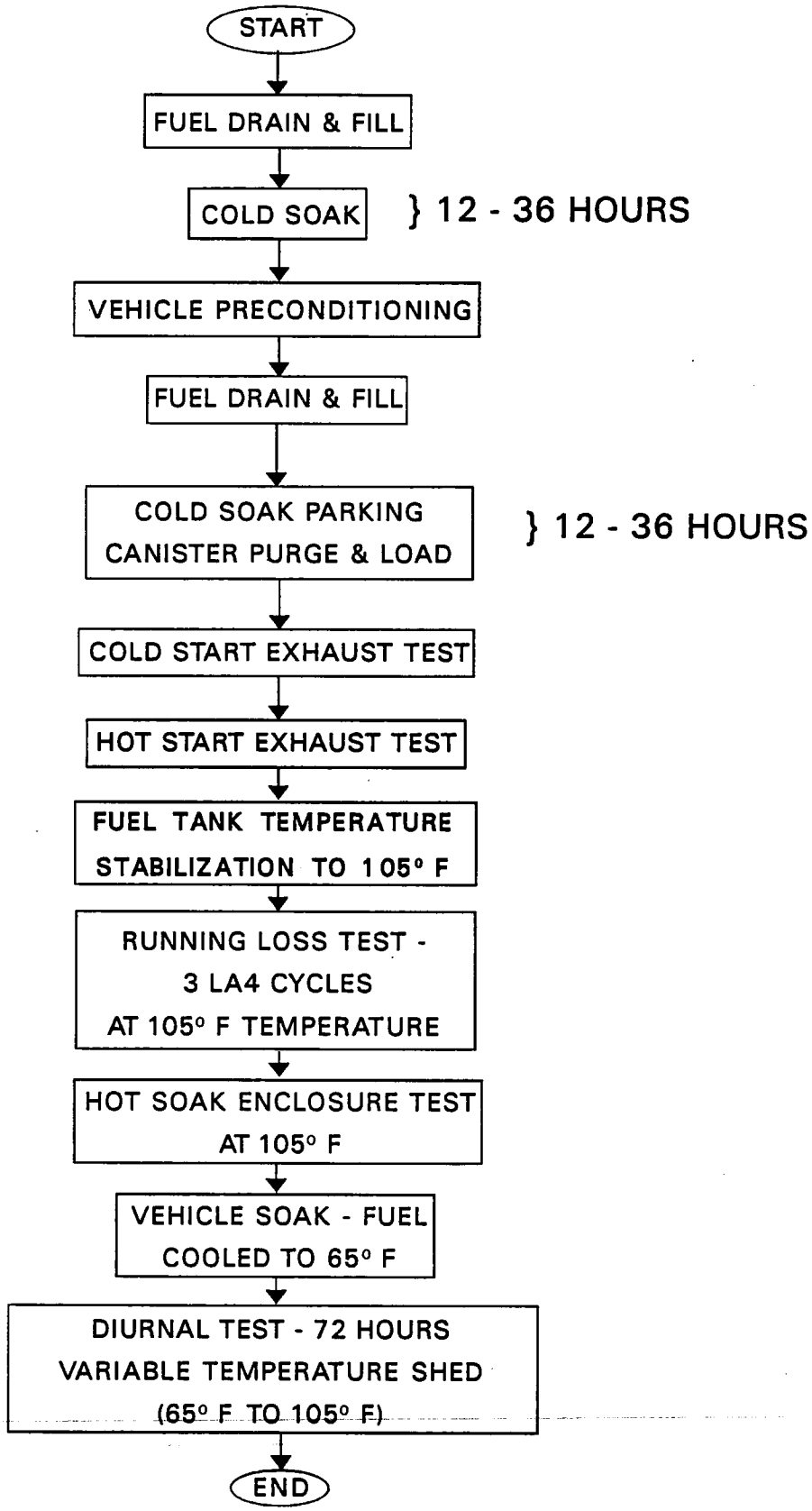

FIGURE 2. EVAPORATIVE EMISSIONS TEST PROCEDURE

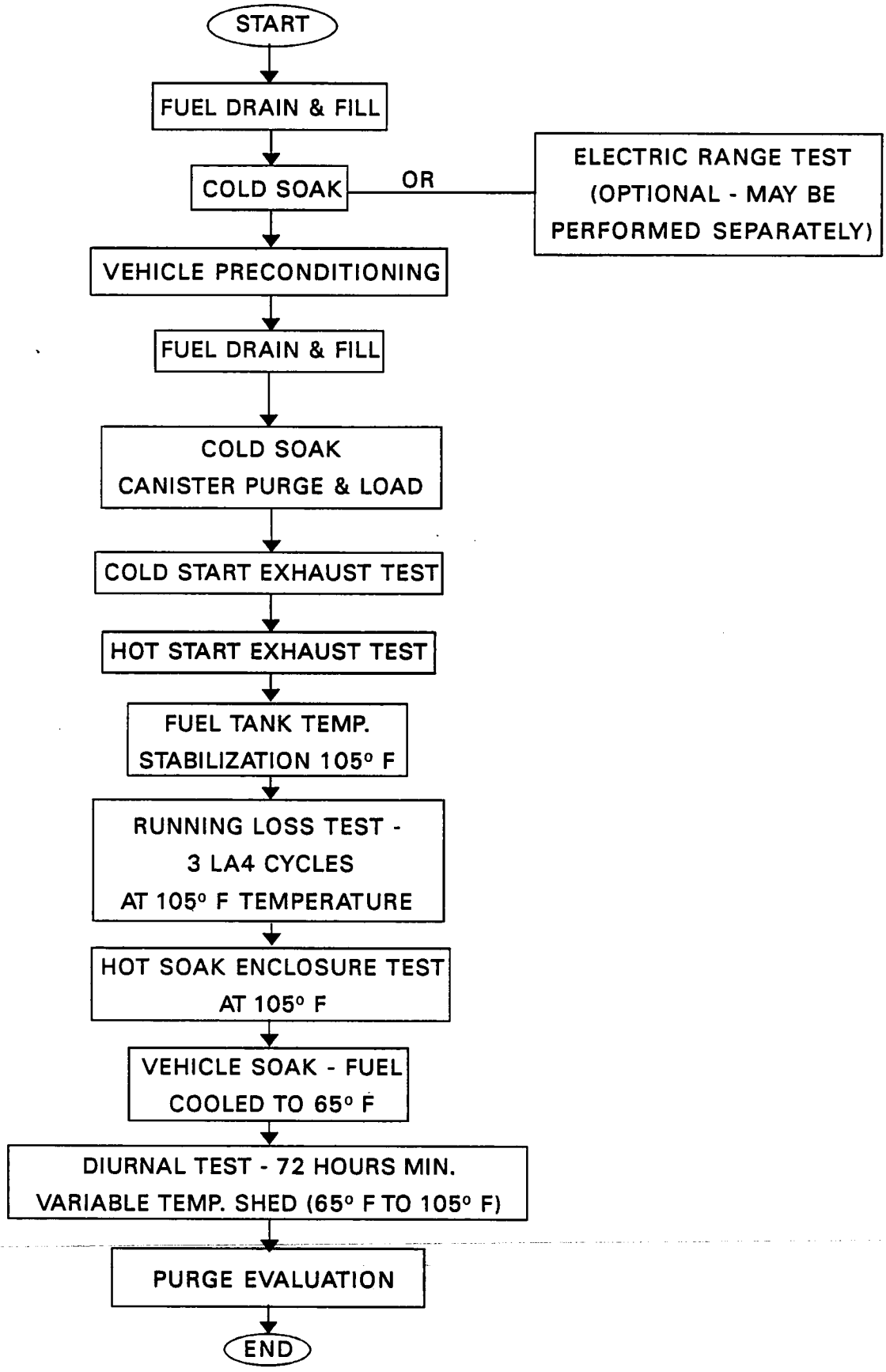

FIGURE 3. TEST PROCEDURE FOR HYBRID ELECTRIC VEHICLES

State of California
AIR RESOURCES BOARD

CALIFORNIA NON-METHANE ORGANIC GAS TEST PROCEDURES

Adopted: July 12, 1991
Amended: _____

State of California

AIR RESOURCES BOARD

California Non-Methane Organic Gas Test Procedures

A. GENERAL APPLICABILITY AND REQUIREMENTS

1. These test procedures shall apply to all 1993 and subsequent model-year transitional low-emission vehicles (TLEV), low-emission vehicles (LEV), and ultra-low-emission vehicles (ULEV) certifying to non-methane organic gas (NMOG) emission standards.

2. This document sets forth the analysis and calculation procedures that shall be performed to determine NMOG mass emissions. The document consists of the following parts:

A. General Applicability and Requirements
B. Determination of Non-Methane Hydrocarbon Mass Emissions by Flame Ionization Detection
C. Determination of Alcohols in Automotive Source Samples by Gas Chromatography (method no. 1001)
D. Determination of C_2 to C_5 Hydrocarbons in Automotive Source Samples by Gas Chromatography (method no. 1002)
E. Determination of C_6 to C_{12} Hydrocarbons in Automotive Source Samples by Gas Chromatography (method no. 1003)
F. Determination of Aldehyde and Ketone Compounds in Automotive Source Samples by High Performance Liquid Chromatography (method no. 1004)
G. ~~Determination of Ethers in Automotive Source Samples by Gas Chromatography (method no. 1005)~~
H. ~~G.~~ Determination of NMOG Mass Emissions

Alternative procedures may be used if shown to yield equivalent results and if approved in advance by the Executive Officer of the Air Resources Board.

3. The analyses specified in the table below shall be performed to determine mass emission rates of NMOG in grams per mile (g/mile) or milligrams per mile (mg/mile) for vehicles operated on the listed fuel:

Fuel	NMHC by FID	NMHC by GC	Alcohols	Carbonyls	Ethers
Alcohol	X		X	X	
~~CNG~~		X		X	
Diesel	X			X	
Gasoline	X			X	
LPG	X			X	X

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where "LPG" means "liquified petroleum gas", "CNG" means "compressed natural gas", "NMHC" means "non-methane hydrocarbon", "FID" means "flame ionization detector", and "GC" means "gas chromatograph".

The specified analyses shall be performed in accordance with the following parts of this document:

NMHC by FID -- B. Determination of Non-Methane Hydrocarbon Mass Emissions by Flame Ionization Detection

NMHC by GC -- D. Determination of C_2 to C_5 Hydrocarbons in Automotive Source Samples by Gas Chromatography (method no. 1002) and
E. Determination of C_6 to C_{12} Hydrocarbons in Automotive Source Samples by Gas Chromatography (method no. 1003)

Carbonyls -- F. Determination of Aldehyde and Ketone Compounds in Automotive Source Samples by High Performance Liquid Chromatography (method no. 1004)

Alcohols -- C. Determination of Alcohols in Automotive Source Samples by Gas Chromatography (method no. 1001)

~~Ethers -- G. Determination of Ethers in Automotive Source Samples by Gas Chromatography (method no. 1005)~~

4. For those manufacturers which choose to develop reactivity adjustment factors unique to a specific engine family, exhaust NMOG emissions shall be fully speciated. NMHC emissions shall be analyzed in accordance with parts D and E (method nos. 1002 and 1003). In addition, aldehydes and ketones, alcohols, and ethers shall be analyzed according to parts F, C, and ~~G~~ E (method nos. 1004, 1001, and ~~1005~~ 1003). ~~Analysis for alcohols shall be~~ required only for vehicles which are operated on fuels containing alcohols, and for ethers on fuels containing ethers.

5. For diesel-fueled vehicles, the development of speciated hydrocarbon emission profiles is of concern from a technical standpoint. At present, sampling and analysis of diesel-fueled vehicle exhaust emissions shall be performed according to the following guidelines:

> A sample of motor vehicle diesel exhaust at an elevated temperature would be passed through a porous polymer sample tube (XAD-2 or equivalent). The sample tube would be extracted with a solvent (methylene chloride or equivalent), concentrated and introduced into a GC/FID with a high temperature capillary column (SE-30 or similar) for analysis. Other methods may be utilized but should be submitted to the Board for prior approval. See also Technical Reports: EPA/AA/CTAB/PA/80-5 (September, 1980) "Comparison of Gas Phase Hydrocarbon from Light-Duty Gasoline Vehicles and Light-Duty Vehicles Equipped with Diesel Engines," and F. Black and L. High (SAE No. 790422) "Methodology for Determining Particulate and Gaseous Diesel Hydrocarbon Emissions."

Because the composition of the exhaust emissions from diesel-fueled vehicles is highly complex, the mass of hydrocarbons grouped according to carbon number rather than fully speciated data may be submitted.

6. For natural gas-fueled vehicles, the methane concentration in the exhaust sample shall be measured with a methane analyzer. A GC combined with a FID is used for direct measurement of methane concentrations. SAE Recommended Practice J1151 is a reference on generally accepted GC principles and analytical techniques for this application. A density of 18.89 g/ft^3 shall be used to determine the methane mass emissions. The methane mass emissions shall be multiplied by the appropriate methane reactivity adjustment factor and then added to the reactivity-adjusted NMOG emissions as specified in "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles."

7. The mass of NMOG emissions shall be calculated in accordance with part H G, "Determination of NMOG Mass Emissions". The mass of NMOG emissions in g/mile or mg/mile shall be calculated by summing the mass of NMHC determined by the FID, the mass of aldehydes and ketones, and the mass of alcohols and ethers if any.

AIR RESOURCES BOARD

DETERMINATION OF NON-METHANE HYDROCARBON MASS EMISSIONS BY FLAME IONIZATION DETECTION

California Air Resources Board
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This has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policy of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

DETERMINATION OF NON-METHANE HYDROCARBON MASS EMISSIONS BY FLAME IONIZATION DETECTION

1. INTRODUCTION

1.1 This procedure describes a method for determining non-methane hydrocarbon (NMHC) exhaust mass emissions from motor vehicles. Other applicable forms of instrumentation and analytical techniques which prove to yield equivalent results to those specified in this procedure may be used subject to the approval of the Executive Officer of the Air Resources Board.

2. TOTAL HYDROCARBON MEASUREMENT

2.1 A flame ionization detector (FID) is used to measure total hydrocarbon concentration in vehicle exhaust in accordance with the Code of Federal Regulations(1). SAE Recommended Practices J254(2) and J1094a(3) are references on generally accepted gas analysis and constant volume sampling techniques. For Beckman 400 FIDs only, implementation of the recommendations outlined in SAE paper 770141, "Optimization of Flame Ionization Detector for Determination of Hydrocarbons in Diluted Automobile Exhaust"; author, Glenn D. Reschke (4) shall be required. Other FID analyzer models shall be checked and adjusted, if necessary, to minimize any ~~non-linearity~~ non-uniformity of relative response to different hydrocarbons.

3. METHANE MEASUREMENT

3.1 A gas chromatograph (GC) combined with a FID constitute a methane analyzer and shall be used for direct measurement of methane concentrations. The SAE Recommended Practice J1151(5) is a reference on generally accepted GC principles and analytical techniques for this specific application.

4. TOTAL HC FID RESPONSE TO METHANE

4.1 The FID is calibrated to propane and therefore tends to over respond to the methane portion of the vehicle exhaust sample during hydrocarbon analysis. In order to calculate the NMHC concentration, a methane response factor must be applied to the methane concentration (as measured by the methane analyzer) before it can be deducted from the total hydrocarbon concentration. To determine the total hydrocarbon FID response to methane, known methane in air concentrations traceable to National Institute of Standards and Technology (NIST) shall be analyzed by the FID. Several methane concentrations shall be analyzed by the FID in the range of the exhaust sample concentration. The total hydrocarbon FID response to methane is calculated as follows:

r_{CH_4} = FIDppm/SAMppm

where:

r_{CH_4} = FID methane response factor.

FIDppm = FID reading in ppmC.
SAMppm = the known methane concentration in ppmC.

The FID response to methane shall be checked at each calibration interval.

5. NMHC MASS EMISSION PER TEST PHASE

5.1 The following calculations shall be used to determine the NMHC mass emissions for each phase of the Federal Test Procedure(1).

5.2 Non-Alcohol Fueled Vehicles

5.2.1 $NMHC_e = FID\ THC_e - (r_{CH_4} * CH_{4e})$

NOTE: If $NMHC_e$ is calculated to be less than zero, then $NMHC_e = 0$.

5.2.2 $NMHC_d = FID\ THC_d - (r_{CH_4} * CH_{4d})$

NOTE: If $NMHC_d$ is calculated to be less than zero, then $NMHC_d = 0$.

5.2.3 $CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

a) For gasoline, $CH_{1.85}$, where HCR = 1.85:

$$CO_e = (1 - 0.01925 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

b) For LPG, $CH_{2.66}$, where HCR = 2.66:

$$CO_e = (1 - 0.02330 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

5.2.4 $$DF = \frac{100 * \frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)}}{CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}}$$

(where fuel composition is $C_xH_yO_z$ as measured for the fuel used.)

a) For gasoline, $CH_{1.85}$, where x = 1, y = 1.85, and z = 0:

$$DF = 13.46 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$$

b) For LPG, $CH_{2.66}$, where x = 1, y = 2.66, and z = 0:

$$DF = 11.63 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$$

5.3 Vehicles Operating on Fuels Containing Methanol

5.3.1 $NMHC_e = FID\ THC_e - (r_{CH_4} * CH_{4e}) - (r_{CH_3OH} * CH_3OH_e)$

NOTE: If $NMHC_e$ is calculated to be less than zero, then $NMHC_e = 0$.

5.3.2 $NMHC_d = FID\ THC_d - (r_{CH_4} * CH_{4d}) - (r_{CH_3OH} * CH_3OH_d)$

NOTE: If $NMHC_d$ is calculated to be less than zero, then $NMHC_d = 0$.

5.3.3 $CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

a) For M100 (100% methanol), CH_3OH, where HCR = 4:

$$CO_e = (1 - 0.03000 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

b) For M85 (85% methanol, 15% indolene), $CH_{3.41}O_{0.72}$, where HCR = 3.41:

$$CO_e = (1 - 0.02705 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

5.3.4 $$DF = \frac{100 * \frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)}}{CO_{2e} + (NMHC_e + CH_{4e} + CO_e + CH_3OH_e + \underline{HCHO_e}) * 10^{-4}}$$

(where fuel composition is $C_xH_yO_z$ as measured for the fuel used.)

a) For M100 (100% methanol), CH_3OH, where x = 1, y = 4, and z = 1:

$$DF = 11.57 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e + CH_3OH_e + \underline{HCHO_e}) * 10^{-4}]$$

b) For M85 (85% methanol, 15% Indolene), $CH_{3.41}O_{0.72}$, where x = 1, y = 3.41, and z = 0.72:

$$DF = 12.01 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e + CH_3OH_e + \underline{HCHO_e}) * 10^{-4}]$$

5.4 Vehicles Operating on Fuels Containing Ethanol

5.4.1 $NMHC_e = FID\ THC_e - (r_{CH_4} * CH_{4e}) - (r_{C_2H_5OH} * C_2H_5OH_e)$

NOTE: If $NMHC_e$ is calculated to be less than zero, then $NMHC_e = 0$.

5.4.2 $NMHC_d = FID\ THC_d - (r_{CH_4} * CH_{4d}) - (r_{C_2H_5OH} * C_2H_5OH_d)$

NOTE: If $NMHC_d$ is calculated to be less than zero, then $NMHC_d = 0$.

5.4.3 $CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

a) For E100 (100% ethanol), C_2H_5OH, where HCR = 3:

$$CO_e = (1 - 0.02500 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

5.4.4 $$DF = \frac{100 * \frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)}}{CO_{2e} + (NMHC_e + CH_{4e} + CO_e + C_2H_5OH_e + \underline{HCHO_e}) * 10^{-4}}$$

(where fuel composition is $C_xH_yO_z$ as measured for the fuel used.)

a) For E100 (100% ethanol), C_2H_5OH, where x = 1, y = 3, and z = 0.5:

$$DF = 12.27 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e + C_2H_5OH_e + \underline{HCHO_e}) * 10^{-4}]$$

5.5 All Vehicles

5.5.1 $NMHC_{conc} = NMHC_e - NMHC_d * [1 - (1 / DF)]$

NOTE: If $NMHC_{conc}$ is calculated to be less than zero, then $NMHC_{conc} = 0$.

5.5.2 $NMHC_{mass_n} = NMHC_{conc} * NMHC_{dens} * VMIX * 10^{-6}$

6. TOTAL WEIGHTED NMHC MASS EMISSIONS

6.1 All Vehicles

6.1.1 $$NMHC_{wm} = 0.43 * \frac{NMHC_{mass_1} + NMHC_{mass_2}}{D_{phase_1} + D_{phase_2}} + 0.57 * \frac{NMHC_{mass_3} + NMHC_{mass_2}}{D_{phase_3} + D_{phase_2}}$$

7. SAMPLE CALCULATIONS

7.1 Given the following data for a gasoline vehicle, calculate the weighted NMHC mass emission.

Test Phase	FID THC_e (ppmC)	FID THC_d (ppmC)	CH_{4e} (ppmC)	CH_{4d} (ppmC)	CO_{em} (ppm)	CO_{2e} (%)	VMIX (ft^3)	D_{phase_n} (mile)	R_a (%)
1	41.8	8.6	7.53	5.27	147.2	1.19	2846	3.583	38
2	13.0	8.4	5.68	5.10	20.8	0.80	4856	3.848	38
3	15.4	8.9	6.16	5.20	36.7	1.04	2839	3.586	38

For Phase 1:

$$NMHC_e = \text{FID } THC_e - (r_{CH_4} * CH_{4e})$$

$$= 41.8 \text{ ppmC} - (1.20 * 7.53 \text{ ppmC})$$

$$= 32.76 \text{ ppmC}$$

$$NMHC_d = \text{FID } THC_d - (r_{CH_4} * CH_{4d})$$

$$= 8.6 \text{ ppmC} - (1.20 * 5.27 \text{ ppmC})$$

$$= 2.28 \text{ ppmC}$$

$$CO_e = (1 - 0.01925 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

$$= (1 - 0.01925 * 1.19\% - 0.000323 * 38\%) * 147.18 \text{ ppm}$$

$$= 142.0 \text{ ppm}$$

$$DF = 13.46 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$$

$$= 13.46 / [1.19\% + (32.76 \text{ ppmC} + 7.53 \text{ ppmC} + 142.0 \text{ ppmC}) * 10^{-4}]$$

$$= 11.14$$

$$NMHC_{conc} = NMHC_e - NMHC_d * [1 - (1 / DF)]$$

$$= 32.76 \text{ ppmC} - 2.28 \text{ ppmC} * [1 - (1 / 11.14)]$$

$$= 30.68 \text{ ppmC}$$

$$NMHC_{mass_n} = NMHC_{conc} * NMHC_{dens} * VMIX * 10^{-6}$$

$$= 30.68 \text{ ppmC} * 16.33 \text{ g/ft}^3 * 2846 \text{ ft}^3 * 10^{-6}$$

$$NMHC_{mass_1} = 1.42 \text{ g}$$

Similarly, for Phase 2:

$$NMHC_{mass_2} = 0.32 \text{ g}$$

and for Phase 3:

$$NMHC_{mass_3} = 0.26 \text{ g}$$

Therefore,

$$NMHC_{wm} = 0.43 * \frac{NMHC_{mass_1} + NMHC_{mass_2}}{D_{phase_1} + D_{phase_2}} + 0.57 * \frac{NMHC_{mass_3} + NMHC_{mass_2}}{D_{phase_3} + D_{phase_2}}$$

$$= 0.43 * \frac{1.42 \text{ g} + 0.32 \text{ g}}{3.583 \text{ mile} + 3.848 \text{ mile}} + 0.57 * \frac{0.26 \text{ g} + 0.32 \text{ g}}{3.586 \text{ mile} + 3.848 \text{ mile}}$$

$$NMHC_{wm} = 0.14 \text{ g/mile}$$

7.2 Given the following data for a vehicle operating on 85% methanol and 15% gasoline (M85), calculate the weighted NMHC mass emission.

Test Phase	FID THC_e (ppmC)	FID THC_d (ppmC)	CH_{4e} (ppmC)	CH_{4d} (ppmC)	CH_3OH_e (ppmC)	CO_{em} (ppm)	CO_{2e} (%)	VMIX (ft^3)	D_{phase_n} (mile)	R_a (%)	$HCHO_e$ (ppm)
1	88.5	5.5	17.76	2.82	72.9	303.2	1.28	2832	3.570	32	0.96
2	14.5	7.0	8.01	2.82	5.1	9.7	0.83	4827	3.850	32	0.10
3	21.8	7.7	10.13	2.93	7.4	18.2	1.13	2825	3.586	32	0.12

[For this example, CH_3OH_d was assumed to be 0.0 ppmC for all three background bag samples.]

For Phase 1:

$NMHC_e$ = FID THC_e - (r_{CH_4} * CH_{4e}) - (r_{CH_3OH} * CH_3OH_e)

= 88.5 ppmC - (1.20 * 17.76 ppmC) - (0.78 * 72.9 ppmC)

= 10.33 ppmC

$NMHC_d$ = FID THC_d - (r_{CH_4} * CH_{4d}) - (r_{CH_3OH} * CH_3OH_d)

= 5.5 ppmC - (1.20 * 2.82 ppmC) - (0.78 * 0.0 ppmC)

= 2.12 ppmC

$CO_e = (1 - 0.02705 * CO_{2e} - 0.000323 * R_a) * CO_{em}$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

= (1 - 0.02705 * 1.28% - 0.000323 * 32%) * 303.2 ppm

= 289.6 ppm

$$DF = 12.01 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e + CH_3OH_e + \underline{HCHO_e}) * 10^{-4}]$$

$$= \frac{12.01}{1.28\% + (10.33\text{ppmC} + 17.76\text{ppmC} + 289.6\text{ppmC} + 72.9\text{ppmC} + \underline{0.96\text{ppm}}) * 10^{-4}}$$

= 9.10

$NMHC_{conc}$ = $NMHC_e$ - $NMHC_d$ * [1 - (1 / DF)]

= 10.33 ppmC - 2.12 ppmC * [1 - (1 / 9.10)]

= 8.44 ppmC

$NMHC_{mass_n}$ = $NMHC_{conc}$ * $NMHC_{dens}$ * VMIX * 10^{-6}

= 8.44 ppmC * 16.33 g/ft^3 * 2832 ft^3 * 10^{-6}

$NMHC_{mass_1}$ = 0.39 g

Similarly, for Phase 2:

$NMHC_{mass_2}$ = 0.0 g

and for Phase 3:

$NMHC_{mass_3}$ = 0.004 g

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Therefore,

$$NMHC_{wm} = 0.43 * \frac{NMHC_{mass_1} + NMHC_{mass_2}}{D_{phase_1} + D_{phase_2}} + 0.57 * \frac{NMHC_{mass_3} + NMHC_{mass_2}}{D_{phase_3} + D_{phase_2}}$$

$$= 0.43 * \frac{0.39\ g + 0.0\ g}{3.570\ mile + 3.850\ mile} + 0.57 * \frac{0.004\ g + 0.0\ g}{3.586\ mile + 3.850\ mile}$$

$NMHC_{wm}$ = 0.023 g/mile

8. DEFINITIONS

CH_3OH_d = the methanol concentration in the dilution air as determined from the dilution air methanol sample using the procedure specified in method no. 1001, ppmC.

CH_3OH_e = the methanol concentration in the dilute exhaust as determined from the dilute exhaust methanol sample using the procedure specified in method no. 1001, ppmC.

CH_{4d} = the methane concentration in the dilution air, ppmC.

CH_{4e} = the methane concentration in the dilute exhaust, ppmC.

$C_2H_5OH_d$ = the ethanol concentration in the dilution air as determined from the dilution air ethanol sample using the procedure specified in method no. 1001, ppmC.

$C_2H_5OH_e$ = the ethanol concentration in the dilute exhaust as determined from the dilute exhaust ethanol sample using the procedure specified in method no. 1001, ppmC.

CO_e = the carbon monoxide concentration in the dilute exhaust corrected for carbon dioxide and water removal, ppm.

CO_{em} = the carbon monoxide concentration in the dilute exhaust uncorrected for carbon dioxide and water removal, ppm.

CO_{2e} = the carbon dioxide concentration in the dilute exhaust, %.

D_{phase_n} = the distance driven by the test vehicle on a chassis dynamometer during test phase n (where n is either 1, 2, or 3), mile.

DF = dilution factor.

$FID\ THC_d$ = the total hydrocarbon concentration including methane and methanol (for methanol-fueled engines) or ethanol (for ethanol-fueled engines) in the dilution air as measured by the FID, ppmC.

$FID\ THC_e$ = the total hydrocarbon concentration including methane and methanol (for methanol-fueled engines) or ethanol (for ethanol-fueled engines) in the dilute exhaust as measured by the FID, ppmC.

$HCHO_e$ = the formaldehyde concentration in the dilute exhaust as determined from the dilute exhaust carbonyl sample using the procedure specified in method no. 1004, ppm.

HCR = the hydrogen-to-carbon ratio for the fuel used.

$NMHC_{conc}$ = the non-methane hydrocarbon concentration in the dilute exhaust corrected for background, ppmC.

$NMHC_d$ = the non-methane hydrocarbon concentration in the dilution air corrected for methane and alcohol removal, ppmC.

$NMHC_{dens}$ = the mass per unit volume of non-methane hydrocarbon corrected to standard conditions (16.33 g/ft^3 at 293.16°K and 760 mm Hg assuming a C:H ratio of 1:1.85 and 17.28 g/ft^3 for LPG at 293.16°K and 760 mm Hg), g/ft^3.

$NMHC_e$ = the non-methane hydrocarbon concentration in the dilute exhaust corrected for methane and alcohol removal, ppmC.

$NMHC_{mass_n}$ = the mass emission of non-methane hydrocarbon per test phase n (where n is either 1, 2, or 3), g.

$NMHC_{wm}$ = the total weighted mass of non-methane hydrocarbon per mile for all three phases of the FTP, g/mile.

R_a = the relative humidity of the ambient air, percent.

r_{CH_3OH} = the FID response factor to methanol (see CFR 40, 86.121-90(c)).

r_{CH_4} = the FID response factor to methane (see section 4).

$r_{C_2H_5OH}$ = the FID response factor to ethanol (same procedure for methanol response factor, see CFR 40, 86.121-90(c)).

VMIX = the total dilute exhaust volume measured per test phase and corrected to standard conditions (293.16°K and 760 mm Hg), ft^3.

9. REFERENCES

(1) Code of Federal Regulations, title 40, part 86, subpart B

(2) SAE J254, "Instrumentation and Techniques for Exhaust Gas Emissions Measurement"

(3) SAE J1094a, "Constant Volume Sampler System for Exhaust Emissions Measurement"

(4) SAE 770141, "Optimization of a Flame Ionization Detector for Determination of Hydrocarbon in Diluted Automotive Exhausts". G.D. Reschke, Vehicle Emissions Laboratory, General Motors Proving Ground

(5) SAE J1154, "Methane Measurement Using Gas Chromatography", (revised December 1991)

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AIR RESOURCES BOARD

DETERMINATION OF

ALCOHOLS

IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1001

California Air Resources Board
Southern Laboratory Branch
Monitoring and Laboratory Division
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This has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policy of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

1. INTRODUCTION

1.1 This document describes a method of sampling and analyzing automotive exhaust for alcohols in the range of 4 to 1200 micrograms (ug) per 15 milliliters (ml) of solution. Currently, the target alcohols are methanol and ethanol.

1.2 This procedure is based on a method developed by the EPA (Ref 9.1) which involves flowing diluted engine exhaust through deionized water contained in glass impingers and analyzing this solution by gas chromatography (GC).

2. METHOD SUMMARY

2.1 The samples are received by the laboratory in impingers. Compound separation and analysis are performed using a GC. The sample is injected into the GC by means of a liquid autosampler. Separation of the sample mixture into its component constituents is performed using a capillary column operated with a temperature gradient. A flame ionization detector (FID) is used for alcohol detection.

2.2 The computerized GC data system identifies the alcohol associated with each of the peaks. The alcohol concentrations are determined by integrating the peak areas and using calibration factors determined with external standards.

3. INTERFERENCES AND LIMITATIONS

3.1 An interference is any component present in the sample with a retention time similar to that of the target alcohols described in this method. To reduce interference error, proof of chemical identity may require performance of periodic confirmations using an alternate method and/or instrumentation, e.g., gas chromatograph/mass spectrometer (GC/MS).

3.2 The concentration of the alcohols in the range of interest is stable for ~~thirty~~ six days as long as the samples are sealed and refrigerated at a temperature below 40°F.

4. INSTRUMENTATION AND APPARATUS

4.1 For each mode of the CVS test, ~~two~~ sampling impingers, ~~each~~ containing ~~15 ml~~ a known amount of deionized water (e.g. 15 ml for this procedure), are used to contain the sample.

4.1.1 A temperature-progammable GC, equipped with a DB-Wax Megabore column (30 meter (m), 0.53 millimeter (mm) ID, 1.0 micron (u) film thickness) and FID. A different column may be used, provided that it is demonstrated to the Executive Officer of the Air Resources Board to be equivalent or better with respect to precision, accuracy, and resolution of all the target alcohols.

4.1.2 A liquid autosampler.

4.1.3 A PC-controlled data acquisition system for quantitation of peak areas is required.

5. REAGENTS AND MATERIALS

5.1 Methanol shall have a purity of 99.9 percent, high performance liquid chromatography grade, EM Science or equivalent.

5.2 Ethanol, absolute, ACS reagent grade.

5.3 American Standards for Testing Materials Type I deionized water.

5.4 A stock solution ~~of a 1 percent methanol and 1 percent ethanol is prepared by diluting 1 ml each of methanol and ethanol to 100 ml with deionized water~~ is prepared by diluting methanol and ethanol with deionized water, e.g., for this method the stock solution is 1 percent by volume of each target alcohol.

5.4.1 A calibration standard ~~of 50 parts per million (v/v) (ppm)~~ at the concentration expected range of the samples is prepared by successive dilutions of the stock solution with deionized water, e.g., 50 parts per million (ppm) volume to volume (v/v) is typical. Figure 1 illustrates a typical chromatogram of the analysis of the target alcohols.

5.4.2 A control standard containing all target alcohols is prepared by successive dilutions of a stock solution different from that of Section 5.4.1. This standard, at an approximate concentration of the samples, is used to update control charts for each target alcohol.

5.4.3 All standards should be refrigerated at less than 40°F during storage.

5.5 Gas requirements.

5.5.1 Air shall be "Zero" grade.

5.5.2 Nitrogen, shall have a minimum purity of 99.998 percent.

5.5.3 Helium, shall have a minimum purity of 99.995 percent.

5.5.4 Hydrogen, shall have a minimum purity of 99.995 percent.

6. PROCEDURE

6.1 Each of ~~six~~ the graduated fritted midget sampling impingers is filled with 15 ml of deionized water.

6.2 ~~The six impingers are divided into three sets of two. A seventh is used as a field blank. Each set is connected in series and placed in an ice bath.~~ The impingers are placed in an ice bath ~~now ready for~~ during the sample collection.

6.3 After sampling the impingers are allowed to warm to room temperature and the solution contained in each impinger is transferred to a vial and sealed.

6.3.1 Samples should be refrigerated (at 40°F or lower) if immediate analysis is not feasible, or if reanalysis at a later date may be required.

6.4 A 1 microliter aliquot of each of unmodified samples is injected via autosampler into a GC, configured as follows:

Column:	DB-wax, 30 m, 0.53 mm ID, 1.0 u film thickness
Carrier gas:	Helium at 5 milliliters per minute (ml/min)
Make-up gas:	Nitrogen at 25 ml/min
Detector:	FID, Hydrogen at 30 ml/min and Air at 300 ml/min
Injector:	Packed column injector with Megabore adapter insert; on-column injection
Temperature:	50°C (1 min), 50°C to 70°C (5°C/min), 70°C to 110°C (15°C/min), 110°C (4 min)
Data system:	PC-based data acquisition system

Other operating conditions may be substituted provided that it is demonstrated to the Executive Officer of the Air Resources Board that they produce equivalent or better resolution, precision, and accuracy than this method.

6.4.1 One calibration standard, one control standard, and one deionized water blank are analyzed daily at the beginning of each set of samples.

6.4.2 A replicate analysis is performed ~~on one of every 10 samples, or~~ at least once per ~~shift~~ 24 hour period.

6.4.3 The control standard is ~~repeated every 10 samples and again at the end of the sample batch or day~~ performed at least once per 24 hour period.

6.4.4 For compounds having concentrations above the documented range of instrument linearity, the sample must be diluted and reanalyzed.

6.4.5 The peak integrations are corrected as necessary in the data system. Any misplaced baseline segments are corrected in the reconstructed chromatogram.

6.4.6 The peak identifications provided by the computer are checked and corrected if necessary.

6.4.7 ~~The level of peak rejection is set just below the limit of detection (LOD)~~ The peaks at or above the limit of detection are reported.

CALCULATIONS

7.1 The concentration of each target alcohol, in ppm ug/ml is determined by the following calculation that compares the sample peak area with that of an external standard:

Concentration (volume ppm ug/ml) $_{sample}$ = Area $_{sample}$ x Response Factor

7.2 The response factor (RF) is calculated during the calibration by:

$$RF = \frac{\text{Concentration standard (volume ppm ug/ml)}}{\text{Peak Area}_{standard}}$$

7.3 This concentration is then used to calculate the total amount of alcohol in each impinger:

Mass (ug) = Concentration (volume ppm ug/ml) x Impinger volume (ml) * Alcohol density (g/ml)

The alcohol densities are 0.7915 g/ml for methanol and 0.7690 g/ml for ethanol.

8. QUALITY CONTROL

8.1 Calibration and control standards are prepared at least every six months and analyzed daily.

8.2 Blank Run

A blank run is performed before running the calibration standard, control standard, and samples. All target alcohol concentrations from the blank analysis must be below the LOD before the analysis may proceed.

8.3 Calibration Run

One run of the calibration standard is performed daily to generate the calibration factor needed for quantitating sample analyses.

8.4 Control Standard Run

One run of the quality control standard is performed after the calibration run. Measurements of all target alcohols in the control standard must fall within the control limits before sample analysis may proceed. To meet this requirement, it may be necessary to inspect and repair the GC, and rerun the calibration and/or control standards.

8.5 Control Charts

Quality control chart(s) are maintained for each analyte of the control sample. The control chart, used on a daily basis, establishes that the method is in "statistical control". The following describes how to construct a typical control chart:

1. Obtain at least 20 daily control sample results,

2. Calculate the average control sample concentration and standard deviation(s) for the target analyte(s), and

3. Create a control chart for the target analyte(s) by placing the concentration on the Y-axis and the date on the X-axis. Draw an upper warning limit and a lower warning limit at two standard deviations (2s) above and below the average concentration. Draw an upper control limit and a lower control limit at three standard deviations (3s) above and below the average concentration.

The control sample must be "in-control" for all target analytes for the sample results to be considered acceptable. A control sample measurement is considered to be "out-of-control" when the analyzed value exceeds the 3s limit, or two successive control sample measurements of the same analyte exceed the 2s limit.

8.6 Duplicates

A duplicate analysis of one sample is performed ~~for every 10 samples or~~ at least once a day.

The relative percent difference (RPD) is calculated for each duplicate run:

$$\text{RPD (\%)} = \frac{\text{Difference between duplicate and original measurements}}{\text{Average of duplicate and original measurements}} \times 100$$

For each compound, the allowable RPD depends on the average concentration level for the duplicate runs, as shown in the following table:

Average Measurement for Duplicate Runs	Allowable RPD (%)
1 to 10 times LOD	100
10 to 20 " "	30
20 to 50 " "	20
Greater than 50 " "	15

If the results of the duplicate analyses do not meet these criteria for all target alcohols, the sample must be reanalyzed. If the criteria are ~~still not met, all samples~~ results for the ~~day/shift~~ from this instrument must be ~~reanalyzed or~~ deleted.

8.7 Linearity

A multipoint calibration to check for instrument linearity is performed for all target alcohols at least once every six months. The multipoint calibration consists of at least five concentration or mass loading levels above the LOD, evenly distributed over the range of expected linearity of the instrument. Each concentration level is measured at least twice. A linear regression analysis is performed using concentration and area counts to determine the regression correlation coefficient (r). The r must be greater than 0.995 to be considered sufficiently linear for one point calibrations.

8.8 Limit of Detection

The limit of detection for the target alcohols must be determined at least every six months. To make the necessary calculations, it is necessary to perform a multipoint calibration consisting of at least four "low" concentration levels above the LOD. The LOD must be calculated using the following equation (Ref 9.2):

$$LOD = |\underline{A}| + 3.3(\underline{S})$$

where each term in the equation is expressed in concentration units, and $|\underline{A}|$ is the absolute value of the least squares X-intercept calculated from the multipoint data.

$\underline{S}$ is the standard deviation of replicate determinations of the lowest standard. At least three replicates are required. The lowest standard must be run at one to five times the estimated detection limit. If data is not available in the concentration range near the detection limit, $\underline{S}$ may be estimated by:

$$\underline{S} = RSD \times |\underline{A}|$$

where RSD is the relative standard deviation of the lowest standard analyzed.

An example of typical LODs is given in the table below:

CAS Nos.	COMPOUND	LOD (ppm)
00067-56-1	methanol	0.24
00064-17-5	ethanol	0.17

The maximum allowable LOD for each alcohol is 0.50 ppm.

9. REFERENCES

9.1 U.S. Environmental Protection Agency, Characterization of Exhaust Emissions from Methanol and Gasoline Fueled Automobiles, EPA 460/3-82-004.

9.2 U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, (Method T03-15) EPA-600/4-89-017 Research Triangle Park, North Carolina, June, 1989.

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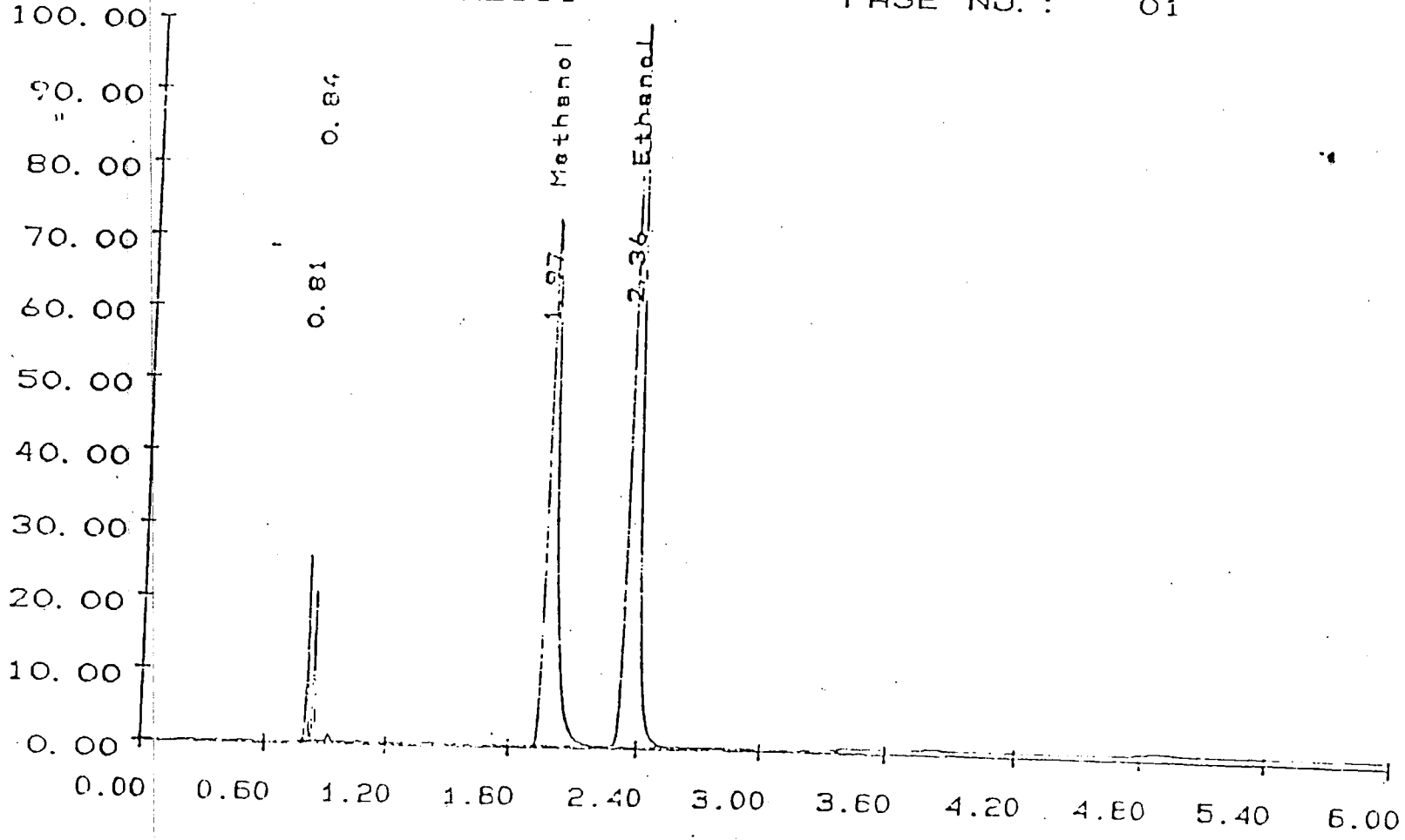
Figure 1: 50 PPM METHANOL STANDARD

SAMPLE NO. : 89005893.01
TEST NO. : ALCOH
METHOD NO. : ALCO1 / ALCO1

INSTRUMENT: 18
DATE TIME: 05/25/89 14:13:25
PAGE NO. : 01



Y MAXIMUM: 545.
Y MINIMUM: 54.

START TIME: 0.00
END TIME: 6.00

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AIR RESOURCES BOARD

DETERMINATION

OF C_2 TO C_5 HYDROCARBONS

IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1002

California Air Resources Board
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This has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policy of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

1. INTRODUCTION

1.1 This document describes a method of determining, by gas chromatograph, C_2 to C_5 hydrocarbons (light-end hydrocarbons) in the range of parts per billion carbon (ppbC) from automotive source samples. This method does not include sample collection procedures (Ref 9.1). Currently, the target hydrocarbons analyzed and reported by this method are listed in Attachment 1. ~~Hexane is also measured as a light/mid-range crossover compound for quality control purposes, but is not reported.~~

2. METHOD SUMMARY

2.1 This is a rapid method intended for routine analysis.

2.2 The samples are received by the laboratory in Tedlar bags, which are sub-sampled into a gas chromatograph (GC) for separation and analyses.

2.3 The gas chromatographic analysis is performed on a packed column operated isothermally at 35°C, or an Alumina (Al) Porous Layer Open Tubular (PLOT) column temperature programmed from 0°C to 200°C. A flame ionization detector (FID) is used for detection. Other columns and operating conditions may be used, provided baseline resolution of peaks can be achieved.

2.4 The sample is cryogenically preconcentrated and injected into the GC by means of gas sampling valves. Separation of the sample hydrocarbon mixture into its component constituents takes place in the chromatographic column. The chromatographic column and the corresponding operating parameters described in this method normally provide complete resolution of most target hydrocarbons.

2.5 The computerized GC data system identifies the hydrocarbons associated with each of the peaks. The hydrocarbon concentrations are determined by integrating the peak areas and using calibration factors determined with NIST-traceable standards.

3. INTERFERENCES AND LIMITATIONS

3.1 An interference is any component present in the sample with a retention time very similar to that of the target hydrocarbons described in this method. To reduce interference error, proof of chemical identity may require performance of periodic confirmations using an alternate method and/or instrumentation, e.g., gas chromatograph/mass spectrometer, photoionization detector, etc.

3.2 To maximize sample integrity, sample bags ~~should not leak or be exposed to bright light or excessive heat.~~ Sampling bags must be shielded from direct sunlight to avoid changes as a result of reaction of the reactive hydrocarbons. The compound 1,3-butadiene, most of which is in CVS bag no. 1, is unstable. Therefore all CVS bag no. 1 samples must be analyzed within 2 4 hours; CVS bag no. 2, CVS bag no. 3, and

background samples must be analyzed within 24 hours, although analysis within 8 hours is recommended.

4. INSTRUMENTS AND APPARATUS

4.1 Tedlar bags, 2 mil in thickness, nominally 5 to 10 liters in capacity and equipped with quick-connect fittings, are used to contain the sample.

4.2 For manual sub-sampling into a GC, a ground glass syringe (100 milliliters (ml) capacity) is used to transfer gaseous samples from Tedlar bags to the GC sample inlet. For automated systems, a ~~metering valve and timing system are~~ sample loop is used to transfer a minimum of 10 ml from the Tedlar bag to the sample inlet of the GC. The sample aliquot size is nominally 100 ml. Other aliquot sizes may be chosen, based on considerations of instrument sensitivity or linearity.

4.3 A temperature programmable GC equipped with a gas sampling valve system, a FID, and accessories is required (See Figure 1).

4.4 A stainless steel column [6 feet (ft) x 1/8 inch (in)] packed with phenylisocyanate Durapak 80/100 mesh is used. Other column(s) may be used, provided that it can be demonstrated to the Executive Officer of the Air Resources Board that the alternate system is equivalent or better with respect to precision, accuracy and resolution of all the target hydrocarbons. An Al PLOT column (60 m x 0.32 mm) has been shown ~~to be equivalent~~.

4.5 A stainless steel sample trap capable of being cryogenically cooled is required.

4.6 An electronic integrator for quantitation of peak areas is required. If the data acquisition system cannot record the chromatogram, an analog recorder is also required.

4.7 Dewar flasks (250 ml) are used to contain liquid nitrogen or hot water.

5. REAGENTS AND MATERIALS

5.1 Helium shall have a minimum purity of 99.995 percent. Pass the helium through a trap immersed in liquid nitrogen to ensure purity before entering the GC. For automated systems, helium purity of 99.9999 percent is required.

5.2 Hydrogen shall have a minimum purity of 99.995 percent.

5.3 Air shall be "Zero" grade.

5.4 Calibration Standard - The quantitative calibration standard for all target hydrocarbons shall be propane at a concentration ~~level between~~ of at least 40 ~~to 60~~ ppb-mole and within the calculated linearity of the method (see section 8.6). This propane standard shall be analyzed by the National Institute of Standards and Technology (NIST) in order

to verify traceability with a NIST primary propane standard. The use of NIST-certified weights in the gravimetric preparation of standards will not alone satisfy NIST traceability. It is recommended that at least the following target compounds be included in the NIST propane calibration standard for the purpose of qualitative verification: ethane, ethene, propene, methylpropane, n-butane, ethyne, 2-methylpropene, 1-butene, methylbutane, and n-pentane. Figure 2 illustrates a typical chromatogram of the analysis of the light-end hydrocarbons.

Alternative standards (non-NIST) may be used if shown to yield equivalent or better results and if approved in advance by the Executive Officer of the Air Resources Board.

5.5 Control Standard - A quality control standard, containing ethane, ethene, propane, propene, methylpropane, n-butane, ethyne, 2-methylpropene, 1-butene, methylbutane and n-pentane within a concentration range of samples (30 to 50 ppb-mole), is used for the following quality control purposes:

1. Daily update of control charts,

2. Daily determination of retention time windows if target compounds are not in the NIST calibration standard mixture, and

3. Semi-annual determination of LOD and linearity checks if NIST-traceable standards are not available.

The control standard(s) must have concentrations verified against a NIST-traceable propane standard (See Section 5.4 for definition of NIST-traceable) when used for either LOD determinations or linearity checks. This verification can be performed at the laboratory conducting the sample analysis.

5.6 A high concentration calibration standard, containing the target hydrocarbons listed in Section 5.4, nominally 2 ppm (4 to 10 parts per million carbon (ppmC)), is used semi-annually for LOD and linearity determinations. The high calibration standard must have concentrations verified against a NIST-traceable propane standard. This verification can be performed at the laboratory performing the analysis.

5.7 Liquid nitrogen is used to cool the cryogenic sample trap and column oven where applicable.

6. PROCEDURE

6.1 The gaseous sample is analyzed for the target hydrocarbons C_2 through C_5 by using a cryogenic preconcentration method.

6.2 ~~Typical~~ Suggested standard operating conditions for the gas chromatograph are:

Helium carrier gas flow: 50 milliliter/minute (ml/min) (packed column)

Hydrogen gas flow:	32 ml/min
~~Oxygen gas flow:~~	~~153 ml/min~~
Air flow:	300 ml/min
Sample valve temperature:	ambient
Heating bath temperature:	60 - 80°C
Injector temperature:	35°C (packed column)
Column temperature:	35°C (isothermal) (packed column)
	0° to 200°C (temperature program) (Al PLOT column)
Detector temperature:	200 to 250°C

Other operating conditions may be substituted provided that it can be demonstrated to the Executive Officer of the Air Resources Board that they produce equivalent or better resolution, precision, and accuracy, than this method.

6.3 Cool the sample trap with liquid nitrogen and allow temperature to stabilize. For traps immersed in liquid nitrogen, temperature equilibrium is achieved when liquid nitrogen stops boiling.

6.4 Withdraw a precisely measured sample (±2 percent) aliquot (nominally 100 ml) from the sample and ~~inject~~ pass the sample ~~into~~ through the freeze-out sample trap.

~~6.5 For manual GC analysis using a 100 ml syringe, refill the syringe with another 20 ml of helium and flush the 20 ml through the trap. Then flush helium through the loop for two mins to flush out the condensed oxygen.~~

6.6 Isolate the cryogenic trap by using the isolation valve, to prevent loss of sample when the trap is heated.

6.7 Replace the liquid nitrogen Dewar with a hot water Dewar at about 60-80°C.

6.8 Allow sufficient time for the temperature of the trap to rise until the ice accumulated on the surface of the trap is melted completely.

6.9 Introduce the sample into the carrier gas stream through the injection valve.

6.10 For automated systems, connect the sample queue bag to the GC queue and begin the analytical process.

6.11 Each separated component exits from the column ~~through~~ into the FID where a response is generated.

6.12 Concentrations of hydrocarbons are calculated by an electronic integrator device, which has been calibrated using a NIST-traceable propane calibration standard.

6.13 For compounds having concentrations above the documented range of instrument linearity, ~~the sample must be diluted and reanalyzed~~ a smaller aliquot must be taken (for manual systems, a smaller syringe or smaller loop; for automated systems, a smaller loop).

6.14 The peak integrations are corrected as necessary in the data system. Any misplaced baseline segments are corrected in the reconstructed chromatogram.

6.15 The peak identifications provided by the computer are checked and corrected if necessary.

6.16 ~~The level of peak rejection is set just below the limit of detection of the lowest LOD.~~ The peak areas of identified compounds at or above the LOD are reported.

6.17 The maximum retention time in this analysis is typically about 16 mins.

6.18 After each run, the packed column is back-flushed with helium while the ~~column~~ oven temperature is raised and maintained at 60°C for 15 mins, or as required to flush the column. The Al PLOT column is programmed to 200°C to assure all compounds are eluted before the next run.

6.19 Before the next run, sufficient time (typically 15 mins) is allowed after back-flush of the packed column to re-establish the required temperature of the column.

6.20 The total run time is typically about 45-50 mins.

7. CALCULATIONS

7.1 The hydrocarbon concentrations, in ppbC, are calculated by the data system using an external standard method.

$$\text{Concentration}_{\text{sample}} = \text{Peak Area}_{\text{sample}} \times \text{Response Factor}$$

7.2 The response factor (RF) is calculated during the calibration by:

$$RF = \frac{\text{Concentration of NIST-traceable propane standard, ppbC}}{\text{Area of propane peak}}$$

8. QUALITY CONTROL

8.1 Blank Run

A blank (pure nitrogen or helium) ~~run~~ is performed once daily before ~~running the calibration standard~~ (see 5.4 for method's definition of calibration standard), control standard (see 5.5 for method's definition of quality control standard), and samples. All target hydrocarbons concentrations from the blank analysis must be below the LOD before the analysis may proceed.

8.2 Calibration Run
~~One~~ A daily run of the calibration standard is performed to generate the calibration factor needed for quantitating sample analyses.

8.3 Control Standard Run
One run of the quality control standard is performed after the calibration run. Measurements of all compounds in the control standard must fall within the control limits before sample analysis may proceed. To meet this requirement, it may be necessary to inspect and repair the GC, and rerun the calibration and/or control standards

8.4 Control Charts
Quality control chart(s) are maintained for each component of the control sample. The control chart, used on a daily basis, establishes that the method is in "statistical control". The following describes how to construct a typical control chart:

1. Obtain at least 20 daily control sample results,

2. Calculate the average control sample concentration and standard deviation(s) for each target hydrocarbon, and

3. Create a control chart for each target hydrocarbon by placing concentration on the Y-axis and the date on the X-axis. Draw an upper warning limit and a lower warning limit at two standard deviations (2s) above and below the average concentration. Draw an upper control limit and a lower control limit at three ~~standard deviations~~ (3s) above and below the average concentration.

The control sample must be "in-control" for all target hydrocarbons listed in Section ~~5.4~~ 5.5 for the sample results to be considered acceptable. A control sample measurement is considered to be "out-of-control" when the analyzed value of the sample measurement exceeds the 3s limit, or two successive control sample measurements of the same analyte exceed the 2s limit.

8.5 Duplicates
A duplicate analysis of one sample is performed ~~for every 10 samples~~ or at least once a day. The relative percent difference (RPD) is calculated for each duplicate run:

$$\text{RPD (\%)} = \frac{\text{Difference between duplicate and original measurements}}{\text{Average of duplicate and original measurements}} \times 100$$

For each compound in the control standard, the allowable RPD depends on the average measurement for the duplicate runs, as shown in the following table:

Average Measurement for the Duplicate Runs	Allowable RPD
1 to 10 times LOD	100
10 to 20 " "	30
20 to 50 " "	20
Greater than 50 " "	15

If the results of the duplicate analyses do not meet these criteria for all target hydrocarbons listed in Section 5.5, the sample must be reanalyzed. If the criteria are still not met, all samples results for the day/shift from this instrument must be reanalyzed or deleted.

8.6 Linearity

A multipoint calibration to check for instrument linearity is performed for the target hydrocarbons listed in Section 5.4 5.5 at least once every six months. The multipoint calibration consists of at least five concentration or mass loading levels (using smaller or larger volume sample sizes of existing standards is acceptable) above the LOD, evenly distributed over the range of expected linearity of the instrument. Each concentration level is measured at least twice. A linear regression analysis is performed using concentration and average area counts to determine the regression correlation coefficient (r). The r must be greater than 0.995 to be considered sufficiently linear for one point calibrations.

8.7 Limit of Detection

The limit of detection for the target hydrocarbons listed in Section 5.5 must be determined at least every six months. To make the necessary calculations, it is necessary to perform a multipoint calibration consisting of at least four "low" concentration levels above the LOD. The LOD must be calculated using the following equation (Ref 9.2):

$$LOD = |\underline{A}| + 3.3(\underline{S})$$

where $|\underline{A}|$ is the least squares X-intercept calculated from the multipoint data.

$\underline{S}$ is the standard deviation of replicate determinations of the lowest standard. At least three replicates are required. The lowest standard must be run at one to five times the estimated detection limit. If data is not available in the concentration range near the detection limit, $\underline{S}$ may be estimated by:

$$\underline{S} = RSD \times |\underline{A}|$$

where RSD is the relative standard deviation of the lowest standard analyzed.

An example of typical LODs is given in the table below:

COMPOUND	LOD (ppbC)
ethane	1.0
ethene	1.7
propane	0.9
ethyne	1.7
methylpropane	1.2
n-butane	1.4
propene	2.3
methylbutane	4.3

n-pentane	3.5
1-butene	2.4
2-methylpropene	1.2

The maximum allowable LOD for each compound is 5 ppbC propane.

For purposes of calculating the total mass (ppbC) of all species, the concentrations of all compounds below the LOD are considered to be zero.

8.8 Method 1002/Method No. 1003 Crossover Check

For each sample, hexane shall be measured by both Method No. 1002 (C_2 to C_5 hydrocarbons) and Method No. 1003 (C_6 to C_{12} hydrocarbons). The RPD is calculated as in Section 8.5. The allowable RPD depends on the average concentration level for the two analyses, as shown in the following table

Method Nos. 1002, 1003 Average Hexane Measurement	Allowable RPD (%)
1 to 10 times Method 1003 hexane LOD	150
10 to 20 " " " " "	50
20 to 50 " " " " "	35
Greater than 50 " " " " "	30

All samples analyzed during the day/shift for which this criteria is not met for hexane must be reanalyzed or deleted.

9. REFERENCES

9.1 Standard Test Method for C_1 Through C_6 Hydrocarbons in the Atmosphere by Gas Chromatography, American Standards for Testing Materials (ASTM) Standards on Chromatography (1981).

9.2 U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (Method TO3-15),EPA-600/4-84-041. Research Triangle Park, North Carolina, April 1989.

06825

Attachment 1
List of C_2 to C_5 Hydrocarbons

~~(listed by approximate order of elution)~~
(listed by CAS (Chemical Abstract System) numbers)

CAS #	Hydrocarbon
00074-84-0	ethane
00074-85-1	ethene
00074-86-2	ethyne
00074-98-6	propane
00074-99-7	1-propyne*
00075-28-5	methylpropane
00078-78-4	methylbutane
00078-79-5	2-methyl-1,3-butadiene
00106-97-8	n-butane
00106-98-9	1-butene
00106-99-0	1,3-butadiene
00107-00-6	1-butyne
00109-66-0	n-pentane
00109-67-1	1-pentene
00115-07-1	propene
00115-11-7	2-methylpropene
00142-29-0	cyclopentene
00287-92-3	cyclopentane
00463-49-0	propadiene*
00463-82-1	2,2-dimethylpropane
00503-17-3	2-butyne
00513-35-9	2-methyl-2-butene
00542-92-7	cyclopentadiene
00563-45-1	3-methyl-1-butene
00563-46-2	2-methyl-1-butene
00590-18-1	cis-2-butene
00624-64-6	trans-2-butene
00627-20-3	cis-2-pentene
00646-04-8	trans-2-pentene

* Propadiene may coelute with 1-propyne

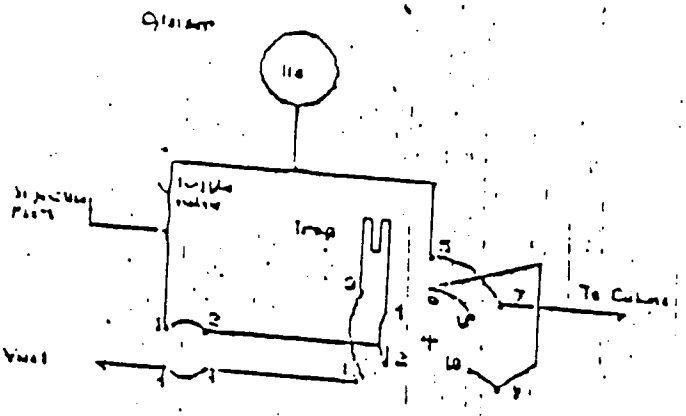


Fig. 1 (A) Sample

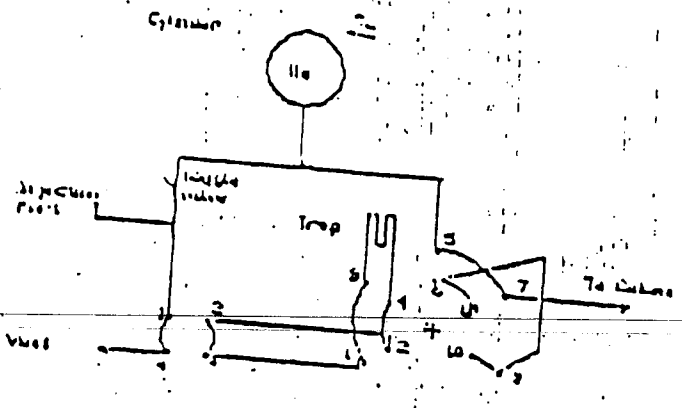


Fig. 1 (B) Isolate

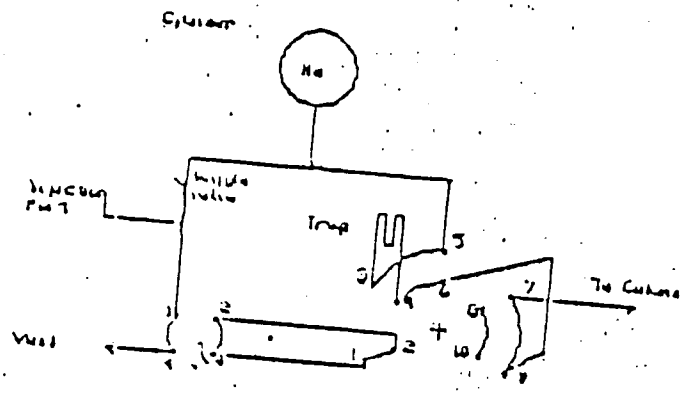
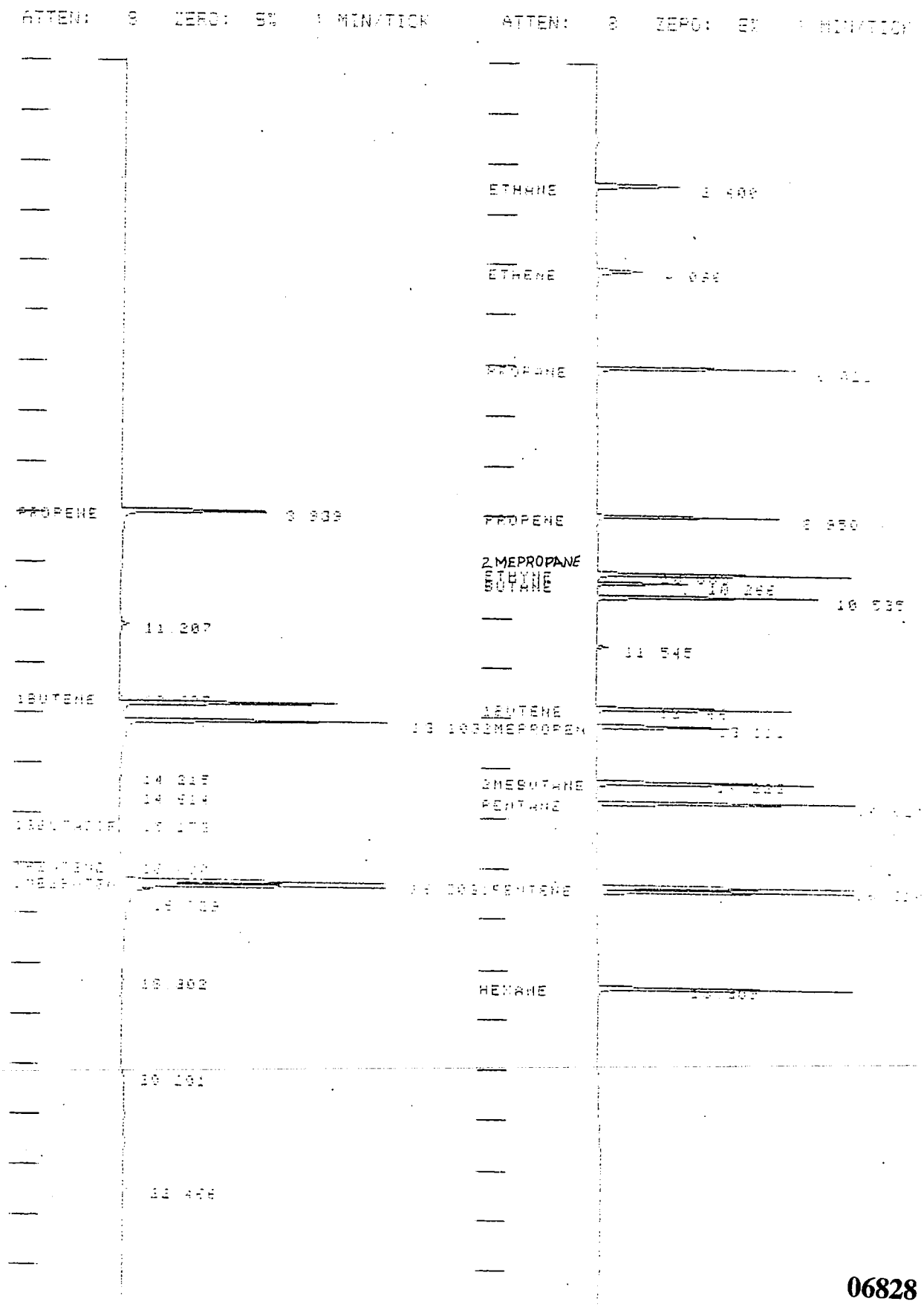


Fig. 1 (C) Inject

SCHEMATIC VALVING SYSTEM

Method 1002:
Sample Chromatogram



AIR RESOURCES BOARD

DETERMINATION

OF C_6 TO C_{12} HYDROCARBONS

IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1003

California Air Resources Board
Southern Laboratory Branch
Monitoring and Laboratory Division
9528 Telstar Avenue
El Monte, CA 91731

This has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policy of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

1. INTRODUCTION

1.1 This procedure describes a method of analyzing, by gas chromatography, C_6 to C_{12} hydrocarbons (midrange hydrocarbons) in the range of parts per billion carbon (ppbC) from automotive source samples. This method does not include sample collection procedures. The target hydrocarbons analyzed and reported by this method are listed in Attachment 1.

2. METHOD SUMMARY

2.1 This is a rapid method intended for routine analysis.

2.2 The samples are received by the laboratory in Tedlar bags, which are sub-sampled into a gas chromatograph (GC) for separation and analyses.

2.3 The gas chromatographic analysis is performed through a capillary column operated using gradient temperature. A flame ionization detector (FID) is used for detection. A photoionization detector (PID) may be used to help with compound identification.

2.4 The sample is injected into the GC by means of gas sampling valves. Separation of the sample hydrocarbon mixture into its component constituents takes place in the chromatographic column. The chromatographic column and the corresponding operating parameters described in this method normally provide complete resolution of most target hydrocarbons. When co-elution exists, periodic measurements with another method (GC/MS, for example) are performed to estimate the expected relative sizes of the co-eluting peaks.

2.5 The computerized GC data acquisition system identifies the hydrocarbons associated with each of the peaks. The hydrocarbon concentrations are determined by integrating the peak areas and using a calibration factor determined with an external standard.

3. INTERFERENCES AND LIMITATIONS

3.1 An interference is any component present in the sample with a retention time similar to that of the target hydrocarbons described in this method. To reduce interference error, proof of chemical identity may require performance of periodic confirmations using an alternate method and/or instrumentation, e.g., gas chromatograph/mass spectrometer (GC/MS), photoionization detector (PID), different column, etc.

3.2 The concentration of hydrocarbons in the range of interest is stable for at least ~~72~~ 24 hours in the Tedlar sampling bags, provided the sample bags do not leak and are not exposed to bright light or excessive heat. Sampling bags must be shielded from direct sunlight to avoid losses from reaction of the reactive hydrocarbons. Samples should be analyzed within 24 hours whenever possible.

4. INSTRUMENTATION AND APPARATUS

4.1 Tedlar bags, 2 mil in thickness, nominally 5 to 10 liters in capacity and equipped with quick-connect fittings, are used to contain the sample.

4.2 For manual subsampling into a GC, a ground glass syringe (nominally 250 milliliter (ml) capacity) is used to transfer the gaseous samples from Tedlar bags to a nominal 50 ml sample loop for concentration in the cryogenic trap. For automated systems, a ~~valve, metering and timer system~~ sample loop is used to transfer an aliquot from the Tedlar bag to the cryogenic trap. Other aliquot sizes may be chosen, or dilution of the sample performed, based on considerations of instrument sensitivity or linearity.

4.3 The GC is equipped with a FID, a PID, and a gas sampling valve system connected to a cryogenic trap.

4.4 A Valco rotary valve is connected to a cryogenic sample concentration system. A schematic of the valve system is shown in Figure 1.

4.5 A capillary column [J&W DB-1, 60 m x 0.32 mm ID, film thickness 1.0 micron] is used. Other column(s) may be used, provided that it can be demonstrated to the Executive Officer of the Air Resources Board that ~~the alternate system~~ it is equivalent or better with respect to precision, accuracy, and resolution of all the target hydrocarbons.

4.6 ~~A computer-controlled data acquisition system is required for the~~ quantitation of peak areas.

4.7 Dewar flasks are used to contain liquid nitrogen or hot water. A convenient size is 250 ml.

5. REAGENTS AND MATERIALS

5.1 Helium shall have a minimum purity of 99.995 percent. For automated systems, 99.9999 percent is required.

5.2 Hydrogen shall have a minimum purity of 99.995 percent.

5.3 Air shall be "Zero" grade.

5.4 Nitrogen shall have a minimum purity of 99.9 percent.

5.5 Calibration Standard - The quantitative calibration standard for all target hydrocarbons shall be benzene at a concentration ~~level between~~ of at least 80 ~~to 120~~ ppb-mole and within the calculated linearity of the method (see section 8.6). This benzene standard shall be analyzed by the National Institute of Standards and Technology (NIST) in order to verify traceability with a NIST primary benzene standard. The use of NIST-certified weights in the gravimetric preparation of standards will not alone satisfy NIST traceability. It is recommended that at least n-hexane, n-octane, n-decane, toluene, and m-xylene also be included in the NIST calibration standard for the purpose of qualitative verification.

Alternative standards (non-NIST) may be used provided that it is demonstrated to the Executive Officer of the Air Resources Board that they produce equivalent or better resolution, precision and accuracy than this method.

5.6 Control Standard - A quality control standard, containing at least n-hexane, n-octane, n-decane, benzene, toluene, and m-xylene species within a concentration range of samples (20 to 100 ppb-mole) is used for the following quality control purposes:

1. Daily update of control charts,

2. Daily determination of retention time windows if control compounds are not in the NIST calibration standard mixture, and

3. Semi-annual determination of limit of detection (LOD) and linearity checks if NIST-traceable standards are not available.

The control standard(s) must have concentrations verified against a NIST-traceable benzene (See Section 5.5 for definition of NIST-traceable) when used for either LOD determinations or linearity checks. This verification can be performed at the laboratory conducting the sample analysis.

5.7 A high concentration calibration standard, containing the control hydrocarbons, nominally 0.4 to 1.0 parts per million carbon (ppmC) concentration is used semi-annually for LOD and linearity determinations. The high calibration standard must have concentrations verified against a NIST-traceable benzene standard (See Section 5.5 for definition of NIST-traceable). This verification can be performed at the laboratory performing the analysis.

5.8 Liquid nitrogen is used to cool the cryogenic trap and column oven.

6. PROCEDURE

6.1 The vehicle exhaust sample is analyzed for the target hydrocarbons by using a cryogenic preconcentration method.

6.2 Typical operating conditions.

6.2.1 ~~Typical~~ Suggested operating conditions for the manual GC are:

Helium carrier gas average linear velocity 30 centimeters/second at 200° C
Nitrogen make-up gas flow 30 ml/minute (min)
Hydrogen gas flow (for FID) 30 ml/min
"Zero" air gas flow (for FID) 300 ml/min
Autozero FID and PID at 0.0 min
Range 11, Attenuation 8 (or another suitable value)
Sample valve temperature: 150°C
Injector temperature: 150°C
Column Entrance Port temperature: 95°C

Detector temperature: 250°C

Column temperature: Initial temperature 0°C; 10°C/min to 200°C

6.2.2 ~~Typical~~ Suggested operating conditions for the automated GC are:

Helium carrier gas average linear velocity 20 centimeters/second at 200°C
Nitrogen make-up gas flow 30 ml/min
Hydrogen gas flow (for FID) 30 ml/min
"Zero" air gas flow (for FID) 300 ml/min
Autozero FID and PID at 0.0 min
Range 11, attenuation 8 (or another suitable value)

Sample valve temperature: 150°C

Detector temperature: 250°C

Column Temperature: Initial temperature 0°C (5 min), 5°C/min to 50°C, 10°C/min to 200°C

Other operating conditions may be substituted provided that it can be demonstrated to the Executive Officer of the Air Resources Board that they produce equivalent or better resolution, precision, and accuracy.

6.3 Manual Sample Preconcentration

6.3.1 The trap is immersed in a Dewar filled with liquid nitrogen before obtaining the sample.

6.3.2 An aliquot of the sample is transferred from the sample bag via a 250 ml syringe to a nominal 50 ml sample loop and concentrated in the cryogenic trap.

6.3.3 The cryogenic trap is flushed for 3 minutes with helium at a flow rate of 40 ml/min.

6.3.4 The GC is cooled down to 0°C while the sample is being sub-sampled into the trap.

6.3.5 The analysis begins when the start button on the GC and the data acquisition system are activated simultaneously. An external event signal triggers the turning of the sample valve, thereby diverting carrier gas through the cryogenic trap. The Dewar of liquid nitrogen in which the trap is immersed is immediately replaced by a flask of boiling water. This vaporizes and transfers the sample through a heated entrance port into the capillary column.

6.3.6 Each separated compound passes through the PID and afterwards through into the FID.

6.4 Automated Sample Preconcentration

6.4.1 With cryotrap cooled to -120°C ~~(instrument setting of -30)~~ valves 3 and 3A are turned on to flush the sample from the 100ml sample loop into the cryotrap (see Figure 1). This flushing is continued for 2.9 min to be sure all the sample is transferred and to flush the air components (oxygen and nitrogen) out of the cryotrap.

6.4.2 The cryotrap is isolated and heated to 200°C ~~(instrument setting of 250)~~ to re-evaporate the analyte.

6.4.3 Valves 2 and 4 are turned to inject the evaporated analyte into the analytical column (see Figure 1).

6.5 Data Reduction

6.5.1 ~~The peak reject for shall~~ be set at or ~~below the lowest LOD~~ All peaks at or above the limit of detection are reported.

6.5.2 The results are calculated from the FID responses. The PID responses are used to help with peak identifications as the PID responds more strongly to aromatics and olefins.

6.5.3 The results are examined to see that the peaks are correctly identified and integrated.

6.5.4 After running a particularly "dirty" sample, the analyst should run a blank before proceeding to the next sample as there may be sample carryover, or flush the sampling system with air.

6.5.5 The peak identifications provided by the computer are reviewed and, if necessary, corrected using the following procedure and criteria:

(1) The relative retention indices from GC/MS analyses are used to help confirm peak identifications.

(2) The primary peak identification is done by the computer using the relative retention times based on reference calibration runs.

(3) Confirm that the largest peaks of the sample run ("fingerprint") match the typical fingerprint seen in past sample runs.

(4) Compare the relative retention time of the sample peaks with those of reference runs.

(5) Any peak with a reasonable doubt is labeled 'Unidentified'.

6.5.6 The concentrations of the hydrocarbons are calculated by an electronic integrator device.

6.5.7 For compounds having concentrations above the documented range of instrument linearity, a smaller aliquot (sample loop) must be taken.

7. CALCULATIONS

7.1 The target hydrocarbon concentrations, in ppbC, are calculated by the data system using benzene as an external standard.

$$\text{Concentration}_{\text{sample}}\ \text{ppbC} = \text{Peak Area}_{\text{sample}} \times \text{Response Factor}_{\text{sample}}$$

7.2 The Calibration Factor (RF) is calculated during daily calibration by:

$$RF = \frac{\text{Concentration of NIST-traceable benzene, ppbC}}{\text{Area of benzene peak}}$$

8. QUALITY CONTROL

8.1 Blank Run

A blank (pure nitrogen or helium) run is performed before running the calibration standard, control standard, and samples. All target hydrocarbons concentrations from the blank analysis must be below the LOD before the analysis may proceed.

8.2 Calibration Run

One run of the calibration standard (see section 5.5 for definition of calibration standard) is performed per day to generate the calibration factor needed for quantitating sample analyses.

8.3 Control Standard Run

One run of the quality control standard (see section 5.6 for definition of quality control standard) is performed after the calibration run. Measurements of all compounds in the control standard must fall within the control limits before sample analysis may proceed. To meet this requirement, it may be necessary to inspect and repair the GC, and rerun the calibration and/or control standards.

8.4 Control Charts

Quality control chart(s) are maintained for each component of the control sample. The control chart, used on a daily basis, establishes that the method is in "statistical control". The following describes how to construct a typical control chart:

1. Obtain at least 20 daily control sample results,

2. Calculate the average control sample concentration and standard deviation(s) for each target hydrocarbon, and

3. Create a control chart for each target hydrocarbon by placing the concentration on the Y-axis and the date on the X-axis. Draw an upper warning limit and a lower warning limit at two standard deviations (2s) above and below the average concentration. Draw an upper control limit and a lower control limit at three standard deviations (3s) above and below the average concentration.

The control sample must be "in-control" for all target hydrocarbons for the sample results to be considered acceptable. A control sample measurement is considered to be "out-of-control" when the analyzed

value exceeds the 3s limit, or two successive control sample measurements of the same analyte exceed the 2s limit.

8.5 Duplicates

A duplicate analysis of one sample is performed ~~for every 10 samples or~~ at least once per a day~~/shift~~.

The relative percent difference (RPD) is calculated for each duplicate run:

$$\text{RPD (\%)} = \frac{\text{Difference between duplicate and original measurements}}{\text{Average of duplicate original measurements}} \times 100$$

For each compound listed in section 5.6, the allowable RPD depends on the average concentration level for the duplicate runs, as shown in the following table:

Average Measurement for Duplicate Runs	Allowable RPD (%)
1 to 10 times LOD	100
10 to 20 " "	30
20 to 50 " "	20
Greater than 50 " "	15

If the results of the duplicate analyses do not meet these criteria for all ~~target hydrocarbons~~ compounds listed in section 5.6, the sample must be reanalyzed. If the criteria are still not met, all samples results for the day~~/shift~~ from this instrument must be ~~reanalyzed or~~ deleted.

8.6 Linearity

A multipoint calibration to check for instrument linearity is performed for all target hydrocarbons in the control standard at least once every six months. The multipoint calibration consists of at least five concentration or mass loading levels (using smaller or larger volume sample sizes of existing standards is acceptable) above the LOD, evenly distributed over the range of expected linearity of the instrument. Each concentration level is measured at least twice. A linear regression analysis is performed using concentration and average area counts to determine the regression correlation coefficient (r). The r must be greater than 0.995 to be considered sufficiently linear for one point calibrations.

8.7 Limit of Detection

The limit of detection for the target hydrocarbons in the control standard must be determined at least every six months. To make the necessary calculations, it is necessary to perform a multipoint calibration consisting of at least four "low" concentration levels above the LOD. The LOD must be calculated using the following equation (Ref 9.1):

$$LOD = |\underline{A}| + 3.3(\underline{S})$$

where each term in the equation is expressed in concentration units, and $|\underline{A}|$ is the absolute value of the least squares X-intercept calculated from the multipoint data.

$\underline{S}$ is the standard deviation of replicate determinations of the lowest standard. At least three replicates are required. The lowest standard must be run at one to five times the estimated detection limit. If data is not available in the concentration range near the detection limit, $\underline{S}$ may be estimated by:

$$\underline{S} = RSD \times |\underline{A}|$$

where RSD is the relative standard deviation of the lowest standard analyzed.

An example of typical LODs is given in the table below:

COMPOUND	LOD (ppbC)
n-hexane	20
n-octane	7
n-decane	10
benzene	10
toluene	7
m-xylene	9

The maximum allowable LOD for any compound is 20 ppbC benzene.

For purposes of calculating the total mass (ppbC) of all species, the concentrations of the compounds below the LOD are considered to be zero.

~~8.8 Method No. 1002/Method No. 1003 Crossover Check~~

~~For each sample, hexane shall be measured by both Method No. 1002 (C_2 to C_5 hydrocarbons) and Method No. 1003 (C_6 to C_{12} hydrocarbons). The RPD is calculated as in Section 8.5. The allowable RPD depends on the average concentration for the two analyses, as shown in the following table:~~

Method 1002, 1003 Average Hexane Concentration	Allowable RPD (%)
1 to 10 times Method 1003 hexane LOD	100
10 to 20 " " " " "	30
20 to 50 " " " " "	25
Greater than 50 " " " " "	20

~~All samples analyzed during the day/shift for which this criteria is not met for hexane must be reanalyzed or deleted.~~

9. REFERENCE

9.1 U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (Method T93-15), EPA-600/4-89-017, Research Triangle Park, North Carolina, June 1989.

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Attachment 1
List of Mid-Range Hydrocarbons
(listed by approximate order of CAS (Chemical Abstract System) numbers elution)

00071-43-2	benzene*
00075-83-2	2,2-dimethylbutane
00079-29-8	2,3-dimethylbutane
00091-20-3	naphthalene
00095-47-6	o-xylene
00095-63-6	1,2,4-trimethylbenzene
00095-93-2	1,2,4,5-tetramethylbenzene
00096-14-0	3-methylpentane
00096-37-7	methylcyclopentane
00098-19-1	1-(1,1-dimethylethyl)-3,5-dimethylbenzene
00098-82-8	(1-methylethyl)benzene
00099-87-6	1-methyl-4-(1-methylethyl)benzene
00100-41-4	ethylbenzene
00100-42-5	styrene
00103-65-1	n-propylbenzene
00105-05-5	1,4-diethylbenzene
00107-39-1	2,4,4-trimethyl-1-pentene
00107-40-4	2,4,4-trimethyl-2-pentene
00107-83-5	2-methylpentane
00108-08-7	2,4-dimethylpentane
00108-38-3	m- & p-xylene
00108-67-8	1,3,5-trimethylbenzene
00108-87-2	methylcyclohexane
00108-88-3	toluene**
00110-54-3	n-hexane
00110-82-7	cyclohexane
00111-65-9	n-octane
00111-66-0	1-octene
00112-40-3	n-dodecane
00124-11-8	1-nonene
00124-18-5	n-decane
00135-01-3	1,2-diethylbenzene
00135-98-8	(1-methylpropyl)benzene
00141-93-5	1,3-diethylbenzene
00142-82-5	n-heptane
00464-06-2	2,2,3-trimethylbutane
00488-23-3	1,2,3,4-tetramethylbenzene
00496-11-7	2,3-dihydroindene (indan)
00527-53-7	1,2,3,5-tetramethylbenzene
00527-84-4	1-methyl-2-(1-methylethyl)benzene
00535-77-3	1-methyl-3-(1-methylethyl)benzene
00538-68-1	n-pentylbenzene
00538-93-2	(2-methylpropyl)benzene
00540-84-1	2,2,4-trimethylpentane
00558-37-2	3,3-dimethyl-1-butene
00560-21-4	2,3,3-trimethylpentane**
00562-49-2	3,3-dimethylpentane
00563-16-6	3,3-dimethylhexane
00565-59-3	2,3-dimethylpentane
00565-75-3	2,3,4-trimethylpentane
00576-73-8	1,2,3-trimethylbenzene
00584-94-1	2,3-dimethylhexane

00589-34-4	3-methylhexane
00589-43-5	2,4-dimethylhexane
00589-53-7	4-methylheptane
00589-81-1	3-methylheptane
00590-73-8	2,2-dimethylhexane
00591-35-2	2,2-dimethylpentane
00591-76-4	2-methylhexane
00592-27-8	2-methylheptane
00592-41-6	1-hexene
00592-76-7	1-heptene
00611-14-3	1-methyl-2-ethylbenzene
00616-12-6	3-methyl-trans-2-pentene
00617-78-7	3-ethylpentane
00620-14-4	1-methyl-3-ethylbenzene
00622-96-8	1-methyl-4-ethylbenzene
00625-27-4	2-methyl-2-pentene
00637-92-3	1-ethyl-tert-butyl-ether
00638-04-0	cis-1,3-dimethylcyclohexane
00674-76-0	4-methyl-trans-2-pentene
00691-37-2	4-methyl-1-pentene
00691-38-3	4-methyl-cis-2-pentene
00693-89-0	1-methylcyclopentene*
00760-20-3	3-methyl-1-pentene
00763-29-1	2-methyl-1-pentene
00816-79-5	3-ethyl-cis-2-pentene
00822-50-4	trans-1,2-dimethylcyclopentane
00874-41-9	1,3-dimethyl-4-ethylbenzene
00926-82-9	3,5-dimethylheptane
00933-98-2	1,2-dimethyl-3-ethylbenzene
00934-80-5	1,2-dimethyl-4-ethylbenzene
00992-62-3	3-methyl-cis-2-pentene
01069-53-0	2,3,5-trimethylhexane
01074-17-5	1-methyl-2-n-propylbenzene
01074-43-7	1-methyl-3-n-propylbenzene
01074-55-1	1-methyl-4-n-propylbenzene
01120-21-4	n-undecane
01120-62-3	3-methylcyclopentene
01634-04-4	1-methyl-tert-butyl-ether
01678-91-7	ethylcyclohexane
02207-01-4	cis-1,2-dimethylcyclohexane
02207-03-6	trans-1,3-dimethylcyclohexane
02207-04-7	trans-1,4-dimethylcyclohexane
02213-23-2	2,4-dimethylheptane
02216-33-3	3-methyloctane
02532-58-3	cis-1,3-dimethylcyclopentane
02738-19-4	2-methyl-2-hexene
02870-04-4	1,3-dimethyl-2-ethylbenzene
03074-71-3	2,3-dimethylheptane
03404-61-3	3-methyl-1-hexene
03522-94-9	2,2,5-trimethylhexane
03899-36-3	3-methyl-trans-3-hexene
03968-85-2	2-methylbutylbenzene
04032-94-4	2,4-dimethyloctane
04050-45-7	trans-2-hexene

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06443-92-1	cis-2-heptene
07385-78-6	3,4-dimethyl-1-pentene
07642-04-8	cis-2-octene
07642-09-3	cis-3-hexene
07688-21-3	cis-2-hexene
10574-37-5	2,3-dimethyl-2-pentene
10758-88-9	1,4-dimethyl-2-ethylbenzene
13269-52-8	trans-3-hexene
13389-42-9	trans-2-octene
14686-13-6	trans-2-heptene
14686-14-7	trans-3-heptene
14850-23-8	trans-4-octene
15869-87-1	2,2-dimethyloctane
15890-40-1	1-cis,2-trans,3-trimethylcyclopentane
27138-21-2	1-(1,1-dimethylethyl)-2-methylbenzene
	1-methyl-4-(2-methylpropyl)benzene
	ethylcyclopentane
	1,1-dimethylcyclopentane
	5-ethylcyclopentene
	4-methyloctane
	2,2,4-trimethylheptane
	ethylmethylcyclohexane
	cyclohexene
	n-nonane
	2,5-dimethylhexane
	2-methyloctane

* benzene may co-elute with 1-methylcyclopentene
** toluene may co-elute with 2,3,3-trimethylpentane

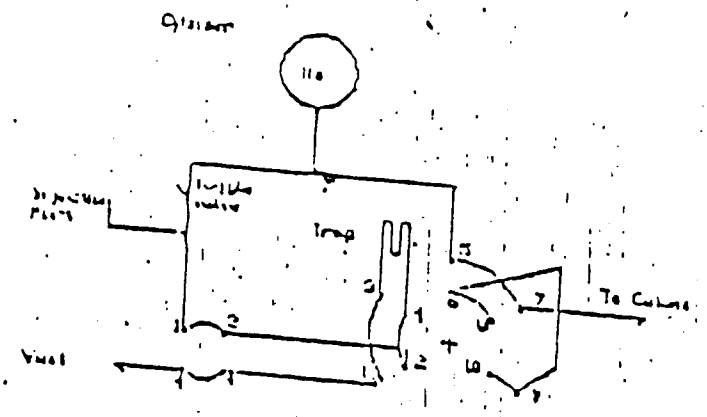

Fig. 1 (A) Sample

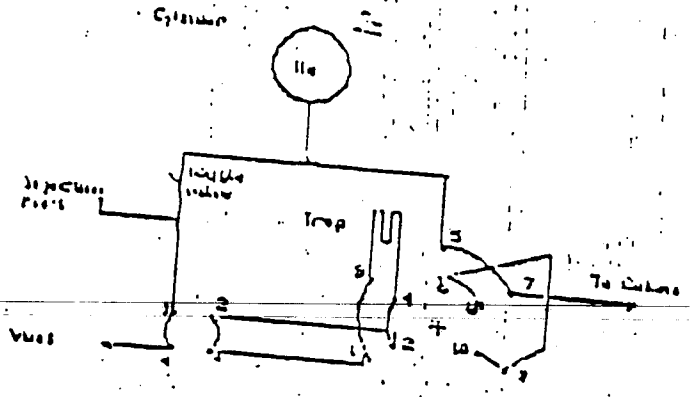

Fig. 1 (B) Isolate

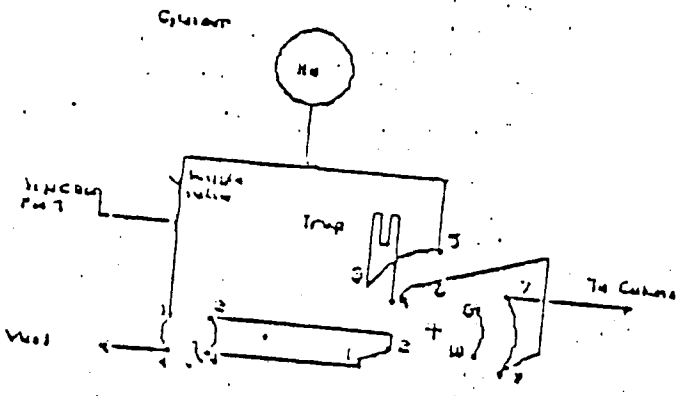

Fig. 1 (C) Inject

SCHEMATIC VALVING SYSTEM

AIR RESOURCES BOARD

DETERMINATION
OF ALDEHYDE AND KETONE COMPOUNDS
IN AUTOMOTIVE SOURCE SAMPLES
BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

METHOD NO. 1004

California Air Resources Board
Southern Laboratory Branch
Monitoring and Laboratory Division
9528 Telstar Avenue
El Monte, CA 91731

This has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policy of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

1 INTRODUCTION

1.1 This document describes a method of analyzing automotive engine exhaust for aldehyde and ketone compounds (carbonyls) using impingers containing 2,4-dinitrophenylhydrazine (DNPH)-absorbing solution. Carbonyl masses ranging between 0.02 to 200 ug are measured by this method. Currently, the target carbonyls analyzed and reported include formaldehyde, acetaldehyde, acrolein, acetone, propionaldehyde, butyraldehyde, ~~hexaldehyde~~ hexanal, benzaldehyde, methyl ethyl ketone, methacrolein, crotonaldehyde, valeraldehyde, and p-tolualdehyde.

1.2 This procedure is derived from a method used by Hull (Ref. 9.1).

2. METHOD SUMMARY

2.1 The samples are received by the laboratory in sample collection impingers (See Section 4.2). The absorbing solution (2,4-DNPH) complexes the carbonyl compounds into their diphenylhydrazone derivatives. Separation and analysis is performed using a High Performance Liquid Chromatograph (HPLC) ~~a spectrophotometer~~ with an ultraviolet detector.

3. INTERFERENCES AND LIMITATIONS

3.1 An interference is any detectable compound present in the sample with a retention time very similar to that of the target carbonyls described in this method. To reduce interference error, proof of chemical identity may require performance of periodical confirmations using an alternate method and/or instrumentation, e.g., using alternative HPLC columns or mobile phase compositions.

3.2 If samples are not analyzed the same day as received, they must be transferred to glass bottles, sealed, and refrigerated at 40°F. Refrigerated samples are stable for 30 days.

4. INSTRUMENT AND APPARATUS

4.1 The HPLC analytical system consists of the following:

4.1.1 Dual high pressure pumps.

4.1.2 Automated gradient controller.

4.1.3 A liquid autosampler.

4.1.4 Two DuPont Zorbax ODS columns in tandem and a guard column, (2 centimeters (cm) long packed with C18 5 micrometers (um) pellicular beads). Other column(s) may be used, provided that it is demonstrated to the Executive Officer of the Air Resources Board that the alternate system is equivalent or better with respect to precision, accuracy, and resolution of all the target carbonyls.

4.1.5 An ultraviolet/visible (UV/VIS) ~~spectrophotometer~~ detector.

4.1.6 Data system for peak integration.

4.2 Sample collection containers are glass impingers. DNPH-impregnated cartridges may also be used.

5. REAGENTS AND MATERIALS

5.1 Acetonitrile, HPLC grade, Burdick and Jackson or equivalent.

5.2 Water, HPLC grade, Burdick and Jackson or equivalent.

5.3 2,4-Dinitrophenylhydrazine (DNPH), Eastman or equivalent, recrystallized twice from acetonitrile. The recrystallized DNPH is checked for contaminants by injecting a dilute solution of DNPH in contaminant-free acetonitrile into the HPLC.

5.4 Sulfuric acid, analytical reagent grade, Baker Analyzed or equivalent.

5.5 Synthesized 2,4-dinitrophenylhydrazones (Ref. 9.2) are:

5.5.1 Formaldehyde/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, melting point (m.p.) 168°C.

5.5.2 Acetaldehyde/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 166-168°C.

5.5.3 Acrolein/2,4-dinitrophenylhydrazone, recrystallized from acetonitrile and 95 percent ethanol, m.p. 158-159.5°C.

5.5.4 Acetone/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 126-128°C.

5.5.5 Propionaldehyde/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 138-140°C.

5.5.6 Butyraldehyde/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 109-111°C.

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5.5.7 Hexaldehyde Hexanal/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 105-106°C.

5.5.8 Benzaldehyde/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 235-237°C.

5.5.9 Methyl ethyl ketone/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 115-116°C.

5.5.10 Methacrolein/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 206°C.

5.5.11 Crotonaldehyde/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 185-188°C.

5.5.12 Valeraldehyde/dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 103-106°C.

5.5.13 p-Tolualdehyde/2,4-dinitrophenylhydrazone, recrystallized three times from 95 percent ethanol, m.p. 239°C.

5.6 Stock Calibration Standard - A stock calibration standard is prepared by diluting the target carbonyls with acetonitrile, e.g., a typical 100 ml acetonitrile standard stock solution contains:

14.8 milligrams (mg) formaldehyde/2,4-dinitrophenylhydrazone
8.4 mg acetaldehyde/2,4-dinitrophenylhydrazone
6.0 mg acrolein/2,4-dinitrophenylhydrazone
5.7 mg acetone/2,4-dinitrophenylhydrazone
4.7 mg propionaldehyde/2,4-dinitrophenylhydrazone
5.0 mg butyraldehyde/2,4-dinitrophenylhydrazone
5.0 mg benzaldehyde/2,4-dinitrophenylhydrazone
5.0 mg hexaldehyde hexanal/2,4-dinitrophenylhydrazone
5.0 mg methyl ethyl ketone/2,4-dinitrophenylhydrazone
5.0 mg methacrolein/2,4-dinitrophenylhydrazone
5.0 mg crotonaldehyde/2,4-dinitrophenylhydrazone
5.0 mg valeraldehyde/2,4-dinitrophenylhydrazone
5.0 mg p-tolualdehyde/2,4-dinitrophenylhydrazone

Commercial standards are also available for the these compounds.

5.7 Working Standard - A working standard is prepared every two weeks by diluting the stock calibration solution making sure that the highest concentration of the standard is above the expected test level, e.g., 1 ml of the stock calibration solution to 100 ml.

5.8 Control Standard - A quality control standard, containing all target carbonyl/2,4-dinitrophenylhydrazone complexes, within the typical concentration range of real samples is analyzed to update daily control charts. The control standard may be prepared by batch

mixing old samples and stirring for 24 hours. All target compounds except acrolein have been found to be stable in the control standard.

6. PROCEDURE

6.1.1 An absorbing solution is prepared by dissolving 0.11 - 0.13 grams of recrystallized DNPH in 1 liter (l) of HPLC grade acetonitrile. The absorbing solution should be ~~stored in the refrigerator at 40°F or~~ ~~lower and~~ prepared at least every two weeks. Each batch of acetonitrile used in this procedure is checked for oxygenated impurities by addition of contaminant-free dilute solution of DNPH and analyzed in the HPLC. Cartridges should be sealed and refrigerated at less than 40°F.

6.1.2 In the laboratory, pipette 15 ml of the DNPH absorbing solution into each of the ~~nine~~ 30 ml graduated fritted midget impingers for each emission test. Add 0.1 ml of ~~5.7~~ 2.85 N sulfuric acid to each impinger. ~~The ninth impinger is reserved as a field blank. One pair of impingers is reserved for the composite background samples.~~

6.1.3 DNPH impregnated cartridges may also be used to collect carbonyl samples. At the volumes being sampled (1 L/minute), no back-up cartridge is needed. Leave the cartridges capped.

6.2 Connect the impinger pairs in series and cap the open ends to prevent contamination. (These sets of impingers (cartridges) are picked up by the automotive test personnel for sampling).

6.3 After the sampling has been completed, ~~and~~ cap the impingers or cartridges ~~are~~ have been capped and returned them to the laboratory. At the laboratory, uncap and place the ~~eight~~ impingers and the field blank impinger in preheated water at 70-80°C for 30 minutes (min) to complete derivatization. Heating samples in the water bath may be omitted if omission of this step is demonstrated to the Executive Officer of the Air Resources Board to result in equivalent or better resolution, precision and accuracy of all target carbonyls.

6.3.1 For sampling with cartridges, remove the caps and extract with ~~10~~ 5 ml acetonitrile running the extract into glass storage bottles.

6.4 Remove the ~~nine~~ impingers from the water bath and cool to room temperature. Replace any lost solvent by adding acetonitrile to the 15 ml mark.

6.5 Transfer 3-~~ml~~ of the solution from each impinger/cartridge to 4-~~ml~~ glass vials and seal with new septum screw caps.

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6.6 Place the vials containing blank, working standard, control standard, and samples into the autosampler for subsequent injection into an HPLC configured as follows:

Columns - 4.6 millimeters (mm) ID x 250 mm x 1/4 inches OD Dupont Zorbax ODS two columns in series, Guard column - 2 cm long packed with C18 5 um pellicular.
Detector - UV/VIS at 360 nanometers
Sample volume - 20 microliters
Solvent A - acetonitrile
Solvent B - 10 percent (volume/volume) methanol in water
Flow - 1 ml per min

Program - 50 percent A, 50 percent B 0 (initial time)
65 percent A, 35 percent B 0 to 5 min
100 percent A, 0 percent B 5 to 35 "
~~50 percent A, 50 percent B 36 to 46 "~~
50 percent A, 50 percent B 35 to 36 "
50 percent A, 50 percent B 36 to 46 " (hold)

Data System: The outputs from the UV/VIS ~~spectrophotometer~~ detector are sent to a PC-controlled data acquisition system.

Other operating conditions and/or columns may be substituted provided that it can be demonstrated to the Executive Officer of the Air Resources Board that they produce equivalent or better resolution, precision, and accuracy than this method. A sample chromatogram is shown in Figure 1.

6.7 The peak integrations are corrected as necessary in the data system. Any misplaced baseline segments are corrected in the reconstructed chromatogram.

6.8 ~~The level of peak rejection is set just below the limit of detection (LOD)~~ The peaks at or above the limit of detection are reported.

~~6.9 The maximum allowable LOD for any target carbonyl is 0.02 ug/ml.~~

7. CALCULATIONS

7.1 The concentration of each target carbonyl compound is determined with the following calculation that compares the sample peak area with that of an external standard.

7.1.1 For each target carbonyl, the carbonyl mass is calculated from its carbonyl 2,4-dinitrophenylhydrazone mass.

7.1.2 The mass of each carbonyl compound, ug per 15 ml impinger, is determined by the following calculation:

$Mass_{sample}$ = Peak $Area_{sample}$ x Response Factor x Impinger volume(ml) x B

where B is the ratio of the molecular weight of the carbonyl compound to its 2,4-dinitrophenylhydrazone.

~~7.1.3~~ ~~The ratios B for the target carbonyls by ARB are:~~

~~Formaldehyde~~	~~B = .1428~~	~~Butyraldehyde~~	~~B = .288~~
~~Acetaldehyde~~	~~.1965~~	~~Benzaldehyde~~	~~.371~~
~~Acrolein~~	~~.2374~~	~~Hexaldehyde~~	~~.367~~
~~Acetone~~	~~.2438~~		
~~Propionaldehyde~~	~~.2438~~		

7.1.3 The Response Factor (RF) for each carbonyl is calculated during the calibration by:

$$RF = \frac{Concentration_{standard}\ (\text{units ug 2,4-DNPH species/ml})}{Peak\ Area_{standard}}$$

8. QUALITY CONTROL

8.1 Blanks

The solvents used are of the highest HPLC grade and are checked at least daily ~~for impurities by conducting blank analyses.~~

8.2 Phenylhydrazone Purity

The 2,4-dinitrophenylhydrazones are checked for purity by their melting points and their chromatograms. Analysis of the solution of phenylhydrazone must yield only the peak of interest.

8.3 Calibration Run

One run of the calibration standard is performed at least daily to generate the calibration factors needed for quantifying sample analyses ~~each day/shift.~~

8.4 Control Standard Run

One run of the quality control standard is performed at least daily after the calibration run. Measurements of all compounds in the control standard except acrolein must fall within the control limits before sample analysis may proceed. To meet this requirement, it may be necessary to rerun the calibration and control standards, and inspect and repair the HPLC.

8.5 Control Charts

Quality control chart(s) are maintained for each component of the control sample except acrolein. The control chart, used on a daily basis, establishes that the method is in "statistical control". The following describes how to construct a typical control chart:

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1. Obtain at least 20 daily control sample results,

2. Calculate the average control sample concentration and standard deviation(s) for each target analyte, and

3. Create a control chart for each target analyte by placing the concentration on the Y-axis and the date on the X-axis. Draw an upper warning limit and a lower warning limit at two standard deviations (2s) above and below the average concentration. Draw an upper control limit and a lower control limit at three standard deviations (3s) above and below the average concentration.

The control sample must be "in-control" for all target analytes for the sample results to be considered acceptable. A control sample measurement is considered to be "out-of-control" when the analyzed value exceeds the 3s limit, or two successive control sample measurements of the same analyte exceed the 2s limit.

8.6 Field Blanks
One field blank is analyzed for each set of ~~eight bubblers~~ impingers for each emission test.

8.7 One cartridge per batch number is analyzed as a blank.

8.8 Duplicates
A duplicate analysis of one sample is performed ~~for every 10 samples or~~ at least once a ~~day/shift~~.

The relative percent difference (RPD) is calculated for each duplicate run:

$$RPD(\%) = \frac{\text{Difference between duplicate and original measurements}}{\text{Average of duplicate and original measurements}} \times 100$$

For each compound, the allowable RPD depends on the average concentration level for the duplicate runs, as shown in the following table:

Average Measurement for Duplicate Runs	Allowable RPD (%)
1 to 10 times LOD	100
10 to 20 " "	30
20 to 50 " "	20
Greater than 50 " "	15

If the results of the duplicate analyses do not meet these criteria for all target carbonyls, the sample must be reanalyzed. If the criteria are still not met, all samples results analyzed during the ~~day/shift~~ from this instrument must be ~~reanalyzed or~~ deleted.

8.9 Linearity

A multipoint calibration to check for instrument linearity is performed for all target analytes at least once every six months. The multipoint calibration consists of at least five concentration or mass loading levels (using smaller or larger volume sample sizes of existing standards is acceptable) above the LOD, evenly distributed over the range of expected linearity of the instrument. Each concentration level is measured at least twice. A linear regression analysis is performed using concentration and average area counts to determine regression correlation coefficient (r). The r must be greater than 0.995 to be considered linear for one point calibrations.

8.10 Limit of Detection

The limit of detection for the target analytes must be determined at least every six months. To make the necessary calculations, it is necessary to perform a multipoint calibration consisting of at least ~~five~~ four "low" concentration levels above the LOD. The LOD must be calculated using the following equation (Ref. 9.3):

$$LOD = |\underline{A}| + 3.3(\underline{S})$$

where each term in the equation is expressed in concentration units, ~~and |A| is the absolute value of the least squares X-intercept~~ calculated from the multipoint data.

$\underline{S}$ is the standard deviation of replicate determinations of the lowest standard. At least three replicates are required. The lowest standard must be run at one to five times the estimated detection limit. If data is not available in the concentration range near the detection limit, $\underline{S}$ may be estimated by:

$$\underline{S} = RSD \times |\underline{A}|$$

where RSD is the relative standard deviation of the lowest standard analyzed.

An example of typical LODs is given in the table below:

Compound	LOD (ug/ml)
Formaldehyde/2,4-dinitrophenylhydrazone	~~0.023~~ 0.048
Acetaldehyde/2,4-dinitrophenylhydrazone	~~0.011~~ 0.011
Acrolein/2,4-dinitrophenylhydrazone	~~0.011~~ 0.006
Acetone/2,4-dinitrophenylhydrazone	~~0.015~~ 0.004
Propionaldehyde/2,4-dinitrophenylhydrazone	~~0.045~~ 0.016
Butyraldehyde/2,4-dinitrophenylhydrazone	~~0.039~~ 0.06*
~~Hexaldehyde~~ Hexanal/2,4-dinitrophenylhydrazone	~~0.035~~ 0.019
Benzaldehyde/2,4-dinitrophenylhydrazone	~~0.047~~ 0.027

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Compound	LOD (ug/ml)
Methyl ethyl ketone/2,4-dinitrophenylhydrazone	-*
Methacrolein/2,4-dinitrophenylhydrazone	-
Crotonaldehyde/2,4-dinitrophenylhydrazone	0.016
Valeraldehyde/2,4-dinitrophenylhydrazone	0.009
p-Tolualdehyde/2,4-dinitrophenylhydrazone	-

CAS Nos.	Compound	LOD (ug/ml)
00050-00-0	Formaldehyde	~~0.003~~ 0.007
00075-07-0	Acetaldehyde	~~0.001~~ 0.002
00107-02-8	Acrolein	~~0.003~~ 0.002
00067-64-1	Acetone	~~0.004~~ 0.001
00123-38-6	Propionaldehyde	~~0.011~~ 0.004
00123-72-8	Butyraldehyde	~~0.011~~ 0.019*
00066-25-1	~~Hexaldehyde~~ Hexanal	~~0.013~~ 0.007
00100-52-7	Benzaldehyde	~~0.017~~ 0.010
00078-93-3	Methyl Ethyl Ketone	-*
00078-85-3	Methacrolein	-
04170-30-3	Crotonaldehyde	0.016
00110-62-3	Valeraldehyde	0.009
00104-87-0	p-Tolualdehyde	-**

* Butyraldehyde may co-elute with methyl ethyl ketone
**p-Tolualdehyde may co-elute with m-Tolualdehyde and o-Tolualdehyde

The maximum allowable LOD is 0.06 ug carbonyl derivative/ml.

9. REFERENCES

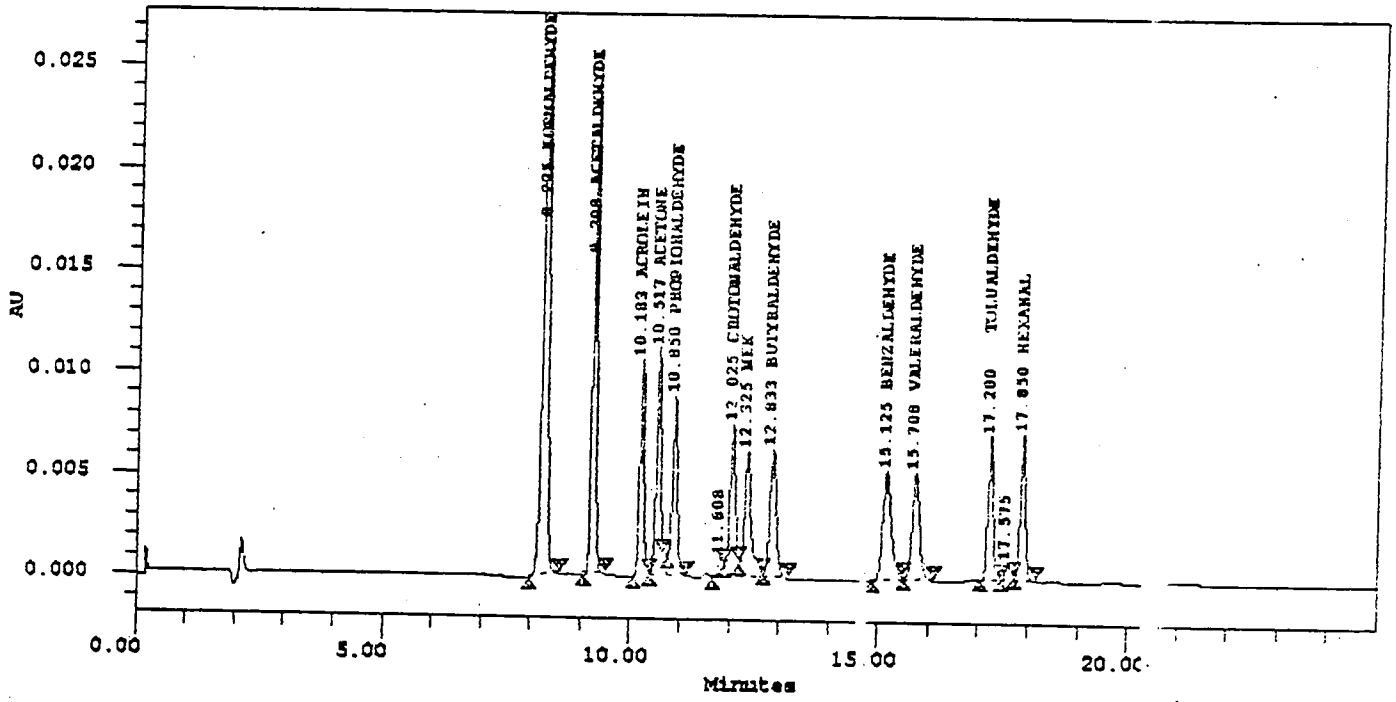
9.1 Hull, L.A., Procedures for 2,4-Dinitrophenylhydrazone Aldehyde-Ketone Air Analysis, Internal Report at U.S. EPA.

9.2 Shriner, R.L. and Fuson, R.C., Identification of Organic Compounds, 2nd. Ed., John Wiley and Sons, Inc., 1940, p. 143.

9.3 U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (Method TO3-15), EPA-600/4-89-017, Research Triangle Park, North Carolina, June 1989.

Fig. 1

Method 1004:
Sample Chromatogram for Aldehydes & Ketones



Peak Results

#	Name	Ret Time (min)	Area (uV*sec)	Height (uV)	Amount	Int Type
1	FORMALDEHYDE	8.225	212902	26141		BB
2	ACETALDEHYDE	9.208	141256	24511		BB
3	ACROLEIN	10.183	66374	10635		BV
4	ACETONE	10.517	73783	11335		VV
5	PROPIONALDEHYDE	10.850	62558	8847		VB
6		11.808	7410	988		VV
7	CROTONALDEHYDE	12.025	62360	7541		VV
8	MEK	12.325	62406	6216		VV
9	BUTYRALDEHYDE	12.833	58260	6345		VB
10	BENZALDEHYDE	15.125	63915	539		BV
11	VALERALDEHYDE	15.708	55597	533		VB
12	TOLUALDEHYDE	17.200	52796	721		VV
13		17.575	7199	89		VV
14	HEXANAL					

AIR RESOURCES BOARD

DETERMINATION OF OXYGENATED COMPOUNDS IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1005

California Air Resources Board
Southern Laboratory Branch
Monitoring and Laboratory Division
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This has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policy of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

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1. INTRODUCTION

1.1 This document describes a method of sampling and analyzing automotive exhaust for oxygenated compounds. Currently, the target oxygenates are methyl tertiary-butyl ether (MTBE) and ethyl tertiary-butyl ether (ETBE).

1.2 This procedure involves flowing diluted engine exhaust into Tedlar bags and analyzing this solution by gas chromatography (GC).

1.3 This method is currently under development.

2. METHOD SUMMARY

2.1 The samples are received by the laboratory in Tedlar bags. Compound separation and anaysis are performed using a GC. The sample is injected into the GC by means of a gas sampling valve system with a pump. Separation of the sample mixture into its component constituents takes place on a capillary column operated with a temperature gradient. A thermionic ionization detector (TID) is used for oxygenate detection.

2.2 The computerized GC data system identifies the oxygenate associated with each of the chromatographic peaks. The oxygenate concentrations are determined by integrating the peak areas and using calibration factors determined with external standards.

3. INTERFERENCES AND LIMITATIONS

3.1 An interference is any oxygenated component present in the sample with a retention time similar to that of the target oxygenate described in this method. Proof of chemical identity may require performance of periodic confirmations using an alternate method and/or instrumentation, e.g., gas chromatograph/mass spectrometer (GC/MS).

4. INSTRUMENTATION AND APPARATUS

4.1 A Tedlar bag is used to contain the sample for each mode of the test. Each bag is 2 mm thick, has a capacity of 5 to 10 liters,and is equipped with quick-connect fittings.

4.1.1 A temperature-progammable GC, equipped with a gas sampling valve system, a DB-1 Megabore column (30 meter (m), 0.53 millimeter (mm) ID, 1.5 micron (u) film thickness) and a TID. A different column may be used, provided that it is demonstrated to the Executive Officer of the Air Resources Board to be equivalent to or better than the specified column with respect to precision, accuracy, and resolution of all the target oxygenates.

4.1.2 A PC-controlled data acquisition system for quantitation of peak areas is required.

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5. REAGENTS AND MATERIALS

5.1 Standards

5.1.1 A gas phase calibration standard contains all of the oxygenates of interest, with the balance nitrogen. Figure 1 illustrates a typical chromatogram of the analysis of MTBE.

5.1.2 A gas phase control standard contains all of the oxygenates of interest, with the balance nitrogen. This standard, at the approximate concentration of the samples, is used to update control charts for each target alcohol.

5.2 Gas Requirements

5.2.1 Air shall be "Zero" grade.

5.2.2 Nitrogen shall have a minimum purity of 99.998 percent.

5.2.3 Helium shall have a minimum purity of 99.995 percent.

6. PROCEDURE

6.1 A 10 mL aliquot of each unmodified sample is injected into a GC, configured as follows:

Column: DB-1, 30 m, 0.53 mm ID, 1.5 u film thickness
Carrier gas: Helium at 6 milliliters per minute (ml/min)
Detector: TID, 320 °C, Nitrogen at 115 ml/min
Injector: Air-actuated gas sample valve system with 10 mL fixed volume sample loop
Temperature: 0°C (5 min), 0°C to 200°C (30°C/min, hold 8.34 min)
Data system: PC-based data acquisition system

Other operating conditions may be substituted provided that they can be demonstrated to the Executive Officer of the Air Resources Board to produce resolution, precision, and accuracy equivalent to or better than this method.

6.2.1 One calibration standard, one control standard, and one nitrogen blank are analyzed daily at the beginning of each set of samples.

6.2.2 A replicate analysis is performed at least once per sample batch.

6.2.3 The control standard is repeated at the end of the sample batch or day.

6.3 For compounds having concentrations above the documented range of instrument linearity, the sample must be diluted and reanalyzed.

6.4 The peak integrations are corrected as necessary in the data system. Any misplaced baseline segments are corrected in the reconstructed chromatogram.

1. Obtain at least 20 daily control sample results,

2. Calculate the average control sample concentration and standard deviation(s) for the target analyte(s), and

3. Create a control chart for each target analyte by placing the concentration on the Y-axis and the date on the X-axis. Draw an upper warning limit and a lower warning limit at two standard deviations (2s) above and below the average concentration. Draw an upper control limit and a lower control limit at three standard deviations (3s) above and below the average concentration.

The control sample must be "in-control" for all target analytes for the sample results to be considered acceptable. A control sample measurement is considered to be "out-of-control" when the analyzed value exceeds the 3s limit, or two successive control sample measurements of the same analyte exceed the 2s limit.

8.6 Duplicates

A duplicate analysis of one sample is performed at least once a day.

The relative percent difference (RPD) is calculated for each duplicate run:

$$\text{RPD (\%)} = \frac{\text{Difference between duplicate and original measurements}}{\text{Average of duplicate and original measurements}} \times 100$$

For each compound, the allowable RPD for each duplicate run depends on the average concentration level of the duplicate runs, as shown in the following table:

Average Measurement for Duplicate Runs	Allowable RPD (%)
1 to 10 times LOD	100
10 to 20 times LOD	30
20 to 50 times LOD	20
Greater than 50 times LOD	15

If the results of the duplicate analyses do not meet these criteria for all target oxygenates, the sample must be reanalyzed. If the criteria are still not met, all samples for the day/shift must be reanalyzed or deleted.

8.7 Linearity

A multipoint calibration to check for instrument linearity is performed for all target oxygenates at least once every six months. The multipoint calibration consists of at least five concentration or mass loading levels above the LOD, evenly distributed over the range of expected sample concentration. Each concentration level is measured at least twice. A linear regression analysis is performed using concentration and area counts to determine the regression correlation coefficient (r). The r must be greater than 0.995 to be considered sufficiently linear for one point calibrations.

6.4.1 The peak identifications provided by the computer are checked and corrected if necessary.

6.4.2 The level of peak rejection is set just below the lowest limit of detection (LOD).

7. CALCULATIONS

7.1 The concentration, in ppm, of each target oxygenate is determined by the following calculation that compares the sample peak area with that of an external standard:

$$\text{Concentration}_{\text{sample}} = \text{Area}_{\text{sample}} \times \text{Response Factor}$$

7.2 The response factor (RF) is calculated by:

$$RF = \frac{\text{Concentration}_{\text{standard}}}{\text{Peak Area}_{\text{standard}}}$$

8. QUALITY CONTROL

8.1 Calibration and control standards will be analyzed by FTIR upon arrival to confirm the concentration of the target sompounds and on a weekly basis to determine stability.

8.2 Blank Run

A blank run is performed before running the calibration standard, control standard, and samples. All target oxygenate concentrations in the blank must be below the LOD before the analysis may proceed.

8.3 Calibration Run

One run of the calibration standard is performed to generate the response factor(s) needed for quantitating sample analyses.

8.4 Control Standard Run

One run of the quality control standard is performed after the calibration run. Measurements of all target oxygenates in the control standard must fall within the control limits before sample analysis may proceed. To meet this requirement, it may be necessary to inspect and repair the GC and/or rerun the calibration and/or control standards.

8.5 Control Charts

Quality control chart(s) are maintained for each analyte of the control sample. The control charts, used on a daily basis, establishes that the method is in "statistical control". The following describes how to construct a typical control chart:

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8.8 Limit of Detection

The limit of detection for the target oxygenates must be determined at least every six months. To make the necessary calculations, it is necessary to perform a multipoint calibration consisting of at least four "low" concentration levels, all above the LOD. The LOD must be calculated using the following equation (Ref 9.2):

$$LOD = |\underline{A}| + 3.3(\underline{S})$$

where each term in the equation is expressed in concentration units, and $|\underline{A}|$ is the absolute value of the least squares X-intercept calculated from the multipoint data.

$\underline{S}$ is the standard deviation of replicate determinations of the lowest standard. At least three replicates are required. The concentation of the lowest standard must be one to five times the estimated detection limit. If data is not available in the concentration range near the detection limit, $\underline{S}$ may be estimated by:

$$\underline{S} = RSD \times |\underline{A}|$$

where RSD is the relative standard deviation of the lowest standard analyzed.

9. REFERENCES

U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (Method TO3-15), EPA-600/4-89-017, Research Triangle Park, North Carolina, June 1989.

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AIR RESOURCES BOARD

DETERMINATION OF

NMOG MASS EMISSIONS

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This has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policy of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

DETERMINATION OF NMOG MASS EMISSIONS

1. INTRODUCTION

1.1 Non-methane organic gases (NMOG) mass emissions consist of non-methane hydrocarbons and oxygenated hydrocarbons.

2. NMOG WEIGHTED MASS EMISSIONS

2.1 NMOG weighted mass (wm) emissions shall be calculated as follows:

$$NMOG_{wm} = \Sigma NMHC_{wm} + \Sigma ROH_{wm} + \Sigma RHO_{wm} + \Sigma R\theta R_{wm}$$

Non-methane hydrocarbon weighted mass emissions ($NMHC_{wm}$) can be determined by either flame ionization detection (FID) or gas chromatography (GC). If the FID method is used to calculate $NMHC_{wm}$, refer to "Determination of Non-Methane Hydrocarbon Mass Emissions by Flame Ionization Detection". If the GC method is used to calculate $NMHC_{wm}$, refer to the "Speciated Hydrocarbon Mass Emissions Calculation" section contained herein. Carbonyl weighted mass emissions (RHO_{wm}) are to be calculated according to the "Carbonyl Mass Emissions Calculation" section contained herein. For alcohol fueled vehicles, alcohol weighted mass emissions (ROH_{wm}) are to be calculated according to the "Alcohol Mass Emissions Calculation" section contained herein. Ethers weighted mass emissions ($R\theta R_{wm}$) are to be treated as speciated hydrocarbons and determined by the "Speciated Hydrocarbon Mass Emissions Calculation" section.

SPECIATED HYDROCARBON MASS EMISSIONS CALCULATION

1. INTRODUCTION

1.1 Vehicular exhaust emissions are measured according to the Federal Test Procedure (FTP)(1). For each of the three phases of the FTP, a tedlar bag of 0.5 ft^3 capacity is used to collect a dilute exhaust sample. A fourth 0.5 ft^3 tedlar bag is used to collect a composite dilution air (background) sample from all three phases of the FTP. All bag samples are analyzed according to method no. 1002 and method no. 1003 to determine the dilute exhaust and dilution air concentrations of individual hydrocarbon compounds. The measured hydrocarbon compound concentrations are used in the following equations to calculate the weighted mass emissions of each hydrocarbon compound.

2. HC MASS EMISSIONS CALCULATION PER TEST PHASE

2.1 $$HC_{mass_n} = (HC_{conc} * HC_{dens} * VMIX * 10^{-6}) / (\text{Carbon No.})$$

2.2 $$HC_{conc} = HC_e - (HC_d * (1 - (1 / DF)))$$

NOTE: If HC_{conc} is calculated to be less than zero, then $HC_{conc} = 0$.

3. WEIGHTED HC MASS EMISSIONS CALCULATION

3.1 $$HC_{wm} = 0.43 * \frac{(HC_{mass_1} + HC_{mass_2})}{(D_{phase_1} + D_{phase_2})} + 0.57 * \frac{(HC_{mass_3} + HC_{mass_2})}{(D_{phase_3} + D_{phase_2})}$$

4. SAMPLE CALCULATION

4.1 Exhaust emissions from a gasoline vehicle are collected in three dilute exhaust sample bags and one dilution air (background) sample bag during the FTP. Gas chromatography is used to determine the benzene concentration of each bag sample. Calculate the weighted benzene mass emissions based on the following data:

Test Phase	HC_e (ppbC)	HC_d (ppbC)	FID THC_e (ppmC)	CH_{4e} (ppmC)	CO_{2e} (%)	CO_{em} (ppm)	R_a (%)	VMIX (ft^3)	D_{phase_n} (mile)
1	500	25	98	6	1.20	280	28	2846	3.584
2	100	25	22	4	0.95	87	25	4854	3.842
3	120	25	29	5	1.07	101	24	2840	3.586

For Phase 1:

$$DF = 13.46 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}] \quad \text{(see DF Calc.)}$$

$$NMHC_e = \text{FID } THC_e - (r_{CH_4} * CH_{4e})$$

$$= 98 \text{ ppmC} - (1.20 * 6 \text{ ppmC})$$

$$= 90.8 \text{ ppmC}$$

$$CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

$$= (1 - (0.01925) * 1.2\% - 0.000323 * 28\%) * 280 \text{ ppm}$$

$$= 271 \text{ ppm}$$

$$DF = 13.46 / [1.2\% + (90.8 \text{ ppmC} + 6 \text{ ppmC} + 271 \text{ ppm}) * 10^{-4}]$$

$$= 10.88$$

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

$$= 500 \text{ ppbC} - (25 \text{ ppbC} * (1 - (1 / 10.88)))$$

$$= 477 \text{ ppbC}$$

$$\text{Mol. Wt. of } C_6H_6 = (6 * 12.01115) + (6 * 1.00797)$$

$$= 78.11472 \text{ g/mole}$$

$$HC_{dens} = (\text{Mol. Wt.} * \text{conversion of liter to ft}^3) / (\text{Mol. Vol.})$$

$$= (78.11472 \text{ g/mole} * 28.316 \text{ liter/ft}^3) / 24.055 \text{ liter/mole}$$

$$= 91.952 \text{ g/ft}^3$$

$$HC_{mass_n} = (HC_{conc} * HC_{dens} * VMIX * 10^{-6}) / (\text{Carbon No.})$$

$$HC_{mass_1} = (477 \text{ ppbC} * 91.952 \text{ g/ft}^3 * 2846 \text{ ft}^3 * 10^{-6}) / 6$$

$$= 20.82 \text{ mg}$$

Similarly, for Phase 2:

$$HC_{mass_2} = 5.71 \text{ mg}$$

and for Phase 3:

$$HC_{mass_3} = 4.22 \text{ mg}$$

Therefore,

$$HC_{wm} = 0.43 * \frac{(HC_{mass_1} + HC_{mass_2})}{(D_{phase_1} + D_{phase_2})} + 0.57 * \frac{(HC_{mass_3} + HC_{mass_2})}{(D_{phase_3} + D_{phase_2})}$$

$$HC_{wm} = 0.43 * \frac{(20.82 \text{ mg} + 5.71 \text{ mg})}{(3.584 \text{ mile} + 3.842 \text{ mile})} + 0.57 * \frac{(4.22 \text{ mg} + 5.71 \text{ mg})}{(3.586 \text{ mile} + 3.842 \text{ mile})}$$

$HC_{wm} = 2.30$ mg/mile (benzene weighted mass emissions)

ALCOHOL MASS EMISSIONS CALCULATION

1. INTRODUCTION

1.1 Vehicular emissions are measured according to the Federal Test Procedure (FTP)(1). For each of the three phases of the FTP, a set of two impingers is used to collect alcohol emissions in the dilute exhaust. A fourth set of two impingers is used to collect a composite dilution air (background) alcohol sample from all three phases of the FTP. All impingers are analyzed according to method no. 1001 to determine the alcohol concentration in each impinger. The measured alcohol concentrations are used in the following equations to calculate the weighted mass emissions of alcohol compounds.

2. ALCOHOL MASS EMISSIONS CALCULATION PER TEST PHASE

2.1 $ROH_{mass_n} = (ROH_{conc} * ROH_{dens} * VMIX * 10^{-6}) / (Carbon\ No.)$

2.2 $ROH_{conc} = ROH_e - (ROH_d * (1 - (1 / DF)))$

NOTE: If ROH_{conc} is calculated to be less than zero, then $ROH_{conc} = 0$.

2.3 $ROH_e = (Imass_e / Ivol_e) * (Mol.\ Vol. / Mol.\ Wt.)$

2.4 $Imass_e = (Iconc_{e1} + Iconc_{e2}) * Dens_{ROH} * Ivol_r$

2.5 $Ivol_e = Ivol_{em} * (Itemp_e / 293.16^{\circ}K) * (760\ mm\ Hg / P_B)$

2.6 $ROH_d = (Imass_d / Ivol_d) * (Mol.\ Vol. / Mol.\ Wt.)$

2.7 $Imass_d = (Iconc_{d1} + Iconc_{d2}) * Dens_{ROH} * Ivol_r$

2.8 $Ivol_d = Ivol_{dm} * (Itemp_d / 293.16^{\circ}K) * (760\ mm\ Hg / P_B)$

3. WEIGHTED ALCOHOL MASS EMISSIONS CALCULATION

3.1 $$ROH_{wm} = 0.43 * \frac{(ROH_{mass_1} + ROH_{mass_2})}{(D_{phase_1} + D_{phase_2})} + 0.57 * \frac{(ROH_{mass_3} + ROH_{mass_2})}{(D_{phase_3} + D_{phase_2})}$$

4. SAMPLE CALCULATION

4.1 Alcohol emissions from an M85 fueled vehicle are collected in three sets of dilute exhaust impingers and one set of dilution air impingers during the FTP. Gas chromatography is used to determine the methanol concentration in each impinger. Calculate the weighted methanol mass emissions based on the following data:

Test Phase	$Ivol_r$ (ml)	$Iconc_{e1}$ (ppmC)	$Iconc_{e2}$ (ppmC)	$Ivol_{em}$ (liter)	$Iconc_{d1}$ (ppmC)	$Iconc_{d2}$ (ppmC)	$Ivol_{dm}$ (liter)	$Itemp_e$ (^oK)	$Itemp_d$ (^oK)
1	15	2.24	0.05	3.90	0.07	0.01	13.50	295	294
2	15	0.29	0.06	6.50	0.07	0.01	13.50	297	294
3	15	0.32	0.02	4.00	0.07	0.01	13.50	298	294

Test Phase	FID THC_e (ppmC)	CH_{4e} (ppmC)	CO_{2e} (%)	CO_{em} (ppm)	R_a (%)	VMIX (ft^3)	D_{phase_n} (mile)	P_B (mm Hg)	$HCHO_e$ (ppm)
1	82	9	1.5	250	30	2834	3.581	760	0.81
2	19	5	0.7	20	32	4862	3.845	760	0.09
3	22	6	0.8	32	29	2835	3.583	760	0.10

For Phase 1:

$$Imass_e = (Iconc_{e1} + Iconc_{e2}) * Dens_{ROH} * Ivol_r$$

$$= (2.24 \text{ ppmC} + 0.05 \text{ ppmC}) * 0.7914 \text{ g/ml} * 15 \text{ ml} * 10^6 \text{ ug/g}$$

$$= 27.2 \text{ ug}$$

Mol. Wt. of $CH_3OH = (1 * 12.01115) + (4 * 1.00797) + (1 * 15.9994)$

$$= 32.0428 \text{ g/mole}$$

$$Ivol_e = Ivol_{em} * (Itemp_e / 293.16^oK) * (760 \text{ mm Hg} / P_B)$$

$$= 3.90 \text{ liter} * (295^oK / 293.16^oK) * (760 \text{ mm Hg} / 760 \text{ mm Hg})$$

$$= 3.92 \text{ liter}$$

$$ROH_e = (Imass_e / Ivol_e) * (\text{Mol. Vol.} / \text{Mol. Wt.})$$

$$= (27.2 * 10^{-6}\text{g} / 3.92 \text{ liter}) * (24.37 \text{ liter/mole} / 32.0428 \text{ g/mole})$$

$$= 5.27 \text{ ppmC}$$

$$Imass_d = (Iconc_{d1} + Iconc_{d2}) * Dens_{ROH} * Ivol_r$$

$$= (0.07 \text{ ppmC} + 0.01 \text{ ppmC}) * 0.7914 \text{ g/ml} * 15 \text{ ml} * 10^6 \text{ ug/g}$$

$$= 0.95 \text{ ug}$$

$Ivol_d = Ivol_{dm} * (Itemp_d / 293.16^oK) * (760\ mm\ Hg / P_B)$

$= 13.50\ liter * (294^oK / 293.16^oK) * (760\ mm\ Hg / 760\ mm\ Hg)$

$= 13.54\ liter$

$ROH_d = (Imass_d / Ivol_d) * (Mol.\ Vol. / Mol.\ Wt.)$

$= (0.95 * 10^{-6} g / 13.54\ liter) * (24.37\ liter/mole / 32.0428\ g/mole)$

$= 0.05\ ppmC$

$DF = 12.01 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e + ROH_e + HCHO_e) * 10^{-4}]$ (see DF Calc.)

$NMHC_e = FID\ THC_e - (r_{CH_4} * CH_{4e}) - (r_{CH_3OH} * ROH_e)$

$= 82\ ppmC - (1.20 * 9\ ppmC) - (0.78 * 5.27\ ppmC)$

$= 67\ ppmC$

$CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

$= (1 - (0.02705) * 1.5\% - 0.000323 * 30\%) * 250\ ppm$

$= 237\ ppm$

$DF = 12.01 / [1.5\% + (67ppmC + 9ppmC + 236ppm + 5.30ppmC + 0.81ppm) * 10^{-4}]$

$= 7.84$

$ROH_{conc} = ROH_e - (ROH_d * (1 - (1 / DF)))$

$= 5.27\ ppmC - (0.05\ ppmC * (1 - (1 / 7.84)))$

$= 5.22\ ppmC$

$ROH_{dens} = (Mol.\ Wt. * conversion\ of\ liter\ to\ ft^3) / (Mol.\ Vol.)$

$= (32.0428\ g/mole * 28.316\ liter/ft^3) / 24.055\ liter/mole$

$= 37.719\ g/ft^3$

$ROH_{mass_n} = (ROH_{conc} * ROH_{dens} * VMIX * 10^{-6}) / (Carbon\ No.)$

$ROH_{mass_1} = (5.22\ ppmC * 37.719\ g/ft^3 * 2834\ ft^3 * 10^{-6}) / 1$

$= 0.56\ g$

Similarly, for Phase 2:

$$ROH_{mass_2} = 0.08 \text{ g}$$

and for Phase 3:

$$ROH_{mass_3} = 0.08 \text{ g}$$

Therefore,

$$ROH_{wm} = 0.43 * \frac{(ROH_{mass_1} + ROH_{mass_2})}{(D_{phase_1} + D_{phase_2})} + 0.57 * \frac{(ROH_{mass_3} + ROH_{mass_2})}{(D_{phase_3} + D_{phase_2})}$$

$$= 0.43 * \frac{(0.56 \text{ g} + 0.08 \text{ g})}{(3.581 \text{ mile} + 3.845 \text{ mile})} + 0.57 * \frac{(0.08 \text{ g} + 0.08 \text{ g})}{(3.583 \text{ mile} + 3.845 \text{ mile})}$$

ROH_{wm} = 0.05 g (methanol weighted mass emissions)

CARBONYL MASS EMISSIONS CALCULATIONS

1. INTRODUCTION

1.1 Vehicular emissions are measured according to the Federal Test Procedure (FTP)(1). For each of the three phases of the FTP, a set of two impingers is used to collect carbonyl emissions in the dilute exhaust. A fourth set of two impingers is used to collect a composite dilution air (background) carbonyl sample from all three phases of the FTP. All impingers are analyzed according to method no. 1004 to determine the mass of individual carbonyl compounds in each impinger. The measured carbonyl masses are used in the following equations to calculate the weighted mass emissions of each carbonyl compound.

2. CARBONYL MASS EMISSIONS CALCULATION PER TEST PHASE

2.1 $RHO_{mass_n} = (RHO_{conc} * RHO_{dens} * VMIX * 10^{-6}) \div$ (Garbon No.)

2.2 $RHO_{conc} = RHO_e - (RHO_d * (1 - (1 / DF)))$

NOTE: If RHO_{conc} is calculated to be less than zero, then $RHO_{conc} = 0$.

2.3 $RHO_e = (Imass_e / Ivol_e) * (Mol.\ Vol. / Mol.\ Wt.)$

2.4 $Ivol_e = Ivol_{em} * (Itemp_e / 293.16^{\circ}K) * (760\ mm\ Hg / P_B)$

2.5 $RHO_d = (Imass_d / Ivol_d) * (Mol.\ Vol. / Mol.\ Wt.)$

2.6 $Ivol_d = Ivol_{dm} * (Itemp_d / 293.16^{\circ}K) * (760\ mm\ Hg / P_B)$

3. WEIGHTED CARBONYL MASS EMISSIONS CALCULATION

3.1 $$RHO_{wm} = 0.43 * \frac{(RHO_{mass_1} + RHO_{mass_2})}{(D_{phase_1} + D_{phase_2})} + 0.57 * \frac{(RHO_{mass_3} + RHO_{mass_2})}{(D_{phase_3} + D_{phase_2})}$$

4. SAMPLE CALCULATION

4.1 Carbonyl emissions from a compressed natural gas (CNG) vehicle are collected in three sets of dilute exhaust impingers and one set of dilution air impingers during the FTP. High performance liquid chromatography is used to determine the formaldehyde mass in each impinger. Calculate the weighted formaldehyde mass emissions based on the following data:

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Test Phase	$Ivol_r$ (ml)	$Imass_e$ (ug)	$Ivol_{em}$ (liter)	$Imass_d$ (ug)	$Ivol_{dm}$ (liter)	$Itemp_e$ (^oK)	$Itemp_d$ (^oK)
1	15	2.45	8.49	0.17	31.57	295	292
2	15	0.76	14.55	0.17	31.57	298	292
3	15	0.64	4.00	0.17	31.57	298	292

Test Phase	FID THC_e (ppmC)	CH_{4e} (ppmC)	CO_{2e} (%)	CO_{em} (ppm)	R_a (%)	VMIX (ft^3)	D_{phase_n} (mile)	P_B (mm Hg)
1	132	108	0.9	8	68	2866	3.581	760
2	4	3	0.1	4	67	4841	3.845	760
3	22	9	0.5	5	65	2837	3.583	760

For Phase 1:

Mol. Wt. of HCHO = (1 * 12.01115) + (2 * 1.00797) + (1 * 15.9994)

= 30.0268 g/mole

$Ivol_e = Ivol_{em} * (Itemp_e / 293.16^oK) * (760 \text{ mm Hg} / P_B)$

= 8.49 liter * (295^oK / 293.16^oK) * (760 mm Hg / 760 mm Hg)

= 8.54 liter

$RHO_e = (Imass_e / Ivol_e) * (\text{Mol. Vol.} / \text{Mol. Wt.})$

= ($2.45 * 10^{-6}$g / 8.54 liter) * (24.24 liter/mole / 30.0268 g/mole)

= 232 ppbC

$Ivol_d = Ivol_{dm} * (Itemp_d / 293.16^oK) * (760 \text{ mm Hg} / P_B)$

= 31.57 liter * (292^oK / 293.16^oK) * (760 mm Hg / 760 mm Hg)

= 31.45 liter

$RHO_d = (Imass_d / Ivol_d) * \text{Mol. Vol.} / \text{Mol. Wt.}$

= ($0.17 * 10^{-6}$g / 31.45 liter) * (24.24 liter/mole / 30.0268 g/mole)

= 4.36 ppbC

$$DF = 9.76 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$$ (see DF Calc.)

$$NMHC_e = FID\ THC_e - (r_{CH_4} * CH_{4e})$$

$$= 132\ ppmC - (1.20 * 108\ ppmC)$$

$$= 2.4\ ppmC$$

$$CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

$$= (1 - 0.02900 * 0.9\% - 0.000323 * 68\%) * 8\ ppm$$

$$= 7.6\ ppm$$

$$DF = 9.76 / [0.9\% + (2.4\ ppmC + 108\ ppmC + 7.6\ ppm) * 10^{-4}]$$

$$= 10.70$$

$$RHO_{conc} = RHO_e - (RHO_d * (1 - (1 / DF)))$$

$$= 232\ ppbC - (4.36\ ppbC * (1 - (1 / 10.70)))$$

$$= 228\ ppbC$$

$$RHO_{dens} = (Mol.\ Wt.) * (conversion\ of\ liter\ to\ ft^3) / (Mol.\ Vol.)$$

$$= (30.0268\ g/mole * 28.316\ liter/ft^3) / 24.237\ liter/mole$$

$$= 35.080\ g/ft^3$$

$$RHO_{mass_n} = (RHO_{conc} * RHO_{dens} * VMIX * 10^{-6}) / (Carbon\ No.)$$

$$RHO_{mass_1} = (228\ ppbC * 35.080\ g/ft^3 * 2866\ ft^3 * 10^{-6}) / 1\ carbon\ atom$$

$$= 22.9\ mg$$

Similarly, for Phase 2:

$$RHO_{mass_2} = 6.3\ mg$$

and for Phase 3:

$$RHO_{mass_3} = 12.2\ mg$$

Therefore,

$$RHO_{wm} = 0.43 * \frac{(RHO_{mass_1} + RHO_{mass_2})}{(D_{phase_1} + D_{phase_2})} + 0.57 * \frac{(RHO_{mass_3} + RHO_{mass_2})}{(D_{phase_3} + D_{phase_2})}$$

$$RHO_{wm} = 0.43 * \frac{(22.9\ mg + 6.3\ mg)}{(3.581\ mile + 3.845\ mile)} + 0.57 * \frac{(12.2\ mg + 6.3\ mg)}{(3.583\ mile + 3.845\ mile)}$$

RHO_{wm} = 3.1 mg/mile (formaldehyde weighted mass emissions)

DILUTION FACTOR CALCULATION

1. DILUTION FACTORS

1.1 For Non-Alcohol Fueled Vehicles:

1.1.1 $$DF = \frac{100 * \frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)}}{CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}}$$

(where fuel composition is $C_xH_yO_z$ as measured for the fuel used.)

1.1.2 $$CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

a) For gasoline, $CH_{1.85}$, where x = 1, y = 1.85, and z = 0:

$$DF = 13.46 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$$

$$CO_e = (1 - 0.01925 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

b) For LPG, $CH_{2.66}$, where x = 1, y = 2.66, and z = 0:

$$DF = 11.63 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$$

$$CO_e = (1 - 0.02330 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

c) For CNG, $CH_{3.80}$, where x = 1, y = 3.80, and z = 0:

$$DF = 9.76 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$$

$$CO_e = (1 - 0.02900 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

1.2 For Alcohol Fueled Vehicles:

1.2.1 $$DF = \frac{100 * \frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)}}{CO_{2e} + (NMHC_e + CH_4 + CO_e + ROH_e + HCHO_e) * 10^{-4}}$$

(where fuel composition is $C_xH_yO_z$ as measured for the fuel used.)

1.2.2 $$CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.

a) For M100 (100% methanol), CH_3OH, where x = 1, y = 4, and z = 1:

$$DF = 11.57 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e + ROH_e + HCHO_e) * 10^{-4}]$$

$$CO_e = (1 - 0.03000 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

b) For M85 (85% methanol, 15% indolene), $CH_{3.41}O_{0.72}$, where x = 1, y = 3.41, and z = 0.72:

$$DF = 12.01 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e + ROH_e + HCHO_e) * 10^{-4}]$$

$$CO_e = (1 - 0.02705 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

c) For E100 (100% ethanol), C_2H_5OH, where x = 1, y = 3, and z = 0.5:

$$DF = 12.27 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e + ROH_e + HCHO_e) * 10^{-4}]$$

$$CO_e = (1 - 0.02500 * CO_{2e} - 0.000323 * R_a) * CO_{em}$$

DEFINITIONS

Carbon No. = number of carbon atoms in the hydrocarbon or organic compound being measured.

CH_{4e} = methane concentration in the dilute exhaust, ppmC.

CO_e = carbon monoxide concentration in the dilute exhaust corrected for carbon dioxide and water removal, ppm.

CO_{em} = carbon monoxide concentration in the dilute exhaust uncorrected for carbon dioxide and water removal, ppm.

CO_{2e} = carbon dioxide concentration in the dilute exhaust, %.

D_{phase_n} = distance driven by the test vehicle on a chassis dynamometer during test phase n (where n is either 1, 2, or 3), mile.

$Dens_{ROH}$ = density of alcohol, g/ml.

DF = dilution factor (see Dilution Factor Calculation).

FID THC_e = total hydrocarbon concentration including methane and alcohol in the dilute exhaust as measured by the FID, ppmC.

HC_{conc} = net concentration of an HC compound in the dilute exhaust corrected for background per test phase, ppbC.

HC_d = composite concentration of an HC compound in the dilution air (background) for all three test phases as determined from the composite dilution air sample using the procedure specified in method no. 1002 and method no. 1003, ppbC.

HC_{dens} = mass per unit volume of an HC compound corrected to standard conditions (293.16°K and 760 mm Hg), g/ft^3.

HC_e = concentration of an HC compound in the dilute exhaust per test phase as determined from the dilute exhaust sample using the procedure specified in method no. 1002 and method no. 1003, ppbC.

HC_{mass_n} = mass emissions of an HC compound per test phase n (where n is either 1, 2, or 3), mg.

HC_{wm} = total weighted mass emissions of an HC compound per mile, g/mile.

$HCHO_e$ = formaldehyde concentration in the dilute exhaust as determined from the dilute exhaust carbonyl sample using the procedure specified in method no. 1004, ppm.

HCR = hydrogen-to-carbon ratio for the fuel used.

$Iconc_{d1}$ = dilution air (background) alcohol concentration in the primary impinger for all three test phases as determined by the procedure specified in method no. 1001, ppmC.

$Iconc_{d2}$ = dilution air (background) alcohol concentration in the secondary impinger for all three test phases as determined by the procedure specified in method no. 1001, ppmC.

$Iconc_{e1}$ = dilute exhaust alcohol concentration in the primary impinger per test phase as determined by the procedure specified in method no. 1001, ppmC.

$Iconc_{e2}$ = dilute exhaust alcohol concentration in the secondary impinger per test phase as determined by the procedure specified in method no. 1001, ppmC.

$Imass_d$ = total mass of an alcohol or carbonyl compound collected from the dilution air (background) in both primary and secondary impingers for all three test phases as determined by the procedure specified in method no. 1001 (alcohol) or method no. 1004 (carbonyl), ug.

$Imass_e$ = total mass of an alcohol or carbonyl compound collected from the dilute exhaust in both primary and secondary impingers per test phase as determined by the procedure specified in method no. 1001 (alcohol) or method no. 1004 (carbonyl), ug.

$Itemp_d$ = dilution air temperature at the flowmeter inlet for impinger sampling, ^{o}K.

$Itemp_e$ = dilute exhaust temperature at the flowmeter inlet for impinger sampling, ^{o}K.

$Ivol_d$ = total volume of dilution air (background) bubbled through the impingers for all three test phases corrected to standard conditions ($293.16^{o}K$ and 760 mm Hg), liter.

$Ivol_{dm}$ = total volume of dilution air (background) bubbled through the impingers for all three test phases as measured during testing, liter.

$Ivol_e$ = total volume of dilute exhaust bubbled through the impingers per test phase corrected to standard conditions ($293.16^{o}K$ and 760 mm Hg), liter.

$Ivol_{em}$ = total volume of dilute exhaust bubbled through the impingers per test phase as measured during testing, liter.

$Ivol_r$ = volume of the reagent used in an impinger, ml.

Mol. Vol. = molecular volume which is 24.055 liter/mole at standard conditions (293.16°K and 760 mm Hg).

Mol. Wt. = molecular weight of the compound being measured, g/mole.

$NMHC_e$ = non-methane hydrocarbon concentration in the dilute exhaust corrected for methane and alcohol removal, ppmC.

P_B = barometric pressure during testing, mm Hg.

R_a = relative humidity of the ambient air, %.

r_{CH_3OH} = FID response factor to methanol (see CFR 40, 86.121-90(c)).

r_{CH_4} = FID response factor to methane (see "Determination of NMHC by FID", section 4).

$r_{C_2H_5OH}$ = FID response factor to ethanol (same procedure for methanol response factor, see CFR 40, 86.121-90(c)).

RHO = generic symbol representing a carbonyl compound such as formaldehyde, acetaldehyde, acetone, etc.

RHO_{conc} = net concentration of a carbonyl compound in the dilute exhaust corrected for background per test phase, ppmC.

RHO_d = composite concentration of a carbonyl compound in the dilution air (background) for all three test phases, ppmC.

RHO_{dens} = mass per unit volume of a carbonyl compound corrected to standard conditions (293.16°K and 760 mm Hg), g/ft^3.

RHO_e = concentration of a carbonyl compound in the dilute exhaust per test phase, ppmC.

RHO_{mass_n} = mass emissions of a carbonyl compound per test phase n (where n is either 1, 2, or 3), g.

RHO_{wm} = total weighted mass emissions of a carbonyl compound per mile, g/mile.

ROH = generic symbol representing an alcohol compound such as methanol or ethanol.

ROH_{conc} = net concentration of an alcohol compound in the dilute exhaust corrected for background per test phase, ppmC.

ROH_d = composite concentration of an alcohol compound in the dilution air (background) for all three test phases, ppmC.

ROH_{dens} = mass per unit volume of an alcohol compound corrected to standard conditions (293.16°K and 760 mm Hg)., g/ft^3.

ROH_e = concentration of an alcohol compound in the dilute exhaust per test phase, ppmC.

ROH_{mass_n} = mass emissions of an alcohol compound per test phase n (where n is either 1, 2, or 3), g.

ROH_{wm} = total weighted mass emissions of an alcohol compound per mile, g/mile.

ROR = ~~generic symbol representing an ether compound such as MTBE.~~

ROR_{wm} = ~~total weighted mass emissions of an ether compound per mile, g/mile.~~

VMIX = total dilute exhaust volume measured per test phase corrected to standard conditions (293.16°K and 760 mm Hg), ft^3.

REFERENCE

(1) Code of Federal Regulations, title 40, part 86, subpart B

MAIL-OUT #93-05

State of California
AIR RESOURCES BOARD

Notice of Public Availability of Modified Text
and Supporting Documents and Information

PUBLIC HEARING TO CONSIDER AMENDMENTS TO CERTIFICATION REQUIREMENTS AND PROCEDURES FOR LOW-EMISSION PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

Public Hearing Date: January 14, 1993
Public Availability Date: March 22, 1993
Deadline for Public Comment: April 5, 1993

At a public hearing held January 14, 1993, the Air Resources Board (the Board or ARB) considered amendments to certification requirements and test procedures for low-emission passenger cars, light-duty trucks, and medium-duty vehicles, including the adoption of reactivity adjustment factors (RAFs) for transitional low-emission vehicles (TLEVs) and low-emission vehicles (LEVs) operating on Phase 2 gasoline. The amendments affect sections 1960.1, 1976 and 2061, Title 13, California Code of Regulations (CCR), and four ARB Test Procedures that are incorporated by reference in those sections: "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles," "California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," and "California Non-Methane Organic Gas Test Procedures." The proposed regulatory action is described in detail in the Initial Statement of Proposed Rulemaking released on September 25, 1992, the Supplement to Initial Statement of Proposed Rulemaking (Mail-out #92-59) released on November 13, 1992 and the Modeling Protocol and Final Results released on December 15, 1992.

At the hearing, the Board approved the regulatory amendments proposed by the staff with various modifications to the originally proposed regulatory language. The modifications to the original staff proposal include:

- Adopt interim reactivity adjustment factors for 1993 through 1997 model-year TLEVs and LEVs operating on Phase 2 gasoline of 0.98 and 0.95, respectively (as discussed below, since the hearing the proposed LEV RAF has been revised to 0.94)

- Identify reactivity of LEV and ultra low-emission vehicles (ULEVs) operating on conventional gasoline of 3.13 grams ozone per gram NMOG

- Update test requirements for hybrid electric vehicles

- Amend 50°F NMOG emission requirement for TLEVs to two times the TLEV emission standard.

- Modify provisions of Assembly-Line Test Procedures pertaining to canister loading.

- Allow gasoline to methanol ratios during quality audit testing.

- Clarify fuel to be used during assembly-line quality audit testing.

Appended as Attachment I is a copy of Board Resolution 93-3, which sets forth the Board's action. Included with the resolution is an Attachment F, which describes the modifications to the original proposal suggested by the staff and approved by the Board. Appended as Attachment II is the modified text of sections 1960.1, with additions to the originally proposed text shown by ***bold italics*** and deletions shown by ~~*bold italics*~~.

The four Test Procedures being amended in this rulemaking are voluminous and include very technical and detailed provisions that are of limited general interest. For all persons who testified at the hearing, submitted written comments at the hearing or during the public comment period, or requested notification of the availability of the modifications to the originally proposed text, Attachment III includes the complete texts of the test procedures being amended in this rulemaking, with the modifications to the originally proposed texts clearly indicated. For the other recipients of this notice, Attachment III contains a form that may be used to request ~~copies of the complete modified texts of the Test Procedures.~~ Copies of the Test Procedures showing the modifications to the original proposal can be requested from Donna Barragan, Mobile Source Division, California Air Resources Board, 9528 Telstar Avenue, El Monte, California 91731, fax no. (818) 575-6699.

The modified texts of the regulations and Test Procedures being made available in conjunction with this notice include a few additional corrections identified since the January 14, 1993 hearing. These additional modifications are described in Attachment IV; they include a revision of the RAF for LEVs operated on phase 2 gasoline from 0.95 to 0.94 to reflect a reevaluation of the speciated exhaust peak that represents methyl-tertiary butyl ether (MTBE) coeluted with 2,3-dimethyl butane.

In addition, the staff has added to the rulemaking record the following documents and information:

- "Establishment of Corrections to Reactivity Adjustment Factors for Transitional Low-Emission Vehicles and Low-Emission Vehicles Operating on Phase 2 Reformulated Gasoline: Modeling Protocol and Updated Final Results," California Air Resources Board Research Division, March 1, 1993

- Memorandum from ARB Monitoring and Laboratory Division Chief Bill Loscutoff to ARB Mobile Source Division Chief Don Drachand, dated November 18, 1992, and the attachment thereto

A copy of the first document is appended as Attachment V. It includes a discussion of the airshed modeling performed based on the RAFs for TLEVs and LEVs operating on Phase 2 reformulated gasoline certification fuel. Copies of the second document were distributed at the January 14, 1993 hearing, and are available upon request from Donna Barragan at the address listed above. This document contains responses to comments dated October 20, 1992 from the Motor Vehicle Manufacturers Association pertaining to the proposed amendments to the California Non-Methane Organic Gas Test Procedures, and includes a discussion of the modifications being made to the originally proposed text of this Test Procedure.

In accordance with section 11346.8 of the Government Code, the Board directed the Executive Officer to adopt the proposed regulatory language after making the modified regulatory language and additional supporting documents and information available to the public for comment for a period of at least 15 days, provided that the Executive Officer shall consider such written comments as may be submitted during this period, shall make such modifications as may be appropriate in light of the comments received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

Written comments must be submitted to the Board Secretary, Air Resources Board, P.O. Box 2815, Sacramento, California 95812, no later than the deadline for public comment identified above, for consideration by the Executive Officer prior to final action. Only comments relating to the modifications or supporting documents and information described in this notice will be considered by the Executive Officer.

Sincerely,

K. D. Drachand, Chief
Mobile Source Division

Attachments

ATTACHMENT I

State of California
AIR RESOURCES BOARD

Resolution 93-3

January 14, 1993

Agenda Item No.: 93-1-3

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

WHEREAS, in section 43000 of the Health and Safety Code the Legislature has declared that the emission of air contaminants from motor vehicles is the primary cause of air pollution in many parts of the state;

WHEREAS, section 43018(a) of the Health and Safety Code, enacted by the California Clean Air Act of 1988, directs the Board to endeavor to achieve the maximum degree of emission reduction possible from vehicular and other mobile sources in order to accomplish the attainment of the state ambient air quality standards at the earliest practicable date;

WHEREAS, section 43018(b) of the Health and Safety Code directs the Board no later than January 1, 1992 to take whatever actions are necessary, cost-effective, and technologically feasible in order to achieve, by December 31, 2000, a reduction of reactive organic gases (ROG) of at least 55 percent and a 15 percent reduction in the emissions of oxides of nitrogen (NOx) from motor vehicles, and the maximum feasible reductions in particulates (PM), carbon monoxide (CO), and toxic air contaminants from vehicular sources;

WHEREAS, section 43018(c) of the Health and Safety Code provides that in carrying out section 43018, the Board shall adopt standards and regulations which will result in the most cost-effective combination of control measures on all classes of motor vehicles and motor vehicle fuel, including but not limited to reductions in motor vehicle exhaust and evaporative emissions, reductions in in-use vehicular emissions through durability and performance improvements, requiring the purchase of low-emission vehicles by state fleet operators, and specification of vehicular fuel composition;

WHEREAS, section 43101 of the Health and Safety Code directs the Board to adopt and implement emission standards for new motor vehicles which the Board has found to be necessary and technologically feasible to carry out the purposes of Division 26 of the Health and Safety Code;

WHEREAS, section 43104 of the Health and Safety Code directs the Board to adopt test procedures for determining whether new motor vehicles are in compliance with the emission standards established by the Board;

WHEREAS, in a 1990-1991 rulemaking, the Board adopted the Low-Emission Vehicle regulations, which require the phased introduction of vehicles meeting standards for four progressively more stringent categories of light-duty vehicles: Transitional Low-Emission Vehicles (TLEVs), Low-Emission Vehicles (LEVs), Ultra-Low-Emission Vehicles (ULEVs), and Zero-Emission Vehicles (ZEVs);

WHEREAS, the Low-Emission Vehicle regulations include a protocol under which the Executive Officer is to establish reactivity adjustment factors (RAFs) for representative vehicle/fuel combinations by applying a reactivity scale based on the maximum incremental reactivity (MIR) of individual hydrocarbon species to hydrocarbon exhaust speciation profiles; these RAFs are to be applied to the non-methane organic gas exhaust mass emissions from TLEVs, LEVs and ULEVs operating on fuels other than conventional gasoline, to determine compliance with applicable emission standards;

WHEREAS, following a hearing on November 14, 1991, the Board adopted amendments to the Low-Emission Vehicle regulations which established a RAF for TLEVs operated on methanol (M85) and made various changes regarding the calculation and use of RAFs for low-emission vehicles;

WHEREAS, at a June 11, 1992 public meeting, the staff presented a status report to the Board on the progress being made by the industry to comply with the Low-Emission Vehicle regulations; following the staff's presentation and comments from industry representatives and other members of the public, the Board adopted Resolution 92-46, which found that the low-emission vehicle standards continue to be technologically feasible within the required timeframes;

WHEREAS, in conjunction with a public hearing notice dated September 15, 1992, the staff proposed a wide range of regulatory amendments to the Low-Emission Vehicle regulations and to the general certification requirements and procedures for light- and medium-duty vehicles, intended to augment various provisions, improve clarity and facilitate implementation; these amendments include the establishment of a test procedure and certification requirements for hybrid electric vehicles, revision of the requirements for compliance with the NMOG and formaldehyde standards at 50°F, establishment of RAFs for TLEVs and LEVs operated on Phase 2 reformulated gasoline certification fuel, and establishment of a methane RAF for compressed natural gas (CNG) low-emission vehicles;

WHEREAS, the staff's proposal would be effected by amendments to Title 13, California Code of Regulations, sections 1960.1, 1976 and 2061 as set forth in Attachment A hereto; amendments to the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, which is incorporated by reference in section 1960.1, as set forth in Attachment B hereto; amendments to the California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles, which is incorporated by reference in section 1976, as set forth in Attachment C hereto; amendments to the

California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, which is incorporated by reference in section 2016, as set forth in Attachment D hereto; and amendments to the California Non-Methane Organic Gas Test Procedures, as set forth in Attachment E hereto;

WHEREAS, the California Environmental Quality Act and Board regulations require that an action not be adopted as proposed where it will have significant adverse environmental impacts if feasible alternatives or mitigation measures are available which would substantially reduce or avoid such impacts;

WHEREAS, the Board has considered the impact of the proposed regulatory action on the economy of the state;

WHEREAS, a public hearing and other administrative proceedings have been held in accordance with the provisions of Chapter 3.5 (commencing with section 11340), Part 1, Division 3, Title 2 of the Government Code; and

WHEREAS, the Board finds that:

The amendments approved herein, including the revisions pertaining to test procedures for hybrid electric vehicles, cold CO requirements, ZEV certification procedures, test procedures for ethanol vehicles, 50°F test requirements, the ZEV credit system, RAFs for Phase 2 reformulated gasoline certification fuel, a methane RAF for CNG low-emission vehicles, deterioration factors for engine-specific RAFs, and calculation of penalties for violations, are necessary and appropriate to add specificity, enhance clarity, and facilitate implementation of the low-emission vehicle requirements;

It is appropriate at this time to establish RAFs for TLEV and LEV light-duty vehicles operating on Phase 2 reformulated gasoline certification fuel, and to establish baseline values of reactivity expressed in grams of ozone/ gram NMOG for LEVs and ULEVs operating on conventional gasoline, only for the 1993 through 1997 model-years, so that any additional data and analytical methods can be considered in the subsequent adoption of RAFs and baseline reactivity values for such categories for the 1998 and subsequent model years;

The baseline values of reactivity approved herein for 1993 through 1997 LEVs and ULEVs operating on conventional gasoline are appropriately based on tests of vehicles equipped with advanced emission control systems demonstrated by the Board to be capable of achieving compliance with LEV and ULEV standards when operating on conventional gasoline;

The RAFs approved herein for the TLEV and LEV emission categories for vehicles operating on Phase 2 reformulated gasoline are appropriately based on application of the established MIRs to the best available speciated hydrocarbon exhaust emission data from vehicles operating on these fuels and meeting the TLEV and LEV standards;

Confirmatory modeling indicates that there is little or no bias in the application of the established MIR scale to the speciated exhaust of TLEVs and LEVs operating on Phase 2 reformulated gasoline, and thus no correction factor is necessary or appropriate for the Phase 2 reformulated gasoline RAFs for these vehicle categories; and

The amendments approved herein will not have any significant adverse environmental impacts.

NOW, THEREFORE, BE IT RESOLVED that the Board hereby approves the amendments to sections 1960.1, 1976 and 2061, and the documents incorporated therein, as set forth in Attachments A through E hereto, with the modifications described in Attachment F hereto.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to incorporate into the approved amendments the modifications described in ~~Attachment F hereto, with such other conforming modifications as may be~~ appropriate, and to adopt the amendments approved herein, after making the modified regulatory language available for public comment for a period of 15 days, provided that the Executive Officer shall consider such written comments regarding the modifications as may be submitted during this period, shall make modifications after comments have been received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to schedule a rulemaking hearing by March, 1994, to establish baseline values of reactivity for 1998 and subsequent model-year LEVs and ULEVs operating on conventional gasoline, and RAFs for 1998 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles operated on Phase 2 reformulated gasoline certification fuel, subject to the availability of suitable test vehicles; in proposing such baseline values and RAFs the Executive Officer shall work cooperatively with industry to identify any relevant new data or analytical methods.

BE IT FURTHER RESOLVED that it is the intent of the Board that any proposed revisions to the baseline reactivity values for LEVs and ULEVs shall not reduce the stringency of the adopted emission standards, except as may result from improved test methods and data analysis.

BE IT FURTHER RESOLVED that the Board directs the staff to continue to evaluate the need to adjust the RAF process in order to account for the

reactivity of emissions of CO from low-emission vehicles, and to report back to the Board as appropriate on recommendations in this area.

BE IT FURTHER RESOLVED that the Board hereby determines that the amendments approved herein will not cause the California motor vehicle emission standards, in the aggregate, to be less protective of public health and welfare than applicable federal standards.

BE IT FURTHER RESOLVED that the Board hereby finds that separate California motor vehicle emission standards and test procedures are necessary to meet compelling and extraordinary conditions.

BE IT FURTHER RESOLVED that the Board finds that the California motor vehicle emission standards and test procedures as amended herein will not cause the California requirements to be inconsistent with section 202(a) of the Clean Air Act and raise no new issues affecting previous waiver determinations of the Administrator of the Environmental Protection Agency pursuant to section 209(b) of the Clean Air Act.

BE IT FURTHER RESOLVED that the Executive Officer shall, upon adoption, forward the amendments to the Environmental Protection Agency with a request for confirmation that the amendments are within the scope of an existing waiver of federal preemption pursuant to section 209(b) of the Clean Air Act.

I hereby certify that the above is a true and correct copy of Resolution 93-3 as adopted by the Air Resources Board.

Pat Hutchens

Pat Hutchens, Board Secretary

Resolution 93-3

January 14, 1993

Identification of Attachments to the Resolution

Attachment A: Amendments to Title 13, California Code of Regulations, sections 1960.1, 1976, and 2061, as appended to the Staff Report released September 25, 1992.

Attachment B: Amendments to the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, as made available by the ARB's Mobile Source Division September 25, 1992.

Attachment C: Amendments to the California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles, as made available by the ARB's Mobile Source Division September 25, 1992.

Attachment D: Amendments to the California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, as made available by the ARB's Mobile Source Division September 25, 1992.

Attachment E: Amendments to the California Non-Methane Organic Gas Test Procedures, as made available by the ARB's Mobile Source Division September 25, 1992.

Attachment F: Staff's Suggested Changes to the Original Proposal, distributed at the hearing on January 14, 1993.

Public Hearing to Consider Amendments to Certification Requirements and Procedures for Low-Emission Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles

January 14, 1993

STAFF'S SUGGESTED MODIFICATIONS TO THE ORIGINAL PROPOSAL

The staff report for the proposed amendments to the certification requirements and test procedures for low-emission passenger cars, light-duty trucks and medium-duty vehicles was originally released to the public on September 25, 1992. A supplement to this staff report, pertaining to reactivity adjustment factors (RAFs), was released on November 13, 1992. A modeling protocol and final results for corrections to the proposed RAFs was released December 15, 1992. Based on further analyses conducted by staff and comments received on these documents and the regulations referenced therein, the staff is recommending modifications to the originally proposed regulatory amendments. These suggested modifications are described in the following three parts:

Part A: **Suggested Modifications Pertaining to RAFs**

Part B: **Suggested Modifications Pertaining to the NMOG Test Procedures**

Part C: **Suggested Modifications Other Than Those Pertaining to RAFs and the NMOG Test Procedures**

Part A

Suggested Modifications Pertaining to RAFs

Modify the reactivity adjustment factors (RAFs) for TLEVs and LEVs operated on Phase 2 reformulated gasoline certification fuel to be 0.98 and 0.95 respectively. Identify the 'g ozone potential per g NMOG' (baseline reactivity value) for conventional gasoline as 3.13 for all LEVs and ULEVs in the passenger car and light-duty truck 0-5750 lbs. LVW category. Provide that these RAFs and baseline reactivity values apply to 1993-1997 model-year vehicles.

Section Affected: California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, section 13.a. and 13.d. (pp. 13-1 and 13-2)

Note that the modified RAFs and baseline reactivity values reflect a reinterpretation of aspects of the speciated exhaust emission data, specifically the identification of the compounds represented by two of the peaks and the resulting assignment of MIRs to these peaks. It had originally been assumed that iso-octane (2,2,4-trimethyl pentane) co-eluted with an olefin in approximately a 50/50 ratio. After further examination, staff concluded that even though an olefin does co-elute with iso-octane, the peak is predominantly iso-octane (greater than 95%). Therefore, the iso-octane MIR value of 0.93 was assigned to the peak, rather than the previously assigned value of 2.59. It had also been assumed that 4-ethyl toluene (C9 Dialkyl Benzenes) co-elutes with a cycloalkane; subsequent analysis indicates that the peak is predominantly 4-ethyl toluene and therefore the 7.2 MIR value for 4-ethyl toluene has been applied to the peak rather than the 4.59 value previously applied. The attached Summary of Test Data and accompanying tables present the corrected specific reactivities of the vehicles tested for this rulemaking.

Part B

Suggested Modifications Pertaining to the NMOG Test Procedures

Modify the originally proposed amendments to the California Non-Methane Organic Gas Test Procedures to reflect the modifications identified in the "ARB Responses" set forth in the November 18, 1992 memorandum from Monitoring and Laboratory Division Chief Bill Loscutoff to Mobile Source Division Chief Don Drachand, and the attachment thereto.

Include additional modifications to reflect the requested changes pertaining to chemical abstract system numbers, and the species identified, set forth on pages 6 and 7 of the January 4, 1993, letter from Trescott E. Jensen of the Environmental Research Consortium.

Part C

Suggested Modifications Other Than Those Pertaining to RAFs and the NMOG Test Procedures

Except as otherwise indicated, the text of the originally proposed amendments is shown below in underline to indicate additions and ~~strikeout~~ to show deletions. The modifications now proposed by staff are shown in ***bold italics*** to show additions and ~~***bold italics***~~ to show deletions.

1. Modify the definition of hybrid electric vehicles (HEVs) to allow the use of a shut-off switch for the auxiliary power unit (APU) on Type A and Type B HEVs. These are the HEVs that will generate credits for calculating a manufacturer's Non-Methane Organic Matter (NMOG) fleet average.

Section Affected: California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles (Exhaust Standards and Test Procedures), section 2.Av. (p. 2-5)

> Av. . . . . This definition shall also apply to any hybrid electric vehicle which allows the operator to control the time or mode of operation of the auxiliary power unit either directly or indirectly ***(with the exception that a mechanism which allows the operator only to shut off the auxiliary power unit is permissible for Type A and Type B HEVs),*** to any hybrid electric vehicle which can be operated solely through the use of the auxiliary power unit, to any hybrid electric vehicle which utilizes a climate control system that cannot be operated without using the auxiliary power unit, and ***to*** all other types of hybrid electric vehicles, excluding Type A and Type B hybrid electric vehicles.

2. Delete the originally proposed new language providing that, in determining the number of Tier 1 vehicles eligible for the alternative in-use compliance standards, a manufacturer is to apply the maximum percentage to the manufacturer's total projected sales of Tier 1 vehicles only. With this deletion, the manufacturer would apply the required percentages to the manufacturer's total projected sales of low-emission vehicles as well as conventional vehicles.

Section affected: Exhaust Standards and Test Procedures, section 3.f, note (8) (p. 3-10), and Title 13, California Code of Regulations, section 1960.1(f)(2), note (8).

> ~~(8) For the 1995 and 1996 model years, all manufacturers,~~ except those certifying to optional diesel standards, are

permitted alternative in-use compliance. Alternative in-use compliance is permitted for 60% of a manufacturer's vehicles in the 1995 model year and 20% of a manufacturer's vehicles in the 1996 model year. For the 1995 and 1996 model years, small volume manufacturers only are permitted alternative in-use compliance for 100% of the fleet. The percentages shall be applied to the manufacturers' total projected sales of California-certified *-certified* passenger cars and light-duty trucks *certified to the emission standards in this Section 3/1/ of these test procedures* for the model year. . . .

3. The regulations do not specify the battery state-of-charge during the highway fuel economy test for hybrid electric vehicles. In order to ensure that the emission performance of HEV APUs is reasonably characterized, two conditions would be identified for the validity of the emission test.

Section affected: California Exhaust Emission Standards and Test Procedures, section 11.c. (p. 11-2)

Add the following text at the end of the first paragraph of section 11.c:

Hybrid electric vehicles shall be tested with the battery state-of-charge set such that one of the following two conditions is satisfied: (1) the state-of-charge is at the lowest level allowed by the control unit of the auxiliary power unit; or (2) the state-of-charge is set such that auxiliary power unit operation will be at its maximum level at the beginning and throughout the emission test.

4. Under the originally proposed amendments to the 50 degree Fahrenheit requirement, NMOG and formaldehyde emissions at 50 degrees Fahrenheit would not be permitted to exceed the 50,000 mile certification standard multiplied by a factor of 1.75 for all TLEVs. Staff is proposing that the multiplicative factor for TLEVs be changed to 2.0.

Section affected: Exhaust Standards and Test Procedures, section 11.K (p. 11-4).

5. Clarify the vehicle selection process for cold temperature CO compliance. The current test procedures do not expressly identify the method for the selection of vehicles to be used to demonstrate compliance with cold temperature CO exhaust emission standards.

Sections affected: Exhaust Standards and Test Procedures, Appendix II (p. II-3)

C. For determining cold temperature CO exhaust emission compliance for each engine family, the Executive Officer shall select for testing the vehicle expected to emit the highest emissions from the vehicles selected in accordance with sections I.A. and I.B. of this Appendix. The selected vehicle shall be tested by the manufacturer in accordance with the test procedures in Subpart C, Part 86, Title 40, Code of Federal Regulations or with alternative procedures requested by the manufacturer and approved in advance by the Executive Officer.

6. Correct the display of the table of Maximum Incremental Reactivities (MIRs) being replaced in this rulemaking by showing in strikeout the table as established following the hearing on November 14, 1991. This correction will have no regulatory effect.

Section affected: Exhaust Standards and Test Procedures, Appendix VIII, section (10). (pp. VIII-8 through VIII-10.)

7. Modify the battery state-of-charge conditions for hybrid electric vehicle emission testing to better ensure an accurate representation of auxiliary power unit emissions.

Section affected: California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles (Evaporative Standards and Test Procedures), section 4.g.i.E. (p. 25)

E. During the 12 to 36 hour soak specified in subparagraph D. above, the vehicle's canister shall be purged with a volume of air equivalent to 300 canister charcoal bed volumes at a flow rate of 48 SCFH (22.7 slpm). For hybrid electric vehicles, the battery pack shall be discharged to or just below the state of charge at which operation of the auxiliary power unit will be initiated by the vehicle's control strategy/ *the state of charge that satisfies one of the following two conditions: (1) the state of charge is at the lowest level allowed by the control unit of the auxiliary power unit, or (2) the state of charge is set such that auxiliary power unit operation will be at its maximum level at the beginning and through the emission test.*

8. Delete the originally proposed requirement that HEVs perform additional 24-hour diurnal test increments as necessary to ensure that the APU will be operated to purge the evaporative emission canister. In addition, delete the originally proposed requirement that testing of the evaporative emission control system and evaporative emission control purge system be performed during the final 24-hour diurnal test cycle.

Sections affected: Evaporative Standards and Test Procedures, section 4.g.i.L. and section 4.g.i.M. (p. 26) These two subsections, part of the orginally proposed new language, would be deleted.

9. For Type C HEVs, add a requirement that any APU activation switch must be on for the duration of emission testing.

Section affected: Evaporative Standards and Test Procedures, section 4.g.iii(i). (p. 27)

iii(i) . . . <u>One Urban Dynamometer Driving Schedule (UDDS) shall be used for preconditioning.</u> ***If the auxiliary power unit is capable of being manually activated (which would cause the vehicle to be classified as a Type C HEV), the auxiliary power unit shall be activated at the beginning and throughout the emission test.***

10. Delete the requirement that the manufacturer shall record the weight of the evaporative emission canister at the conclusion of the running loss test procedure for HEVs.

Section affected: Evaporative Standards and Test Procedures, section 4.g.viii.D. (p. 33) This subsection, part of the orginally proposed new language, would be deleted.

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11. Delete the requirement that additional tests may be required for HEVs to ensure that the APU will be operated to purge the evaporative emission control canister during emission testing.

Section affected: Evaporative Standards and Test Procedures, section 4.g.x.H. (p. 35) The originally proposed new sentence in that subsection would be deleted.

12. Revise the procedure for ensuring proper operation of the evaporative emission control system, to reduce manufacturers' testing burden.

Section affected: Evaporative Standards and Test Procedures, section 4.g.x.K. (pp. 36-37.)

Delete the originally proposed new section 4.g.x.K. Replace it with the following text for subsection K and new subsections L and M:

K. Add section (u) to read: The manufacturer shall specify the working capacity of the evaporative emission control canister, and shall specify the number of 24-hour diurnals

that can elapse before the APU will activate solely for the purposes of purging the canister of hydrocarbon vapor.

L. Add section (v) to read: In order to determine that the working capacity of the canister is sufficient to store the hydrocarbon vapor generated over the manufacturer specified number of days between auxiliary power unit activation events for the purposes of purging the evaporative canister, the evaporative canister shall be weighed after completion of the 72-hour diurnal period. The weight of the vapor contained in the canister shall not exceed the working capacity of the canister multiplied by three days and divided by the manufacturer specified number of days between auxiliary power unit activation events.

M. Add section (w) to read: The manufacturer shall specify the time interval of auxiliary power unit operation necessary to purge the evaporative emission control canister, and shall submit an engineering analysis to demonstrate that the canister will be purged to within five percent of its working capacity over the time interval.

13. Modify the provisions in the Assembly-Line Test Procedures pertaining to canister loading. The originally proposed third option for satisfying the requirement is that manufacturers shall demonstrate "that there does not exist a measurable difference in exhaust emissions" between vehicles with and without loaded canisters. A modification would be made to provide that manufacturers shall demonstrate "the difference or lack of difference in exhaust emissions" between vehicles with and without loaded canisters, and that this difference (additive and not less than 0) would be applied to the audit vehicles tested without loaded canisters. This difference shall be based on the average results of at least 10 vehicles tested (under both conditions) per engine family. Manufacturers would submit for approval beforehand their test plan and how many vehicles they would be testing to establish any difference. In addition, for each of the three canister loading options, a provision would be added requiring that the canister be cycled no less than two times.

Section affected: California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles (Assembly-Line Test Procedures), section D.2.(c)(i), (ii), and (iii) (pp. 8-9)

(i) The vehicle canister loading procedure shall be conducted in accordance with subsections 4.g.iii.C. and 4.g.iii.D., *except that prior to the canister loading, the canister shall be cycled no less than 2 times using the method specified in subsection 4.c.iii, utilizing the fuel used in normal operation, in order to place a heel on the canister.* Alternative methods of loading the original canister may be

used, provided such a method is approved in advance by the Executive Officer on the basis of achieving canister loading comparable to the prescribed method.

OR

(ii) The vehicle canister loading procedure described in subsections 4.g.iii.C. and 4.g.iii.D. shall be employed for a canister which is loaded separate from the vehicle, and then attached prior to the exhaust tests, with the original canister disabled. Such a canister loaded separate from the vehicle shall be identical in nominal working bed capacity, charcoal bed volume and configuration to the original canister present on the vehicle. The loading procedure for this canister shall be as described in subsections 4.g.iii.C. and 4.g.iii.D., except ~~that~~ ***for the following: (1)*** the rate of butane loading shall not exceed 40 grams/hour, ***and (2) prior to the loading, the canister shall be cycled at least 2 times according to the method specified in subsection 4.c.iii, utilizing the fuel used in normal operation. If the canister has been cycled for use in a previous exhaust test, this step may be omitted.*** An alternative to this option (ii) may be used provided such a method is approved in advance by the Executive Officer on the basis of whether the flow of vapor from the canister to the engine is comparable to the prescribed method.

OR

(iii) Data shall be submitted to the Executive Officer demonstrating ~~that there does not exist a measurable difference~~ the difference or lack of difference in exhaust emissions, for ~~both~~ hydrocarbons, ~~and~~ OMHCE ***and carbon monoxide***, between vehicles possessing a canister(s) loaded in accordance with subsections 4.g.iii.C. and 4.g.iii.D. ***and cycled no less than 2 times according to the method specified in subsection 4.c.iii utilizing the fuel used in normal operation,*** and vehicles possessing an unloaded canister(s). For the purposes of this section, the preparation and preconditioning of vehicles with an unloaded canister shall be conducted in an identical manner as described in 2.(c)(1) of this procedure for vehicles equipped with a loaded canister, except that canister loading requirements contained in subsections 4.g.iii.C. and 4.g.iii.D. shall be omitted.

A test plan for generation of such data shall be submitted to the Executive Officer for approval prior to testing. Such testing shall involve a minimum of ten (10) vehicles for each engine family chosen to use this option, tested both with loaded and unloaded canisters. This testing shall be conducted during the first calendar quarter of production for

a given model-year in order to properly apply the results to each quality-audit vehicle which is tested. Such testing shall establish a measured exhaust emissions difference for each vehicle, for hydrocarbons, OMHCE, and carbon monoxide. For each pollutant these differences shall be averaged to generate average exhaust emissions differences (referred to below as D). These differences shall be applied, as an additive factor, to the applicable exhaust emissions results of each quality-audit vehicle that is not tested with a canister loaded in accordance with 2.(c)(1)(i) or 2.(c)(1)(ii). Compliance with the applicable exhaust emission standards shall be based on the sum of D and the measured quality-audit emission data for each vehicle. However, in no case shall this additive factor be applied when its value is less than zero.

14. Provide for the use of a methanol to gasoline ratio for two percent quality audit testing for fuel-flexible vehicles (FFVs).

The original regulatory proposal would require that one percent of FFVs be assembly-line tested on both gasoline and methanol. Based on concerns expressed by industry regarding handling and disposal of methanol, staff is proposing new language that would allow manufacturers the option of developing a gasoline NMOG to M85 NMOG certification ratio which would allow manufacturers to quality-audit test solely on gasoline but would also ensure that the emission standards are met by the alternative fuel. If manufacturers choose this option, they would have to test the full two percent of FFVs during assembly-line testing.

Sections affected: Assembly-Line Test Procedures, new section D.5.(e) (p. 12)

Add a new section D.5.(e) to read as follows:
(e) For fuel-flexible vehicles certified to either organic material non-methane hydrocarbon equivalent (OMNMHCE) or non-methane organic gas (NMOG) standards, the manufacturer may request from the Executive Officer the use of a methanol (M85) exhaust emission to gasoline NMHC exhaust emission ratio which shall be established during certification testing for each certification test data vehicle for the applicable engine family. The average of the individual test ratios of measured M85 NMOG to gasoline NMHC emissions for the engine family shall be submitted to the Executive Officer in the application for certification. Following approval of the application for certification, the manufacturer may conduct quality-audit testing on the engine family by measuring gasoline NMHC exhaust emissions rather than M85 NMOG exhaust emissions. The measured gasoline NMHC exhaust emissions shall be multiplied by the M85 NMOG to gasoline NMHC ratio submitted in the application for certification for the engine family to

determine the equivalent NMOG exhaust emission values for the quality audit test vehicle. The equivalent NMOG exhaust emission value shall be used in place of the measured NMOG exhaust emission value in determining the reactivity adjusted exhaust NMOG results. The equivalent reactivity adjusted NMOG exhaust emission values shall be compared to the NMOG exhaust emission standard applicable to the vehicle emission category (TLEV, LEV, or ULEV) in which the engine family was certified. Manufacturers which choose this option shall test the full two percent of the vehicles selected for quality-audit testing.

15. Clarify the fuel to be used in assembly-line testing. The current regulations do not clearly specify the choice of fuels for assembly-line testing. New language is being proposed which would clarify that for 1993 and 1994 model-year vehicles, Indolene as well as Phase 1 or Phase 2 fuel may be used. For all 1995 and subsequent model-year vehicles, all assembly-line quality audit tests would be conducted with Phase 2 fuel. This requirement would apply to both low-emission vehicles and conventional vehicles.

Sections affected: Assembly-Line Test Procedures, new section D.5.(f). (p. 12)

Add a new section D.5.(f) to read as follows:

(f) For 1993 and 1994 model-year vehicles, the manufacturer ~~has the option of using the fuel meeting the specifications~~ set forth in Section 9.a(1), 9.a(1)(i), or 9.a(1)(ii) of the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles for purposes of quality audit testing. All 1995 and subsequent conventional and low-emission vehicles which certify with fuel meeting the specifications set forth in Section 9.a(1) of the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles must use that fuel for purposes of quality audit testing. All 1995 and subsequent conventional and low-emission vehicles which certify with fuel meeting the specifications set forth in Section 9.a(ii) of the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles must use that fuel for purposes of quality audit testing.

SECTION 1960.1, TITLE 13, CCR

Amend Title 13, California Code of Regulations, section 1960.1 to read as follows:[1]

1960.1. **Exhaust Emission Standards and Test Procedures - 1981 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.**

(a) through (d) [No Change]

(e)(1) and (e)(2) [No Change]

(e)(3) The exhaust emissions from 1992 and subsequent model-year transitional low-emission vehicles, low-emission vehicles, and ultra-low-emission vehicles, including fuel-flexible and dual-fuel vehicles, shall meet all the requirements of (g)(1) and (h)(2) with the following additions:

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1. The regulatory amendments originally proposed in this rulemaking are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions from existing regulations. Modifications to the originally noticed text are designated by ***bold italics*** and ~~***slash out***~~ to represent additions and deletions, respectively.

EXHAUST EMISSION STANDARDS FOR
TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES,
AND ULTRA-LOW-EMISSION VEHICLES IN THE
LIGHT-DUTY AND MEDIUM-DUTY VEHICLE WEIGHT CLASSES (5)(6)(7)
["milligrams per mile" (or "mg/mi")]

Vehicle Type (1)	Vehicle Weight (lbs.)(2)	Durability Vehicle Basis (mi)	Vehicle Emission Category(3)	Formaldehyde (mg/mi)(4)(5)
PC and LDT	All 0-3750	50,000	TLEV	15 (23)
			LEV	15 (15)
			ULEV	8 (12)
		100,000	TLEV	18
			LEV	18
			ULEV	11
LDT	3751-5750	50,000	TLEV	18 (27)
			LEV	18 (18)
			ULEV	9 (14)
		100,000	TLEV	23
			LEV	23
			ULEV	13
MDV	0-3750	50,000	LEV	15 (15)
			ULEV	8 (12)
		120,000	LEV	22
			ULEV	12
MDV	3751-5750	50,000	LEV	18 (18)
			ULEV	9 (14)
		120,000	LEV	27
			ULEV	13
MDV	5751-8500	50,000	LEV	22 (22)
			ULEV	11 (17)
		120,000	LEV	32
			ULEV	16
MDV	8501-10,000	50,000	LEV	28 (28)
			ULEV	14 (21)
		120,000	LEV	40
			ULEV	21
MDV	10,001-14,000	50,000	LEV	36 (36)
			ULEV	18 (27)
		120,000	LEV	52
			ULEV	26

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.

(2) For light-duty or medium-duty vehicles, Vehicle Weight shall mean "Loaded Vehicle Weight" (or "LVW") or "Test Weight" (or "TW"), respectively.

(3) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(4) Formaldehyde exhaust emission standards apply to vehicles certified to operate on any available fuel, including fuel-flexible and dual-fuel vehicles.

(5) The standards in parentheses are intermediate in-use compliance standards for 50,000 miles.

a. For PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles, intermediate in-use compliance standards shall apply to TLEVs through the 1995 model year, LEVs and ULEVs through the 1998 model year. In-use Gcompliance with standards beyond 50,000 miles shall be waived through 1995 for TLEVs, and through 1998 for LEVs and ULEVs.

b. For MDVs from 0-14,000 lbs. TW, including fuel-flexible and dual-fuel vehicles, intermediate in-use compliance standards shall apply to LEVs and ULEVs through the 1999 model year. In-use Gcompliance with standards beyond 50,000 miles shall be waived through the 1999 model year for LEVs and ULEVs.

(6) Manufacturers shall demonstrate compliance with the above standards ~~for formaldehyde at 50 degrees F according to the procedures specified~~ in section 11k of the "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(k). Hybrid electric, natural gas, and diesel-fueled vehicles shall be exempt from 50 degrees F test requirements.

(7) In-use compliance testing shall be limited to PCs and LDTs with fewer than 75,000 miles and MDVs with fewer than 90,000 miles.

(f)(1) The exhaust emissions from new 1993 and 1994 model passenger cars and light-duty trucks, except those produced by a small volume manufacturer, shall not exceed:

1993 AND 1994 MODEL-YEAR PASSENGER CAR AND LIGHT-DUTY TRUCK EXHAUST EMISSIONS STANDARDS (5)(8)(9)
(grams per mile)

Vehicle Type(1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Non-Methane Hydrocarbons (2)(7)	Carbon Monoxide (7)	Oxides of Nitrogen (1)(3)(4)
PC	All	50,000	0.39 (0.25)	7.0 (3.4)	0.4
PC(6)	All	50,000	0.39 (0.25)	7.0 (3.4)	0.7
PC	All	100,000	(0.31)	(4.2)	n/a
Diesel PC (Option 2)	All	100,000	0.46 (0.31)	8.3 (4.2)	1.0
LDT	0-3750	50,000	0.39 (0.25)	9.0 (3.4)	0.4
LDT (6)	0-3750	50,000	0.39 (0.25)	9.0 (3.4)	0.7
LDT	0-3750	100,000	(0.31)	(4.2)	n/a
Diesel LDT (Option 2)	0-3750	100,000	0.46 (0.31)	10.6 (4.2)	1.0
LDT	3751-5750	50,000	0.50 (0.32)	9.0 (4.4)	1.0
LDT	3751-5750	100,000	(0.40)	(5.5)	n/a
Diesel LDT (Option 1)	3751-5750	100,000	0.50 (0.40)	9.0 (5.5)	1.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"n/a" means not applicable.

(2) For methanol-fueled vehicles certifying to these standards, including fuel-flexible-fueled vehicles when certifying on methanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Hydrocarbon Equivalent" (or "OMHCE"). For methanol- or ethanol-fueled vehicles certifying to the phase-in standards in parenthesis, including fuel-flexible vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(3) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 1.33 times the applicable passenger car standards and 2.00 times the applicable light-duty truck and medium-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded

in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(4) The standard for in-use compliance for passenger cars and light-duty trucks certifying to the 0.4 g/mi NOx standard shall be 0.55 g/mi NOx for 50,000 miles. If the in-use compliance level is above 0.4 g/mi NOx but does not exceed 0.55 g/mi NOx, and based on a review of information derived from a statistically valid and representative sample of vehicles, the Executive Officer determines that a substantial percentage of any class or category of such vehicles exhibits, prior to 50,000 miles or 5 years, whichever occurs first, an identifiable, systematic defect in a component listed in section 1960.1.5(c)(2), Title 13, California Code of Regulations, which causes a significant increase in emissions above those exhibited by vehicles free of such defects and of the same class or category and having the same period of use and mileage, then the Executive Officer may invoke the enforcement authority under subchapter 2.5, Title 13, California Code of Regulations, commencing with section 2111, to require remedial action by the vehicle manufacturer. Such remedial action shall be limited to owner notification and repair or replacement of the defective component. As used in this section, the term "defect" shall not include failures which are the result of abuse, neglect, or improper maintenance. This provision is applicable for the 1993 model year only.

(5) Diesel passenger cars and light-duty trucks certifying to these standards are subject to a particulate exhaust emission standard ~~of 0.08 g/mi, determined on a 50,000 mile durability vehicle~~ basis.

(6) This set of standards is optional. A manufacturer may choose to certify to these standards pursuant to the conditions set forth in section 1960.1.5.

(7) The emission standards in parenthesis are phase-in standards. For the 1993 model year, each manufacturer must certify a minimum of 40% of their vehicles to the phase-in standards or the more stringent standards in section 1960.1, (g)(1). ~~For the 1994 model year, each manufacturer must certify a minimum of 80% of their vehicles to the phase-in standards or the more stringent standards in section 1960.1, (g)(1).~~ The percentages shall be applied to the manufacturer's total projected sales of California-certified passenger cars and light-duty trucks for the 1993 model year. For 1994 and subsequent model years, each manufacturer shall comply with the fleet average requirements specified in section 1960.1, (g)(2).

(8) The following conditions shall apply to the in-use compliance standards for 1993 and 1994 model-year passenger cars and light-duty trucks only.

a. The in-use compliance standards for those passenger cars and light-duty trucks certifying to the 0.25 g/mi non-methane hydrocarbon and 3.4 g/mi carbon monoxide standards shall be 0.32 g/mi non-methane hydrocarbon and 5.2 g/mi carbon monoxide for 50,000 miles.

b. The in-use compliance standards for those light-duty trucks certifying to the 0.32 g/mi non-methane hydrocarbon and 4.4 g/mi carbon monoxide standards shall be 0.41 g/mi non-methane hydrocarbon and 6.7 g/mi carbon monoxide for 50,000 miles.

c. In-use compliance standards shall be waived beyond 50,000 miles.

(9) All passenger cars and light-duty trucks, except those diesel vehicles certifying to optional 100,000 mile standards, are subject to non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards determined on a 50,000 mile durability basis and non-methane hydrocarbon and carbon monoxide standards determined on a 100,000 mile basis.

(f)(2) The exhaust emissions from new 1995 and subsequent model passenger cars and light-duty trucks shall not exceed:

1995 AND SUBSEQUENT MODEL-YEAR PASSENGER CAR AND LIGHT-DUTY TRUCK EXHAUST EMISSIONS STANDARDS (5)(6)(8)(10)
(grams per mile)

Vehicle Type(1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Non-Methane Hydrocarbons (2)(7)	Carbon Monoxide (7)	Oxides of Nitrogen (1)(3)
PC	All	50,000	0.25	3.4	0.4(4)
PC	All	100,000	0.31	4.2	0.6(9)n/a
Diesel PC (Option 2)	All	100,000	0.31	4.2	1.0
LDT	0-3750	50,000	0.25	3.4	0.4(4)
LDT	0-3750	100,000	0.31	4.2	0.6(9)n/a
Diesel LDT (Option 2)	0-3750	100,000	0.31	4.2	1.0
LDT	3751-5750	50,000	0.32	4.4	0.7
LDT	3751-5750	100,000	0.40	5.5	0.97(9)n/a
Diesel LDT (Option 1)	3751-5750	100,000	0.40	5.5	1.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"n/a" means not applicable.

(2) For methanol- or ethanol-fueled vehicles certifying to these standards, including fuel-flexible-fueled vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(3) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 1.33 times the applicable passenger car standards and 2.00 times the applicable light-duty truck standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(4) Small volume manufacturers may choose to certify to an optional 0.7 g/mi NOx standard for the 1995 model year only, pursuant to the conditions set forth in sections 1960.1 (f)(1) and 1960.1.5.

(5) Diesel passenger cars and light-duty trucks certifying to these standards are subject to a particulate exhaust emission standard of 0.08 g/mi, determined on a 50,000 mile durability vehicle basis.

(6) For all vehicles, except those certifying to optional diesel standards, in-use compliance with the exhaust emission standards shall be limited to vehicles with less than 75,000 miles.

(7) For the 1995 and 1996 model years, all manufacturers, except those certifying to optional diesel standards, are permitted alternative in-use compliance. Alternative in-use compliance is permitted for 60% of a manufacturer's vehicles in the 1995 model year and 20% of a manufacturer's vehicles in the 1996 model year. For the 1995 and 1996 model years, small volume manufacturers only are permitted alternative in-use compliance for 100% of the fleet. The percentages shall be applied to the manufacturers' total projected sales of California-certified passenger cars and light-duty trucks for the model year. "Alternative in-use compliance" shall consist of the following:

a. For all passenger cars and those light-duty trucks from 0-3750 lbs., loaded vehicle weight, except those diesel vehicles certifying to optional 100,000 mile standards, in-use compliance standards shall be 0.32 g/mi non-methane hydrocarbon and 5.2 g/mi carbon monoxide for 50,000 miles.

b. For light-duty trucks from 3751-5750 lbs., loaded vehicle weight, except those diesel light-duty trucks certifying to optional 100,000 mile standards, in-use compliance standards ~~shall be 0.41 g/mi non-methane hydrocarbon and 6.7 g/mi~~ carbon monoxide for 50,000 miles.

c. In-use compliance standards shall be waived beyond 50,000 miles.

(8) All passenger cars and light-duty trucks, except those diesel vehicles certifying to optional standards, are subject to non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards determined on a 50,000 mile durability basis and non-methane hydrocarbon and carbon monoxide standards determined on a 100,000 mile durability basis.

(9) 100,000 mile NOx standards are applicable for 1996 and subsequent model-year vehicles.

(10) Each manufacturer shall also comply with the requirements specified in section 1960.1, (g)(2).

(g)(1) The exhaust emissions from new 1992 and subsequent model-year light-duty transitional low-emission vehicles, low-emission vehicles, and ultra-low-emission vehicles shall not exceed:

EXHAUST EMISSION STANDARDS
FOR TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES
AND ULTRA-LOW-EMISSION VEHICLES IN PASSENGER CAR
AND LIGHT-DUTY TRUCK VEHICLE CLASSES (6)(7)(8)(9)(10)
[grams per mile (or "g/mi")]

Vehicle Type (1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Vehicle Emission Category (2)	Non-Methane Organic Gases (3)(4)	Carbon Monoxide	Oxides of Nitrogen (5)
PC and LDT	All 0-3750	50,000	TLEV	0.125 (0.188)	3.4 (3.4)	0.4 (0.4)
			LEV	0.075 (0.100)	3.4 (3.4)	0.2 (0.3)
			ULEV	0.040 (0.058)	1.7 (2.6)	0.2 (0.3)
		100,000	TLEV	0.156	4.2	0.6
			LEV	0.090	4.2	0.3
			ULEV	0.055	2.1	0.3
LDT	3751-5750	50,000	TLEV	0.160 (0.238)	4.4 (4.4)	0.7 (0.7)
			LEV	0.100 (0.128)	4.4 (4.4)	0.4 (0.5)
			ULEV	0.050 (0.075)	2.2 (3.3)	0.4 (0.5)
		100,000	TLEV	0.200	5.5	0.9
			LEV	0.130	5.5	0.5
			ULEV	0.070	2.8	0.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.

(2) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(3) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions. To demonstrate compliance with an NMOG standard, NMOG emissions shall be measured in accordance with the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991 and last amended _____, which is incorporated herein by reference. For TLEVs, LEVs, and ULEVs certified to operate exclusively on any fuel other than conventional gasoline, and for fuel-flexible and dual-fuel TLEVs, LEVs, and ULEVs when certifying on a fuel other than ~~conventional~~ gasoline, manufacturers shall multiply NMOG exhaust certification ~~mass emission~~ levels at ~~50,000~~ and ~~100,000~~ ~~miles~~ by the applicable reactivity adjustment factor set forth in section 13 of the "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(k), or established by the ~~Executive Officer pursuant to Appendix VIII of the foregoing test~~ procedures. In addition, natural gas vehicles certifying to TLEV, LEV or ULEV standards shall calculate a reactivity-adjusted methane exhaust emission value by multiplying the methane exhaust certification level by the applicable methane reactivity adjustment factor set forth in section 13 of the above-referenced test procedures. The product of the NMOG exhaust certification ~~mass~~

~~emission~~ levels and the reactivity adjustment factor shall be compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance. For natural gas vehicles, the reactivity-adjusted NMOG value shall be added to the reactivity-adjusted methane value and then compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance.

a. Each manufacturer shall certify PCs or LDTs to meet the exhaust mass emission standards for TLEVs, LEVs, ULEVs, or the exhaust emission standards of sections 1960.1 (e)(1), 1960.1 (f)(1), or 1960.1 (f)(2), Title 13, California Code of Regulations, or as Zero-Emission Vehicles such that the manufacturer's fleet average NMOG values for California-certified PCs and LDTs from 0-3750 lbs. "Loaded Vehicle Weight" (or "LVW"), and LDTs from 3751-5750 lbs. LVW ~~sold~~ produced and delivered for sale in California are less than or equal to the requirement for the corresponding Model Year, Vehicle Type, and LVW Class in section 1960.1 (g)(2), Title 13, California Code of Regulations.

(4) Fuel-flexible and dual-fuel PCs and LDTs from 0-5750 lbs. LVW shall be certified to exhaust mass emission standards for NMOG established for the operation of the vehicle on any available fuel other than ~~conventional~~ gasoline, and ~~conventional~~ gasoline.

a. For TLEVs, LEVs, and ULEVs, when certifying for operation on a fuel other than ~~conventional~~ gasoline, manufacturers shall multiply exhaust NMOG certification ~~mass emission~~ levels at ~~50,000 and 100,000 miles~~ by the applicable reactivity adjustment factor. ~~In addition to multiplying the exhaust NMOG certification~~ levels by the applicable reactivity adjustment factor, natural gas vehicles shall multiply the exhaust methane certification level by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. The exhaust NMOG certification levels for fuel-flexible or dual-fuel vehicles when certifying on gasoline shall not be multiplied by a reactivity adjustment factor.

b. For PCs and LDTs from 0-3750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For TLEVs, 0.25 g/mi and 0.31 g/mi for 50,000 and 100,000 miles, respectively.
   (ii) For LEVs, 0.125 g/mi and 0.156 g/mi for 50,000 and 100,000 miles, respectively.
   (iii) For ULEVs, 0.075 g/mi and 0.090 g/mi for 50,000 and 100,000 miles, respectively.

c. For LDTs from 3751-5750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For TLEVs, 0.32 g/mi and 0.40 g/mi for 50,000 and 100,000 miles, respectively.
   (ii) For LEVs, 0.160 g/mi and 0.200 g/mi for 50,000 and 100,000 miles, respectively.
   (iii) For ULEVs, 0.100 g/mi and 0.130 g/mi for 50,000 and 100,000 miles, respectively.

(5) The maximum projected emissions of "Oxides of Nitrogen" (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR 600

Subpart B) shall be not greater than 1.33 times the applicable light-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) The standards in parentheses are intermediate in-use compliance standards for 50,000 miles. For PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, intermediate in-use compliance standards shall apply to TLEVs through the 1995 model year, and LEVs and ULEVs through the 1998 model year. In-use ~~C~~compliance with standards beyond 50,000 miles shall be waived through the 1995 model year for TLEVs, and through the 1998 model year for LEVs and ULEVs.

a. For TLEVs, LEVs, and ULEVs designed to operate on any fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on any fuel other than ~~conventional~~ gasoline, exhaust NMOG mass emission results ~~levels~~ shall be multiplied by the applicable reactivity adjustment factor to determine compliance with intermediate in-use compliance standards for NMOG. In addition to multiplying the exhaust NMOG ~~certification level~~ ***emission results*** by the applicable reactivity adjustment factor, natural gas vehicles shall multiply the exhaust methane ~~certification level~~ ***emission results*** by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. Exhaust NMOG mass emissions from fuel-flexible or dual-fuel vehicles when operating on gasoline shall not be multiplied by a reactivity adjustment factor.

b. For fuel-flexible and dual-fuel PCs and LDTs from 0-3750 lbs. LVW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.32 g/mi, 0.188 g/mi, and 0.100 g/mi for TLEVs, LEVs, and ULEVs, respectively.

c. For fuel-flexible and dual-fuel PCs and LDTs from 3751-5750 lbs. LVW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.41 g/mi, 0.238 g/mi, and 0.128 g/mi for TLEVs, LEVs, and ULEVs, respectively.

(7) Manufacturers of diesel vehicles shall also certify to particulate standards at 100,000 miles. For all PCs and LDTs from 0-5750 lbs LVW, the particulate standard is 0.08 g/mi, 0.08 g/mi, and 0.04 g/mi for TLEVs, LEVs, and ULEVs, respectively.

(8) Manufacturers shall demonstrate compliance with the above standards for NMOG, CO, and NOx at 50 degrees F according to the procedure specified in section 11k of the "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(k). ~~For~~ Hybrid electric, natural gas, ~~and diesel-fueled~~ vehicles shall be exempt from 50 degrees F test requirements.~~, compliance with the particulate standard shall also be demonstrated as specified in section 11k of the foregoing test procedures.~~

(9) In-use compliance testing shall be limited to vehicles with fewer than 75,000 miles.

(10) Deterioration factors for hybrid electric vehicles shall be based on the emissions and mileage accumulation of the auxiliary power unit. For certification purposes only, Type A hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors), and demonstrating compliance with 100,000 mile emission standards shall not be required. For certification purposes only, Type B hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 100,000 mile emission standards (using 75,000 mile deterioration factors). For certification purposes only, Type C hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 100,000 mile emission standards (using 100,000 mile deterioration factors).

(g)(2) The fleet average non-methane organic gas exhaust emission values from a ~~manufacturer's sales of~~ the passenger cars and light-duty trucks produced and delivered for sale in California by a manufacturer each model year shall not exceed:

FLEET AVERAGE NON-METHANE ORGANIC GAS EXHAUST EMISSION REQUIREMENTS FOR LIGHT-DUTY VEHICLE WEIGHT CLASSES (7)(8)(9)
[grams per mile (or "g/mi")]

Vehicle Type (1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)(7)	Model Year	Fleet Average Non-Methane Organic Gases (2)(3)(4)(5)(6)
PC and LDT	All 0-3750	50,000	1994	0.250
			1995	0.231
			1996	0.225
			1997	0.202
			1998	0.157
			1999	0.113
			2000	0.073
			2001	0.070
			2002	0.068
			2003 & subsequent	0.062
LDT	3751-5750	50,000	1994	0.320
			1995	0.295
			1996	0.287
			1997	0.260
			1998	0.205
			1999	0.150
			2000	0.099
			2001	0.098
			2002	0.095
			2003 & subsequent	0.093

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.

(2) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions.

(3) For the purpose of calculating fleet average NMOG values, a manufacturer may adjust the certification levels of hybrid electric vehicles (or "HEVs") based on the range of the HEV without the use of the engine. For the purpose of calculating the adjusted NMOG emissions, the following definitions shall apply:

~~"Type A HEV" shall mean an HEV which achieves a minimum range of 60 miles over the Dynamometer Driving Cycle as defined by~~ the All-Electric Range Test 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 (k). ~~"Federal Highway Fuel Economy Test Procedure"~~

~~(HWFET: 40 CFR 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 60 miles. This definition shall also apply to vehicles which have no tailpipe emissions, but use fuel fired heaters, regardless of the operating range of the vehicle.~~

"Type B HEV" shall mean an HEV which achieves a range of 40 - 59 miles over the Dynamometer Driving Cycle as defined by the ~~"~~Federal Highway Fuel Economy Test Procedure~~"~~ ~~(~~HWFET: 40 CFR 600 Subpart B~~)~~ ~~without the use of the engine.~~ Use of vehicle accessories cannot lower the battery-only range below 40 ~~miles.~~ All-Electric Range Test 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(k).

"Type C HEV" shall mean an HEV which achieves a range of 0 - 39 miles over the All-Electric Range Test Dynamometer Driving Cycle as defined by the ~~"~~Federal Highway Fuel Economy Test Procedure~~"~~ ~~(~~HWFET: 40 CFR 600 Subpart B~~)~~ ~~without the use of the engine, an HEV which enables the vehicle operators to control the engine time and modes of operation either directly or indirectly, an HEV which can be operated solely through the use of the engine,~~ and all other HEVs excluding "Type A" and "Type B" HEVs 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(k).

a. For the purpose of calculating fleet average NMOG values, vehicles which have no tailpipe emissions but use fuel-fired heaters and which are not certified as ZEVs shall be treated as "Type A HEV ULEVs."

(4) Each manufacturer's fleet average NMOG value for the total number of PCs and LDTs from 0-3750 lbs. "Loaded Vehicle Weight" (or "LVW") ~~sold~~ produced and delivered for sale in California shall be calculated in units of g/mi NMOG according to the following equation, where the term "Produced" means produced and delivered for sale in California as: {[(No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (e)(1) and Produced ~~Sold~~ x (0.39)] + [No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (f)(1) and Produced x (0.25)] + [(No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (f)(2) and Produced ~~Sold~~ x (0.25)] + [(No. of Transitional Low-Emission Vehicles (or "TLEVs") excluding HEVs and Produced ~~Sold~~) x (0.125)] + [(No. of Low-Emission Vehicles (or "LEVs") excluding HEVs and Produced ~~Sold~~) x (0.075)] + [(No. of Ultra-Low-Emission Vehicles (or "ULEVs") excluding HEVs and Produced ~~Sold~~) x (0.040)] + (HEV contribution factor)}/(Total No. of Vehicles Produced ~~Sold~~, Including Zero-Emission Vehicles and HEVs):

a. "HEV contribution factor" shall mean the NMOG emission contribution of HEVs to the fleet average NMOG value. The HEV contribution factor shall be calculated in units of g/mi as follows, where the term "Produced" means produced and delivered for sale in California:

HEV contribution factor = {[No. of "Type A HEV" TLEVs Produced ~~Sold~~] x (0.100) + [No. of "Type B HEV" TLEVs Produced ~~Sold~~] x (0.113) + [No. of "Type C HEV" TLEVs Produced ~~Sold~~] x (0.125)} + {[No. of "Type A HEV" LEVs Produced ~~Sold~~] x (0.057) + [No. of "Type B HEV" LEVs Produced ~~Sold~~] x (0.066) + [No. of "Type C HEV" LEVs Produced ~~Sold~~] x (0.075)} + {[No. of "Type A HEV" ULEVs Produced ~~Sold~~] x (0.020) + [No. of "Type B HEV" ULEVs Produced ~~Sold~~] x (0.030) + [No. of "Type C HEV" ULEVs Produced ~~Sold~~] x (0.040)}

b. "Zero-Emission Vehicles" (or "ZEVs") classified as LDTs 3751-5750 lbs. LVW which have been counted toward the ZEV requirements for PCs and LDTs 0-3750 lbs. LVW as specified in note (9) shall be included in the equation of note (4). ~~medium-duty vehicles by weight may be designated as light-duty vehicles for the purpose of calculating fleet average NMOG values.~~

c. Beginning with the 1996 model year, manufacturers that produce and deliver for sale in California PCs and LDTs 0-3750 lbs. LVW that are certified to federal Tier I exhaust emission standards in 40 CFR 86.094-8 and 86.094-9 shall add the following term to the numerator of the fleet average NMOG equation in note (4) and calculate their fleet average NMOG values accordingly:
[(No. of Vehicles Certified to federal Tier I exhaust emission standards and Produced) x (0.25)]

(5) Manufacturers that certify LDTs from 3751-5750 lbs. LVW, shall calculate a fleet average NMOG value in units of g/mi NMOG according to the following equation, where the term "Produced" means produced and delivered for sale in California as:
{[(No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (e)(1), and Produced ~~Sold~~ x (0.50)] + [(No. of Vehicles Certified to the Phase-In Exhaust Emission Standards in section 1960.1 (f)(1), and Produced x (0.32)] + [(No. of Vehicles Certified to the Exhaust Emission Standards in section 1960.1 (f)(2), and Produced ~~Sold~~ x (0.32)] + [(No. of TLEVs Produced ~~Sold~~ excluding HEVs) x (0.160)] + [(No. of LEVs Produced ~~Sold~~ excluding HEVs) x (0.100)] + [(No. of ULEVs Produced ~~Sold~~ excluding HEVs) x (0.050)] + (HEV contribution factor)}/(Total No. of Vehicles Produced ~~Sold~~, Including ZEVs and HEVs).

a. "HEV contribution factor" shall mean the NMOG emission contribution of HEVs to the fleet average NMOG. The HEV contribution factor shall be calculated in units of g/mi as follows, where the term "Produced" means produced and delivered for sale in California:
HEV contribution factor = {[No. of "Type A HEV" TLEVs Produced ~~Sold~~] x (0.130) + [No. of "Type B HEV" TLEVs Produced ~~Sold~~] x (0.145) + [No. of "Type C HEV" TLEVs Produced ~~Sold~~] x (0.160)} + {[No. of "Type A HEV" LEVs Produced ~~Sold~~] x (0.075) + [No. of "Type B HEV" LEVs Produced ~~Sold~~] x (0.087) + [No. of "Type C HEV" LEVs Produced ~~Sold~~] x (0.100)} + {[No. of "Type A HEV" ULEVs Produced ~~Sold~~] x (0.025) + [No. of "Type B HEV" ULEVs

Produced ~~Sold~~] x (0.037) + [No. of "Type C HEV" ULEVs Produced ~~Sold~~] x (0.050)}

b. Only ZEVs which have been certified as LDTs 3751-5750 lbs. LVW and which have not been counted toward the ZEV requirements for PCs and LDTs 0-3750 lbs. LVW as specified in note (9) shall be included in the equation of note (5).

c. Beginning with the 1996 model year, manufacturers that produce and deliver for sale in California LDTs 3751-5750 lbs. LVW that are certified to the Tier I exhaust emission standards in 40 CFR 86.094-9 shall add the following term to the numerator of the fleet average NMOG equation in note (5) and calculate their fleet average NMOG values accordingly:
[(No. of Vehicles Certified to federal Tier I exhaust emission standards and Produced and Delivered for Sale in California) x (0.32)]

(6) As used in this subsection, the term "small volume manufacturer" shall mean any vehicle manufacturer with California sales less than or equal to 3000 new ~~LDVs~~ PCs, LDTs and MDVs per model year based on the average number of vehicles sold by the manufacturer each model year from 1989 to 1991, except as noted below. For manufacturers certifying for the first time in California, model-year sales shall be based on projected California sales. In 2000 and subsequent model years, small volume manufacturers shall comply with the fleet average NMOG requirements set forth below.

a. ~~Prior to the model year 2000, compliance with the specified~~ fleet average NMOG requirements shall be waived.

b. In 2000 and subsequent model years, small volume manufacturers shall not exceed a fleet average NMOG value of 0.075 g/mi for PCs and LDTs from 0-3750 lbs. LVW calculated in accordance with note (4) ~~for 50,000 miles~~.

c. In 2000 and subsequent model years, small volume manufacturers shall not exceed a fleet average NMOG value of 0.100 g/mi for LDTs from 3751-5750 lbs. LVW calculated in accordance with note (5) ~~for 50,000 miles~~.

d. If a manufacturer's average California sales exceeds 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the fleet average requirements applicable for larger manufacturers as specified in section 1960.1 (g)(2) beginning with the fourth model year after the last of the three consecutive model years.

e. If a manufacturer's average California sales falls below 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall be treated as a small volume manufacturer and shall be subject to requirements for small volume manufacturers as specified in section 1960.1 (g)(2) beginning with the next model year.

(7) In ~~1994~~ *1992* and subsequent model years, manufacturers that achieve fleet average NMOG values lower than the fleet average NMOG requirement for the corresponding model year shall receive

credits in units of g/mi NMOG determined as: {[(Fleet Average NMOG Requirement) - (Manufacturer's Fleet Average NMOG Value)] x (Total No. of Vehicles Produced and Delivered for Sale in California ~~Sold~~, Including ZEVs and HEVs)}.

a. Manufacturers with fleet average NMOG values greater than the fleet average requirement for the corresponding model year shall receive debits in units of g/mi NMOG equal to the amount of negative credits determined by the aforementioned equation. For any given model year, the total g/mi NMOG credits or debits earned for PCs and LDTs 0-3750 lbs. LVW and for LDTs 3751-5750 lbs. LVW shall be summed together. The resulting amount shall constitute the g/mi NMOG credits or debits accrued by the manufacturer for the model year.

b. For the 1994 through 1997 model years, manufacturers shall equalize emission debits within three model years and prior to the end of the 1998 model year by earning g/mi NMOG emission credits in an amount equal to their g/mi NMOG debits, or by submitting a commensurate amount of g/mi NMOG credits to the Executive Officer that were earned previously or acquired from another manufacturer. For 1998 and subsequent model years, manufacturers shall equalize emission debits by the end of the following model year. If emission debits are not equalized within the specified time period, the manufacturer shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the emission debits are not equalized by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's emission standards shall be determined by dividing the total amount of g/mi NMOG emission debits for the model year by the g/mi NMOG fleet average requirement for PCs and LDTs 0-3750 lbs. LVW applicable for the model year in which the debits were first incurred.

c. The g/mi NMOG emission credits earned in any given model year shall retain full value through the subsequent model year.

d. The g/mi NMOG value of any credits not used to equalize the previous model-year's debit, shall be discounted by 50% at the beginning of the second model year after being earned, discounted to 25% of its original value if not used by the beginning of the third model year after being earned, and will have no value if not used by the beginning of the fourth model year after being earned.

e. ~~Any g/mi NMOG emission credits earned by a manufacturer may be applied toward either the fleet average requirement for passenger cars and light-duty trucks from 0-3750 lbs. LVW, or the fleet average requirement for light-duty trucks from 3751-5750 lbs. LVW, at the manufacturer's discretion.~~

(8) Manufacturers that produce and deliver for sale in California ~~sell~~ vehicles certified to the phase-in exhaust emission standards in section 1960.1 (f)(1), or vehicles certified to the

exhaust emission standards in sections 1960.1 (f)(2) or 1960.1 (g)(1) and/or ZEVs, in the 1992 and 1993 model years, shall receive emission credits ~~for the sale of these vehicles~~ as determined by the equations in footnotes (4), ~~or~~ (5), and (7) ~~depending upon Vehicle Weight Class, and footnote (7).~~

a. For PCs and LDTs from 0-3750 lbs. LVW, the fleet average NMOG requirement for calculating a manufacturer's emission credits shall be 0.390 and 0.334 g/mi NMOG for vehicles certified for the 1992 and 1993 model years, respectively.

b. For LDTs from 3751-5750 lbs. LVW, the fleet average NMOG requirement for calculating a manufacturer's emission credits shall be 0.500 and 0.428 g/mi NMOG for vehicles certified for the 1992 and 1993 model years, respectively.

c. Emission credits earned prior to the 1994 model year shall be considered as earned in the 1994 model year and discounted in accordance with the schedule specified in footnote (7).

(9) While meeting the fleet average requirements, each manufacturer shall certify, produce, and deliver for sale in California ~~its sales fleet of passenger cars and light-duty trucks from 0-3750 lbs. LVW shall be composed of~~ at least 2% ZEVs each model year from 1998 through 2000, 5% ZEVs in 2001 and 2002, and 10% ZEVs in 2003 and subsequent model years. These percentages shall be applied to the manufacturer's total production of PCs and LDTs 0-3750 lbs. LVW delivered for sale in California.

~~a.~~ ~~Manufacturers which produce for sale in California more ZEVs~~ than required in a given model year shall earn ZEV credits, which shall have units of g/mi NMOG. The amount of ZEV credits earned shall be equal to the number of ZEVs required to be produced and delivered for sale in California for the model year subtracted from the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year and then multiplied by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for the model year. All ZEVs credits earned prior to the 1998 model year shall be treated as if earned in the 1998 model year and shall be discounted in accordance with notes (7)c and (7)d.

~~a~~ b. A manufacturer may meet the ZEV requirements in any given model year by submitting to the Executive Officer a commensurate amount of ZEV credits. ~~g/mi NMOG emission credits earned exclusively from the sale of ZEVs.~~ These credits may be earned previously by the manufacturer or acquired from another manufacturer. The amount of ZEV credits required to be submitted shall be calculated by subtracting the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year from the number of ZEVs required to be produced by the manufacturer for the model year and then multiplying by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for that model year.

~~b~~ c. Manufacturers which certify, produce, and deliver for sale in California ~~sell~~ fewer ZEVs than required in a given model year shall make up the deficit by the end of the next model year by ~~selling an additional number of~~ ZEVs equal to

~~their deficit or~~ by submitting to the Executive Officer a commensurate amount of ZEV ~~g/mi~~ NMOG credits ~~earned exclusively from the sale of ZEVs~~. The amount of ZEV credits required to be submitted shall be calculated by subtracting the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year from the number of ZEVs required to be produced by the manufacturer for the model year and then multiplying by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for the model year in which the deficit is incurred.

d. Any manufacturer which fails to produce and deliver for sale in California the required number of ZEVs or submit an appropriate amount of ZEV credits and does not make up ZEV deficits within the specified time period shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the ZEV deficits are not balanced by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's standards shall be calculated according to the following equation: (No. of ZEVs required to be produced and delivered for sale in California for the model year) - (No. of ZEVs actually produced and delivered for sale in California for the model year) - [(Amount of ZEV credits submitted for the model year) / (the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for the model year)].

e. ZEVs classified as MDVs or as LDTs 3751-5750 lbs. LVW may be counted toward the ZEV requirement for PCs and LDTs 0-3750 lbs. LVW and included in the calculation of ZEV credits as specified in note (9)a., if the manufacturer so designates.

~~e~~ f. Small volume manufacturers shall not be required to meet the percentage ZEV requirements. However, small volume manufacturers may earn and market credits for ZEVs they produce and ~~sell~~ deliver for sale in California.

~~d~~ g. Intermediate volume manufacturers as defined in section 1960.1 (o) shall not be required to meet the percentage ZEV requirements before the 2003 model year.

(h)(1) The exhaust emissions from new 1995 and subsequent model medium-duty vehicles shall not exceed:

1995 AND SUBSEQUENT MODEL-YEAR
MEDIUM-DUTY VEHICLE EXHAUST EMISSIONS STANDARDS (1)(2)(3)(7)(8)
(grams per mile)

Test Weight(lbs.)	Durability Vehicle Basis(mi)	Non-Methane Hydrocarbons(4)	Carbon Monoxide	Oxides of Nitrogen(5)	Particulates (6)
0-3,750	50,000	0.25	3.4	0.4	n/a
0-3,750	120,000	0.36	5.0	0.55	0.08
3,751-5,750	50,000	0.32	4.4	0.7	n/a
3,751-5,750	120,000	0.46	6.4	0.98	0.10
5,751-8,500	50,000	0.39	5.0	1.1	n/a
5,751-8,500	120,000	0.56	7.3	1.53	0.12
8,501-10,000	50,000	0.46	5.5	1.3	n/a
8,501-10,000	120,000	0.66	8.1	1.81	0.12
10,001-14,000	50,000	0.60	7.0	2.0	n/a
10,001-14,000	120,000	0.86	10.3	2.77	0.12

(1) "n/a" means not applicable.
"Test Weight" shall mean the average of the vehicle's curb weight and gross vehicle weight.

(2) ~~Manufacturers have the option of certifying engines used in~~ incomplete and diesel medium-duty vehicles from 8501-14,000 pounds, gross vehicle weight to the heavy-duty engine standards and test procedures set forth in section 1956.8(e), Title 13, California Code of Regulations. Manufacturers certifying incomplete or diesel medium-duty vehicles to the heavy-duty engine standards and test procedures shall specify, in the application for certification, an in-use compliance test procedure, as provided in section 2139(c), Title 13, California Code of Regulations.

(3) For the 1995 model year only, manufacturers of medium-duty vehicles may certify a maximum of 50 percent of their vehicles to the applicable 1994 model-year standards and test procedures. For the 1995 model year only, small volume manufacturers may certify 100 percent of their vehicles to the applicable 1994 model-year standards and test procedures. The percentage shall be based upon each manufacturer's projected sales of California-certified medium-duty vehicles.

(4) For methanol- and ethanol-fueled vehicles certifying to these standards, including flexible-fueled vehicles when certifying on methanol or ethanol, "Non-Methane Hydrocarbons" shall mean "Organic Material Non-Methane Hydrocarbon Equivalent" (or "OMNMHCE").

(5) The maximum projected emissions of oxides of nitrogen measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall be not greater than 2.00 times the applicable medium-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in

accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) Particulate standards are only applicable for diesel vehicles and shall be determined on a 120,000 mile basis.

(7) In-use compliance testing shall be limited to vehicles with less than 90,000 miles. For the 1995 through 1997 models, alternative in-use compliance is available for medium-duty vehicle manufacturers. A manufacturer may use alternative in-use compliance for up to 100 percent of its fleet in the 1995 and 1996 model years and up to 50 percent of its fleet in the 1997 model year. Small volume manufacturers may use alternative in-use compliance for up to 100 percent of their fleets in the 1995 through 1997 model years. The percentages shall be determined from the manufacturers' projected California sales of medium-duty vehicles. For vehicles certified to the standards and test procedures of this subsection, "alternative in-use compliance" shall consist of an in-use allowance of 25 percent over the applicable 1995 model-year non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen 50,000 mile emission standards and a waiver of the emission standards beyond 50,000 miles.

(8) All medium-duty vehicles, except diesel-fueled vehicles and those incomplete and diesel vehicles certifying to heavy-duty engine test procedures, are subject to 50,000 mile and 120,000 mile non-methane hydrocarbon, carbon monoxide, and oxides of nitrogen standards. Diesel-fueled vehicles shall be subject to 120,000 mile non-methane hydrocarbon, carbon monoxide, oxides of nitrogen, and particulate standards only.

(h)(2) The exhaust emissions from new 1992 and subsequent model-year medium-duty low-emission vehicles, and ultra-low-emission vehicles shall not exceed:

EXHAUST EMISSION STANDARDS FOR LOW-EMISSION VEHICLES, AND ULTRA-LOW-EMISSION VEHICLES IN THE MEDIUM-DUTY VEHICLE WEIGHT CLASS (8)(9)(10)(11)(12)(13)(14)(15)(16)
[grams per mile (or "g/mi")]

Test Weight lbs.) (1)	Durability Vehicle Basis (mi)	Vehicle Emission Category (2)	Non-Methane Organic Gases (3)(4)	Carbon Monoxide	Oxides of Nitrogen (5)	Particulates (6)(7)
0-3750	50,000	LEV	0.125 (0.188)	3.4 (3.4)	0.4 (0.4)	n/a
		ULEV	0.075 (0.100)	1.7 (2.6)	0.2 (0.3)	n/a
	120,000	LEV	0.180	5.0	0.6	0.08
		ULEV	0.107	2.5	0.3	0.04
3751-5750	50,000	LEV	0.160 (0.238)	4.4 (4.4)	0.7 (0.7)	n/a
		ULEV	0.100 (0.128)	2.2 (3.3)	0.4 (0.5)	n/a
	120,000	LEV	0.230	6.4	1.0	0.10
		ULEV	0.143	3.2	0.5	0.05
5751-8500	50,000	LEV	0.195 (0.293)	5.0 (5.0)	1.1 (1.1)	n/a
		ULEV	0.117 (0.156)	2.5 (3.8)	0.6 (0.8)	n/a
	120,000	LEV	0.280	7.3	1.5	0.12
		ULEV	0.167	3.7	0.8	0.06
8501-10000	50,000	LEV	0.230 (0.345)	5.5 (5.5)	1.3 (1.3)	n/a
		~~ULEV~~	~~0.138 (0.184)~~	~~2.8 (4.2)~~	~~0.7 (1.0)~~	~~n/a~~
	120,000	LEV	0.330	8.1	1.8	0.12
		ULEV	0.197	4.1	0.9	0.06
10,001-14000	50,000	LEV	0.300 (0.450)	7.0 (7.0)	2.0 (2.0)	n/a
		ULEV	0.180 (0.240)	3.5 (5.3)	1.0 (1.5)	n/a
	120,000	LEV	0.430	10.3	2.8	0.12
		ULEV	0.257	5.2	1.4	0.06

(1) "Test Weight" (or "TW") shall mean the average of the vehicle's curb weight and gross vehicle weight.

(2) "LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(3) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions. To determine compliance with an NMOG standard, NMOG emissions shall be measured in accordance with "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991 and last amended _____, which is incorporated herein by reference.

a. For LEVs and ULEVs certified to operate on any available fuel other than conventional gasoline, including fuel-flexible or dual-fuel vehicles when certifying on a fuel other than ~~conventional~~ gasoline, manufacturers shall multiply the exhaust NMOG certification ~~mass emission~~ levels at ~~50,000~~ and ~~120,000 miles~~ by the applicable reactivity adjustment factor set forth in section 13 of the "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(k), or established by the Executive Officer pursuant to Appendix VIII of the foregoing test procedures. In addition, natural gas vehicles certifying to LEV or ULEV standards shall calculate a reactivity-adjusted methane exhaust emission value by multiplying the methane exhaust certification level by the applicable methane reactivity adjustment factor set forth in section 13 of the above-referenced test procedures. The product of the exhaust NMOG certification ~~mass emission~~ levels and the reactivity adjustment factor shall be compared to the exhaust NMOG mass emission standard established for the particular vehicle emission category to determine compliance. For natural gas vehicles, the reactivity-adjusted NMOG value shall be added to the reactivity-adjusted methane value and then compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance.

(4) Fuel-flexible and dual-fuel medium-duty vehicles (or "MDVs") from 0-14,000 lbs. TW shall be certified to exhaust mass emission standards for NMOG established for the operation of the vehicle on any fuel other than ~~conventional~~ gasoline, and ~~conventional~~ gasoline.

a. For LEVs and ULEVs when certifying on the fuel other than gasoline, manufacturers shall multiply the exhaust NMOG certification ~~mass emission~~ levels at ~~50,000 and 120,000 miles~~ by the applicable reactivity adjustment factor. In addition to multiplying the exhaust NMOG certification levels by the applicable reactivity adjustment factor, natural gas vehicles shall multiply the exhaust methane certification level by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. When certifying on gasoline, the exhaust NMOG certification levels of fuel-flexible and dual-fuel vehicles shall not be multiplied by a reactivity adjustment factor.

b. For MDVs from 0-3750 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.25 g/mi and 0.36 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.125 g/mi and 0.180 ~~0.190~~ g/mi for 50,000 and 120,000 miles, respectively.

c. For MDVs from 3751-5750 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.32 g/mi and 0.46 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.160 g/mi and 0.230 g/mi for 50,000 and 120,000 miles, respectively.

d. For MDVs from 5751-8500 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for ~~operation on conventional gasoline~~ shall be:
   (i) For LEVs, 0.39 g/mi and 0.56 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.195 g/mi and 0.280 g/mi for 50,000 and 120,000 miles, respectively.

e. For MDVs from 8501-10,000 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.46 g/mi and 0.66 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.230 g/mi and 0.330 g/mi for 50,000 and 120,000 miles, respectively.

f. For MDVs from 10,001-14,000 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on ~~conventional~~ gasoline shall be:
   (i) For LEVs, 0.60 g/mi and 0.86 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.300 g/mi and 0.430 g/mi for 50,000 and 120,000 miles, respectively.

(5) The maximum projected emissions of "Oxides of Nitrogen" (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall not be greater than 2.00 times the applicable MDV standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) Particulate standards are only applicable for diesel vehicles and shall be determined on a 120,000 mile basis.

(7) "n/a" means not applicable.

(8) Manufacturers have the option of certifying engines used in incomplete and diesel MDVs to the heavy-duty engine standards and test procedures set forth in section 1956.8(h), Title 13, California Code of ~~Regulations. Manufacturers certifying incomplete or diesel MDVs to~~ the heavy-duty engine standards and test procedures shall specify in the application for certification an in-use compliance procedure as provided in section 2139(c), Title 13, California Code of Regulations.

(9) The standards in parenthesis are intermediate <u>in-use</u> compliance standards for 50,000 miles. For MDVs from 0-14,000 lbs. TW, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, intermediate <u>in-use</u> compliance standards shall apply to LEVs and ULEVs through the 1999 model year. <u>In-use</u> <u>C</u>compliance with standards beyond 50,000 miles shall be waived through the 1999 model year for LEVs and ULEVs.

a. For LEVs and ULEVs designed to operate on any available fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than ~~conventional~~ gasoline, NMOG emission <u>results</u> ~~levels~~ shall be multiplied by the applicable reactivity adjustment factor. <u>In addition to multiplying the exhaust NMOG *certification levels* *emission results* by the applicable reactivity adjustment factor, natural gas vehicles shall multiply the exhaust methane *certification level* *emission results* by the applicable methane reactivity adjustment factor and add that value to the reactivity-adjusted NMOG value. For fuel-flexible and dual-fuel vehicles when operating on gasoline, NMOG emission results shall not be multiplied by a reactivity adjustment factor.</u>

b. For fuel-flexible and dual-fuel MDVs from 0-3750 lbs. TW, intermediate <u>in-use</u> compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.32 g/mi and 0.188 g/mi for LEVs and ULEVs, respectively.

c. For fuel-flexible and dual-fuel MDVs from 3751-5750 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.41 g/mi and 0.238 g/mi for LEVs and ULEVs, respectively.

d. For fuel-flexible and dual-fuel MDVs from 5751-8500 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.49 g/mi and 0.293 g/mi for LEVs and ULEVs, respectively.

e. For fuel-flexible and dual-fuel MDVs from 8501-10,000 lbs. TW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.58 g/mi and 0.345 g/mi for LEVs and ULEVs, respectively.

f. For fuel-flexible and dual-fuel MDVs from 10,001-14,000 lbs. TW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on ~~conventional~~ gasoline, shall be 0.75 g/mi and 0.450 g/mi for LEVs and ULEVs, respectively.

(10) Each manufacturer's MDV fleet shall be defined as the total number of MDVs from 0-14,000 lbs. TW certified and ~~sold~~ produced and delivered for sale in California.

a. Manufacturers of MDVs shall certify an equivalent of 25% of their MDV fleet to LEV standards in the 1998 model year, 50% of their MDV fleet to LEV standards in the 1999 model year, 75% of their MDV fleet to LEV standards in the 2000 model year, 95% of their MDV fleet to LEV standards in the 2001 model year, 90% of their MDV fleet to LEV standards in the 2002 model year, and 85% of their MDV fleet to LEV standards in the 2003 and subsequent model years.

b. Manufacturers of MDVs shall certify an equivalent of 2% of their MDV fleet to ULEV standards in each model year from 1998 through 2000, 5% of their MDV fleet to ULEV standards in the 2001 model year, 10% of their MDV fleet to ULEV standards in the 2002 model year, and 15% of their MDV fleet to ULEV standards in the 2003 and subsequent model years.

c. These requirements shall not apply to small volume manufacturers. Small volume manufacturers shall comply with the requirements of note (15) below.

(11) For the purpose of calculating "Vehicle Equivalent Credits" (or "VECs"), the contribution of hybrid electric vehicles (or "HEVs") will be calculated based on the range of the HEV without the use of the engine. For the purpose of calculating the contribution of HEVs to the VECs, the following definitions shall apply:

"Type A HEV" shall mean an HEV which achieves a minimum range of 60 miles over the All-Electric Range Test as defined in the "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 (k). ~~Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET; 40 CFR Part 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 60 miles. This definition shall also apply to vehicles which have no tailpipe~~

~~emissions, but use fuel fired heaters, regardless of the operating range of the vehicle.~~

"Type B HEV" shall mean an HEV which achieves a range of 40 - 59 miles over the All-Electric Range Test as defined in the "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 (k). ~~Dynamometer Driving Cycle as defined by the "Federal Highway fuel Economy Test Procedure" (HWFET, 40 CFR part 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 40 miles.~~

"Type C HEV" shall mean an HEV which achieves a range of 0 - 39 miles over the All-Electric Range Test ~~Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET, 40 CFR Part 600 Subpart B) without the use of the engine, an HEV which enables the vehicle operators to control the engine time and modes of operation either directly or indirectly, an HEV which can be operated solely through the use of the engine,~~ and all other HEVs excluding "Type A" and "Type B" HEVs as defined in the "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 (k).

a. For the purpose of calculating VECs, electric vehicles which utilize fuel fired heaters and which are not otherwise certified as ZEVs shall be treated as "Type A HEV ULEVs."

(12) ~~In 1992 and subsequent model years, manufacturers that~~ produce and deliver for sale in California ~~sell~~ MDVs in excess of the equivalent requirements for LEVs and/or ULEVs shall receive VECs calculated in accordance with the following equation, where the term "Produced" means produced and delivered for sale in California as: {[(No. of LEVs Produced ~~Sold~~ excluding HEVs) + (No. of "Type C HEV" LEVs Produced ~~Sold~~)] + [(No. of "Type B HEV" LEVs Produced ~~Sold~~) x (1.1)] + [(No of "Type A HEV" LEVs Produced ~~Sold~~) x (1.2)] - (Equivalent No. of LEVs Required to be Produced ~~Sold~~)} + {[(No. of ULEVs Produced ~~Sold~~ excluding HEVs) x (1.4)] + [(No. of "Type C HEV" ULEVs Produced ~~Sold~~) x (1.4)] + [(No. of "Type B HEV" ULEVs Produced ~~Sold~~) x (1.5)] + [(No. of "Type A HEV" ULEVs Produced ~~Sold~~) x (1.7)] - [(Equivalent No. of ULEVs Required to be Produced ~~Sold~~) x (1.4)]} + [(No. of ZEVs Produced ~~Sold~~ as MDVs) x (2.0)].

a. Manufacturers that fail to produce and deliver for sale in California ~~sell~~ the equivalent quantity of MDVs certified to LEV and/or ULEV exhaust emission standards, shall receive "Vehicle-Equivalent Debits" (or "VEDs") equal to the amount of negative VECs determined by the aforementioned equation.

b. Manufacturers shall equalize emission debits within one model year by earning VECs in an amount equal to their previous model-year's total of VEDs, or by submitting a commensurate amount of VECs to the Executive Officer that were earned previously or acquired from another manufacturer. Any manufacturer which fails to equalize emission debits within the specified time period shall be subject to the Health and Safety Code civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the emission debits

are not equalized by the end of the specified time period. for the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's emission standards shall be equal to the amount of VEDs incurred.

c. The VECs earned in any given model year shall retain full value through the subsequent model year.

d. The value of any VECs not used to equalize the previous model-year's debit, shall be discounted by 50% at the beginning of second model year after being earned, discounted to 25% of its original value if not depleted by the beginning of the third model year after being earned, and will have no value if not depleted by the beginning of the fourth model year after being earned.

e. Any VECs earned prior to the 1998 model year shall be treated as earned in the 1998 model year and discounted in accordance with the schedule specified in note (12)(d).

~~e~~ f. Only ZEVs certified as MDVs shall be included in the calculation of VECs.

(13) Manufacturers shall demonstrate compliance with the above standards for NMOG, carbon monoxide, and oxides of nitrogen at 50 degrees F according to the procedure specified in section 11k of the "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(k). Hybrid electric, natural gas, and diesel-fueled vehicles shall be exempt from 50 degrees F test requirements. ~~For diesel vehicles, compliance with the particulate standard shall also be demonstrated as specified in section 11k of the foregoing test procedures.~~

(14) In-use compliance testing shall be limited to vehicles with fewer than 90,000 miles.

(15) Deterioration factors for hybrid electric vehicles shall be based on the emissions and mileage accumulation of the auxiliary power unit. For certification purposes only, Type A hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors), and demonstrating compliance with 120,000 mile emission standards shall not be required. For certification purposes only, Type B hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 120,000 mile emission standards (using 90,000 mile deterioration factors). For certification purposes only, Type C hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 120,000 mile emission standards (using 120,000 mile deterioration factors).

(16) As used in 1960.1 (h)(2), Title 13, CCR, the term "small volume manufacturer" shall mean any vehicle manufacturer with California sales less than or equal to 3000 new PCs, LDTs, and MDVs per model year based on the average number of vehicles sold by the manufacturer each model year from 1992 to 1994, except as otherwise noted below. For manufacturers certifying for the first time in California, model-year sales shall be based on projected California sales. In 2001 and subsequent model years, small volume manufacturers shall comply with the requirements set forth below.

a. Prior to the model year 2001, small volume manufacturers shall not be required to certify, produce, or deliver LEVs and ULEVs for sale in California.

b. In 2001 and subsequent model years, small volume manufacturers shall certify, produce, and deliver for sale in California LEVs in a quantity equivalent to 100% of their MDV fleet .

c. If a manufacturer's average California sales exceeds 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the LEV and ULEV requirements applicable for larger manufacturers as specified in 1960.1 (h)(2) beginning with the fourth model year after the last of the three consecutive model years.

e. If a manufacturer's average California sales falls below 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall be treated as a small volume manufacturer and shall be subject to requirements for small volume manufacturers as specified in 1960.1 (h)(2) beginning with the next model year.

(i) and (j) [No Change]

(k) The test procedures for determining compliance with these standards are set forth in "California Exhaust Emission Standards and Test Procedures for 1981 through 1987 Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles", adopted by the Sstate Bboard on November 23, 1976, as last amended May 20, 1987, and in "California Exhaust Emission ~~Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars,~~ Light-Duty Trucks, and Medium-Duty Vehicles", adopted by the state board on May 20, 1987 as last amended ~~August 19, 1992~~ [INSERT], both of which are incorporated herein by reference.

(l) through (o) [No Change]

(p) The cold temperature exhaust carbon monoxide emission levels from new 1996 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles shall not exceed:

1996 AND SUBSEQUENT MODEL-YEAR COLD TEMPERATURE CARBON MONOXIDE EXHAUST EMISSIONS STANDARDS FOR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES (1)(2)
(grams per mile)

Vehicle Type	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Carbon Monoxide
Passenger Car	All	50,000	10.0
Light-Duty Truck	0-3750	50,000	10.0
Light-Duty Truck	3751-5750	50,000	12.5
Medium-Duty Vehicle	0-3750	50,000	10.0
Medium-Duty Vehicle	3751-8500 (3)	50,000	12.5

(1) These standards are applicable to vehicles tested in accordance with 40 CFR Part 86 Subpart C, at a nominal temperature of 20°F (-7°C).
(2) Natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles are exempt from these standards.
(3) Medium-duty vehicles with a gross vehicle weight rating greater than 8,500 lbs. are exempt from this standard.

NOTE: Authority cited: Sections 39600, 39601, 43013, 43018, 43101, 43104, and 43105, Health and Safety Code. Reference: Sections 39002, 39003, 43000, 43009.5, 43013, 43018, 43100, 43101, 43101.5, 43102, 43103, 43104, 43105, 43106, 43107, 43204-43205.5, Health and Safety Code.

Attachment III

REQUEST FOR TEST PROCEDURES

On January 14, 1993, the Air Resources Board conducted a public hearing to consider amendments to California regulations for certifying light-duty and medium-duty motor vehicles. Included in this mail-out are a Notice of Public Availability of Modified Text, a description of the modifications to the originally proposed amendments (Attachment F to Resolution 93-3), and the revised text of sections 1960.1, 1976, and 2061 of Title 13, California Code of Regulations.

Incorporated by reference in these Title 13 sections are four Test Procedures which would also be modified as part of this rulemaking. These Test Procedures contain very specific requirements for certifying low-emission vehicles and may be of limited general interest. If you are interested in reviewing the text of any of these Test Procedures with the modifications to the originally proposed regulatory language clearly shown, please indicate below which procedures you would like to receive and mail or fax this form to:

Ms. Donna Barragan
California Air Resources Board
9528 Telstar Avenue
El Monte, California 91731

FAX: 818-575-6699

* * *

_____ California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Vehicles

_____ California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Vehicles

_____ California Assembly-Line Test Procedures for 1983 and Subsequent Model-Year Vehicles

_____ California NMOG Test Procedures

Name: _____

Company: _____

Address: _____

_____

ATTACHMENT IV

ADDITIONAL MODIFICATIONS

1. **RAF for LEVs Operated on Phase 2 gasoline.** In further evaluating the speciated exhaust data for TLEVs and LEVs operating on Phase 2 gasoline, the staff determined that methyl-tertiary butyl ether (MTBE) was mislabelled as 2,3-dimethyl butane. Recent gas chromatography/mass spectroscopy analysis reveals that the two compounds co-elute and the correct percentage of each compound in the peak is 70% MTBE (after an 84% response factor to the flame ionization detector is applied) and 30% 2,3-dimethylbutane. As a result, an incorrect maximum incremental reactivity (MIR) value was assigned to the peak in calculating the reactivity adjustment factors (RAFs) for TLEVs and LEVs . After the appropriate values are applied, (0.63 for MTBE and 1.07 for 2,3-dimethylbutane) the value of the RAF for TLEVs operating on Phase 2 gasoline remains at 0.98 and the RAF for LEVs operating on Phase 2 gasoline is reduced from 0.95 to 0.94. The modified text of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" (herein the Light and Medium Duty Test Procedures), reflects the revised RAF for LEVs operating on Phase 2 gasoline. (p. 13-1.)

2. **References to the Federal Test Procedures.** The Light and Medium Duty Test Procedures incorporate by reference the pertinent Federal Test Procedures contained in 40 C.F.R. Part 86. Appendix I to the Light and Medium Duty Test Procedures sets forth the specific sections of the Federal Test Procedures that are incorporated by reference, and the adoption or amendment date of the version of each section that is being incorporated by reference. The text of Appendix I that was originally proposed in this rulemaking did not include all of the revisions to Appendix I that had been adopted January 22, 1990 in the Board's rulemaking pertaining to standards and test procedures for methanol-powered vehicles. The modified text of Appendix I being made available for the 15-day comment period includes revisions made to correctly reflect actions taken in prior rulemakings. A few corrections have also been made to Appendix I and to the text of the Light and Medium Duty Test Procedures to assure that the references to the incorporated sections of the Federal Test Procedures in Appendix I and the text are consistent.

3. **Other Corrections.** Additional nonsubstantive modifications have been made to Title 13, California Code of Regulations, section 1960.1, and the the Light and Medium Duty Test Procedures, to assure the consistent use of terminology. These modifications are in section 1960.1(g)(1) note (6)a., section 1960.1(h)(2) note (9)a, and in the Light and Medium Duty Test Procedures sections 3.g. note (6)a. and 3.j. note (9)a.

Establishment of Corrections to Reactivity Adjustment Factors for Transitional Low-Emission Vehicles and Low-Emission Vehicles Operating on Phase 2 Reformulated Gasoline

Airshed Modeling Protocol and Updated Final Results

California Air Resources Board
Research Division

March 15, 1993

I. Summary

This report presents the complete protocol (or calculation methodology) and results for airshed modeling performed by Professor Armistead Russell and co-workers at Carnegie Mellon University (CMU) to establish corrections to reactivity adjustment factors (RAFs) for Transitional Low-Emission Vehicles (TLEVs) and Low-Emission Vehicles (LEVs) operating on Phase 2 reformulated gasoline. Although the maximum incremental reactivity (MIR) approach used to calculate the RAFs has been validated by airshed modeling results for individual organic gases (McNair *et al.* 1992; ARB 1992), and has been supported by the National Research Council (1991), RAF corrections are necessary because of differences in spatial and temporal patterns of emissions between motor vehicle fleets (ARB 1992). The following sections describe the processing of motor vehicle test data and other details of the emission inputs. When this information is combined with pre-existing documents describing other model inputs, the reader will have complete information to evaluate and, if desired, reproduce the airshed modeling results.

Reactivity adjustment factors of 0.98 and 0.94 are recommended for TLEVs and LEVs, respectively, operating on Phase 2 gasoline. The recommended values reflect improved MIR assignments for three coeluting pairs of organic gases. Previously, the airshed modeling results had implied the need for 5 and 4 percent increases for TLEVs and LEVs, respectively, operating on Phase 2 gasoline. Subsequently, it was discovered that the vehicle test data for aldehydes were inadvertently provided to Professor Russell in units of mass (mg) rather than mass emission rates (mg/mile). This error led to 4 percent higher RAF values than those used by Professor Russell to adjust the mass of the motor vehicle fleets. Thus, the airshed modeling results indicate that there is no need for a correction to the RAFs for TLEVs and LEVs operating on Phase 2 gasoline.

The aim of the airshed modeling protocol is to provide a rigorous test of the RAFs. The model inputs were selected to represent upper and lower bounds, rather than a best estimate, of future conditions. The final 1987 baseline emission inventory produced by the South Coast Air Quality Management District (SCAQMD) was used, with -4, +19, and +7 percent changes in emissions of nonmethane organic gases (NMOG), oxides of nitrogen (NO_x), and carbon monoxide (CO), respectively, from the draft inventory used in the previous study performed in 1991 (ARB 1992). The 1987 NMOG and CO emission inventories were doubled to respond to concerns on the underestimation of motor vehicle

and other emissions (Pierson *et al.* 1990; Fujita *et al.* 1992; Harley *et al.* 1993), and to provide a more stringent test of the MIR scale, which defines reactivity where hydrocarbon control is most important, *i.e.*, at high NO_x concentrations. This departs from the 1991 study, which included a doubling of the on-road catalyst exhaust emissions of NMOG and CO, rather than a doubling of the entire inventory. The change to the 1987 baseline emission inventory necessitated a verification of the correction for the 85 percent methanol/15 percent gasoline (M85) case done in 1991. A matrix of two ozone episodes (1987 and 1982) in the South Coast Air Basin (SoCAB), two baseline emission inventories (1987 and 2010), and, in addition to the conventional fuel, two alternative fuels (Phase 2 gasoline and M85) and a zero motor vehicle hydrocarbon exhaust emission case for two levels of the new standards (TLEV and LEV) was modeled. This results in twenty-four model simulations for analysis. The results for M85 show better agreement overall with the equal ozone impacts required by the regulation than those reported in the 1991 study.

II. Calculation Methodology

The CIT airshed model is a three-dimensional, photochemical grid model, based on numerically solving the advection-diffusion equation. The model employs the Lurmann, Coyner and Carter (LCC) lumped molecule chemical mechanism. This family of chemical schemes is now referred to as the SAPRC mechanisms, as Carter is affiliated with the Statewide Air Pollution Research Center at the University of California at Riverside. The LCC mechanism is a predecessor of the SAPRC90 mechanism employed in determining the MIR scale. There are three versions of the LCC mechanism, each using various degrees of lumping to condense the hundreds of organic gases into a manageable number of species for model calculations. The CIT airshed model uses the most condensed version of the LCC, which has been shown previously (ARB 1992) to produce the same RAFs as the SAPRC90 mechanism. The LCC mechanism was extended to include the explicit chemical mechanisms for ethane, propane, methanol, and ethanol, normally lumped with other species in the LCC mechanism, because of the large fractions of these species found in the exhaust for some of the alternative fuels.

The CIT airshed model is used to simulate two three-day ozone episodes in the SoCAB. Both periods are conducive to high ozone formation, although each had different meteorological characteristics, and peak ozone concentrations occurred in different parts of the Basin during each episode. The August 30 to September 1, 1982 episode had very stagnant meteorological conditions leading to one of the highest one-hour ozone concentrations (0.35 ppm) recorded in the United States in 1982. The August 27 to 29, 1987 episode was an intensive measurement period during the Southern California Air Quality Study (SCAQS) with a one-hour peak ozone concentration of 0.29 ppm. The CIT airshed model has been evaluated and peer-reviewed for both periods (Russell *et al.* 1990; Harley *et al.* 1993). Initial and boundary conditions were derived from measurements, and were unchanged for all calculations. The initial conditions largely influence the model predictions for the first day or two. After that, emissions and boundary conditions predominate. The ideal situation for investigating the effects of different emission inventories is to minimize the influence of initial conditions. As a consequence, only the third day of the model simulation is reported. Boundary conditions have a minimal influence on model predictions as determined by sensitivity tests (Russell *et al.* 1990; Harley *et al.* 1993).

Emissions of nitrous acid (HONO), an important source of radicals that initiate ozone formation in the morning, were not added to the episodes as was done in the derivation of the MIR scale (ARB 1992). The CIT airshed model includes night-time reactions that create HONO concentrations similar to those observed during SCAQS.

III. Motor Vehicle Test Data

Six 1987 and six 2010 inventories were constructed by adjusting the on-road catalyst exhaust emissions of NMOG to account for changing fuels: a null inventory (NULL) for the case of no catalyst exhaust emissions of NMOG; conventionally-fueled vehicle (CFV) cases, corresponding to industry-average gasoline, termed RF-A in the Auto/Oil Air Quality Improvement Research Program (AQIRP) for TLEVs and LEVs; and alternative fuel inventories for TLEVs and LEVs operated on Phase 2 reformulated gasoline (PH2) and for TLEVs operated on M85 with motor vehicle emissions for each alternative fuel multiplied by the reciprocal of the RAF. Data from testing programs conducted by the California Air Resources Board (ARB), the Auto/Oil AQIRP, and Chevron Research & Technology Company were assigned organic gas identifications (OGID) corresponding to the list of species in the MIR scale adopted in the 1991 RAF regulation. The motor vehicle test data were renormalized in terms of weight fractions, and then the weight fractions for each species for all the tests on an individual vehicle were averaged. The composite profiles for each motor vehicle were averaged to create composite profiles for each fuel. Separate composite profiles were calculated for each bag of the U. S. Environmental Protection Agency's 1975 Federal Test Procedure (FTP).

During the gas chromatographic analysis of motor vehicle emissions, sometimes two compounds will coelute. Coelution is generally not a problem if both compounds are present in only small amounts or if they have similar reactivities. The testing program conducted by ARB was unable to resolve 2,2,4-trimethylpentane from an unidentified alkene, or 4-ethyltoluene from a C_{10} cycloalkane, and methyl *tert*-butyl ether (MTBE) from 2,3-dimethylbutane. For lack of better information, a 50/50 split was assumed for the first two coeluting pairs, and the third was assigned entirely to 2,3-dimethylbutane. Recent gas chromatography/mass spectroscopy analysis reveals that these assumptions were invalid. The first coeluting pair is almost all 2,2,4-trimethylpentane, and the second pair is entirely 4-ethyltoluene. For the Phase 2 gasoline, which is approximately 11 percent MTBE, the third coeluting pair is 70 percent MTBE (with an 84 percent response to the flame ionization detector) and 30 percent 2,3-dimethylbutane.

The composite profiles provided to Professor Russell for TLEVs and LEVs are given in Appendices A and B, respectively. These profiles did not include motor vehicle test results from ARB and the Auto/Oil AQIRP that were not available for processing. In addition, the new species assignments for the three coeluting pairs were also not available. Subsequently, it was discovered that the vehicle test data for aldehydes were inadvertently provided to Professor Russell in units of mass (mg) rather than mass emission rates (mg/mile). The composite profiles for TLEVs and LEVs for the complete data set are given in Appendices C and D, respectively. Note that the new species assignments for the three coeluting pairs were not applied to the data collected as part of the 1991 study, consistent with the philosophy of fixing the RAFs for at least three years after adoption.

ıventories for each fuel were adjusted by the calculated RAFs.
riginal RAFs used by Professor Russell in the airshed modeling, and
t interpretation of the aldehyde data inadvertently supplied in the
ected RAFs are 4 percent higher than those used by Professor
contains the current RAFs based on the entire data set of motor
MIR assignments for the three coeluting pairs, as well as RAFs
ırbon Bond 4 (CB4) chemical mechanism and under maximum ozone
(MOIR) conditions. For Phase 2 gasoline and M85, the variation in
ırent chemical mechanism and reactivity scale is less than 6 percent.

91 study, a more realistic distribution of exhaust emissions between
g, and hot start modes was used. The emission inventories
AB with EMFAC7E have the three phases of the FTP cycle
local information on traffic patterns. Furthermore, different
ıt and hot start emissions are used in the SoCAB inventory and the
he cold and hot starts are represented as an emissions increment
t. In the FTP, the Bag 1 and Bag 3 measurements reflect the start
ıs well as emissions accrued at the cold and hot stabilized rates,
e Bag 2 result (which represents both cold and hot stabilized
btracted from the Bag 1 and Bag 3 results:

$$.59 \times (BAG1 - SCF26 \times BAG2) \quad (1)$$

ıe EMFAC7E cold start emissions increment in grams/start, BAG1 is
ıt emissions in grams/mile, BAG2 is the FTP cold stabilized
ile, 3.59 is the mileage for the FTP cold transient test in miles/start,
FAC7E speed correction factor (0.615 for current vehicles) to adjust
ed (16 mph) to the Bag 1 average speed (26 mph).

ı is performed for each NMOG species in a composite profile, with
ıs increments set to zero. The emissions for all species are summed
art emissions increment. The calculation of the EMFAC7E hot start
s done in a similar manner with the substitution of the Bag 3 result
ı Equation 1. The Bag 2 mass emission rate and speciation results
MFAC7E to represent the running exhaust emissions.

FAC7E exhaust emission modes are weighted according to activity
ısportation models. Activity data for both the 1987 and 2010
SoCAB are given in Table II, with the resulting motor vehicle mass
to Professor Russell and the distributions based on the complete
es III and IV, respectively. However, it is not known how the mass
lternatively-fueled vehicles change as a function of temperature or
asoline operating in TLEVs results in lower running and hot start
ın conventional gasoline, perhaps due to increased catalyst efficiency
er sulfur content of the reformulated fuel. However, this effect of
vas not observed for LEVs. Another puzzling result is that TLEVs
d lower cold start fractions than the LEVs, which were equipped
d catalysts. These issues should be investigated as part of future

IV. Baseline Emission Inventory

The aim of the airshed modeling protocol is to provide a rigorous test of the RAFs. The model inputs were selected to represent upper and lower bounds, rather than a best estimate, of future conditions. Both the 1982 and 1987 episodes were simulated with the same two emission inventories: 1) a baseline year, 1987, with a doubling of NMOG and CO emissions from all sources; and 2) a future year, 2010, with stringent controls. Using the same two inventories for both episodes allows a direct comparison of the effect of meteorological conditions on reactivity. The 2010 time frame is a realistic expectation of when motor vehicles that meet the requirements of the California Low-Emission Vehicles and Clean Fuels regulations will dominate the fleet, but is not considered a stringent test of the RAF approach because the low NMOG to NO_X ratio (3.9) is similar to the high NO_X conditions used to derive the MIR scale. The doubling of the 1987 NMOG and CO inventory responds to recent studies (Pierson *et al.* 1990; Fujita *et al.* 1992; Harley *et al.* 1993) that organic gas emissions from motor vehicles are underestimated by about a factor of two, and to concerns that a higher NMOG to NO_X ratio (8.4) is needed to provide a stringent test of the MIR scale.

Incremental reactivities are, by definition, mathematically additive, but at issue is how large an emission change is considered an "increment". Calculations by Chang and Rudy (1990) with an EKMA-type model indicate that individual emission increments appear to be additive for up to a 30 percent substitution of organic gas emissions in an airshed. In this study, for both the 1987 and 2010 inventories, the speciation for the TLEVs and LEVs were applied to the entire on-road catalyst motor vehicle fleet. This corresponds to 8 and 22 percent of the NMOG inventory in 1987 and 2010, respectively. This assumption of complete conversion of the fleet to TLEVs is not realistic, but does provide the most stringent test of the RAF approach. There was no attempt to modify the fleet emissions to reflect the lower mass emissions from LEVs; only the RAFs and speciation profiles were changed.

The final 1987 baseline emission inventory produced by the SCAQMD was used, with -4, +19, and +7 percent changes in NMOG, NO_X, and CO emissions, respectively, from the draft inventory used in the 1991 study. The major changes from the draft inventory are: 1) motor vehicle emissions of NMOG decreased and of NO_X increased with EMFAC7E; 2) area source evaporative emissions of NMOG increased from floating roof tanks, and NO_X emissions increased from locomotives and public utility equipment; 3) biogenic emissions were included; and 4) NMOG speciation profiles and assignments were updated. The final 1987 baseline emission inventory is documented in the 1991 Air Quality Management Plan, Technical Report III-C and Appendices III-A, III-B, and III-C.

Due to the large increase in NO_X emissions with the new inventory, it was decided to double the entire 1987 NMOG and CO emission inventories, rather than just the catalyst exhaust emissions of NMOG and CO as was done in the 1991 study. This change in the protocol is necessary to provide a stringent test of the MIR approach at a high NMOG to NO_X ratio, and is consistent with current ARB practices for airshed model sensitivity studies. The NULL case corresponds to NMOG exhaust emissions for catalyst-equipped motor vehicles from the baseline fleet, *i.e.*, without doubling. In the 1991 study, the NULL case was defined as zero NMOG exhaust emissions for catalyst-equipped motor vehicles. However, the high sensitivity of the Urban Airshed

Model to formaldehyde emissions, which are primarily from motor vehicles, created the concern that zeroing emissions would lead to non-linear effects.

The 1987 baseline emission inventory represents an average summer weekday with day-specific stationary source emissions for the August 27 to 29 SCAQS episode. Except for the doubling of the NMOG and CO emissions, stationary source, off-road mobile emissions, diesel exhaust, and non-catalyst motor vehicle emissions were unchanged, as was NO_X. Evaporative emission rates and speciation profiles were also unchanged from the baseline motor vehicle fleet. These assumptions are not realistic, but the objective of the study was to test the way the reactivity scale is being applied in the ARB regulations, assuming that all fuels just meet the reactivity-adjusted standards. The 2010 emission inventory is a projection of the draft 1987 baseline emission inventory. The 2010 inventory was constructed in a similar manner to the 1987 inventory, except that the NMOG and CO emissions were not doubled to provide a lower bound of the NMOG to NO_X ratio, and for comparison with the 1991 study where the 2010 inventory gave the highest null test result. The mass emissions are summarized in Table V and the LCC species emissions are summarized in Table VI.

V. Results and Discussion

The CIT airshed model was used to simulate the air quality impacts of the twelve separate emission inventories on both sets of meteorological conditions. A matrix of two ozone episodes (1987 and 1982) in the South Coast Air Basin, two baseline emission inventories (1987 and 2010), and exhaust emissions from three alternative fuels (RF-A, Phase 2 gasoline, and M85) for two levels of the new standards (TLEV and LEV) was modeled. This results in twenty-four model simulations for analysis. The ozone predictions for the completed model simulations are summarized in Table VII. Four metrics are presented: 1) peak, one-hour average ozone basinwide; 2) spatial ozone exposure showing the number of hours and grids where ozone concentrations are greater than a prescribed value (*e.g.*, the 0.09 ppm California and 0.12 ppm national ambient air quality standards); 3) concentration-weighted spatial ozone dosage; and 4) population- and concentration-weighted ozone dosage. The NULL calculation gives results distinctly different than the CFV and the alternative fuel simulations for each ozone metric other than the peak. If this were not the case, it would be very difficult to assess the impact of the change in organic gas composition and additional emissions of the alternative fuels.

A useful statistic for judging how closely the RAF leads to an equal ozone impact is the "null test" (perhaps better stated as the "level playing field test"), defined as the concentration increment due to the alternative fuel, normalized relative to that of the conventional fuel:

$$\text{Null test result} = \frac{C_{AFV} - C_{NULL}}{C_{CFV} - C_{NULL}} \qquad (2)$$

where C_{AFV} is the concentration (or other metric) for an alternatively-fueled vehicle (AFV) simulation, and C_{CFV} and C_{NULL} are the corresponding metrics for the CFV and NULL simulations, respectively. The closer the null test result is to one, the closer the RAF comes to producing the desired result. If the value found from the multi-day airshed

modeling is greater or less than one, the exhaust is greater or less reactive, respectively, than the RAF would imply. The null test results are shown in Table VIII.

In general, the null test results for the ozone exposure and dosage metrics are within ±5 percent of the equal ozone impacts required by the regulation, with much closer agreement in many cases. However, the null test results for some of the ozone peak predictions show larger deviations from the desired result. In these cases, the ozone peak is found in a location that is less sensitive to NMOG emissions than much of the urban area, as reflected by the small differences (about 0.01 ppm) between the peak predictions in the CFV and NULL simulations. Thus, small differences in peak concentrations between the conventional- and alternatively-fueled vehicles are magnified in the normalization specified for the null test result in Equation 2. In the one case where there is a large difference (about 0.06 ppm) between the peak ozone predictions for the CFV and NULL simulations, for the 1982 meteorology with the 1987 emission inventory, the null test results are the most reasonable.

The change in the 1987 inventory necessitated a verification of the correction for the M85 case done in 1991. The results for M85 show better agreement overall with the equal ozone impacts required by the regulation than those reported in the 1991 study. The only formally adopted RAF to date, a value of 0.41 for M85 vehicles, includes a 10 percent increase based on the airshed modeling results for the population-weighted dosage statistic for the higher 1982 episode. The new airshed modeling results imply that only a 7 percent correction is needed. However, if the new MIR assignments for the three coeluting pairs are used for M85, the uncorrected RAF increases from 0.37 to 0.38. Applying the new correction results in a RAF of 0.41, the same as adopted in 1991.

The null test results for TLEVs and LEVs operating on Phase 2 gasoline are 5 and 4 percent increases, respectively. However, the error in the aldehyde data led to 4 percent higher RAF values than those used by Professor Russell. Chang and Rudy's (1990) work implies that ozone formation should be linear for these small perturbations (4 percent of the 22 percent the motor vehicle fleet comprises of the 2010 NMOG inventory) of organic gas emissions in the airshed. Thus, the airshed modeling results indicate that there is no need for a correction to the RAF for TLEVs and LEVs operating on Phase 2 gasoline.

VI. References

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Table I. RAFs at various stages of development.

Vehicle Type	Reactivity Adjustment Factors				
	Provided to CMU		Current[c]		
	Original[a]	Corrected[b]	MIR	CB4	MOIR
TLEV PH2	1.02	1.06	0.98	1.01	0.99
TLEV M85	0.37	0.37	0.37	0.39	0.39
LEV PH2	0.96	1.00	0.94	0.98	0.97

[a]Provided to Professor Russell of CMU, which does not include some vehicle test results from ARB, any test results from the Auto/Oil AQIRP, nor new MIR assignments for coeluting pairs. Motor vehicle aldehyde data was inadvertently supplied in units of mg rather than mg/mile.
[b]Correct interpretation of motor vehicle aldehyde data.
[c]Includes new MIR assignments for coeluting pairs, and all vehicle test results.

Table II. Activity data[a] for the South Coast Air Basin.

Baseline Year	Miles per Start	Cold Start Fraction	Hot Start Fraction
1987	8.3	0.58	0.42
2010	9.8	0.60	0.40

[a]Based on BURDEN model.

Table III. Exhaust emissions distribution for test data for TLEVs and LEVs provided to CMU.

Vehicle Type	Percent of Mass in Each Exhaust Mode					
	1987 Activity Data			2010 Activity Data		
	Cold	Run	Hot	Cold	Run	Hot
TLEV RFA	72.2	21.9	5.9	70.5	24.3	5.2
TLEV PH2	87.3	9.8	2.9	86.4	11.0	2.6
TLEV M85	95.1	3.7	1.2	94.8	4.2	1.0
LEV RFA	81.6	13.7	4.8	80.5	15.3	4.3
LEV PH2	78.6	17.3	4.1	77.1	19.2	3.6

Table IV. Exhaust emissions distribution for test data for TLEVs and LEVs for the complete data set.

Vehicle Type	Percent of Mass in Each Exhaust Mode					
	1987 Activity Data			2010 Activity Data		
	Cold	Run	Hot	Cold	Run	Hot
TLEV RFA	72.2	21.9	5.9	70.5	24.3	5.2
TLEV PH2	83.2	12.0	4.7	82.3	13.5	4.2
TLEV M85	95.1	3.7	1.2	94.8	4.2	1.0
LEV RFA	81.0	13.9	5.1	79.9	15.5	4.6
LEV PH2	79.9	15.7	4.4	78.6	17.5	3.9

Table V. 1987 and 2010 emissions by pollutant and category.

Vehicle Type	Emissions (10^3 kg/day)					
	1987[a]			2010		
	NMOG	NO_x	CO	NMOG	NO_x	CO
NULL	3200	1352	12,028	901	967	3571
TLEV RFA	3459	1352	12,028	1150	967	3571
TLEV PH2	3454	1352	12,028	1145	967	3571
TLEV M85	3900	1352	12,028	1574	967	3571
LEV RFA	3459	1352	12,028	1150	967	3571
LEV PH2	3470	1352	12,028	1160	967	3571

[a]With NMOG and CO emissions doubled.

Table VI. LCC species profiles.

LCC Species	Fleet Emissions (kg-moles/day)				
	TLEV			LEV	
	RFA	PH2	M85	RFA	PH2
ETHE	816	512	226	459	501
ALKE	414	634	130	346	574
ALKA	1183	1071	377	1380	1340
TOLU	366	361	156	283	298
AROM	345	319	142	399	246
HCHO	150	393[a]	1318	345[a]	712[a]
ALD2	99	67	46	97	96
MEK	52	8	76	8	13
MEOH	0	0	18,363	0	0

[a]Based on incorrect aldehyde data approximately a factor of 3.6 too high.

Table VIIa. CIT airshed model predictions[a] for August 27 to 29, 1987 meteorology and 1987[b] inventory.

Ozone Statistic	Ozone Results					
	TLEV			LEV		NULL
	RFA	PH2	M85	RFA	PH2	
basin peak (ppb)	237.6	237.4	238.5	237.3	237.6	229.0
grid-hours[c] > 0.09 ppm	2779	2786	2780	2782	2780	2611
grid-hours[c] > 0.12 ppm	1499	1509	1502	1506	1505	1385
ppm-grid-hours[d] > 0.09 ppm	361	362	362	362	362	336
ppm-grid-hours[d] > 0.12 ppm	229	230	230	230	230	208
10^3 person-ppm-hours[e] > 0.09 ppm	3891	3902	3900	3883	3900	3236
10^3 person-ppm-hours[e] > 0.12 ppm	1961	1967	1971	1976	1964	1625

Table VIIb. CIT airshed model predictions[a] for August 27 to 29, 1987 meteorology and 2010 inventory.

Ozone Statistic	Ozone Results					
	TLEV			LEV		NULL
	RFA	PH2	M85	RFA	PH2	
basin peak (ppb)	159.7	160.0	159.3	159.8	160.2	151.4
grid-hours[c] > 0.09 ppm	2091	2094	2081	2098	2113	1806
grid-hours[c] > 0.12 ppm	764	756	755	770	787	480
ppm-grid-hours[d] > 0.09 ppm	241	241	240	242	244	200
ppm-grid-hours[d] > 0.12 ppm	101	100	100	102	104	62
10^3 person-ppm-hours[e] > 0.09 ppm	1605	1611	1583	1617	1641	1059
10^3 person-ppm-hours[e] > 0.12 ppm	155.7	150.2	152.5	166.6	185.4	67.1

[a]Results for third day of model simulation.
[b]With NMOG and CO emissions doubled.
[c]Summation of the number of grids × hours that any modeling grid experienced an ozone concentration greater than the prescribed value.
[d]Summation of the concentration × grids × hours that any modeling grid experienced an ozone concentration greater than the prescribed value.
[e]Summation of the population × concentration × hours for any modeling grid that experienced an ozone concentration greater than the prescribed value.

Table VIIc. CIT airshed model predictions[a] for August 30 to September 1, 1982 meteorology and 1987[b] inventory.

Ozone Statistic	Ozone Results					
	TLEV			LEV		NULL
	RFA	PH2	M85	RFA	PH2	
basin peak (ppb)	498.4	498.6	501.0	499.9	501.5	438.2
grid-hours[c] > 0.09 ppm	5976	5957	5969	5984	5968	5667
grid-hours[c] > 0.12 ppm	4677	4686	4686	4677	4675	4383
ppm-grid-hours[d] > 0.09 ppm	1147	1146	1147	1148	1147	1054
ppm-grid-hours[d] > 0.12 ppm	1012	1014	1014	1012	1012	921
10^4 person-ppm-hours[e] > 0.09 ppm	1522	1519	1521	1523	1518	1289
10^4 person-ppm-hours[e] > 0.12 ppm	1336	1340	1340	1339	1336	1110

Table VIId. CIT airshed model predictions[a] for August 30 to September 1, 1982 meteorology and 2010 inventory.

Ozone Statistic	Ozone Results					
	TLEV			LEV		NULL
	RFA	PH2	M85	RFA	PH2	
basin peak (ppb)	239.5	241.4	242.5	239.4	240.1	217.7
grid-hours[c] > 0.09 ppm	4270	4305	4321	4309	4330	3581
grid-hours[c] > 0.12 ppm	2415	2448	2467	2435	2463	1894
ppm-grid-hours[d] > 0.09 ppm	583	588	592	588	592	462
ppm-grid-hours[d] > 0.12 ppm	390	395	399	393	398	287
10^3 person-ppm-hours[e] > 0.09 ppm	5765	5858	5850	5861	5934	3884
10^3 person-ppm-hours[e] > 0.12 ppm	4233	4312	4330	4311	4378	2745

[a]Results for third day of model simulation.
[b]With NMOG and CO emissions doubled.
[c]Summation of the number of grids × hours that any modeling grid experienced an ozone concentration greater than the prescribed value.
[d]Summation of the concentration × grids × hours that any modeling grid experienced an ozone concentration greater than the prescribed value.
[e]Summation of the population × concentration × hours for any modeling grid that experienced an ozone concentration greater than the prescribed value.

Table VIIIa. Null test results for CIT airshed model simulations of August 27 to 29, 1987 meteorology.

Ozone Statistic	Null Test Result					
	1987 Inventory[a]			2010 Inventory		
	TLEV		LEV	TLEV		LEV
	PH2	M85	PH2	PH2	M85	PH2
basin peak[b]	0.98	1.10	1.04	1.04	0.95	1.05
grid-hours > 0.09 ppm	1.04	1.01	0.99	1.01	0.96	1.05
grid-hours > 0.12 ppm	1.09	1.03	0.99	0.97	0.97	1.06
ppm-grid-hours > 0.09 ppm	1.04	1.04	1.00	1.00	0.98	1.05
ppm-grid-hours > 0.12 ppm	1.05	1.05	1.00	0.97	0.97	1.05
person-ppm-hours > 0.09 ppm	1.02	1.01	1.03	1.01	0.96	1.04
person-ppm-hours > 0.12 ppm	1.02	1.03	0.97	0.94	0.96	1.19

Table VIIIb. Null test results for CIT airshed model simulations of August 30 to September 1, 1982 meteorology.

Ozone Statistic	Null Test Result					
	1987 Inventory[a]			2010 Inventory		
	TLEV		LEV	TLEV		LEV
	PH2	M85	PH2	PH2	M85	PH2
basin peak[b]	1.00	1.04	1.03	1.09	1.14	1.03
grid-hours > 0.09 ppm	0.94	0.98	0.95	1.05	1.07	1.03
grid-hours > 0.12 ppm	1.03	1.03	0.99	1.06	1.10	1.05
ppm-grid-hours > 0.09 ppm	0.99	1.00	0.99	1.04	1.07	1.03
ppm-grid-hours > 0.12 ppm	1.02	1.02	1.00	1.05	1.09	1.05
person-ppm-hours > 0.09 ppm	0.99	1.00	0.98	1.05	1.05	1.04
person-ppm-hours > 0.12 ppm	1.02	1.02	0.99	1.05	1.07	1.04

[a]With NMOG and CO emissions doubled.
[b]Far downwind ozone peak. Peak relatively insensitive to NMOG emission changes, so ratio of two small numbers.

Appendix A

Transitional Low Emitting Vehicle Profiles Provided to Professor Russell

California Air Resources Board Transitional Low Emitting Vehicle (TLEV) Profiles - November 13, 1992

Federal Test Procedure (FTP) weight fractions and mass in grams/mile

All standard deviations (SD) in percent

		--- U. S. National Average Gasoline (RF-A) ---								------ 85% Methanol/15% RF-A (M85/RF-A) ------						---------- Phase 2 Gasoline (Phase 2) ----------							
OGID	SAROAD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD
MASS		0.3659	6	0.0266	15	0.0549	10	0.1047	6	1.1006	14	0.0106	28	0.0241	29	0.2396	14	0.4642	5	0.0128	12	0.0283	15	0.1055	4
ETHANE	43202	0.0245	10	0.0841	27	0.0874	20	0.0399	14	0.0013	60	0.0349	87	0.0202	79	0.0026	50	0.0182	7	0.0436	26	0.0784	26	0.0244	10
PROPANE	43204	0.0025	50	0.0061	68	0.0053	30	0.0033	37	0.0001	84	0.0023	69	0.0036	83	0.0002	61	0.0009	28	0.0055	58	0.0092	77	0.0018	26
BUTANE	43212	0.0405	7	0.0430	33	0.0692	20	0.0442	10	0.0064	37	0.0459	107	0.0597	43	0.0094	42	0.0076	15	0.0217	43	0.0143	28	0.0091	14
PENTANE	43220	0.0264	9	0.0202	31	0.0345	18	0.0268	12	0.0029	26	0.0068	60	0.0237	42	0.0037	27	0.0068	12	0.0125	32	0.0078	22	0.0074	9
HEXANE	43231	0.0182	13	0.0187	26	0.0199	19	0.0183	13	0.0019	31	0.0000	0	0.0041	133	0.0019	32	0.0069	11	0.0086	85	0.0067	42	0.0072	9
HEPTANE	43232	0.0119	11	0.0168	33	0.0138	20	0.0129	13	0.0008	50	0.0000	0	0.0000	0	0.0008	50	0.0109	5	0.0085	61	0.0089	17	0.0111	6
OCTANE	43233	0.0061	7	0.0010	79	0.0028	38	0.0050	7	0.0001	133	0.0000	0	0.0000	0	0.0001	133	0.0045	10	0.0000	0	0.0048	28	0.0045	10
NONANE	43235	0.0022	55	0.0000	0	0.0006	116	0.0016	50	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0016	13	0.0000	0	0.0000	0	0.0014	13
DECANE	43238	0.0004	132	0.0013	136	0.0000	0	0.0006	91	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0006	15	0.0015	141	0.0000	0	0.0006	26
UNDECANE	43241	0.0010	38	0.0000	0	0.0000	0	0.0007	38	0.0001	159	0.0000	0	0.0000	0	0.0001	159	0.0004	33	0.0040	141	0.0000	0	0.0006	50
2MC3	43214	0.0057	60	0.0024	48	0.0026	30	0.0049	54	0.0000	77	0.0077	115	0.0046	83	0.0002	90	0.0008	11	0.0092	91	0.0022	27	0.0016	44
2MC4	98132	0.0378	9	0.0481	25	0.0625	18	0.0429	11	0.0037	22	0.0790	74	0.0342	40	0.0058	31	0.0633	16	0.0765	34	0.0758	13	0.0673	14
2MC5	43229	0.0266	17	0.0250	37	0.0364	19	0.0282	18	0.0024	58	0.0000	0	0.0123	103	0.0027	61	0.0248	13	0.0150	47	0.0237	18	0.0251	12
3MC5	43230	0.0154	16	0.0194	33	0.0229	18	0.0172	15	0.0012	58	0.0000	0	0.0000	0	0.0012	58	0.0111	12	0.0104	45	0.0118	20	0.0115	9
22DMC4	43291	0.0076	24	0.0026	88	0.0058	45	0.0069	24	0.0005	68	0.0000	0	0.0000	0	0.0005	68	0.0037	46	0.0010	141	0.0042	58	0.0038	46
23DMC4	98001	0.0115	23	0.0086	41	0.0140	28	0.0117	22	0.0004	101	0.0000	0	0.0000	0	0.0004	101	0.0377	19	0.0104	44	0.0108	37	0.0358	18
2MC6	43275	0.0037	71	0.0027	104	0.0034	100	0.0036	75	0.0003	108	0.0000	0	0.0000	0	0.0002	108	0.0000	0	0.0000	0	0.0000	0	0.0000	0
3MC6	43295	0.0133	9	0.0218	30	0.0198	24	0.0153	11	0.0011	40	0.0000	0	0.0058	133	0.0012	45	0.0133	4	0.0108	46	0.0138	17	0.0138	4
23DMC5	43274	0.0013	100	0.0000	0	0.0000	0	0.0010	100	0.0004	100	0.0000	0	0.0000	0	0.0004	100	0.0000	0	0.0000	0	0.0000	0	0.0000	0
24DMC5	43271	0.0017	64	0.0016	107	0.0012	101	0.0016	66	0.0001	189	0.0000	0	0.0000	0	0.0001	189	0.0000	0	0.0021	141	0.0000	0	0.0001	141
BRC7PAR	43106	0.0258	25	0.0372	33	0.0362	26	0.0286	24	0.0024	61	0.0000	0	0.0053	133	0.0024	62	0.0635	5	0.0441	32	0.0735	11	0.0659	5
2MC7	98140	0.0014	73	0.0009	101	0.0014	100	0.0014	77	0.0001	120	0.0000	0	0.0000	0	0.0001	120	0.0000	0	0.0000	0	0.0000	0	0.0000	0
3MC7	43298	0.0020	66	0.0013	103	0.0015	101	0.0019	67	0.0001	145	0.0000	0	0.0000	0	0.0001	145	0.0000	0	0.0000	0	0.0000	0	0.0000	0
23DMC6	98139	0.0033	15	0.0018	120	0.0020	40	0.0030	18	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0080	11	0.0028	112	0.0099	15	0.0082	11
24DMC6	43277	0.0012	66	0.0007	101	0.0008	101	0.0011	66	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
25DMC6	43278	0.0009	66	0.0006	101	0.0007	101	0.0009	67	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
224TMC5	43276	0.0061	66	0.0125	73	0.0108	66	0.0076	66	0.0018	59	0.0000	0	0.0020	189	0.0018	59	0.0000	0	0.0000	0	0.0000	0	0.0000	0
234TMC5	43279	0.0085	11	0.0104	35	0.0107	22	0.0093	11	0.0011	40	0.0000	0	0.0000	0	0.0011	40	0.0064	57	0.0048	83	0.0071	63	0.0066	57
BRC8PAR	43107	0.0300	23	0.0399	25	0.0367	23	0.0322	22	0.0021	59	0.0000	0	0.0116	76	0.0022	59	0.0678	5	0.0315	45	0.0847	10	0.0698	5
24DMC7	98142	0.0001	101	0.0001	155	0.0001	101	0.0001	101	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
225TMC6	98033	0.0037	10	0.0005	106	0.0016	60	0.0030	13	0.0003	71	0.0095	189	0.0000	0	0.0005	83	0.0089	8	0.0029	112	0.0125	10	0.0092	9
BRC9PAR	43108	0.0040	18	0.0063	121	0.0039	86	0.0047	32	0.0000	0	0.0000	0	0.0047	189	0.0003	189	0.0046	15	0.0125	58	0.0115	30	0.0059	19
BRC10PAR	43109	0.0006	107	0.0000	0	0.0000	0	0.0004	107	0.0002	120	0.0000	0	0.0000	0	0.0002	120	0.0001	141	0.0000	0	0.0000	0	0.0001	141
CYC5	43242	0.0010	78	0.0000	0	0.0004	111	0.0009	76	0.0004	93	0.0121	189	0.0007	189	0.0008	103	0.0000	141	0.0000	0	0.0000	0	0.0000	141
CYC6	43248	0.0015	71	0.0115	87	0.0022	114	0.0034	67	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	15	0.0000	0	0.0010	141	0.0006	36
MCYC5	43262	0.0074	9	0.0037	67	0.0068	27	0.0071	10	0.0007	50	0.0000	0	0.0073	133	0.0008	59	0.0038	14	0.0125	68	0.0037	56	0.0044	22
MCYC6	43261	0.0052	17	0.0039	58	0.0021	48	0.0046	18	0.0001	133	0.0000	0	0.0000	0	0.0001	133	0.0029	12	0.0006	98	0.0018	47	0.0028	11
13DMCYC5	90064	0.0004	100	0.0011	103	0.0007	105	0.0005	100	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
CYC8PAR	43116	0.0072	24	0.0019	67	0.0085	29	0.0067	23	0.0003	73	0.0000	0	0.0000	0	0.0003	73	0.0042	27	0.0049	81	0.0096	8	0.0047	20
CYC10PAR	98066	0.0023	32	0.0009	93	0.0002	88	0.0018	34	0.0002	69	0.0000	0	0.0000	0	0.0002	69	0.0023	26	0.0100	44	0.0022	49	0.0030	28
ETHENE	43203	0.0995	9	0.0303	34	0.0766	26	0.0880	10	0.0084	22	0.0228	108	0.0103	79	0.0091	19	0.0589	8	0.0289	18	0.0265	27	0.0573	8
PROPENE	43205	0.0368	10	0.0078	43	0.0168	17	0.0306	10	0.0045	18	0.0013	77	0.0028	100	0.0044	16	0.0444	7	0.0224	17	0.0226	24	0.0433	7
1C4=	43213	0.0063	12	0.0018	37	0.0036	29	0.0053	11	0.0003	72	0.0007	66	0.0006	74	0.0003	68	0.0075	40	0.0066	62	0.0058	70	0.0076	42
2MC3=	43215	0.0184	20	0.0051	35	0.0096	30	0.0154	18	0.0020	37	0.0005	104	0.0024	84	0.0020	36	0.0401	14	0.0258	18	0.0308	29	0.0402	14
1C5=	43224	0.0015	96	0.0016	155	0.0000	0	0.0014	86	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
2M1C4=	43225	0.0002	103	0.0000	0	0.0000	0	0.0001	102	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
3M1C4=	43223	0.0001	104	0.0000	0	0.0000	0	0.0001	104	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
1C6=	43245	0.0002	101	0.0005	124	0.0002	112	0.0002	105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6OLE1	43245	0.0022	46	0.0000	0	0.0009	92	0.0018	45	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0033	11	0.0000	0	0.0000	0	0.0030	12
C7OLE1	98005	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0046	159	0.0004	159	0.0002	35	0.0016	133	0.0007	83	0.0003	67
C8OLE1	43265	0.0070	24	0.0173	27	0.0106	25	0.0088	24	0.0007	58	0.0000	0	0.0058	76	0.0008	58	0.0199	6	0.0112	42	0.0259	14	0.0207	6
C9OLE1	43267	0.0005	40	0.0000	0	0.0000	0	0.0003	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0006	14	0.0000	0	0.0000	0	0.0005	14

C-2C4=	43217	0.0001	105	0.0000	0	0.0000	0	0.0001	105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
T-2C4=	43216	0.0008	88	0.0000	0	0.0000	0	0.0006	88	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
2M2C4=	43228	0.0019	61	0.0005	155	0.0000	155	0.0015	62	0.0002	120	0.0000	0	0.0000	0	0.0002	120	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
C5OLE2	43226	0.0026	35	0.0000	0	0.0000	0	0.0020	35	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
C6OLE2	43246	0.0035	34	0.0048	155	0.0013	67	0.0032	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0048	10	0.0000	0	0.0000	0	0.0044	11	
C8OLE2	43266	0.0070	24	0.0173	27	0.0106	25	0.0088	24	0.0007	58	0.0000	0	0.0058	76	0.0008	58	0.0199	6	0.0112	42	0.0259	14	0.0207	6	
C9OLE2	98042	0.0005	40	0.0000	0	0.0000	0	0.0003	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0006	14	0.0000	0	0.0000	0	0.0005	14	
13C4==	43218	0.0042	20	0.0022	41	0.0001	89	0.0034	19	0.0005	45	0.0000	0	0.0000	0	0.0005	45	0.0042	16	0.0054	29	0.0031	52	0.0044	16	
ISOPRENE	43243	0.0008	68	0.0000	0	0.0000	0	0.0006	69	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0087	141	0.0000	0	0.0005	141	
CYC5=	43292	0.0026	63	0.0018	114	0.0009	155	0.0022	62	0.0005	110	0.0000	0	0.0041	133	0.0006	109	0.0001	141	0.0000	0	0.0000	0	0.0001	141	
CYC6=	43273	0.0004	101	0.0000	0	0.0000	0	0.0003	101	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
ETHYNE	43206	0.0420	16	0.0040	43	0.0009	71	0.0317	18	0.0037	41	0.0022	73	0.0029	82	0.0036	38	0.0385	18	0.0144	23	0.0024	55	0.0361	17	
BENZENE	45201	0.0616	9	0.0736	26	0.0866	13	0.0683	12	0.0073	16	0.0271	106	0.0982	31	0.0097	19	0.0389	7	0.0190	42	0.0478	23	0.0399	9	
TOLUENE	45202	0.0933	4	0.1271	18	0.1025	11	0.1004	5	0.0145	9	0.0203	104	0.0727	33	0.0162	9	0.0970	5	0.0416	32	0.0655	17	0.0955	5	
EBEN	45203	0.0312	8	0.0214	30	0.0185	20	0.0284	10	0.0039	12	0.0000	0	0.0084	112	0.0039	10	0.0322	10	0.0550	34	0.0299	23	0.0352	10	
N-PBEN	45209	0.0048	21	0.0000	0	0.0001	113	0.0035	23	0.0004	47	0.0269	189	0.0000	0	0.0011	120	0.0070	36	0.0186	62	0.0064	76	0.0085	31	
I-PBEN	98043	0.0007	31	0.0000	0	0.0001	113	0.0006	32	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0023	27	0.0000	0	0.0000	0	0.0021	27	
C10BEN1	45105	0.0009	100	0.0000	0	0.0000	0	0.0007	100	0.0002	159	0.0000	0	0.0000	0	0.0002	159	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
M-XYL	45205	0.0412	11	0.0236	24	0.0290	16	0.0376	10	0.0048	13	0.0000	0	0.0069	76	0.0047	13	0.0311	11	0.0304	25	0.0187	13	0.0315	10	
O-XYL	45204	0.0265	9	0.0161	30	0.0144	18	0.0238	10	0.0034	15	0.0000	0	0.0039	189	0.0034	18	0.0252	11	0.0247	23	0.0134	17	0.0254	10	
P-XYL	45206	0.0356	14	0.0217	28	0.0252	20	0.0327	14	0.0048	13	0.0000	0	0.0069	76	0.0047	13	0.0311	11	0.0304	25	0.0187	13	0.0315	10	
C9BEN2	45104	0.0294	10	0.0090	46	0.0083	34	0.0240	11	0.0033	25	0.0000	0	0.0000	0	0.0032	25	0.0197	15	0.0907	31	0.0197	31	0.0260	15	
C10BEN2	45106	0.0002	107	0.0000	0	0.0000	0	0.0002	107	0.0001	159	0.0000	0	0.0000	0	0.0001	159	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
123TMBEN	45225	0.0008	89	0.0000	0	0.0000	0	0.0006	90	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
124TMBEN	45208	0.0229	15	0.0120	44	0.0058	35	0.0190	16	0.0026	27	0.0000	0	0.0000	0	0.0025	27	0.0186	19	0.0256	28	0.0057	33	0.0191	18	
135TMBEN	45207	0.0073	18	0.0013	136	0.0005	80	0.0056	20	0.0011	28	0.0000	0	0.0000	0	0.0010	28	0.0070	11	0.0185	43	0.0059	22	0.0081	13	
C10BEN4	45232	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	189	0.0717	118	0.0000	0	0.0022	118	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
STYRENE	45220	0.0055	8	0.0004	124	0.0015	100	0.0042	9	0.0004	45	0.0000	0	0.0000	0	0.0004	45	0.0099	32	0.0147	37	0.0104	28	0.0109	28	
INDAN	98044	0.0002	101	0.0007	155	0.0000	155	0.0002	112	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
NAPHTHAL	98046	0.0003	107	0.0000	0	0.0000	0	0.0002	107	0.0003	98	0.0000	0	0.0000	0	0.0003	98	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
METHANOL	43301	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.8488	1	0.1495	62	0.2637	60	0.8204	2	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
ETHANOL	43302	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
FORMALD	43502	0.0123	29	0.0400	50	0.0169	54	0.0148	37	0.0448	12	0.3303	28	0.1835	47	0.0526	14	0.0369	27	0.1163	46	0.1174	29	0.0142	28	
ACETALD	43503	0.0071	17	0.0339	38	0.0125	26	0.0097	18	0.0009	37	0.0207	61	0.0420	69	0.0021	48	0.0114	11	0.0103	46	0.0071	40	0.0032	10	
PROPALD	43504	0.0015	42	0.0080	107	0.0010	107	0.0016	43	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	94	0.0000	0	0.0000	0	0.0000	94	
C4ALD	43510	0.0004	57	0.0000	0	0.0000	0	0.0003	56	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
C5ALD	43512	0.0001	155	0.0000	0	0.0000	0	0.0001	155	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
C6ALD	98095	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	189	0.0000	0	0.0000	0	0.0005	189	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
CROTALD	98156	0.0002	86	0.0017	107	0.0011	107	0.0004	92	0.0001	159	0.0010	159	0.0029	159	0.0002	159	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
BENZALD	98157	0.0009	63	0.0042	102	0.0006	106	0.0011	56	0.0000	0	0.0083	189	0.0164	159	0.0003	117	0.0000	0	0.0000	0	0.0000	0	0.0000	0	
ACETONE	43551	0.0036	28	0.0337	49	0.0117	39	0.0073	32	0.0020	39	0.1186	46	0.0547	61	0.0052	42	0.0021	15	0.0000	0	0.0000	0	0.0000	0	
C4KET	43552	0.0000	0	0.0140	107	0.0002	107	0.0007	107	0.0000	189	0.0000	0	0.0007	189	0.0001	189	0.0000	0	0.0000	0	0.0000	0	0.0005	16	
ACROLEIN	43505	0.0017	32	0.0040	85	0.0013	129	0.0018	48	0.0002	82	0.0000	0	0.0000	0	0.0002	83	0.0004	34	0.0000	0	0.0000	0	0.0001	36	

Appendix B

Low Emitting Vehicle Profiles Provided to Professor Russell

California Air Resources Board Low Emitting Vehicle (LEV) Profiles - November 13, 1992

Federal Test Procedure (FTP) weight fractions and mass in grams/mile

All standard deviations (SD) in percent

		--- U. S. National Average Gasoline (RF-A) ---								--------- Phase 2 Gasoline (Phase 2) ---------							
OGID	SAROAD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD
MASS		0.2453	10	0.0100	18	0.0252	24	0.0605	5	0.2254	10	0.0120	31	0.0225	19	0.0547	11
ETHANE	43202	0.0316	16	0.0941	30	0.1252	21	0.0450	13	0.0341	16	0.0435	26	0.1151	20	0.0450	14
PROPANE	43204	0.0018	16	0.0068	34	0.0080	82	0.0030	31	0.0104	97	0.0472	82	0.0110	72	0.0121	80
BUTANE	43212	0.0486	11	0.0559	15	0.0651	24	0.0516	11	0.0096	17	0.0303	32	0.0220	32	0.0131	15
PENTANE	43220	0.0302	11	0.0348	19	0.0303	24	0.0312	11	0.0095	10	0.0326	97	0.0071	26	0.0127	36
HEXANE	43231	0.0266	7	0.0198	93	0.0161	38	0.0260	9	0.0090	8	0.0030	88	0.0028	37	0.0083	8
HEPTANE	43232	0.0148	4	0.0045	57	0.0095	31	0.0142	5	0.0115	7	0.0049	48	0.0071	30	0.0115	7
OCTANE	43233	0.0074	10	0.0023	130	0.0056	40	0.0075	9	0.0051	6	0.0000	0	0.0020	55	0.0048	8
NONANE	43235	0.0030	16	0.0000	0	0.0000	0	0.0025	16	0.0015	27	0.0029	117	0.0002	145	0.0016	29
DECANE	43238	0.0008	39	0.0000	0	0.0007	149	0.0008	43	0.0008	22	0.0011	166	0.0002	145	0.0008	21
UNDECANE	43241	0.0010	24	0.0100	122	0.0000	0	0.0024	87	0.0005	77	0.0000	0	0.0000	0	0.0005	78
2MC3	43214	0.0013	12	0.0025	57	0.0016	36	0.0015	15	0.0034	107	0.0065	35	0.0038	41	0.0039	81
2MC4	98132	0.0442	9	0.0932	27	0.0558	28	0.0495	12	0.0792	8	0.0831	34	0.0886	22	0.0856	5
2MC5	43229	0.0524	8	0.0133	50	0.0371	27	0.0500	8	0.0334	8	0.0137	46	0.0172	28	0.0325	8
3MC5	43230	0.0251	8	0.0084	41	0.0218	22	0.0246	9	0.0150	7	0.0088	60	0.0098	34	0.0152	11
22DMC4	43291	0.0087	31	0.0055	91	0.0100	47	0.0091	31	0.0032	55	0.0014	89	0.0024	60	0.0031	54
23DMC4	98001	0.0178	11	0.0058	47	0.0125	36	0.0172	11	0.0375	18	0.0231	38	0.0143	44	0.0360	16
3MC6	43295	0.0150	10	0.0025	53	0.0122	31	0.0144	9	0.0154	5	0.0053	55	0.0097	28	0.0152	5
24DMC5	43271	0.0002	121	0.0000	0	0.0000	0	0.0002	121	0.0002	78	0.0000	0	0.0000	0	0.0001	78
BRC7PAR	43106	0.0400	7	0.0054	60	0.0323	28	0.0383	6	0.0745	5	0.0305	31	0.0549	24	0.0747	5
23DMC6	98139	0.0053	8	0.0015	130	0.0013	93	0.0049	11	0.0083	7	0.0000	0	0.0063	35	0.0080	9
234TMC5	43279	0.0043	41	0.0013	130	0.0038	51	0.0042	41	0.0064	51	0.0038	80	0.0035	68	0.0061	52
BRC8PAR	43107	0.0450	5	0.0363	62	0.0427	17	0.0474	8	0.0772	6	0.0287	30	0.0666	22	0.0780	6
225TMC6	98033	0.0053	9	0.0045	130	0.0043	59	0.0058	17	0.0098	6	0.0011	117	0.0086	28	0.0097	8
BRC9PAR	43108	0.0070	20	0.0007	130	0.0039	50	0.0065	22	0.0047	12	0.0027	94	0.0025	72	0.0048	16
BRC10PAR	43109	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	79	0.0000	0	0.0003	145	0.0002	82
CYC6	43248	0.0022	9	0.0001	155	0.0008	88	0.0019	11	0.0007	27	0.0035	143	0.0000	179	0.0011	55
MCYC5	43262	0.0095	7	0.0047	70	0.0063	40	0.0091	10	0.0045	10	0.0021	71	0.0009	54	0.0042	12
MCYC6	43261	0.0065	6	0.0057	130	0.0016	64	0.0067	18	0.0029	12	0.0010	127	0.0013	88	0.0028	15
CYC8PAR	43116	0.0074	22	0.0037	83	0.0107	26	0.0082	20	0.0034	26	0.0011	179	0.0054	39	0.0037	19
CYC10PAR	98066	0.0051	30	0.0049	80	0.0033	61	0.0050	28	0.0020	25	0.0024	87	0.0017	103	0.0022	27
ETHENE	43203	0.0519	7	0.0355	30	0.0217	37	0.0490	8	0.0573	14	0.0233	27	0.0220	33	0.0536	13
PROPENE	43205	0.0259	5	0.0121	23	0.0119	41	0.0244	6	0.0367	14	0.0178	26	0.0134	33	0.0345	12
1C4=	43213	0.0042	9	0.0018	49	0.0015	38	0.0039	10	0.0045	19	0.0039	33	0.0017	26	0.0043	16
2MC3=	43215	0.0118	21	0.0080	27	0.0097	40	0.0118	22	0.0364	11	0.0321	43	0.0214	27	0.0367	12
2M1C4=	43225	0.0002	122	0.0000	0	0.0000	0	0.0002	123	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6OLE1	43245	0.0044	43	0.0000	0	0.0021	97	0.0039	44	0.0031	11	0.0020	126	0.0000	0	0.0028	15

C7OLE1	98005	0.0023	112	0.0003	93	0.0003	155	0.0016	102	0.0002	48	0.0060	142	0.0000	0	0.0005	77
C8OLE1	43265	0.0096	4	0.0039	44	0.0101	31	0.0095	5	0.0241	5	0.0109	30	0.0224	21	0.0247	5
C9OLE1	43267	0.0008	19	0.0010	130	0.0002	130	0.0009	32	0.0008	19	0.0004	117	0.0002	117	0.0008	21
C5OLE2	43226	0.0015	84	0.0000	0	0.0042	155	0.0015	87	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6OLE2	43246	0.0072	27	0.0000	0	0.0257	142	0.0090	48	0.0045	9	0.0012	179	0.0000	0	0.0039	10
C8OLE2	43266	0.0096	4	0.0039	44	0.0101	31	0.0095	5	0.0241	5	0.0109	30	0.0224	21	0.0247	5
C9OLE2	98042	0.0008	19	0.0010	130	0.0002	130	0.0009	32	0.0008	19	0.0004	117	0.0002	117	0.0008	21
13C4==	43218	0.0034	11	0.0011	69	0.0013	64	0.0031	11	0.0028	16	0.0030	39	0.0017	57	0.0029	19
CYC5=	43292	0.0001	155	0.0000	0	0.0014	121	0.0002	136	0.0000	0	0.0005	179	0.0000	0	0.0001	179
ETHYNE	43206	0.0275	47	0.0117	47	0.0009	61	0.0243	49	0.0236	24	0.0124	31	0.0020	80	0.0220	25
BENZENE	45201	0.0490	8	0.0344	62	0.0674	48	0.0535	10	0.0321	8	0.0443	77	0.0433	38	0.0404	21
TOLUENE	45202	0.0744	5	0.0386	29	0.0538	45	0.0732	7	0.0825	4	0.0168	43	0.0373	31	0.0776	4
EBEN	45203	0.0295	11	0.0148	54	0.0145	38	0.0282	11	0.0250	8	0.0458	43	0.0140	38	0.0274	8
N-PBEN	45209	0.0054	39	0.0018	130	0.0026	78	0.0053	37	0.0046	27	0.0029	99	0.0045	99	0.0047	23
I-PBEN	98043	0.0020	34	0.0000	0	0.0000	0	0.0016	28	0.0018	16	0.0000	0	0.0002	145	0.0016	15
M-XYL	45205	0.0357	10	0.0277	29	0.0203	29	0.0349	10	0.0252	6	0.0120	43	0.0096	49	0.0240	7
O-XYL	45204	0.0282	14	0.0173	58	0.0141	28	0.0269	16	0.0195	6	0.0148	53	0.0078	46	0.0189	7
P-XYL	45206	0.0357	10	0.0277	29	0.0203	29	0.0349	10	0.0252	6	0.0120	43	0.0096	49	0.0240	7
C9BEN2	45104	0.0342	24	0.0408	37	0.0238	38	0.0364	25	0.0168	16	0.0403	51	0.0148	49	0.0205	16
124TMBEN	45208	0.0268	28	0.0491	27	0.0156	26	0.0286	26	0.0079	26	0.0231	52	0.0056	60	0.0092	27
135TMBEN	45207	0.0108	18	0.0161	45	0.0129	66	0.0120	21	0.0056	10	0.0093	103	0.0031	89	0.0064	22
STYRENE	45220	0.0064	23	0.0033	88	0.0035	62	0.0064	24	0.0055	17	0.0025	61	0.0044	39	0.0057	17
FORMALD	43502	0.0191	28	0.1613	37	0.1122	64	0.0107	30	0.0401	20	0.2313	31	0.2562	31	0.0247	21
ACETALD	43503	0.0111	9	0.0590	41	0.0153	70	0.0043	18	0.0120	18	0.0356	30	0.0167	40	0.0042	14
ACETONE	43551	0.0020	24	0.0000	0	0.0000	0	0.0005	22	0.0033	36	0.0000	0	0.0000	0	0.0008	35
ACROLEIN	43505	0.0000	155	0.0000	0	0.0000	0	0.0000	155	0.0001	85	0.0000	0	0.0000	0	0.0000	86

Appendix C

Transitional Low Emitting Vehicle Profiles for the Complete Data Set

California Air Resources Board Transitional Low Emitting Vehicle (TLEV) Profiles - January 14, 1993

Federal Test Procedure (FTP) weight fractions and mass in grams/mile

All standard deviations (SD) in percent

		--- U. S. National Average Gasoline (RF-A) ---								------ 85% Methanol/15% RF-A (M85/RF-A) ------								--------- Phase 2 Gasoline (Phase 2) ---------							
OGID	SAROAD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD
MASS		0.3659	6	0.0266	15	0.0549	10	0.1047	6	1.1006	14	0.0106	28	0.0241	29	0.2396	14	0.3962	4	0.0140	15	0.0386	20	0.0999	4
ETHANE	43202	0.0245	10	0.0841	27	0.0874	20	0.0399	14	0.0013	60	0.0349	87	0.0202	79	0.0026	50	0.0219	5	0.0707	21	0.0887	13	0.0308	8
PROPANE	43204	0.0025	50	0.0061	68	0.0053	30	0.0033	37	0.0001	84	0.0023	69	0.0036	83	0.0002	61	0.0011	18	0.0091	52	0.0051	62	0.0017	17
BUTANE	43212	0.0405	7	0.0430	33	0.0692	20	0.0442	10	0.0064	37	0.0459	107	0.0597	43	0.0094	42	0.0091	11	0.0314	27	0.0160	17	0.0115	10
PENTANE	43220	0.0264	9	0.0202	31	0.0345	18	0.0268	12	0.0019	31	0.0000	0	0.0041	133	0.0019	32	0.0136	19	0.0089	40	0.0161	27	0.0136	20
HEPTANE	43232	0.0119	11	0.0168	33	0.0138	20	0.0129	13	0.0008	50	0.0000	0	0.0000	0	0.0008	50	0.0086	8	0.0053	44	0.0086	12	0.0084	8
OCTANE	43233	0.0061	7	0.0010	79	0.0028	38	0.0050	7	0.0001	133	0.0000	0	0.0000	0	0.0001	133	0.0044	6	0.0008	74	0.0041	21	0.0042	6
NONANE	43235	0.0022	55	0.0000	0	0.0006	116	0.0016	50	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0013	10	0.0000	0	0.0002	45	0.0012	11
DECANE	43238	0.0004	132	0.0013	136	0.0000	0	0.0006	91	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0007	12	0.0006	162	0.0002	91	0.0006	14
UNDECANE	43241	0.0010	38	0.0000	0	0.0000	0	0.0007	38	0.0001	159	0.0000	0	0.0000	0	0.0001	159	0.0004	43	0.0020	116	0.0003	113	0.0005	36
DODECANE	43255	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0003	96	0.0000	0	0.0005	102	0.0004	78
2MC3	43214	0.0057	60	0.0024	48	0.0026	30	0.0049	54	0.0000	77	0.0077	115	0.0046	83	0.0002	90	0.0017	38	0.0078	47	0.0024	25	0.0022	27
2MC4	98132	0.0378	9	0.0481	25	0.0625	18	0.0429	11	0.0037	22	0.0790	74	0.0342	40	0.0058	31	0.0609	8	0.1194	21	0.0889	10	0.0704	6
2MC5	43229	0.0266	17	0.0250	37	0.0364	19	0.0282	18	0.0024	58	0.0000	0	0.0123	103	0.0027	61	0.0294	7	0.0224	34	0.0318	13	0.0297	7
3MC5	43230	0.0154	16	0.0194	33	0.0229	18	0.0172	15	0.0012	58	0.0000	0	0.0000	0	0.0012	58	0.0144	7	0.0121	25	0.0170	13	0.0145	8
22DMC4	43291	0.0076	24	0.0026	88	0.0058	45	0.0069	24	0.0005	68	0.0000	0	0.0000	0	0.0005	68	0.0058	16	0.0037	34	0.0083	19	0.0060	16
23DMC4	98001	0.0115	23	0.0086	41	0.0140	28	0.0117	22	0.0004	101	0.0000	0	0.0000	0	0.0004	101	0.0262	18	0.0123	23	0.0156	12	0.0248	16
2MC6	43275	0.0037	71	0.0027	104	0.0034	100	0.0036	75	0.0003	108	0.0000	0	0.0000	0	0.0002	108	0.0038	36	0.0038	68	0.0041	37	0.0038	36
3MC6	43295	0.0133	9	0.0218	30	0.0198	24	0.0153	11	0.0011	40	0.0000	0	0.0058	133	0.0012	45	0.0117	6	0.0076	35	0.0127	14	0.0116	6
23DMC5	43274	0.0013	100	0.0000	0	0.0000	0	0.0010	100	0.0004	100	0.0000	0	0.0000	0	0.0004	100	0.0094	36	0.0060	46	0.0114	37	0.0094	36
24DMC5	43271	0.0017	64	0.0016	107	0.0012	101	0.0016	66	0.0001	189	0.0000	0	0.0000	0	0.0001	189	0.0056	36	0.0040	39	0.0067	37	0.0056	36
33DMC5	43106	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	37	0.0001	113	0.0006	44	0.0005	36
223TMC4	43106	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	45	0.0007	75	0.0002	60	0.0002	44
BRC7PAR	43106	0.0258	25	0.0372	33	0.0362	26	0.0286	24	0.0024	61	0.0000	0	0.0053	133	0.0024	62	0.0388	23	0.0286	33	0.0504	25	0.0394	23
2MC7	98140	0.0014	73	0.0009	101	0.0014	100	0.0014	77	0.0001	120	0.0000	0	0.0000	0	0.0001	120	0.0023	37	0.0007	91	0.0030	39	0.0023	37
3MC7	43298	0.0020	66	0.0013	103	0.0015	101	0.0019	67	0.0001	145	0.0000	0	0.0000	0	0.0001	145	0.0031	36	0.0017	49	0.0040	36	0.0031	36
4MC7	43297	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0009	36	0.0003	135	0.0010	47	0.0009	37
23DMC6	98139	0.0033	15	0.0018	120	0.0020	40	0.0030	18	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0070	6	0.0059	47	0.0092	10	0.0071	6
24DMC6	43277	0.0012	66	0.0007	101	0.0008	101	0.0011	66	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0036	36	0.0043	59	0.0044	36	0.0037	36
25DMC6	43278	0.0009	66	0.0006	101	0.0007	101	0.0009	67	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0025	36	0.0023	45	0.0030	37	0.0026	36
224TMC5	43276	0.0061	66	0.0125	73	0.0108	66	0.0076	66	0.0018	59	0.0000	0	0.0020	189	0.0018	59	0.0712	7	0.0513	17	0.0999	9	0.0725	7
234TMC5	43279	0.0085	11	0.0104	35	0.0107	22	0.0093	11	0.0011	40	0.0000	0	0.0000	0	0.0011	40	0.0109	19	0.0101	45	0.0136	19	0.0110	19
BRC8PAR	43107	0.0300	23	0.0399	25	0.0367	23	0.0322	22	0.0021	59	0.0000	0	0.0116	76	0.0022	59	0.0191	15	0.0091	36	0.0223	18	0.0191	15
24DMC7	98142	0.0001	101	0.0001	155	0.0001	101	0.0001	101	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	37	0.0000	0	0.0005	48	0.0005	37
225TMC6	98033	0.0037	10	0.0005	106	0.0016	60	0.0030	13	0.0003	71	0.0095	189	0.0000	0	0.0005	83	0.0074	8	0.0030	47	0.0104	9	0.0075	7
BRC9PAR	43108	0.0040	18	0.0063	121	0.0039	86	0.0047	32	0.0000	0	0.0000	0	0.0047	189	0.0003	189	0.0071	16	0.0070	44	0.0095	23	0.0073	15
BRC10PAR	43109	0.0006	107	0.0000	0	0.0000	0	0.0004	107	0.0002	120	0.0000	0	0.0000	0	0.0002	120	0.0019	29	0.0034	70	0.0013	48	0.0020	33
CYC5	43242	0.0010	78	0.0000	0	0.0004	111	0.0009	76	0.0004	93	0.0121	189	0.0007	189	0.0008	103	0.0004	33	0.0017	116	0.0005	53	0.0005	37
CYC6	43248	0.0015	71	0.0115	87	0.0022	114	0.0034	67	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0011	16	0.0022	103	0.0015	51	0.0012	21
MCYC5	43262	0.0074	9	0.0037	67	0.0068	27	0.0071	10	0.0007	50	0.0000	0	0.0073	133	0.0008	59	0.0059	13	0.0085	44	0.0068	22	0.0061	12
MCYC6	43261	0.0052	17	0.0039	58	0.0021	48	0.0046	18	0.0001	133	0.0000	0	0.0000	0	0.0001	133	0.0044	15	0.0027	48	0.0040	24	0.0043	16
13DMCYC5	90064	0.0004	100	0.0011	103	0.0007	105	0.0005	100	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0012	37	0.0003	88	0.0015	39	0.0011	37
ECYC6	43288	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	43	0.0011	81	0.0010	62	0.0006	46
CYC8PAR	43116	0.0072	24	0.0019	67	0.0085	29	0.0067	23	0.0003	73	0.0000	0	0.0000	0	0.0003	73	0.0059	12	0.0104	86	0.0136	46	0.0075	19
CYC10PAR	98066	0.0023	32	0.0009	93	0.0002	88	0.0018	34	0.0002	69	0.0000	0	0.0000	0	0.0002	69	0.0000	0	0.0000	0	0.0000	0	0.0000	0
ETHENE	43203	0.0995	9	0.0303	34	0.0766	26	0.0880	10	0.0084	22	0.0228	108	0.0103	79	0.0091	19	0.0667	7	0.0271	26	0.0352	20	0.0612	6
PROPENE	43205	0.0368	10	0.0078	43	0.0168	17	0.0306	10	0.0045	18	0.0013	77	0.0028	100	0.0044	16	0.0478	5	0.0193	22	0.0233	18	0.0431	5
1C4=	43213	0.0063	12	0.0018	37	0.0036	29	0.0053	11	0.0003	72	0.0007	66	0.0006	74	0.0003	68	0.0061	8	0.0039	29	0.0032	17	0.0057	8
2MC3=	43215	0.0184	20	0.0051	35	0.0096	30	0.0154	18	0.0020	37	0.0005	104	0.0024	84	0.0020	36	0.0489	6	0.0259	17	0.0354	14	0.0459	6
1C5=	43224	0.0015	96	0.0016	155	0.0000	0	0.0014	86	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0009	39	0.0033	109	0.0004	85	0.0012	51
2M1C4=	43225	0.0002	103	0.0000	0	0.0000	0	0.0001	102	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0016	36	0.0014	62	0.0009	46	0.0015	36
3M1C4=	43223	0.0001	104	0.0000	0	0.0000	0	0.0001	104	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0006	37	0.0004	113	0.0002	83	0.0005	40
1C6=	43245	0.0002	101	0.0005	124	0.0002	112	0.0002	105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0003	37	0.0000	0	0.0001	90	0.0003	39

C6OLE1	43245	0.0022	46	0.0000	0	0.0009	92	0.0018	45	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0026	11	0.0002	162	0.0003	157	0.0022	13
C7OLE1	98005	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0046	159	0.0004	159	0.0001	47	0.0006	151	0.0003	93	0.0001	72
C8OLE1	43265	0.0070	24	0.0173	27	0.0106	25	0.0088	24	0.0007	58	0.0000	0	0.0058	76	0.0008	58	0.0008	36	0.0000	0	0.0005	50	0.0007	36
C9OLE1	43267	0.0005	40	0.0000	0	0.0000	0	0.0003	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0014	23	0.0052	113	0.0009	41	0.0015	30
C-2C4=	43217	0.0001	105	0.0000	0	0.0000	0	0.0001	105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0020	37	0.0003	135	0.0016	49	0.0017	38
T-2C4=	43216	0.0008	88	0.0000	0	0.0000	0	0.0006	88	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0009	53	0.0005	63	0.0009	57	0.0009	49
2M2C4=	43228	0.0019	61	0.0005	155	0.0000	155	0.0015	62	0.0002	120	0.0000	0	0.0000	0	0.0002	120	0.0024	36	0.0014	111	0.0013	47	0.0021	36
C5OLE2	43226	0.0026	35	0.0000	0	0.0000	0	0.0020	35	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0018	36	0.0055	58	0.0016	54	0.0021	37
C6OLE2	43246	0.0035	34	0.0048	155	0.0013	67	0.0032	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0054	8	0.0040	74	0.0016	49	0.0050	10
C7OLE2	98041	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	41	0.0000	0	0.0001	135	0.0004	42
C8OLE2	43266	0.0070	24	0.0173	27	0.0106	25	0.0088	24	0.0007	58	0.0000	0	0.0058	76	0.0008	58	0.0009	38	0.0006	113	0.0006	50	0.0008	38
C9OLE2	98042	0.0005	40	0.0000	0	0.0000	0	0.0003	39	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0003	30	0.0000	0	0.0001	124	0.0003	30
13C4==	43218	0.0042	20	0.0022	41	0.0001	89	0.0034	19	0.0005	45	0.0000	0	0.0000	0	0.0005	45	0.0057	11	0.0026	39	0.0016	48	0.0049	9
ISOPRENE	43243	0.0008	68	0.0000	0	0.0000	0	0.0006	69	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0014	37	0.0085	63	0.0013	51	0.0019	35
CYC5=	43292	0.0026	63	0.0018	114	0.0009	155	0.0022	62	0.0005	110	0.0000	0	0.0041	133	0.0006	109	0.0015	36	0.0004	123	0.0002	77	0.0012	35
CYC6=	43273	0.0004	101	0.0000	0	0.0000	0	0.0003	101	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	41	0.0000	0	0.0003	80	0.0004	42
ETHYNE	43206	0.0420	16	0.0040	43	0.0009	71	0.0317	18	0.0037	41	0.0022	73	0.0029	82	0.0036	38	0.0357	12	0.0127	29	0.0013	54	0.0300	12
PROPYNE	43209	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	64	0.0015	137	0.0010	61	0.0005	52
1BUTYNE	43219	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	43	0.0054	103	0.0003	104	0.0010	74
BENZENE	45201	0.0616	9	0.0736	26	0.0866	13	0.0683	12	0.0073	16	0.0271	106	0.0982	31	0.0097	19	0.0352	6	0.0217	20	0.0503	13	0.0361	6
TOLUENE	45202	0.0933	4	0.1271	18	0.1025	11	0.1004	5	0.0145	9	0.0203	104	0.0727	33	0.0162	9	0.0846	7	0.0473	19	0.0627	12	0.0807	7
EBEN	45203	0.0312	8	0.0214	30	0.0185	20	0.0284	10	0.0039	12	0.0000	0	0.0084	112	0.0039	10	0.0271	8	0.0289	33	0.0206	22	0.0262	10
N-PBEN	45209	0.0048	21	0.0000	0	0.0001	113	0.0035	23	0.0004	47	0.0269	189	0.0000	0	0.0011	120	0.0044	25	0.0072	69	0.0036	60	0.0046	27
I-PBEN	98043	0.0007	31	0.0000	0	0.0001	113	0.0006	32	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0019	34	0.0000	0	0.0001	161	0.0016	34
S-BBEN	45216	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	53	0.0001	225	0.0001	113	0.0001	53
C10BEN1	45105	0.0009	100	0.0000	0	0.0000	0	0.0007	100	0.0002	159	0.0000	0	0.0000	0	0.0002	159	0.0000	163	0.0000	0	0.0000	0	0.0000	169
C11BEN1	45245	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	41	0.0003	167	0.0000	0	0.0002	50
M-XYL	45205	0.0412	11	0.0236	24	0.0290	16	0.0376	10	0.0048	13	0.0000	0	0.0069	76	0.0047	13	0.0281	7	0.0228	23	0.0169	13	0.0266	8
O-XYL	45204	0.0265	9	0.0161	30	0.0144	18	0.0238	10	0.0034	15	0.0000	0	0.0039	189	0.0034	18	0.0207	9	0.0175	25	0.0127	14	0.0197	10
P-XYL	45206	0.0356	14	0.0217	28	0.0252	20	0.0327	14	0.0048	13	0.0000	0	0.0069	76	0.0047	13	0.0281	7	0.0228	23	0.0169	13	0.0266	8
C9BEN2	45104	0.0294	10	0.0090	46	0.0083	34	0.0240	11	0.0033	25	0.0000	0	0.0000	0	0.0032	25	0.0212	8	0.0519	38	0.0158	26	0.0224	11
C10BEN2	45106	0.0002	107	0.0000	0	0.0000	0	0.0002	107	0.0001	159	0.0000	0	0.0000	0	0.0001	159	0.0034	37	0.0013	119	0.0013	82	0.0029	37
C11BEN2	45245	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	50	0.0000	0	0.0003	113	0.0004	51
123TMBEN	45225	0.0008	89	0.0000	0	0.0000	0	0.0006	90	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	57	0.0005	127	0.0002	76	0.0002	46
124TMBEN	45208	0.0229	15	0.0120	44	0.0058	35	0.0190	16	0.0026	27	0.0000	0	0.0000	0	0.0025	27	0.0136	14	0.0230	23	0.0079	30	0.0136	14
135TMBEN	45207	0.0073	18	0.0013	136	0.0005	80	0.0056	20	0.0011	28	0.0000	0	0.0000	0	0.0010	28	0.0060	8	0.0148	61	0.0045	20	0.0064	12
C10BEN3	45103	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0014	37	0.0006	117	0.0003	109	0.0011	38
C12BEN3	45247	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	57	0.0000	0	0.0000	0	0.0001	57
C10BEN4	45232	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	189	0.0717	118	0.0000	0	0.0022	118	0.0006	42	0.0010	225	0.0003	143	0.0006	55
STYRENE	45220	0.0055	8	0.0004	124	0.0015	100	0.0042	9	0.0004	45	0.0000	0	0.0000	0	0.0004	45	0.0067	21	0.0057	50	0.0068	29	0.0066	21
INDAN	98044	0.0002	101	0.0007	155	0.0000	155	0.0002	112	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	47	0.0000	0	0.0002	76	0.0002	43
NAPHTHAL	98046	0.0003	107	0.0000	0	0.0000	0	0.0002	107	0.0003	98	0.0000	0	0.0000	0	0.0003	98	0.0003	47	0.0018	154	0.0003	102	0.0005	76
METHANOL	43301	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.8488	1	0.1495	62	0.2637	60	0.8204	2	0.0000	0	0.0000	0	0.0000	0	0.0000	0
ETHANOL	43302	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
FORMALD	43502	0.0123	29	0.0400	50	0.0169	54	0.0148	37	0.0448	12	0.3303	28	0.1835	47	0.0526	14	0.0138	12	0.0530	38	0.0283	24	0.0163	13
ACETALD	43503	0.0071	17	0.0339	38	0.0125	26	0.0097	18	0.0009	37	0.0207	61	0.0420	69	0.0021	48	0.0044	10	0.0188	42	0.0059	37	0.0051	15
PROPALD	43504	0.0015	42	0.0080	107	0.0010	107	0.0016	43	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	62	0.0000	0	0.0000	0	0.0001	60
C4ALD	43510	0.0004	57	0.0000	0	0.0000	0	0.0003	56	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C5ALD	43512	0.0001	155	0.0000	0	0.0000	0	0.0001	155	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C6ALD	98095	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	189	0.0000	0	0.0000	0	0.0005	189	0.0000	0	0.0000	0	0.0000	0	0.0000	0
C7ALD	98158	0.0000	0	0.0042	102	0.0006	106	0.0005	105	0.0000	0	0.0083	189	0.0000	0	0.0001	189	0.0000	0	0.0000	0	0.0000	0	0.0000	0
CROTALD	98156	0.0002	86	0.0017	107	0.0011	107	0.0004	92	0.0001	159	0.0010	159	0.0029	159	0.0002	159	0.0000	113	0.0000	0	0.0000	0	0.0000	113
BENZALD	98157	0.0009	63	0.0000	0	0.0000	0	0.0006	62	0.0000	0	0.0000	0	0.0164	159	0.0002	159	0.0015	49	0.0129	100	0.0065	117	0.0022	50
MTBE	.	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0158	39	0.0023	89	0.0007	49	0.0127	40
ACETONE	43551	0.0036	28	0.0337	49	0.0117	39	0.0073	32	0.0020	39	0.1186	46	0.0547	61	0.0052	42	0.0035	11	0.0134	54	0.0076	30	0.0045	17
C4KET	43552	0.0000	0	0.0140	107	0.0002	107	0.0007	107	0.0000	189	0.0000	0	0.0007	189	0.0001	189	0.0001	113	0.0000	0	0.0000	0	0.0001	113
ACROLEIN	43505	0.0017	32	0.0040	85	0.0013	129	0.0018	48	0.0002	82	0.0000	0	0.0000	0	0.0002	83	0.0011	30	0.0000	0	0.0000	0	0.0009	28

Appendix D

Low Emitting Vehicle Profiles for the Complete Data Set

California Air Resources Board Low Emitting Vehicle (LEV) Profiles - January 14, 1993

Federal Test Procedure (FTP) weight fractions and mass in grams/mile

All standard deviations (SD) in percent

		--- U. S. National Average Gasoline (RF-A) ---							---------- Phase 2 Gasoline (Phase 2) ----------							
OGID	SAROAD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD	Bag 1	SD	Bag 2	SD	Bag 3	SD	Comp	SD
MASS		0.2274	8	0.0095	16	0.0250	19	0.0589	5	0.2113	8	0.0101	23	0.0214	19	0.0549	8
ETHANE	43202	0.0333	11	0.1363	19	0.1490	18	0.0519	13	0.0333	13	0.0540	22	0.1442	25	0.0419	11
PROPANE	43204	0.0020	15	0.0119	26	0.0095	81	0.0034	20	0.0051	94	0.0329	62	0.0110	68	0.0066	69
BUTANE	43212	0.0464	8	0.0712	11	0.0786	15	0.0513	7	0.0105	17	0.0411	28	0.0314	33	0.0158	15
PENTANE	43220	0.0292	8	0.0396	13	0.0354	14	0.0304	7	0.0111	9	0.0207	31	0.0124	25	0.0125	12
HEXANE	43231	0.0258	7	0.0220	60	0.0209	22	0.0253	7	0.0111	17	0.0054	65	0.0090	45	0.0107	21
HEPTANE	43232	0.0144	4	0.0071	41	0.0110	18	0.0138	5	0.0106	10	0.0059	40	0.0063	26	0.0100	11
OCTANE	43233	0.0076	6	0.0011	150	0.0056	27	0.0071	7	0.0051	8	0.0003	139	0.0016	47	0.0044	10
NONANE	43235	0.0029	14	0.0026	150	0.0001	150	0.0025	17	0.0013	26	0.0023	115	0.0002	101	0.0015	40
DECANE	43238	0.0009	26	0.0000	0	0.0009	145	0.0008	29	0.0027	102	0.0037	107	0.0001	109	0.0024	92
UNDECANE	43241	0.0009	20	0.0052	138	0.0000	0	0.0015	81	0.0005	65	0.0001	139	0.0000	0	0.0004	63
2MC3	43214	0.0012	9	0.0025	40	0.0018	23	0.0014	10	0.0013	27	0.0075	35	0.0047	41	0.0023	24
2MC4	98132	0.0444	7	0.0934	22	0.0652	17	0.0493	7	0.0769	8	0.1065	22	0.1082	17	0.0851	6
2MC5	43229	0.0518	7	0.0313	33	0.0474	16	0.0509	5	0.0331	8	0.0227	38	0.0260	22	0.0328	9
3MC5	43230	0.0250	7	0.0164	37	0.0271	14	0.0250	6	0.0164	8	0.0112	50	0.0155	26	0.0161	9
22DMC4	43291	0.0094	25	0.0077	52	0.0119	33	0.0097	24	0.0056	30	0.0022	81	0.0067	53	0.0053	29
23DMC4	98001	0.0181	10	0.0107	37	0.0172	20	0.0178	8	0.0115	12	0.0063	29	0.0071	39	0.0108	12
2MC6	43275	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0011	100	0.0000	0	0.0003	160	0.0008	101
3MC6	43295	0.0155	7	0.0066	42	0.0148	18	0.0150	6	0.0150	7	0.0060	43	0.0106	21	0.0142	8
23DMC5	43274	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0028	100	0.0015	160	0.0040	101	0.0029	100
24DMC5	43271	0.0002	119	0.0000	0	0.0000	0	0.0001	119	0.0018	98	0.0000	0	0.0024	105	0.0017	99
BRC7PAR	43106	0.0420	5	0.0183	42	0.0418	17	0.0411	5	0.0683	13	0.0363	28	0.0591	22	0.0660	13
2MC7	98140	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	106	0.0000	0	0.0000	0	0.0003	106
3MC7	43298	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0007	101	0.0000	0	0.0000	0	0.0005	102
23DMC6	98139	0.0056	7	0.0007	150	0.0032	41	0.0051	9	0.0082	6	0.0003	139	0.0052	35	0.0073	9
24DMC6	43277	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0012	100	0.0000	0	0.0003	160	0.0009	101
25DMC6	43278	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0009	100	0.0000	0	0.0000	0	0.0006	100
224TMC5	43276	0.0411	5	0.0330	31	0.0504	19	0.0419	6	0.0959	5	0.0745	26	0.1047	13	0.0971	5
234TMC5	43279	0.0059	32	0.0016	92	0.0062	39	0.0057	33	0.0118	30	0.0050	75	0.0110	32	0.0113	29
BRC8PAR	43107	0.0263	5	0.0206	66	0.0252	14	0.0267	10	0.0259	15	0.0074	69	0.0191	27	0.0242	15
225TMC6	98033	0.0057	7	0.0023	150	0.0048	33	0.0056	11	0.0095	6	0.0010	108	0.0072	30	0.0086	9
BRC9PAR	43108	0.0073	14	0.0004	150	0.0045	35	0.0065	15	0.0042	15	0.0049	60	0.0038	48	0.0044	17
BRC10PAR	43109	0.0004	93	0.0012	127	0.0002	127	0.0004	94	0.0004	55	0.0000	0	0.0006	73	0.0004	57
CYC5	43242	0.0002	108	0.0000	0	0.0000	0	0.0001	108	0.0000	0	0.0000	0	0.0000	0	0.0000	0
CYC6	43248	0.0022	11	0.0001	100	0.0010	83	0.0019	12	0.0007	23	0.0035	94	0.0001	139	0.0009	41
MCYC5	43262	0.0097	5	0.0062	40	0.0080	23	0.0094	6	0.0051	14	0.0034	37	0.0024	47	0.0048	12
MCYC6	43261	0.0064	5	0.0030	140	0.0032	34	0.0061	12	0.0038	17	0.0018	86	0.0012	57	0.0032	12

13DMCYC5	90064	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	160	0.0000	0	0.0000	0	0.0001	160
CYC7PAR	43115	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0004	91	0.0000	0	0.0000	0	0.0003	91
CYC8PAR	43116	0.0086	20	0.0051	50	0.0116	15	0.0090	17	0.0042	25	0.0014	90	0.0049	33	0.0042	22
ETHENE	43203	0.0587	10	0.0334	26	0.0281	25	0.0527	9	0.0620	13	0.0246	19	0.0278	26	0.0544	11
PROPENE	43205	0.0284	8	0.0129	18	0.0121	26	0.0252	6	0.0387	12	0.0176	21	0.0155	26	0.0337	10
1C4=	43213	0.0047	10	0.0016	53	0.0015	29	0.0041	9	0.0042	23	0.0037	34	0.0016	25	0.0038	20
2MC3=	43215	0.0122	13	0.0079	22	0.0085	27	0.0115	13	0.0421	12	0.0336	29	0.0265	20	0.0396	11
2M1C4=	43225	0.0002	120	0.0000	0	0.0000	0	0.0002	121	0.0005	91	0.0000	0	0.0001	139	0.0003	89
C6OLE1	43245	0.0038	31	0.0000	0	0.0013	98	0.0032	33	0.0026	17	0.0016	98	0.0000	0	0.0023	20
C7OLE1	98005	0.0012	126	0.0002	102	0.0005	120	0.0009	111	0.0002	39	0.0055	99	0.0001	139	0.0005	53
C9OLE1	43267	0.0009	18	0.0005	150	0.0001	150	0.0008	23	0.0006	21	0.0002	139	0.0000	139	0.0006	20
C-2C4=	43217	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0007	100	0.0000	0	0.0000	0	0.0005	100
T-2C4=	43216	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	106	0.0000	0	0.0000	0	0.0003	106
2M2C4=	43228	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0007	101	0.0000	0	0.0000	0	0.0004	101
C5OLE2	43226	0.0009	92	0.0000	0	0.0028	150	0.0009	94	0.0000	0	0.0006	139	0.0001	139	0.0001	139
C6OLE2	43246	0.0064	20	0.0000	0	0.0013	98	0.0053	21	0.0038	16	0.0010	139	0.0000	0	0.0032	17
C9OLE2	98042	0.0009	18	0.0005	150	0.0001	150	0.0008	23	0.0006	21	0.0002	139	0.0000	139	0.0006	20
13C4==	43218	0.0033	8	0.0017	45	0.0010	52	0.0029	7	0.0035	20	0.0027	37	0.0014	54	0.0031	17
ISOPRENE	43243	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0005	100	0.0000	0	0.0000	0	0.0003	100
CYC5=	43292	0.0001	150	0.0000	0	0.0017	119	0.0002	133	0.0001	96	0.0011	139	0.0000	0	0.0001	79
ETHYNE	43206	0.0227	39	0.0112	43	0.0008	54	0.0194	42	0.0243	20	0.0157	29	0.0029	55	0.0213	21
BENZENE	45201	0.0534	7	0.0586	33	0.0693	30	0.0578	8	0.0378	10	0.0518	42	0.0514	27	0.0433	13
TOLUENE	45202	0.0779	3	0.0396	24	0.0497	33	0.0722	5	0.0875	4	0.0540	43	0.0518	26	0.0828	7
EBEN	45203	0.0299	7	0.0166	40	0.0131	32	0.0270	8	0.0245	5	0.0400	35	0.0142	38	0.0241	8
N-PBEN	45209	0.0055	24	0.0010	150	0.0016	80	0.0048	25	0.0039	22	0.0076	92	0.0041	110	0.0041	27
I-PBEN	98043	0.0018	24	0.0000	0	0.0000	0	0.0014	20	0.0014	18	0.0000	0	0.0001	139	0.0012	18
C10BEN1	45105	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0003	127	0.0000	0	0.0023	160	0.0006	147
M-XYL	45205	0.0367	6	0.0268	26	0.0183	25	0.0338	7	0.0259	4	0.0163	28	0.0124	29	0.0237	5
O-XYL	45204	0.0291	9	0.0227	37	0.0140	22	0.0268	10	0.0196	4	0.0141	35	0.0090	30	0.0180	7
P-XYL	45206	0.0367	6	0.0268	26	0.0183	25	0.0338	7	0.0259	4	0.0163	28	0.0124	29	0.0237	5
C9BEN2	45104	0.0383	17	0.0393	47	0.0234	44	0.0364	19	0.0202	13	0.0535	36	0.0227	48	0.0232	12
123TMBEN	45225	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	160	0.0000	0	0.0000	0	0.0001	160
124TMBEN	45208	0.0275	19	0.0410	32	0.0136	28	0.0267	18	0.0101	14	0.0181	41	0.0054	45	0.0099	15
135TMBEN	45207	0.0105	14	0.0128	53	0.0129	78	0.0104	18	0.0059	8	0.0059	49	0.0041	65	0.0057	12
C10BEN4	45232	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0002	128	0.0000	0	0.0000	0	0.0001	129
STYRENE	45220	0.0065	15	0.0017	107	0.0028	54	0.0058	16	0.0052	13	0.0025	69	0.0053	32	0.0050	16
FORMALD	43502	0.0065	20	0.0512	39	0.0346	69	0.0107	22	0.0110	17	0.0808	35	0.0795	48	0.0191	20
ACETALD	43503	0.0035	9	0.0285	28	0.0074	35	0.0059	18	0.0038	13	0.0292	42	0.0110	31	0.0061	19
C4ALD	43510	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0001	126	0.0000	0	0.0000	0	0.0001	126
BENZALD	98157	0.0002	150	0.0000	0	0.0000	0	0.0001	150	0.0006	61	0.0064	119	0.0015	123	0.0012	85
MTBE	.	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0293	14	0.0175	29	0.0113	30	0.0265	14
ACETONE	43551	0.0013	16	0.0056	56	0.0048	57	0.0017	20	0.0027	13	0.0079	86	0.0040	48	0.0031	22
ACROLEIN	43505	0.0000	150	0.0000	0	0.0000	0	0.0000	150	0.0002	56	0.0000	0	0.0000	0	0.0002	57

MAIL-OUT #92-23

State of California
AIR RESOURCES BOARD

Notice of Public Availability of Modified Text and Supporting Documents and Information

PUBLIC HEARING TO CONSIDER AMENDMENTS TO REGULATIONS REGARDING THE CALCULATION AND USE OF REACTIVITY ADJUSTMENT FACTORS FOR LOW-EMISSION VEHICLES AND THE ADOPTION OF INITIAL REACTIVITY ADJUSTMENT FACTORS FOR PASSENGER CARS AND LIGHT-DUTY TRUCKS CERTIFYING TO TRANSITIONAL LOW-EMISSION VEHICLE EXHAUST EMISSION STANDARDS

Public Hearing Date: November 14, 1991
Public Availability Date: April 21, 1992
Deadline for Public Comment: May 6, 1992

At a public hearing held November 14, 1991, the Air Resources Board ("ARB" or "Board") considered amendments to regulations concerning the calculation and use of reactivity adjustment factors ("RAFs") and the adoption of initial RAFs for transitional low-emission vehicles ("TLEVs"). The amendments affect section 1960.1, Title 13, California Code of Regulations ("CCR") and the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," (hereafter "LD/MD Test Procedures") which is incorporated by reference in section 1960.1. The proposed regulatory action is described in detail in the Staff Report and Technical Support Document released to the public on September 27, 1991.

At the hearing, the Board approved the regulations proposed by the staff with various modifications, some of which were suggested by the staff at the hearing. The modifications made to the original staff proposal include:

- Establish a baseline "gram ozone per gram NMOG" value of 3.42 for conventional gasoline TLEVs
- Delete the originally proposed RAFs for compressed natural gas ("CNG") and liquified petroleum gas ("LPG") TLEVs
- Establish a RAF of 0.41 for methanol-fueled TLEVs
- Numerically adjust RAFs for methanol and LPG vehicles upward by 10 percent to account for potential protocol or modeling biases
- Include a procedure for manufacturers to establish RAFs for individual engine families
- Delete the requirement that a 25 percent difference exist between ARB and manufacturer-derived RAFs
- Update the maximum incremental reactivity scale for use in calculating the ozone-forming potential of exhaust emissions

Appended as Attachment I is a copy of Board Resolution 91-53, which sets forth the Board's action. Appended as Attachment II-A is a detailed summary of the proposed modifications. Attachments II-B and II-C contain the modified regulatory text of section 1960.1, Title 13, CCR and the LD/MD Test Procedures, respectively. In preparing the modified text, an informal public workshop was conducted by the staff on February 3, 1992. Except for a revision to the statistical criteria for manufacturer-derived RAFs and various minor clarifying amendments, the proposed modified text is essentially unchanged from the draft version discussed at the workshop.

In addition, the staff has added to the rulemaking record the following documents and information:

- B.E. Croes, "Development and Evaluation of Ozone Reactivity Scale for Low-Emission Vehicles and Clean Fuels Regulations", California Air Resources Board Research Division, April 2, 1992

- Speciated emission data from testing of CNG vehicles

Copies of these materials are included in Attachment III, which is appended to this notice.

In accordance with section 11346.8 of the Government Code, Resolution 91-53 directs the Executive Officer to adopt section 1960.1 and the LD/MD Test Procedures, as approved, after making the modified regulatory language and additional supporting documents and information available to the public for comment for a period of at least 15 days, provided that the Executive Officer shall consider such written comments as may be submitted during this period, shall make such modifications as may be appropriate in light of the comments received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

Written comments must be submitted to the Board Secretary, Air Resources Board, P.O. Box 2815, Sacramento, California 95812, no later than May 6, 1992 for consideration by the Executive Officer prior to final action. Only comments relating to the modifications or supporting documents and information described in this notice will be considered by the Executive Officer. As noted in the announcement of the informal public workshop conducted February 3, 1992, comments made at the workshop are not part of the record of this rulemaking.

Sincerely,

for K. D. Drachand, Chief
Mobile Source Division

Attachments

ATTACHMENT I

Board Resolution 91-53

State of California
AIR RESOURCES BOARD

Resolution 91-53

November 14, 1991

Agenda Item No.: 91-10-2

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

WHEREAS, in section 43000 of the Health and Safety Code the Legislature has declared that the emission of air contaminants from motor vehicles is the primary cause of air pollution in many parts of the state;

WHEREAS, section 43018(a) of the Health and Safety Code, enacted by the California Clean Air Act of 1988, directs the Board to endeavor to achieve the maximum degree of emission reduction possible from vehicular and other mobile sources in order to accomplish the attainment of the state ambient air quality standards at the earliest practicable date;

WHEREAS, section 43018(b) of the Health and Safety Code directs the Board no later than January 1, 1992 to take whatever actions are necessary, cost-effective, and technologically feasible in order to achieve, by December 31, 2000, a reduction of reactive organic gases ("ROG") of at least 55 percent and a 15 percent reduction in the emissions of oxides of nitrogen ("NOx") from motor vehicles, and the maximum feasible reductions in particulates ("PM"), carbon monoxide ("CO"), and toxic air contaminants from vehicular sources;

WHEREAS, section 43018(c) of the Health and Safety Code provides that in carrying out section 43018, the Board shall adopt standards and regulations which will result in the most cost-effective combination of control measures on all classes of motor vehicles and motor vehicle fuel, including but not limited to reductions in motor vehicle exhaust and evaporative emissions, reductions in in-use vehicular emissions through durability and performance improvements, requiring the purchase of low-emission vehicles by state fleet operators, and specification of vehicular fuel composition;

WHEREAS, section 43101 of the Health and Safety Code directs the Board to adopt and implement emission standards for new motor vehicles which the Board has found to be necessary and technologically feasible to carry out the purposes of Division 26 of the Health and Safety Code;

WHEREAS, section 43104 of the Health and Safety Code directs the Board to adopt test procedures for determining whether new motor vehicles are in compliance with the emission standards established by the Board;

WHEREAS, following a hearing on September 27-28, 1990, the Board in Resolution 90-58 approved the Low-Emission Vehicles and Clean Fuels regulations which require the production of low-emission light- and medium-duty vehicles and require that alternative fuels used by these vehicles be made reasonably available to motorists; at the direction of the Board these regulations were subsequently adopted by the Executive Officer in Executive Order G-604;

WHEREAS, the Low-Emission Vehicles and Clean Fuels regulations establish emission standards for low-emission vehicles which require the application of reactivity adjustment factors ("RAFs") to the non-methane organic gas exhaust mass emissions from transitional low-emission vehicles ("TLEVs"), low-emission vehicles, and ultra-low-emission vehicles operating on fuels other than conventional gasoline, to determine compliance with applicable emission standards;

WHEREAS, the Low-Emission Vehicles and Clean Fuels regulations include a protocol under which the Executive Officer can establish RAFs for representative vehicle/fuel combinations by applying a reactivity scale based on the maximum incremental reactivity ("MIR") of individual hydrocarbon species to hydrocarbon exhaust speciation profiles;

WHEREAS, the portions of the Low-Emission Vehicles and Clean Fuels regulations pertaining to low-emission vehicle standards, the establishment and application of RAFs, and the certification of new motor vehicles to the low-emission standards are contained in Title 13, California Code of Regulations, section 1960.1 and the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles (the "Standards and Test Procedures"), which is incorporated by reference in section 1960.1;

WHEREAS, the staff initially proposed regulatory amendments which would establish RAFs for TLEVs which operate on methanol ("M85"), compressed natural gas ("CNG"), and liquefied petroleum gas ("LPG"), to be used to determine compliance with the TLEV exhaust emission standards;

WHEREAS, the staff has also proposed regulatory amendments which would make various changes regarding the calculation and use of RAFs for low-emission vehicles; these changes include revisions to the MIRs of individual hydrocarbon species, revisions to the treatment and applicability of updated RAFs, and identification of a value for the gram ozone potential per gram non-methane organic gases for light-duty TLEVs operating on conventional gasoline;

WHEREAS, the proposal would be effected by amendments to Title 13, California Code of Regulations, section 1960.1, and the incorporated Standards and Test Procedures, as set forth in Attachments A and B hereto;

WHEREAS, the California Environmental Quality Act and Board regulations require that an action not be adopted as proposed where it will have significant adverse environmental impacts if feasible alternatives or mitigation measures are available which would substantially reduce or avoid such impacts;

WHEREAS, the Board has considered the impact of the proposed regulations on the economy of the state;

WHEREAS, a public hearing and other administrative proceedings have been held in accordance with the provisions of Chapter 3.5 (commencing with section 11340), Part 1, Division 3, Title 2 of the Government Code; and

WHEREAS, the Board finds that:

The RAF approved herein for light-duty TLEVs operating on M85 is appropriately based on application of the criteria in the regulatory protocol for setting RAFs as modified herein;

There are insufficient data available to establish technically sound RAFs for light-duty TLEVs operating on CNG or LPG at this time;

The revisions approved herein to the identification of the MIRs of individual hydrocarbon species in the Standards and Test Procedures appropriately reflect the peer review and compilation of new data that has occurred over the past year;

The regulatory amendments approved herein pertaining to the use of RAFs are necessary and appropriate to clarify the regulatory requirements and to specify how updated RAFs are to be used;

Use of an MIR scale in determining RAFs is appropriate because the scale reflects the conditions where hydrocarbon control has the greatest impact on ozone formation; the ten percent correction factor included in the modifications to the original proposal will eliminate any overcrediting of reactivity benefits for M85 and LPG in high ozone episodes due to application of the scale, and will provide a margin of safety against such overcrediting during moderate ozone episodes;

The modifications to the original proposal pertaining to the assignment of a RAF for a specific engine family at the

request of a manufacturer is necessary to assure that appropriate RAFs will be available on a timely basis for all vehicles; the modifications include additional elements which will minimize the possibility that the RAF will not accurately reflect the emissions of in-use higher mileage vehicles;

The amendments approved herein should contribute to a more cost-effective means of reducing motor vehicle emissions by adjusting emission standards to reflect the ozone-forming potential of clean fuel/vehicle systems;

The amendments approved herein will not have any significant adverse environmental impacts.

NOW, THEREFORE, BE IT RESOLVED that the Board hereby approves the amendments to section 1960.1, Title 13, California Code of Regulations, and the incorporated California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, as set forth in Attachments A and B hereto, with the modifications described in Attachment C hereto, and with a further modification to eliminate the requirement that a vehicle manufacturer wishing to have a unique RAF assigned to a specific vehicle/fuel system must submit a speciated profile two years prior to certification of the vehicle.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer (1) to incorporate into the approved amendments the modifications described in Attachment C hereto, with such other conforming modifications as may be appropriate; (2) to conduct an informal workshop on the modified language if warranted; and (3) to adopt the amendments approved herein, after making the modified regulatory language available for public comment for a period of 15 days, provided that the Executive Officer shall consider such written comments regarding the modifications as may be submitted during this period, shall make additional modifications if deemed appropriate after consideration of supplemental comments received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

BE IT FURTHER RESOLVED that the Board hereby determines that the amendments approved herein will not cause California motor vehicle emission standards, in the aggregate, to be less protective of public health and welfare than applicable federal standards.

BE IT FURTHER RESOLVED that the Board hereby finds that separate California emission standards and test procedures are necessary to meet compelling and extraordinary conditions.

BE IT FURTHER RESOLVED that the Board finds that the California emission standards and test procedures as amended herein will not cause the California requirements to be inconsistent with section 202(a) of the Clean

Air Act and raise no new issues affecting previous waiver determinations of the Administrator of the Environmental Protection Agency pursuant to section 209(b) of the Clean Air Act.

BE IT FURTHER RESOLVED that the Executive Officer shall, upon adoption, forward the amendments to the Environmental Protection Agency with a request for a waiver or confirmation that the amendments are within the scope of an existing waiver of federal preemption pursuant to section 209(b) of the Clean Air Act, as appropriate.

BE IT FURTHER RESOLVED, that the Board directs the Executive Officer to identify and propose correction factors for RAFs for fuels other than M85 and LPG to eliminate potential overcrediting of reactivity benefits when adequate data become available.

I hereby certify that the above is a true and correct copy of Resolution 91-53, as adopted by the Air Resources Board.

Pat Hutchens, Board Secretary

Resolution 91-53

November 14, 1991

Identification of Attachments to the Resolution

Attachment A: Amendments to Title 13, California Code of Regulations, section 1960.1, as set forth in Appendix B to the Staff Report.

Attachment B: Amendments to the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, as set forth in Appendix C to the Staff Report.

Attachment C: Staff's Suggested Changes to the Proposed RAF Amendments (Distributed at the hearing on November 14, 1991).

PUBLIC HEARING ON REACTIVITY ADJUSTMENT FACTORS

NOVEMBER 14, 1991

STAFF'S SUGGESTED CHANGES TO THE PROPOSAL

The staff report and technical support document on the proposed regulations regarding the calculation and use of reactivity adjustment factors for low-emission vehicles and the adoption of initial reactivity adjustment factors for transitional low-emission vehicles were released to the public on September 27, 1991. Based on further analyses conducted by the Air Resources Board staff and comments received on these documents and the regulations contained therein, the staff is recommending that the following modifications to the proposed regulations be considered by the Air Resources Board at this hearing.

1. Withdrawal of Proposed RAFs for CNG and LPG

Upon further evaluation of the CNG and LPG data, the staff recommends that reactivity adjustment factors (RAFs) for these fuels not be adopted at this time. For CNG, the staff has conducted additional exhaust emission testing after the release of the staff report. Because of the high uncertainty of the new CNG data, the staff cannot propose a RAF for CNG with any confidence. Because the LPG database consists of only two vehicles, the staff also recommends that the Board not adopt a RAF for LPG at this time. Therefore, the staff recommends that no RAFs be adopted for LPG and CNG at this hearing.

2. Engine Family Specific RAFs

Section Affected: "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles", which is incorporated by reference in Title 13, California Code of Regulations, section 1960.1.

Because the staff is unable to propose generic RAFs for all potential TLEV technologies at this hearing, the staff is proposing that the regulations be amended to facilitate the development of engine family specific RAFs. Previously adopted regulations allow vehicle manufacturers to apply for RAFs specific to their vehicle/fuel system. The Executive

Officer would approve such requests provided that appropriate supporting data are submitted and that there is at least a 25 percent difference between the requested factor and the one already established for the same or similar vehicle/fuel system.

The staff is proposing that the 25 percent criterion be deleted. Vehicle manufacturers would thus be permitted to develop engine family specific RAFs by following the procedure outlined in the test procedures and the additional requirements described below. The staff envisions that durability vehicles for each of the families would have to be emission tested at regular intervals, in accordance with current practice or other approved accelerated durability programs, to generate a deterioration factor for NMOG mass changes and one for changes in the RAF. Neither deterioration factor would be allowed to be less than 1.00. The NMOG mass and RAF deterioration factors would be multiplied together to come up with an overall adjustment factor to apply to in-use vehicle NMOG levels for determining compliance with applicable NMOG emission standards. To confirm that the results from the durability vehicle(s) are reliable, at least 4 emission data vehicles and/or similar qualifying vehicles would also have to be tested using the FTP cycle to determine speciated NMOG emission profiles and attendant RAFs. A statistical process would be used to demonstrate that the data vehicles as a group exhibit similar profiles. In the future, the staff intends to examine further measures to verify that vehicles in-use comply with the intent of the reactivity adjustment process.

3. Correction of Bias in Protocol for Determining RAFs

Section Affected: "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles", which is incorporated by reference in Title 13, California Code of Regulations, section 1960.1.

Following the release of the staff report, airshed modeling analyses conducted by Carnegie Mellon University for the ARB have been completed. The results suggest that there may be a bias in the maximum incremental reactivity scale (MIR) which results in RAFs which are numerically higher than they should be. This bias was found to be 10 percent for M85 and LPG under worst case conditions. Therefore, the staff is recommending that any RAFs developed for M85 or LPG, either by the ARB or by manfacturers, be adjusted upward by 10 percent. Accordingly, the staff recommends that the RAF for M85 be revised from the originally proposed value of 0.36 to 0.41. This adjustment should address any potential biases in the MIR scale as well as other uncertainties in protocol. The staff will determine whether a bias

correction is needed for CNG once more representative vehicle emission data become available.

4. Revised MIR Scale

Section Affected: "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles", which is incorporated by reference in Title 13, California Code of Regulations, section 1960.1.

Subsequent to the release of the staff report, Dr. W.P.L. Carter has made additional updates to the maximum incremental reactivity (MIR) scale. Furthermore, the staff has included the MIRs of compounds which were previously omitted from the regulations. The updated MIR scale which the staff is recommending for Board adoption is included as an attachment to this document. Additions to the originally proposed scale are shown in double-underline, and deletions are shown in strike-out. The revised MIR scale is reflected in the proposed RAF for M85.

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NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)		NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	
ALKANES					
Normal Alkanes			Branched Alkanes		
Methane	0.0148		2,2-Dimethylhexane	1.20	
Ethane	~~0.26~~	0.25	2,3-Dimethylhexane	~~1.31~~	1.32
Propane	0.48		2,4-Dimethylhexane	1.50	
n-Butane	1.02		2,5-Dimethylhexane	1.63	
n-Pentane	~~1.03~~	1.04	3,3-Dimethylhexane	1.20	
n-Hexane	0.98		2-Methylheptane	0.96	
n-Heptane	0.81		3-Methylheptane	0.99	
n-Octane	0.61		4-Methylheptane	1.20	
n-Nonane	0.54		2,4-Dimethylheptane	~~1.33~~	1.34
n-Decane	0.47		2,2,5-Trimethylhexane	0.97	
n-Undecane	0.42		Other Branched C9H20 Alkanes	~~1.13~~	1.14
n-Dodecane	0.38		Branched C10H22 Alkanes	1.01	
n-Tridecane	0.35		Branched C11 Alkanes	1.17	
n-Tetradecane	0.32		Branched C12 Alkanes	1.23	
n-Pentadecane	0.29				
Branched Alkanes			Cyclo Alkanes		
2-Methylpropane	1.21		Cyclopentane	~~2.37~~	2.38
2,2-Dimethylpropane	0.37		Methylcyclopentane	2.82	
2-Methylbutane	1.38		Cyclohexane	1.28	
2,2-Dimethylbutane	0.82		t-1,2-Dimethylcyclopentane	1.85	
2,3-Dimethylbutane	1.07		1,3-Dimethylcyclopentanes	~~2.54~~	2.55
2-Methylpentane	1.53		Methylcyclohexane	~~1.84~~	1.85
3-Methylpentane	1.52		Ethylcyclopentane	2.31	
2,2,3-Trimethylbutane	1.32		Ethylmethylcyclopentane	1.94	
2,2-Dimethylpentane	1.40		1c,2t-3-Trimethylcyclopentane	1.94	
2,3-Dimethylpentane	1.51		1,2,4-Trimethylcyclopentane	1.94	
2,4-Dimethylpentane	1.78		Dimethylcyclohexanes	1.94	
3,3-Dimethylpentane	0.71		Ethylcyclohexane	1.94	
2-Methylhexane	1.08		Ethylmethylcyclohexane	2.30	
3-Methylhexane	1.40		Trimethylcyclohexane	2.30	
2,2,4-Trimethylpentane	~~0.87~~	0.93	C10 Cycloalkanes	1.78	
2,3,3-Trimethylpentane	1.20		C11 Cycloalkanes	1.91	
2,3,4-Trimethylpentane	1.60		C12 Cycloalkanes	1.68	

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NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)		NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	
ALKENES					
Ethene	7.28	7.29	Propadiene	7.28	7.29
Propene	9.39	9.40	1,3-Butadiene	10.88	10.89
1-Butene	8.90	8.91	2-Methyl-1,3-Butadiene	9.07	9.08
2-Butenes	9.93	9.94	Cyclopentadiene	7.66	7.66
2-Methylpropene	5.29	5.31	Cyclopentene	7.66	7.66
1-Pentene	6.22		1-Methylcyclopentene	5.67	
2-Pentenes	8.79	8.80	3-Methylcyclopentene	5.66	5.67
2-Methyl-1-Butene	4.89	4.90	Cyclohexene	5.66	5.67
3-Methyl-1-Butene	6.22		a-Pinene	3.28	
2-Methyl-2-Butene	6.40	6.41	b-Pinene	4.41	
1-Hexene	4.41	4.42			
2-Hexenes	6.67	6.69			
3-Hexenes	6.67	6.69			
Methyl-1-Pentenes	4.41	4.42	**ALKYNES**		
Methyl-2-Pentenes	6.67	6.69			
3,3-Dimethyl-1-Butene	4.41	4.42	Ethyne	0.51	0.50
1-Heptene	3.48		Propyne	4.10	
2-Heptenes	5.52	5.53	1-Butyne	9.23	9.24
3-Heptenes	5.52	5.53	2-Butyne	9.23	9.24
3-Ethyl-2-Pentenes	5.52	5.53			
2,3-Dimethyl-2-Pentene	5.52	5.53			
3-Methyl-1-Hexene	3.48				
2-Methyl-2-Hexenes	5.52	5.53			
4-Methyl-2-Hexene	5.53				
2-Methyl-3-Hexene	5.53				
3-Methyl-3-Hexenes	5.52	5.53			
1-Octene	2.68	2.69			
2-Octenes	5.27	5.29			
3-Octenes	5.27	5.29			
4-Octenes	5.27	5.29			
2,4,4-Trimethyl-1-Pentene	2.68	2.69			
2,4,4-Trimethyl-2-Pentene	5.29				
1-Nonene	2.22	2.23			

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NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	
AROMATIC HYDROCARBONS		
Benzene	0.42	
Toluene	2.72	2.73
Ethylbenzene	2.90	2.70
o-Xylene	6.68	6.46
m&p-Xylenes	8.15	
m-Xylene	8.16	
p-Xylene	6.60	
n-Propylbenzene	2.27	2.12
i-Propylbenzene	2.41	2.24
Methylethylbenzenes	7.20	
1,2,3-Trimethylbenzene	8.61	8.85
1,2,4-Trimethylbenzene	8.69	8.83
1,3,5-Trimethylbenzene	10.11	10.12
n-Butylbenzene	1.87	
s-Butylbenzene	2.04	1.89
Diethylbenzenes	6.44	6.45
1-Methyl-2-Propylbenzene	6.45	
1-Methyl-3-Propylbenzene	6.45	
C10 Trialkyl Benzenes	9.07	
Tetramethylbenzenes	9.06	9.07
C11 Monoalkyl Benzenes	1.70	
1-Methyl-4-Isobutylbenzene	5.83	5.84
C11 Dialkyl Benzenes	5.84	
C11 Trialkyl Benzenes	8.21	
C12 Monoalkyl Benzenes	1.55	
C12 Dialkyl Benzenes	5.34	
C12 Trialkyl Benzenes	7.50	
Indan (C9H10)	1.04	1.06
Methyl Indan	1.06	
Naphthalene	1.16	1.18
Tetralin	0.95	
Methyl Naphthalenes	3.27	
2,3-Dimethyl Naphthalene	5.13	
Styrene	2.20	2.22
AROMATIC OXYGENATES		
Phenol	1.13	
Cresols	2.31	
Benzaldehyde	-0.66	-0.55
p-Tolualdehyde	-0.66	3.32

NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	
OXYGENATES		
Alcohols		
Methanol	0.56	
Ethanol	1.33	1.34
n-Propyl Alcohol	2.26	
Isopropyl Alcohol	0.54	
n-Butyl Alcohol	2.69	
Isobutyl Alcohol	1.92	
t-Butyl Alcohol	0.42	
Aldehydes		
Formaldehyde	7.14	7.15
Acetaldehyde	5.51	5.52
Propionaldyde	6.53	
Acrolein	6.76	6.77
n-Butyraldehyde	5.26	
Crotonaldehyde	5.41	5.42
Pentanaldehyde	4.40	4.41
Hexanaldehyde	3.79	
C7 Aldehydes	3.32	
Ethers		
Methyl t-Butyl Ether	0.62	
Ethyl t-Butyl Ether	1.98	
Ketones		
Acetone	0.56	
Butanone	1.18	

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ATTACHMENT II

A. Summary of modifications

B. Modified regulatory text of section 1960.1, Title 13, California Code of Regulations

C. Modified text of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles"

SUMMARY OF 15-DAY MODIFICATIONS

Substantive modifications affect the document "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" only. All section citations included in this summary refer to these test procedures. Additional non-substantive modifications were made to section 1960.1, Title 13, California Code of Regulations. However, these modifications are of an editorial nature and are not summarized in this document.

1. In section 13.(a)(1), the originally proposed reactivity adjustment factor of 0.36 for methanol TLEVs has been changed to 0.41, and the originally proposed reactivity adjustment factors for compressed natural gas and liquified petroleum gas have been deleted from the regulations. As set forth in the staff report, reactivity adjustment factors of 0.36, 0.50, and 0.18 were originally proposed for methanol, liquified petroleum gas, and compressed natural gas, respectively. The revised reactivity adjustment factor of 0.41 for methanol reflects the updated maximum incremental reactivity scale (refer to item 7 of this summary) and a 10 percent correction for potential modeling and protocol biases. Reactivity adjustment factors for compressed natural gas and liquified petroleum gas have been dropped because of inconsistencies and limitations in the vehicle emission data. The Executive Officer will establish the factors in accordance with the test procedures once sufficient representative data are available.

2. In section 13.(d)(1), the 'g ozone potential per g NMOG' for conventional gasoline TLEVs has been changed from 3.44 to 3.42 to reflect the revisions to the maximum incremental reactivity scale (refer to item 7 of this summary).

3. In Appendix VIII, at the end of note (7), language has been added stating that any reactivity adjustment factors calculated for methanol and liquified petroleum gas are to be adjusted upward by 10 percent to account for potential modeling and protocol biases.

4. In Appendix VIII, note (8)a., additional requirements for engine family specific reactivity adjustment factors have been added. Specifically, vehicle manufacturers are required to submit speciated NMOG exhaust emission profiles from at least four vehicles representative of the engine family. The emission data vehicle(s) for the engine family must be included in the vehicle test sample, and the speciated profile(s) from the emission data vehicle(s) must be obtained from the same

test(s) used to derive the official 4000 mile exhaust certification data. One speciated profile is required from each test vehicle. An "undeteriorated reactivity adjustment factor" is calculated for each vehicle, and the "undeteriorated reactivity adjustment factor" for the engine family is derived by taking the arithmetic mean. To limit the amount of variability in the data, the 95 percent upper confidence bound of the mean reactivity adjustment factor can be no more than 15 percent greater than the value of the mean factor.

5. In Appendix VIII, note (8)b., the requirement for a 25 percent difference between the manufacturer derived reactivity adjustment factor and the ARB established factor has been deleted. In its place, the procedure for determining a "reactivity deterioration factor" has been added. A manufacturer is required to obtain at least two speciated NMOG exhaust emission profiles from at least one durability data vehicle at each mileage interval normally used to determine deterioration factors for mass emissions. The mean reactivity adjustment factor is calculated at each interval, and from this information, a deterioration factor for reactivity is obtained. No reactivity deterioration factor can be less than 1.00. The mean undeteriorated reactivity deterioration factor derived for the engine family is multiplied by the reactivity deterioration factor to obtain the reactivity adjustment factor used to determine compliance with the NMOG standards.

6. In Appendix VIII, note (8)c., the provision requiring a two-year leadtime for submitting speciated profiles has been changed to requiring that speciated profiles, reactivity adjustment factors, and reactivity deterioration factors be submitted with the certification application.

7. In Appendix VIII, note (9), the previous list of maximum incremental reactivities has been replaced with the updated list distributed at the Board hearing. This updated list includes the revisions made to the maximum incremental reactivity scale by Dr. William Carter just prior to the Board hearing.

SECTION 1960.1, TITLE 13, CCR

Amend Title 13, California Code of Regulations, section 1960.1 to read as follows:[1]

1960.1. **Exhaust Emission Standards and Test Procedures - 1991 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.**

(a) through (d) [No Change]

(e)(1) and (e)(2) [No Change]

(e)(3) The exhaust emissions from 1992 and subsequent model-year transitional low-emission vehicles, low-emission vehicles, and ultra-low-emission vehicles, including fuel-flexible and dual-fuel vehicles, shall meet all the requirements of (g)(1) and (h)(2) with the following additions:

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1. The regulatory amendments originally proposed in this rulemaking are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions from existing regulations. Modifications to the originally noticed text are designated by double underline and ~~slash out~~ to represent additions and deletions, respectively.

EXHAUST EMISSION STANDARDS FOR
TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES,
AND ULTRA-LOW-EMISSION VEHICLES IN THE
LIGHT-DUTY AND MEDIUM-DUTY VEHICLE WEIGHT CLASSES (5)(6)(7)
["milligrams per mile" (or "mg/mi")]

Vehicle Type (1)	Vehicle Weight (lbs.)(2)	Durability Vehicle Basis (mi)	Vehicle Emission Category(3)	Formaldehyde (mg/mi)(4)(5)
PC and LDT	All 0-3750	50,000	TLEV	15 (23)
			LEV	15 (15)
			ULEV	8 (12)
		100,000	TLEV	18
			LEV	18
			ULEV	11
LDT	3751-5750	50,000	TLEV	18 (27)
			LEV	18 (18)
			ULEV	9 (14)
		100,000	TLEV	23
			LEV	23
			ULEV	13
MDV	0-3750	50,000	LEV	15 (15)
			ULEV	8 (12)
		120,000	LEV	22
			ULEV	12
MDV	3751-5750	50,000	LEV	18 (18)
			ULEV	9 (14)
		120,000	LEV	27
			ULEV	13
MDV	5751-8500	50,000	LEV	22 (22)
			ULEV	11 (17)
		120,000	LEV	32
			ULEV	16
MDV	8501-10,000	50,000	LEV	28 (28)
			ULEV	14 (21)
		120,000	LEV	40
			ULEV	21
MDV	10,001-14,000	50,000	LEV	36 (36)
			ULEV	18 (27)
		120,000	LEV	52
			ULEV	26

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.

(2) For light-duty or medium-duty vehicles, Vehicle Weight shall mean "Loaded Vehicle Weight" (or "LVW") or "Test Weight" (or "TW"), respectively.

(3) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(4) Formaldehyde exhaust emission standards apply to vehicles ~~designed~~ certified to operate on any available fuel, including fuel-flexible and dual-fuel vehicles.

(5) The standards in parentheses are intermediate compliance standards for 50,000 miles.

a. For PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles, intermediate compliance standards shall apply to TLEVs through the 1995 model year, LEVs and ULEVs through the 1998 model year. Compliance with standards beyond 50,000 miles shall be waived through 1995 for TLEVs, and through 1998 for LEVs and ULEVs.

b. For MDVs from 0-14,000 lbs. TW, including fuel-flexible and dual-fuel vehicles, intermediate compliance standards shall apply to LEVs and ULEVs through the 1999 model year. Compliance with standards beyond 50,000 miles shall be waived through the 1999 model year for LEVs and ULEVs.

(6) Manufacturers shall demonstrate compliance with the above standards for formaldehyde at 50 degrees F according to the procedures specified ~~in section 11k of the "California Exhaust Emission Standards and Test~~ Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as ~~adopted May 20, 1987 and last amended~~ INSERT July ~~12, 1991~~ / which is incorporated herein by reference in section 1960.1(k).

(7) In-use compliance testing shall be limited to PCs and LDTs with fewer than 75,000 miles and MDVs with fewer than 90,000 miles.

(f)(1) and (f)(2) [No Change]

(g)(1) The exhaust emissions from new 1992 and subsequent model-year light-duty transitional low-emission vehicles, low-emission vehicles, and ultra-low-emission vehicles shall not exceed:

EXHAUST EMISSION STANDARDS
FOR TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES
AND ULTRA-LOW-EMISSION VEHICLES IN PASSENGER CAR
AND LIGHT-DUTY TRUCK VEHICLE CLASSES (6)(7)(8)(9)
[grams per mile (or "g/mi")]

Vehicle Type (1)	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Vehicle Emission Category (2)	Non-Methane Organic Gases (3)(4)	Carbon Monoxide	Oxides of Nitrogen (5)
PC and LDT	All 0-3750	50,000	TLEV	0.125 (0.188)	3.4 (3.4)	0.4 (0.4)
			LEV	0.075 (0.100)	3.4 (3.4)	0.2 (0.3)
			ULEV	0.040 (0.058)	1.7 (2.6)	0.2 (0.3)
		100,000	TLEV	0.156	4.2	0.6
			LEV	0.090	4.2	0.3
			ULEV	0.055	2.1	0.3
LDT	3751-5750	50,000	TLEV	0.160 (0.238)	4.4 (4.4)	0.7 (0.7)
			LEV	0.100 (0.128)	4.4 (4.4)	0.4 (0.5)
			ULEV	0.050 (0.075)	2.2 (3.3)	0.4 (0.5)
		100,000	TLEV	0.200	5.5	0.9
			LEV	0.130	5.5	0.5
			ULEV	0.070	2.8	0.5

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.

(2) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(3) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions. To demonstrate compliance with an NMOG standard, NMOG emissions shall be measured in accordance with the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991, which is incorporated herein by reference. For TLEVs, LEVs, and ULEVs ~~designed~~ certified to operate exclusively on any fuel other than conventional gasoline, and for fuel-flexible and dual-fuel TLEVs, LEVs, and ULEVs when certifying on a fuel other than conventional gasoline, manufacturers shall multiply the measured NMOG mass emissions levels at 50,000 and 100,000 miles by the applicable reactivity adjustment factor set forth in section 13 of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as ~~adopted~~ May 20, 1987 and last amended INSERT WHICH is incorporated herein by reference in section 1960.1(k), or established by the Executive Officer pursuant to Appendix VIII of the foregoing test procedures. The product of the NMOG mass emission level and the reactivity adjustment factor shall be

compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance. ~~established for the particular vehicle emission category and fuel combination in the application for certification. The Executive Officer shall determine the reactivity adjustment factor according to the procedure described in Appendix VIII of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as adopted May 20, 1987 and last amended July 12, 1991, which is incorporated herein by reference.~~

a. Each manufacturer shall certify PCs or LDTs to meet the exhaust mass emission standards for TLEVs, LEVs, ULEVs, or the exhaust emission standards of sections 1960.1 (e)(1), 1960.1 (f)(1), or 1960.1 (f)(2), Title 13, California Code of Regulations, or as Zero-Emission Vehicles such that the manufacturer's fleet average NMOG values for California-certified PCs and LDTs from 0-3750 lbs. "Loaded Vehicle Weight" (or "LVW"), and LDTs from 3751-5750 lbs. LVW sold in California are less than or equal to the requirement for the corresponding Model Year, Vehicle Type, and LVW Class in section 1960.1 (g)(2), Title 13, California Code of Regulations.

(4) Fuel-flexible and dual-fuel PCs and LDTs from 0-5750 lbs. LVW shall be certified to exhaust mass emission standards for NMOG established for the operation of the vehicle on any available fuel other than conventional gasoline, and conventional gasoline.

a. For TLEVs, LEVs, and ULEVs, when certifying for operation on a fuel other than conventional gasoline, manufacturers shall ~~multiply the measured NMOG~~ mass emissions levels at 50,000 and 100,000 miles by the applicable reactivity adjustment factor ~~in the application for certification at 50,000 and 100,000 miles.~~

b. For PCs and LDTs from 0-3750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on conventional gasoline shall be:
   (i) For TLEVs, 0.25 g/mi and 0.31 g/mi for 50,000 and 100,000 miles, respectively.
   (ii) For LEVs, 0.125 g/mi and 0.156 g/mi for 50,000 and 100,000 miles, respectively.
   (iii) For ULEVs, 0.075 g/mi and 0.090 g/mi for 50,000 and 100,000 miles, respectively.

c. For LDTs from 3751-5750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on conventional gasoline shall be:
   (i) For TLEVs, 0.32 g/mi and 0.40 g/mi for 50,000 and 100,000 miles, respectively.
   (ii) For LEVs, 0.160 g/mi and 0.200 g/mi for 50,000 and 100,000 miles, respectively.
   (iii) For ULEVs, 0.100 g/mi and 0.130 g/mi for 50,000 and 100,000 miles, respectively.

(5) The maximum projected emissions of "Oxides of Nitrogen" (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR 600 Subpart B) shall be not greater than 1.33 times the applicable light-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

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(6) The standards in parentheses are intermediate compliance standards for 50,000 miles. For PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than conventional gasoline, intermediate compliance standards shall apply to TLEVs through the 1995 model year, and LEVs and ULEVs through the 1998 model year. Compliance with standards beyond 50,000 miles shall be waived through the 1995 model year for TLEVs, and through the 1998 model year for LEVs and ULEVs.

a. For TLEVs, LEVs, and ULEVs designed to operate on any fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on any fuel other than conventional gasoline, measured NMOG mass emissions levels shall be multiplied by the applicable reactivity adjustment factor to determine compliance with intermediate compliance standards for NMOG.

b. For fuel-flexible and dual-fuel PCs and LDTs from 0-3750 lbs. LVW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on conventional gasoline, shall be 0.32 g/mi, 0.188 g/mi, and 0.100 g/mi for TLEVs, LEVs, and ULEVs, respectively.

c. For fuel-flexible and dual-fuel PCs and LDTs from 3751-5750 lbs. LVW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on conventional gasoline, shall be 0.41 g/mi, 0.238 g/mi, and 0.128 g/mi for TLEVs, LEVs, and ULEVs, respectively.

(7) Manufacturers of diesel vehicles shall also certify to particulate standards at 100,000 miles. For all PCs and LDTs from 0-5750 lbs LVW, the particulate standard is 0.08 g/mi, 0.08 g/mi, and 0.04 g/mi for TLEVs, LEVs and ULEVs, respectively.

(8) Manufacturers shall demonstrate compliance with the above standards for NMOG, CO, and NOx at 50 degrees F according to the procedure specified in section 11k of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as ~~adopted May 20, 1987 and last amended~~ INSERT ~~July 12, 1991,~~ incorporated ~~herein~~ by reference in section 1960.1(k). For diesel vehicles, compliance with the particulate standard shall also be demonstrated as specified in section 11k of the foregoing test procedures.

(9) In-use compliance testing shall be limited to vehicles with fewer than 75,000 miles.

(g)(2) and (h)(1) [No Change]

(h)(2) The exhaust emissions from new 1992 and subsequent model-year medium-duty low-emission vehicles, and ultra-low-emission vehicles shall not exceed:

EXHAUST EMISSION STANDARDS FOR LOW-EMISSION VEHICLES,
AND ULTRA-LOW-EMISSION VEHICLES IN THE
MEDIUM-DUTY VEHICLE WEIGHT CLASS (8)(9)(10)(11)(12)(13)(14)
[grams per mile (or "g/mi")]

Test Weight lbs.) (1)	Durability Vehicle Basis (mi)	Vehicle Emission Category (2)	Non-Methane Organic Gases (3)(4)	Carbon Monoxide	Oxides of Nitrogen (5)	Particulates (6)(7)
0-3750	50,000	LEV	0.125 (0.188)	3.4 (3.4)	0.4 (0.4)	n/a
		ULEV	0.075 (0.100)	1.7 (2.6)	0.2 (0.3)	n/a
	120,000	LEV	0.180	5.0	0.6	0.08
		ULEV	0.107	2.5	0.3	0.04
3751-5750	50,000	LEV	0.160 (0.238)	4.4 (4.4)	0.7 (0.7)	n/a
		ULEV	0.100 (0.128)	2.2 (3.3)	0.4 (0.5)	n/a
	120,000	LEV	0.230	6.4	1.0	0.10
		ULEV	0.143	3.2	0.5	0.05
5751-8500	50,000	LEV	0.195 (0.293)	5.0 (5.0)	1.1 (1.1)	n/a
		ULEV	0.117 (0.156)	2.5 (3.8)	0.6 (0.8)	n/a
	120,000	LEV	0.280	7.3	1.5	0.12
		ULEV	0.167	3.7	0.8	0.06
8501-10000	50,000	LEV	0.230 (0.345)	5.5 (5.5)	1.3 (1.3)	n/a
		ULEV	0.138 (0.184)	2.8 (4.2)	0.7 (1.0)	n/a
	120,000	LEV	0.330	8.1	1.8	0.12
		ULEV	0.197	4.1	0.9	0.06
10,001-14000	50,000	LEV	0.300 (0.450)	7.0 (7.0)	2.0 (2.0)	n/a
		ULEV	0.180 (0.240)	3.5 (5.3)	1.0 (1.5)	n/a
	120,000	LEV	0.430	10.3	2.8	0.12
		ULEV	0.257	5.2	1.4	0.06

(1) "Test Weight" (or "TW") shall mean the average of the vehicle's curb weight and gross vehicle weight.

(2) "LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.

(3) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions. To determine compliance with an NMOG standard, NMOG emissions shall be measured in accordance with "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991, which is incorporated herein by reference.

a. For LEVs and ULEVs ~~designed~~ certified to operate on any available fuel other than conventional gasoline, including fuel-flexible or dual-fuel vehicles when certifying on a fuel other than conventional gasoline, manufacturers shall multiply measured NMOG mass emissions levels at 50,000 and 120,000 miles by the applicable reactivity adjustment factor set forth in section 13 of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as ~~adopted May 20, 1987 and last amended~~

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~~INSERT~~ which is incorporated herein by reference in section 1960.1(k), or established by the Executive Officer pursuant to Appendix VIII of the foregoing test procedures. The product of the NMOG mass emission levels and the reactivity adjustment factor shall be compared to the exhaust NMOG mass emission standard established for the particular vehicle emission category to determine compliance. ~~appropriate to the vehicle emission category and fuel combination in the application for certification. The reactivity adjustment factor shall be determined by the Executive Officer according to the procedure described in Appendix VIII of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as adopted May 20, 1987 and last amended July 12, 1991, which is incorporated herein by reference.~~

(4) Fuel-flexible and dual-fuel medium-duty vehicles (or "MDVs") from 0-14,000 lbs. TW shall be certified to exhaust mass emission standards for NMOG established for the operation of the vehicle on any fuel other than conventional gasoline, and conventional gasoline.

a. For LEVs and ULEVs, manufacturers shall multiply measured NMOG mass emissions levels at 50,000 and 120,000 miles by the ~~appropriate~~ applicable reactivity adjustment factor ~~in the application for certification~~.

b. For MDVs from 0-3750 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on conventional gasoline shall be:
   (i) For LEVs, 0.25 g/mi and 0.36 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.125 g/mi and 0.190 g/mi for 50,000 and 120,000 miles, respectively.

c. For MDVs from 3751-5750 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on conventional gasoline shall be:
   (i) For LEVs, 0.32 g/mi and 0.46 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.160 g/mi and 0.230 g/mi for 50,000 and 120,000 miles, respectively.

d. For MDVs from 5751-8500 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on conventional gasoline shall be:
   (i) For LEVs, 0.39 g/mi and 0.56 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.195 g/mi and 0.280 g/mi for 50,000 and 120,000 miles, respectively.

e. For MDVs from 8501-10,000 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on conventional gasoline shall be:
   (i) For LEVs, 0.46 g/mi and 0.66 g/mi for 50,000 and 120,000 miles, respectively.
   (ii) For ULEVs, 0.230 g/mi and 0.330 g/mi for 50,000 and 120,000 miles, respectively.

f. For MDVs from 10,001-14,000 lbs. TW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on conventional gasoline shall be:
   (i) For LEVs, 0.60 g/mi and 0.86 g/mi for 50,000 and 120,000 miles, respectively.

(ii) For ULEVs, 0.300 g/mi and 0.430 g/mi for 50,000 and 120,000 miles, respectively.

(5) The maximum projected emissions of "Oxides of Nitrogen" (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR Part 600 Subpart B) shall not be greater than 2.00 times the applicable MDV standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared.

(6) Particulate standards are only applicable for diesel vehicles and shall be determined on a 120,000 mile basis.

(7) "n/a" means not applicable.

(8) Manufacturers have the option of certifying engines used in incomplete and diesel MDVs to the heavy-duty engine standards and test procedures set forth in section 1956.8(h), Title 13, California Code of Regulations. Manufacturers certifying incomplete or diesel MDVs to the heavy-duty engine standards and test procedures shall specify in the application for certification an in-use compliance procedure as provided in section 2139(c), Title 13, California Code of Regulations.

(9) The standards in parenthesis are intermediate compliance standards for 50,000 miles. For MDVs from 0-14,000 lbs. TW, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than conventional gasoline, intermediate compliance standards shall apply to LEVs and ULEVs through the 1999 model year. Compliance with standards beyond 50,000 miles shall be waived through the 1999 model year for LEVs and ULEVs.

a. For LEVs and ULEVs designed to operate on any available fuel other than conventional gasoline, including fuel-flexible and dual-fuel ~~vehicles when operating on any available fuel other than~~ conventional gasoline, measured NMOG emissions levels shall be multiplied by the ~~appropriate~~ applicable reactivity adjustment factor.

b. For fuel-flexible and dual-fuel MDVs from 0-3750 lbs. TW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on conventional gasoline, shall be 0.32 g/mi and 0.188 g/mi for LEVs and ULEVs, respectively.

c. For fuel-flexible and dual-fuel MDVs from 3751-5750 lbs. TW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on conventional gasoline, shall be 0.41 g/mi and 0.238 g/mi for LEVs and ULEVs, respectively.

d. For fuel-flexible and dual-fuel MDVs from 5751-8500 lbs. TW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on conventional gasoline, shall be 0.49 g/mi and 0.293 g/mi for LEVs and ULEVs, respectively.

e. For fuel-flexible and dual-fuel MDVs from 8501-10,000 lbs. TW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on conventional gasoline, shall be 0.58 g/mi and 0.345 g/mi for LEVs and ULEVs, respectively.

f. For fuel-flexible and dual-fuel MDVs from 10,001-14,000 lbs. TW, intermediate compliance standards for NMOG emissions at 50,000 miles, when the vehicle is operated on conventional gasoline,

shall be 0.75 g/mi and 0.450 g/mi for LEVs and ULEVs, respectively.

(10) Each manufacturer's MDV fleet shall be defined as the total number of MDVs from 0-14,000 lbs. TW certified and sold in California.

a. Manufacturers of MDVs shall certify an equivalent of 25% of their MDV fleet to LEV standards in the 1998 model year, 50% of their MDV fleet to LEV standards in the 1999 model year, 75% of their MDV fleet to LEV standards in the 2000 model year, 95% of their MDV fleet to LEV standards in the 2001 model year, 90% of their MDV fleet to LEV standards in the 2002 model year, and 85% of their MDV fleet to LEV standards in the 2003 and subsequent model years.

b. Manufacturers of MDVs shall certify an equivalent of 2% of their MDV fleet to ULEV standards in each model year from 1998 through 2000, 5% of their MDV fleet to ULEV standards in the 2001 model year, 10% of their MDV fleet to ULEV standards in the 2002 model year, and 15% of their MDV fleet to ULEV standards in the 2003 and subsequent model years.

(11) For the purpose of calculating "Vehicle Equivalent Credits" (or "VECs"), the contribution of hybrid electric vehicles (or "HEVs") will be calculated based on the range of the HEV without the use of the engine. For the purpose of calculating the contribution of HEVs to the VECs, the following definitions shall apply:

"Type A HEV" shall mean an HEV which achieves a minimum range of 60 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET; 40 CFR Part 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 60 miles. This definition shall also apply to vehicles which have no tailpipe emissions, but use fuel fired heaters, regardless of the operating range of the vehicle.

"Type B HEV" shall mean an HEV which achieves a range of 40 - 59 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET; 40 CFR Part 600 Subpart B) without the use of the engine. Use of vehicle accessories cannot lower the battery-only range below 40 miles.

"Type C HEV" shall mean an HEV which achieves a range of 0 - 39 miles over the Dynamometer Driving Cycle as defined by the "Federal Highway Fuel Economy Test Procedure" (HWFET; 40 CFR Part 600 Subpart B) without the use of the engine, an HEV which enables the vehicle operators to control the engine time and modes of operation either directly or indirectly, an HEV which can be operated solely through the use of the engine, and all other HEVs excluding "Type A" and "Type B" HEVs.

(12) In 1992 and subsequent model years, manufacturers that sell MDVs in excess of the equivalent requirements for LEVs and/or ULEVs shall receive VECs calculated as: [[(No. of LEVs Sold excluding HEVs) + (No. of "Type C HEV" LEVs Sold)] + [(No. of "Type B HEV" LEVs Sold) x (1.1)] + [(No of "Type A HEV" LEVs Sold) x (1.2)] - (Equivalent No. of LEVs Required to be Sold)] + [[(No. of ULEVs Sold excluding HEVs) x (1.4)] + [(No. of "Type C HEV" ULEVs Sold) x (1.4)] + [(No. of "Type B HEV" ULEVs Sold) x (1.5)] + [(No. of "Type A HEV" ULEVs Sold) x (1.7)] - (Equivalent No. of ULEVs Required to be Sold)] + [(No. of ZEVs Sold as MDVs) x (2.0)].

a. Manufacturers that fail to sell the equivalent quantity of MDVs certified to LEV and/or ULEV exhaust emission standards, shall receive "Vehicle-Equivalent Debits" (or "VEDs") equal to the amount of negative VECs determined by the aforementioned equation.
b. Manufacturers shall equalize emission debits within one model year by earning VECs in an amount equal to their previous model-year's total of VEDs, or by submitting a commensurate amount of VECs to the Executive Officer that were earned previously or acquired from another manufacturer.
c. The VECs earned in any given model year shall retain full value through the subsequent model year.
d. The value of any VECs not used to equalize the previous model-year's debit, shall be discounted by 50% at the beginning of second model year after being earned, discounted to 25% of its original value if not depleted by the beginning of the third model year after being earned, and will have no value if not depleted by the beginning of the fourth model year after being earned.
e. Only ZEVs certified as MDVs shall be included in the calculation of VECs.

(13) Manufacturers shall demonstrate compliance with the above standards for NMOG, carbon monoxide, and oxides of nitrogen at 50 degrees F according to the procedure specified in section 11k of the "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as ~~adopted May 20, 1987, and last amended July 12, 1991~~ [INSERT] which is incorporated ~~herein~~ by reference in section 1960.1(k). For diesel vehicles, compliance with the particulate standard shall also ~~be demonstrated as specified in section 11k of the foregoing test~~ procedures.

(14) In-use compliance testing shall be limited to vehicles with fewer than 90,000 miles.

(i) and (j) [No Change]

(k) The test procedures for determining compliance with these standards are set forth in "California Exhaust Emission Standards and Test Procedures for 1981 through 1987 Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles", adopted by the State Board on November 23, 1976, as last amended May 20, 1987, and in "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles", adopted by the state board on May 20, 1987 as last amended ~~July 12, 1991~~ [INSERT], both of which are incorporated herein by reference.

(l) through (o) [No Change]

NOTE: Authority cited: Sections 39600, 39601, 43013, 43018, 43101, 43104, and 43105, Health and Safety Code. Reference: Sections 39002, 39003, 43000, 43009.5, 43013, 43018, 43100, 43101, 43101.5, 43102, 43103, 43104, 43105, 43106, 43107, 43204-43205.5, Health and Safety Code.

PROPOSED

State of California
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

Adopted: May 20, 1987
Amended: December 20, 1989
Amended: January 22, 1990
Amended: December 26, 1990
Amended: July 12, 1991
Amended: [INSERT]

NOTE: Unless otherwise indicated, amendments to the standards and test procedures originally proposed in this rulemaking are shown in underline to indicate additions to the text and ~~strikeout~~ to indicate deletions. Modifications to the originally-noticed text are indicated in double-underline and ~~slash out~~ to represent additions and deletions, respectively.

The numbering convention employed in this document, in order of priority, is: 1.a.1.i.A. Any references within specific sections in the Code of Federal Regulations are denoted in order of priority as: (a)(1)(i)(A) - the same numbering system employed in the Code of Federal Regulations.

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CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES

The provisions of Subparts A and B, Part 86, Title 40, Code of Federal Regulations as set forth in Appendix I, to the extent they pertain to Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, are hereby adopted as the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, with the following exceptions and additions.

1. Applicability

[No Change]

2. Definitions

[No Change from Originally Noticed Text]

3. Standards

[No Change from Originally Noticed Text]

4. Initial Requirements

[No Change]

5. Maintenance Requirements

[No Change]

6. Demonstrating Compliance

[No Change]

7. Small-Volume Manufacturer's Certification Procedures

[No Change]

8. Alternative Procedures for Notification of Additions and Changes

[No Change]

9. Test Requirements

[No Change]

10. Optional 100,000 Mile Certification Procedure

[No Change]

11. Additional Requirements

[No Change]

12. Identification of New Clean Fuels to be Used in Certification Testing

[No Change]

13. Reactivity Adjustment Factors

For the purpose of complying with the NMOG exhaust emission standards in Section 1960.1, Title 13, California Code of Regulations, the mass of NMOG emissions from a vehicle certified to operate on a fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operated on a fuel other than conventional gasoline, shall be multiplied by the reactivity adjustment factor applicable to the vehicle emission control technology category and fuel. The product of the NMOG mass emission value and the reactivity adjustment factor shall be compared to the NMOG exhaust emission standards to determine compliance with the standards.

(a) The following reactivity adjustment factors have been established pursuant to the criteria in Appendix VIII of these test procedures:

(1) Passenger cars and light-duty trucks 0-5750 lbs. LVW

Vehicle Emission Control Technology Category	Fuel	Reactivity Adjustment Factor
1993 and subsequent model-year TLEVs	85% methanol, 15% gasoline blends	0/36 0.41
1993 and subsequent model/year TLEVs	compressed natural gas	0/18
1993 and subsequent model/year TLEVs	liquified petroleum gas	0/50

(b) The Executive Officer may establish by executive order new reactivity adjustment factors pursuant to Appendix VIII of these test procedures in addition to those listed in Section 13.(a).

The Executive Officer shall notify manufacturers in writing of the new reactivity adjustment factors within 30 days of their establishment.

(c.) The Executive Officer may revise any reactivity adjustment factor listed in Section 13.(a), or established by the Executive Officer pursuant to Appendix VIII of these test procedures if he or she determines that the revised reactivity adjustment factor is more representative of the ozone-forming potential of vehicle NMOG emissions based on the best available scientific knowledge and sound engineering judgement. The Executive Officer shall notify manufacturers in writing of any such reactivity adjustment factor at least 3 years prior to January 1 of the calendar year which has the same numerical designation as the model year for which the revised reactivity adjustment factor first becomes effective. However, manufacturers may use the revised reactivity adjustment factor in certifying any new engine family whose certification application is submitted following such notification, if they so choose. Manufacturers may also continue to use the original reactivity adjustment factor for any existing engine family previously certified with that reactivity adjustment factor until a new durability data vehicle is tested for that engine family.

(d.) Manufacturers may request the use of a unique reactivity adjustment factor for ~~unique to~~ a specific vehicle emission control technology category and fuel. The Executive Officer shall approve such requests in accordance with the conditions and procedures of Appendix VIII of these test procedures. For the purpose of calculating the reactivity adjustment factor as specified in Appendix VIII, the 'g ozone potential per g NMOG' value for the vehicle emission control technology category and fuel system for which the manufacturer is requesting the use of an unique reactivity adjustment factor shall be divided by the 'g ozone potential per g NMOG' value for a conventional gasoline-fueled vehicle established for the vehicle emission control technology category. The following 'g ozone potential per g NMOG' values for conventional gasoline-fueled vehicle emission control technology categories have been established:

(1.) Passenger cars and light-duty trucks 0-5750 lbs. LVW

Vehicle Emission Control Technology Category	'g ozone potential per g NMOG' for conventional gasoline
All TLEVs	~~3.44~~ 3.42

Appendix I through VII

[No Change]

APPENDIX VIII

Procedure for Determining Vehicle Emission Control Technology Category/Fuel Reactivity Adjustment Factors

The following procedure shall be used by the Executive Officer to establish ~~determine~~ the reactivity adjustment factor for exhaust emissions of non-methane organic gases (NMOG), for the purpose of certifying a vehicle of specific emission control technology category and fuel for sale in California. The NMOG emissions from Transitional Low-Emission Vehicles (TLEVs), Low-Emission Vehicles (LEVs), and Ultra-Low-Emission Vehicles (ULEVs) designed to operate on any available fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on any available fuel other than conventional gasoline, shall be numerically-adjusted to establish a NMOG exhaust mass emission value ~~level~~ equivalent, in terms of ozone-forming potential, to the NMOG exhaust mass emissions from a conventional gasoline-fueled vehicles of the same vehicle emission control technology category.

(1) The Executive Officer shall determine the representative speciated NMOG exhaust emission profile for all light- and medium-duty conventional gasoline-fueled TLEVs, LEVs, and ULEVs according to the following conditions.

a. All testing will be conducted using a specified gasoline blend representative of commercial gasoline.

b. The speciated NMOG profile shall be calculated from a statistically valid number of TLEVs, LEVs, and ULEVs.

c. ~~The speciated NMOG profile shall identify and quantify as many~~ constituents as possible, such that a minimum of 95% of the total g/mile of NMOG emissions measured is accounted for, and shall be provided in units of g/mile or mg/mile.

d. The speciated NMOG profile shall include at a minimum, the g/mile NMOG emission values of all oxygenated organic gases containing five or fewer carbon atoms (i.e., aldehydes, ketones, alcohols, ethers, etc.), and all known alkanes, alkenes, alkynes and aromatics containing twelve or fewer carbon atoms.

(2) The 'g ozone potential per mile' of each NMOG identified in the speciated profile shall be determined by multiplying the 'g/mile NMOG' emission value of the constituent NMOG by its maximum incremental reactivity given in step (9).

(3) The 'total g ozone potential per mile' of NMOG exhaust emissions from the vehicle/fuel system shall be the sum of all the constituent NMOG 'g ozone potential per mile' values calculated in step (2).

(4) The 'g ozone potential per g NMOG' for the vehicle/fuel system shall be determined by dividing the 'total g ozone potential per mile' value calculated in step (3) by the 'total g/mile of NMOG emissions'.

(5) For light- and medium-duty candidate vehicle/fuel systems not powered by conventional gasoline, the Executive Officer shall establish 'reactivity adjustment factors' calculated from exhaust emission profiles derived by according to the same conditions specified in parts b, c, and d of step (1).

(6) The 'g ozone potential per g NMOG' for candidate vehicle/fuel systems not powered by conventional gasoline shall be determined according to steps (2), (3), and (4).

(7) The candidate vehicle/fuel 'reactivity adjustment factor' shall be determined by dividing the 'g ozone potential per g NMOG' calculated in step (6) by the 'g ozone potential per g NMOG' value for the vehicle in the same emission control technology category operated on the specified conventional gasoline blend. The 'g ozone potential per g NMOG' values for conventional gasoline vehicles are listed in Section 13.d. of these test procedures or shall be established by the Executive Officer pursuant to Appendix VIII of these test procedures. For candidate vehicle/fuel systems powered by methanol or liquified petroleum gas, the quotient calculated above shall be multiplied by 1.1. The resulting value shall constitute the 'reactivity adjustment factor' for the methanol or liquified petroleum gas-powered vehicle/fuel system.

(8) The Executive Officer shall assign a reactivity adjustment factor unique to a specific engine family vehicle/fuel system at the request of a vehicle manufacturer provided that each of the following occurs:

a. The manufacturer submits a speciated NMOG exhaust emission profiles to the Executive Officer averaged obtained from emission testings of a minimum of four statistically valid number of different vehicles representative of vehicles that will be certified in the engine family utilizing the same emission control technology and fuel. The test vehicles shall include the official emission data vehicle(s) for the engine family, and the mileage accumulation of each vehicle shall be at or greater than 4,000 miles. One speciated profile shall be submitted for each test vehicle. Emission levels of each constituent NMOG shall be measured according to the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991. For the emission data vehicle(s), the speciated profile(s) shall be obtained from the same test used to obtain the official exhaust emission test results for the emission data vehicle at the 4,000 mile test

point. The manufacturer shall calculate 'g ozone potential per g NMOG' values for each speciated NMOG exhaust emission profile in accordance with the procedures specified in steps (2), (3), and (4) above. By using these 'g ozone potential per g NMOG' values, the manufacturer shall calculate an 'undeteriorated reactivity adjustment factor' for each test vehicle in accordance with the procedure for calculating the 'reactivity adjustment factor' specified in step (7) above. An 'undeteriorated reactivity adjustment factor' for the engine family shall be calculated by taking the arithmetic mean of the 'undeteriorated reactivity adjustment factors' obtained for each test vehicle. The 95 percent upper confidence bound (95% UCB) shall be calculated according to the equation:

$$95\%\ UCB = RAF_m + 1.96 \times \left[\sum_{i=1}^{n}(RAF_i - RAF_m)^2 / (n-1)\right]^{1/2}$$

where RAF_m = mean 'undeteriorated reactivity adjustment factor' calculated for the engine family

RAF_i = 'undeteriorated reactivity adjustment factor' calculated for the ith test vehicle

n = number of test vehicles

The 95 percent upper confidence bound of the 'undeteriorated reactivity adjustment factor' for the engine family shall be less than or equal to 115 percent of the engine family 'undeteriorated reactivity adjustment factor.'

b. The manufacturer submits a 'reactivity deterioration factor' for the 'undeteriorated reactivity adjustment factor' calculated for the engine family. To determine the 'reactivity deterioration factor', the manufacturer shall perform two tests at each mileage interval for one or more durability vehicle(s) tested in accordance with the procedures and conditions specified in Section 6 of these test procedures. The Executive shall approve the use of other mileage intervals and procedures if the manufacturer can demonstrate that equivalently representative 'reactivity deterioration factors' are obtained.

One speciated profile shall be submitted for each test. Emission levels of each constituent NMOG shall be measured according to the "California Non-Methane Organic Gas Test Procedures" as adopted July 12, 1991. A mean 'undeteriorated 'reactivity adjustment factor' shall be calculated at each mileage interval by taking the arithmetic mean of the 'undeteriorated reactivity adjustment factors' calculated from the speciated profiles obtained at that mileage interval. The 'reactivity deterioration factor' shall be calculated in accordance with the procedures in Section 6 of these test procedures except that the mean 'undeteriorated reactivity adjustment factor' determined at each mileage interval shall be used in place of measured mass emissions. If the 'reactivity deterioration factor' is determined to be less than 1.00, the 'reactivity deterioration factor' shall be assigned a value of 1.00. The 'reactivity deterioration factor' shall be multiplied to the mean 'undeteriorated reactivity adjustment factor' for the engine family to obtain the 'reactivity adjustment factor' used to determine compliance with the NMOG emission standards. ~~The /reactivity adjustment factor/ calculated from the /g ozone potential per g NMOG/ value determined from the aforementioned speciated profile differs from the /reactivity adjustment factor/ calculated by the Executive Officer for vehicles of the same or similar emission control technology and fuel by 25% or more/~~

c. The speciated profiles, mean 'undeteriorated reactivity adjustment factor' for the engine family, and 'reactivity deterioration factor' are ~~is~~ provided to the Executive Officer ~~two years prior to~~ with the certification application for the engine family ~~of the vehicle~~.

(9) Table of ~~(draft)~~ maximum incremental reactivities to be used in step (2):[1]

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1. For this table only, additions to the originally-noticed text are indicated in double-underline, and deletions are indicated in ~~strike-out~~. Deletions made as part of the originally-noticed text, which are shown on pages 11 - 13, are also indicated in ~~strike-out~~.

NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)		NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	
ALKANES					
Normal Alkanes			Branched Alkanes		
Methane	0.0148		2,2-Dimethylhexane	1.20	
Ethane	~~0.26~~	0.25	2,3-Dimethylhexane	~~1.31~~	1.32
Propane	0.48		2,4-Dimethylhexane	1.50	
n-Butane	1.02		2,5-Dimethylhexane	1.63	
n-Pentane	~~1.03~~	1.04	3,3-Dimethylhexane	1.20	
n-Hexane	0.98		2-Methylheptane	0.96	
n-Heptane	0.81		3-Methylheptane	0.99	
n-Octane	0.61		4-Methylheptane	1.20	
n-Nonane	0.54		2,4-Dimethylheptane	~~1.33~~	1.34
n-Decane	0.47		2,2,5-Trimethylhexane	0.97	
n-Undecane	0.42		Other Branched C9H20 Alkanes	~~1.13~~	1.14
n-Dodecane	0.38		Branched C10H22 Alkanes	1.01	
n-Tridecane	0.35		Branched C11 Alkanes	1.17	
n-Tetradecane	0.32		Branched C12 Alkanes	1.23	
n-Pentadecane	0.29				
Branched Alkanes			Cyclo Alkanes		
2-Methylpropane	1.21		Cyclopentane	~~2.37~~	2.38
2,2-Dimethylpropane	0.37		Methylcyclopentane	2.82	
2-Methylbutane	1.38		Cyclohexane	1.28	
2,2-Dimethylbutane	0.82		t-1,2-Dimethylcyclopentane	1.85	
2,3-Dimethylbutane	1.07		1,3-Dimethylcyclopentanes	~~2.64~~	2.55
2-Methylpentane	1.53		Methylcyclohexane	~~1.84~~	1.85
3-Methylpentane	1.52		Ethylcyclopentane	2.31	
2,2,3-Trimethylbutane	1.32		Ethylmethylcyclopentane	1.94	
2,2-Dimethylpentane	1.40		1c,2t-3-Trimethylcyclopentane	1.94	
2,3-Dimethylpentane	1.51		1,2,4-Trimethylcyclopentane	1.94	
2,4-Dimethylpentane	1.78		Dimethylcyclohexanes	1.94	
3,3-Dimethylpentane	0.71		Ethylcyclohexane	1.94	
2-Methylhexane	1.08		Ethylmethylcyclohexane	2.30	
3-Methylhexane	1.40		Trimethylcyclohexane	2.30	
2,2,4-Trimethylpentane	~~0.87~~	0.93	C10 Cycloalkanes	1.78	
2,3,3-Trimethylpentane	1.20		C11 Cycloalkanes	1.91	
2,3,4-Trimethylpentane	1.60		C12 Cycloalkanes	1.68	

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NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)		NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	
ALKENES					
Ethene	~~7.28~~	7.29	Propadiene	~~7.28~~	7.29
Propene	~~9.39~~	9.40	1,3-Butadiene	~~10.88~~	10.89
1-Butene	~~8.90~~	8.91	2-Methyl-1,3-Butadiene	~~9.07~~	9.08
2-Butenes	~~9.93~~	9.94	Cyclopentadiene	~~7.66~~	7.66
2-Methylpropene	~~5.29~~	5.31	Cyclopentene	~~7.66~~	7.66
1-Pentene	6.22		1-Methylcyclopentene	5.67	
2-Pentenes	~~8.79~~	8.80	3-Methylcyclopentene	~~5.66~~	5.67
2-Methyl-1-Butene	~~4.89~~	4.90	Cyclohexene	~~5.66~~	5.67
3-Methyl-1-Butene	6.22		a-Pinene	3.28	
2-Methyl-2-Butene	~~6.40~~	6.41	b-Pinene	4.41	
1-Hexene	~~4.41~~	4.42			
2-Hexenes	~~6.67~~	6.69			
3-Hexenes	~~6.67~~	6.69			
Methyl-1-Pentenes	~~4.41~~	4.42	ALKYNES		
Methyl-2-Pentenes	~~6.67~~	6.69			
3,3-Dimethyl-1-Butene	~~4.41~~	4.42	Ethyne	~~0.51~~	0.50
1-Heptene	3.48		Propyne	4.10	
2-Heptenes	~~5.52~~	5.53	1-Butyne	~~9.23~~	9.24
3-Heptenes	~~5.52~~	5.53	2-Butyne	~~9.23~~	9.24
3-Ethyl-2-Pentenes	~~5.52~~	5.53			
2,3-Dimethyl-2-Pentene	~~5.52~~	5.53			
3-Methyl-1-Hexene	3.48				
2-Methyl-2-Hexenes	~~5.52~~	5.53			
4-Methyl-2-Hexene	5.53				
2-Methyl-3-Hexene	5.53				
3-Methyl-3-Hexenes	~~5.52~~	5.53			
1-Octene	~~2.68~~	2.69			
2-Octenes	~~5.27~~	5.29			
3-Octenes	~~5.27~~	5.29			
4-Octenes	~~5.27~~	5.29			
2,4,4-Trimethyl-1-Pentene	~~2.68~~	2.69			
2,4,4-Trimethyl-2-Pentene	5.29				
1-Nonene	~~2.22~~	2.23			

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NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	
AROMATIC HYDROCARBONS		
Benzene	0.42	
Toluene	2.72	2.73
Ethylbenzene	2.90	2.70
o-Xylene	6.68	6.46
m&p-Xylenes	8.15	
m-Xylene	8.16	
p-Xylene	6.60	
n-Propylbenzene	2.27	2.12
i-Propylbenzene	2.41	2.24
Methylethylbenzenes	7.20	
1,2,3-Trimethylbenzene	8.61	8.85
1,2,4-Trimethylbenzene	8.69	8.83
1,3,5-Trimethylbenzene	10.11	10.12
n-Butylbenzene	1.87	
s-Butylbenzene	2.04	1.89
Diethylbenzenes	6.44	6.45
1-Methyl-2-Propylbenzene	6.45	
1-Methyl-3-Propylbenzene	6.45	
C10 Trialkyl Benzenes	9.07	
Tetramethylbenzenes	9.06	9.07
C11 Monoalkyl Benzenes	1.70	
1-Methyl-4-Isobutylbenzene	6.83	5.84
C11 Dialkyl Benzenes	5.84	
C11 Trialkyl Benzenes	8.21	
C12 Monoalkyl Benzenes	1.55	
C12 Dialkyl Benzenes	5.34	
C12 Trialkyl Benzenes	7.50	
Indan (C9H10)	1.04	1.06
Methyl Indan	1.06	
Naphthalene	1.16	1.18
Tetralin	0.95	
Methyl Naphthalenes	3.27	
2,3-Dimethyl Naphthalene	5.13	
Styrene	2.20	2.22
AROMATIC OXYGENATES		
Phenol	1.13	
Cresols	2.31	
Benzaldehyde	-0.66	-0.55
p-Tolualdehyde	-0.66	3.32

NMOG Constituent	Maximum Incremental Reactivity (g O_3/g NMOG)	
OXYGENATES		
Alcohols		
Methanol	0.56	
Ethanol	1.33	1.34
n-Propyl Alcohol	2.26	
Isopropyl Alcohol	0.54	
n-Butyl Alcohol	2.69	
Isobutyl Alcohol	1.92	
t-Butyl Alcohol	0.42	
Aldehydes		
Formaldehyde	7.14	7.15
Acetaldehyde	5.61	5.52
Propionaldyde	6.53	
Acrolein	6.76	6.77
n-Butyraldehyde	5.26	
Crotonaldehyde	5.41	5.42
Pentanaldehyde	4.49	4.41
Hexanaldehyde	3.79	
C7 Aldehydes	3.32	
Ethers		
Methyl t-Butyl Ether	0.62	
Ethyl t-Butyl Ether	1.98	
Ketones		
Acetone	0.56	
Butanone	1.18	

NMOG Constituent	Maximum Incremental Reactivity (g O $_3$/g NMOG)
Alkanes	
Methane	0.0102
Ethane	0.147
Propane	0.33
n-Butane	0.64
n-Pentane	0.64
n-Hexane	0.61
n-Heptane	0.48
n-Octane	0.41
n-Nonane	0.29
n-Decane	0.25
n-Undecane	0.21
n-Dodecane	0.19
n-Tridecane	0.17
n-Tetradecane	0.16
n-Pentadecane	0.144
Isobutane	0.85
Lumped C4-C5 Alkanes	0.78
Branched C5 Alkanes	0.88
Iso-Pentane	0.88
Neopentane	0.19
2-Methylpentane	0.91
3-Methylpentane	0.95
Branched C6 Alkanes	0.91
2,3-Dimethyl Butane	0.74
2,2-Dimethyl Butane	0.41
Lumped C6+ Alkanes	0.70
2,4-Dimethyl Pentane	1.07
3-Methyl Hexane	0.85
4-Methyl Hexane	0.85

NMOG Constituent	Maximum Incremental Reactivity (g O $_3$/g NMOG)
Branched C7 Alkanes	0.85
2,3-Dimethyl Pentane	0.96
Iso-Octane	0.70
4-Methyl Heptane	0.72
Branched C8 Alkanes	0.72
Branched C9 Alkanes	0.68
4-Ethyl Heptane	0.68
Branched C10 Alkanes	0.60
4-Propyl Heptane	0.60
Branched C11 Alkanes	0.72
Branched C12 Alkanes	0.75
Branched C13 Alkanes	0.57
Branched C14 Alkanes	0.44
Branched C15 Alkanes	0.41
Cyclopentane	1.6
Methylcyclopentane	1.7
C6 Cycloalkanes	0.84
Cyclohexane	0.84
C7 Cycloalkanes	1.17
Methylcyclohexane	1.17
Ethylcyclohexane	1.36
C8 Cycloalkanes	1.36
C9 Cycloalkanes	1.6
C10 Cycloalkanes	1.31
C11 Cycloalkanes	1.23
C12 Cycloalkanes	1.20
C13 Cycloalkanes	0.94
C14 Cycloalkanes	0.88
C15 Cycloalkanes	0.85

NMOG Constituent	Maximum Incremental Reactivity (g O / g NMOG)
Alkenes	
Ethene	5.3
Propene	6.6
1-Butene	6.1
1-Pentene	4.2
3-Methyl-1-Butene	4.2
1-Hexene	3.9
G6 Terminal Alkenes	3.9
G7 Terminal Alkenes	2.4
G8 Terminal Alkenes	1.9
G9 Terminal Alkenes	1.6
G10 Terminal Alkenes	1.32
G11 Terminal Alkenes	1.15
G12 Terminal Alkenes	1.03
G13 Terminal Alkenes	0.93
G14 Terminal Alkenes	0.86
G15 Terminal Alkenes	0.80
Isobutene	4.2
2-Methyl-1-Butene	3.7
trans-2-Butene	7.3
cis-2-Butene	7.3
2-Methyl-2-Butene	5.0
G5 Internal Alkenes	6.2
2,3-Dimethyl-2-Butene	3.7
G6 Internal Alkenes	5.3
G7 Internal Alkenes	4.4
G8 Internal Alkenes	3.6
G9 Internal Alkenes	3.2
G10 Internal Alkenes	2.8
G11 Internal Alkenes	2.5
G12 Internal Alkenes	2.3
G13 Internal Alkenes	2.1
G14 Internal Alkenes	1.9
G15 Internal Alkenes	1.8
1,3-Butadiene	7.7
Isoprene	6.5
Cyclopentene	4.0
Cyclohexane	3.3
a-Pinene	1.9
b-Pinene	1.9

NMOG Constituent	Maximum Incremental Reactivity (g O / g_3 NMOG
1,3,5-Trimethyl Benzene	7.5
1,2,3-Trimethyl Benzene	7.4
1,2,4-Trimethyl Benzene	7.4
G10 Trialkyl Benzenes	6.7
G11 Trialkyl Benzenes	6.1
G12 Trialkyl Benzenes	5.6
Tetralin	0.73
Naphthalene	0.87
Methyl Naphthalene	2.4
2,3-Dimethyl Naphthalene	3.7
Alkynes	
Acetylene	0.37
Alcohols	
Methanol	0.40
Ethanol	0.79
n-Propyl Alcohol	1.33
Isopropyl Alcohol	0.37
Isobutyl Alcohol	0.72
n-Butyl Alcohol	1.6
t-Butyl Alcohol	0.29
Ethylene Glycol	1.13
Propylene Glycol	0.92
Aldehydes	
Formaldehyde	6.2
Acetaldehyde	3.8
Propionaldehyde	4.6
Ketones	
Acetone	0.39
G4 Ketones	0.76
Aromatic Oxygenates	
Benzaldehyde	0.54
Phenol	0.79
Cresols	1.6

NMOG Constituent	Maximum Incremental Reactivity (g O / g NMOG)
Aromatic Hydrocarbons	
Benzene	0.28
Toluene	1.9
Ethyl Benzene	1.9
n-Propyl Benzene	1.44
Isopropyl Benzene	1.5
s-Butyl Benzene	1.29
C10 Monoalkyl Benzenes	1.28
C11 Monoalkyl Benzenes	1.16
C12 Monoalkyl Benzenes	1.06
m-Xylene	6.0
o-Xylene	5.2
p-Xylene	5.2
C9 Dialkyl Benzenes	5.3
C10 Dialkyl Benzenes	4.8
C11 Dialkyl Benzenes	4.3
C12 Dialkyl Benzenes	3.9

NMOG Constituent	Maximum Incremental Reactivity (g O / g_3 NMOG)
Ethers	
Methyl t-Butyl Ether	0.47
Ethyl t-Butyl Ether	1.33

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ATTACHMENT III

A. "Development and Evaluation of Ozone Reactivity Scale for Low-Emission Vehicles and Clean Fuels Regulations"

B. Speciated emission data from testing of CNG vehicles

Development and Evaluation of Ozone Reactivity Scale for Low-Emission Vehicles and Clean Fuels Regulations

California Air Resources Board
Research Division

April 2, 1992

I. Summary

On September 27, 1990, the California Air Resources Board (ARB or Board) adopted the Low-Emission Vehicles and Clean Fuels (LEV/CF) regulations applicable to light- and medium-duty vehicles (ARB 1990, 1991a). The regulations are "fuel neutral" in that all alternatively-fueled vehicles can compete in the marketplace as long as they meet nonmethane organic gas (NMOG) exhaust emission standards equivalent or lower in ozone forming potential, or "reactivity", as those set for vehicles fueled with conventional gasoline. Reactivity adjustment factors (RAFs) appear to be the only way to assure fair and equitable treatment for both manufacturers of motor vehicles and for producers of gasoline and all cleaner burning fuels. The exhaust compositions of most alternatively-fueled vehicles are too different from conventional gasoline-fueled vehicles to assume that they have the same ozone-forming potential per unit of mass emissions.

The Board adopted the maximum incremental reactivity (MIR) scale, developed by Dr. William Carter (1991), for calculation of the RAFs. The principal advantage of this scale is that it defines reactivity in areas where hydrocarbon control has its greatest benefits, the upwind areas where the highest emission densities are found. This is complementary to California's NO_x control program, which has its greatest benefits in the downwind, peak ozone areas. Even though all hydrocarbons eventually react, there is little to be gained in designing a reactivity scale that is applicable only to areas where hydrocarbon control has little or no benefit in reducing ambient ozone levels. More advantages of the MIR scale over other approaches include the ease of RAF calculations, a single scale for use in the statewide regulations, and a framework that can easily incorporate chemical mechanism updates.

Several ARB and industry-sponsored reviews of the MIR approach over the past year, including the Reactivity Conference in Irvine, California in April 1991 (Croes et al. 1992) and four meetings of the ad hoc Reactivity Advisory Panel, revealed that the atmospheric chemists and modelers were not in unanimous agreement on the underlying science of a reactivity scale. On the other hand, the regulators made it clear that, given the frequency and magnitude of violations of the air quality standards, regulations will move ahead even without full resolution of all the scientific issues, provided that there is no demonstration that there is a fatal flaw in doing so. Uncertainties in the underlying science have always been present in the move toward solutions to environmental problems. The key issue is not that there are uncertainties, but how much they contribute to uncertainties in outcomes. The approach of the ARB staff and Carter was to

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gauge the effect of these uncertainties on the RAFs for the alternative fuels of interest. The results are encouraging.

While significant uncertainties remain in our understanding of atmospheric chemistry, the RAFs for several alternative fuels changed by less than 10% in sensitivity studies of the effect of the last three years of chemical mechanism development. The RAFs are also relatively insensitive to uncertainties in the representation of airshed conditions used in the derivation of the MIR scale.

Professor Armistead Russell evaluated the MIR scale with the Southern California Air Quality Study (SCAQS) database and other modeling applications (McNair et al. 1992). He found very good agreement for individual hydrocarbons, but noted some deviations (less than 10%) from the equal ozone impacts for any vehicle/fuel combination required by the regulations. These deviations are more likely due to differences in spatial and temporal patterns of emissions between vehicle fleets, rather than a problem with the MIR approach. The only formally adopted RAF to date, a value of 0.41 for 85% methanol/15% gasoline (M85)-fueled vehicles, includes a 10% increase based on the airshed modeling.

For the long term, the Board will continue to sponsor laboratory studies and chemical mechanism development to reduce uncertainties in the MIR scale still further, particularly for aromatic hydrocarbons, and to review research sponsored by other organizations. The Board plans to update the MIR scale every three years.

~~The following section provides background information on the reactivity-based~~ motor vehicle standards. The next section summarizes the key technical issues that Dr. Carter and the ARB staff resolved over the past year. The final section describes Professor Russell's evaluation of the MIR approach with airshed modeling.

II. Background

The LEV/CF regulations include a reactivity adjustment to encourage the use of cleaner burning fuels while avoiding a fuel mandate. This establishes the so-called "level playing field".

A. Low-Emission Vehicles and Clean Fuels Regulations

The regulations adopted by the Board establish increasingly stringent vehicle certification standards for emissions of hydrocarbons, NO_x, carbon monoxide (CO) and formaldehyde (HCHO). Hydrocarbon emission standards are redefined in terms of nonmethane organic gases (NMOG), requiring the measurement of aldehydes, alcohols and other oxygenated compounds in addition to NMHC. A unique feature of the regulations are the use of a RAF to normalize the mass of NMOG emissions according to its ozone-forming potential. The determination of the RAF is based on complete speciation of the exhaust and conversion of each NMOG component to an appropriate mass of ozone using the MIR scale. Transitional-Low Emission Vehicles (TLEV), Low Emission Vehicles (LEV), Ultra-Low Emission Vehicles (ULEV) and Zero Emission Vehicles (ZEV) would certify at 50,000 miles to the standards presented in Table I. Standards at 100,000 miles are slightly higher.