State of California
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY OTTO-CYCLE ENGINES

Adopted: December 27, 2000
Amended: December 12, 2002
Amended: July 26, 2007
Amended: October 17, 2007
Amended: September 27, 2010
Amended: March 22, 2012

Note: The proposed amendments to this document are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions compared to the test procedures as last amended September 27, 2010. [No change] indicates proposed federal provisions that are also proposed for incorporation herein without change. Existing intervening text that is not amended in this rulemaking is indicated by "* * * *".

NOTE: This document is incorporated by reference in section 1956.8(d), title 13, California Code of Regulations ("CCR") and also incorporates by reference various sections of Title 40, Part 86 of the Code of Federal Regulations, with some modifications. It contains the majority of the requirements necessary for certification of heavy-duty Otto-cycle engines for sale in California, in addition to containing the exhaust emissions standards and test procedures for these Otto-cycle engines.[1] The section numbering conventions for this document are set forth in subparagraph 4 on page 4. Reference is also made in this document to other California-specific requirements that are necessary to complete an application for certification. These other documents are designed to be used in conjunction with this document. They include:

1. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1976, title 13, CCR;~~.~~

2. Warranty requirements (sections 2035, et seq., title 13, CCR);~~.~~

3. OBD II (section 1968, et seq., title 13, CCR, as applicable);~~.~~

4. "California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels through 2014," (section 2317, title 13, CCR); and

5. "California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels in 2015 and Subsequent Years," (section 2317, title 13, CCR).

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[1] The requirements for Otto-cycle engines used in complete vehicles up to 14,000 pounds GVW are contained in the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001~~ 2009 through 2016 ~~and Subsequent~~ Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," incorporated by reference in §1961(d), title 13, CCR and the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," incorporated by reference in section 1961.2, title 13, CCR .

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY OTTO-CYCLE ENGINES

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Part I. GENERAL PROVISIONS FOR CERTIFICATION AND IN-USE VERIFICATION OF EMISSIONS

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, Natural Gas-Fueled, Liquefied Petroleum Gas-Fueled and Methanol-Fueled Heavy Duty Vehicles

1. General Applicability. [§86.xxx-1]

A. Federal provisions.

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2. §86.005-1 October 6, 2000.

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2.2 Delete subparagraph (b) and replace with the following: A manufacturer must certify any complete heavy-duty vehicle of 14,000 pounds gross vehicle weight rating or less and any 2020 and subsequent model incomplete heavy-duty vehicle of 10,000 pounds gross vehicle weight rating or less in accordance with the medium-duty vehicle provisions contained in the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001~~ ~~and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," incorporated by reference in §1961(d), title 13, CCR or the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," incorporated by reference in section 1961.2, title 13, CCR, as applicable. Heavy-duty engine or vehicle provisions of subpart A do not apply to such a vehicle.

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2. Definitions. [§86.xxx-2]

A. Federal provisions.

All of the definitions in previous CFR sections continue to apply, except as otherwise noted below. Definitions specific to other requirements such as evaporative emissions are contained in those separate documents.

1. §86.004-2. January 18, 2001.
2. §86.010-2. February 24, 2009.

B. California provions.

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"**Medium-Duty Vehicle**" means any 1992 though 2006 model-year heavy-duty low-emission, ultra-low-emission, super-ultra-low-emission or zero-emission vehicle certified to the standards in section 1960.1(h)(2) having a manufacturer's gross vehicle weight rating of 14,000 pounds or less and any 2000 and subsequent model heavy-duty low-emission, ultra-low-emission, super-ultra-low-emission or zero-emission vehicle certified to the standards in section 1961(a)(1), 1961.2, or 1962 having a manufacturer's gross vehicle weight rating between 8,500 and 14,000 pounds.

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10. **Emission standards for Otto-cycle heavy-duty engines and vehicles.** [§86.xxx-10]

A. Federal provisions.

1. **§86.098-10.** ~~October 6, 2000~~ April 30, 2010. Amend as follows:

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2. **§86.099-10**. [n/a; See evap TPs.]
3. **§86.005-10**. ~~January 18, 2001~~ December 8, 2005. Amend as follows:

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4. **§86.008-10**. ~~January 18, 2001~~ April 30, 2010. Amend as follows:

* * * *

B. California provisions.

1. Exhaust emissions from new 2004 and later model year Otto-cycle medium- and heavy-duty engines, except for Otto-cycle medium- and heavy-duty engines subject to the alternative standards in 40 CFR §86.005-10(f), shall not exceed:

California Emission Standards for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines[A]
(in g/bhp-hr)

Model Year	Emission Category	NMHC + NOx	NMHC	NOx	CO[~~F~~H]	HCHO	PM
Standards for Heavy-Duty Otto-Cycle Engines Used In 2004 through 2019 Model Medium-Duty Vehicles 8,501 to 10,000 pounds GVW[B] and 2004 and Subsequent Model Medium-Duty Vehicles 10,001 to 14,000 pounds GVW[~~B~~C]							
2004	ULEV	2.4 **or** 2.5 with 0.5 NMHC cap[~~C~~D]	n/a	n/a	14.4	0.05	n/a
	SULEV	2.0	n/a	n/a	7.2	0.025	n/a
2005 through 2007[~~E~~F]	ULEV	1.0[~~C,E~~D,F]	n/a	n/a	14.4	0.05	n/a
	SULEV	0.5[~~C,E~~D,F]	n/a	n/a	7.2	0.025	n/a
2008 and subsequent[~~F~~G]	ULEV	n/a	0.14[~~E~~F]	0.20[~~E~~F]	14.4	0.01	0.01
	SULEV	n/a	0.07[~~E~~F]	0.10[~~E~~F]	7.2	0.005	0.005
Standards for Heavy-Duty Otto-Cycle Engines Used In Heavy-Duty Vehicles Over 14,000 pounds GVW							
2004	n/a	2.4 **or** 2.5 with 0.5 NMHC cap[~~C~~D]	n/a	n/a	37.1	0.05[~~D~~E]	n/a
2005 through 2007[~~E~~F]	n/a	1.0[C,E]	n/a	n/a	37.1	0.05[~~D~~E]	n/a
2008 and subsequent[~~F~~G]	n/a	n/a	0.14[~~E~~F]	0.20[E]	14.4	0.01	0.01

[A] These standards apply to petroleum-fueled, alcohol-fueled, liquefied petroleum gas-fueled and natural gas-fueled Otto-cycle engines. Alcohol-fueled engines have the option of certifying to the organic material hydrocarbon equivalent (“OMHCE”) or organic material non-methane hydrocarbon equivalent (“OMNMHCE”) standard.

[B] For the 2020 and subsequent model years, medium-duty vehicles 8,501 to 10,000 pounds GVW must certify to the primary emission standards and test procedures for complete vehicles specified in section 1961.2, title 13, CCR.

[~~B~~C] A manufacturer of engines used in incomplete medium-duty vehicles may choose to comply with these standards as an alternative to the primary emission standards and test procedures for complete vehicles specified in section 1961 or 1961.2, title 13, CCR. A manufacturer that chooses to comply with these optional heavy-duty engine standards and test procedures shall specify, in the Part I application for certification, an in-use compliance test procedure, as provided in section 2139(c), title 13 CCR.

[~~C~~D] A manufacturer may request to certify to the Option 1 or Option 2 federal NMHC + NOx standards as set forth in 40 CFR §86.005-10(f). However, for engines used in medium-duty vehicles the formaldehyde level must meet the standard specified above.

[~~D~~E] This standard only applies to methanol-fueled Otto-cycle engines.

[~~E~~F] A manufacturer may elect to include any or all of its medium- and heavy-duty Otto-cycle engine families in any or all of the emissions ABT programs for HDEs, within the restrictions described in section I.15 of these test procedures. For engine families certified to the Option 1 or 2 federal standards the FEL must not exceed 1.5 g/bhp-hr. If a manufacturer elects to include engine families certified to the 2005 and subsequent model year standards, the NOx plus NMHC FEL must not exceed 1.0 g/bhp-hr. For engine families certified to the 2008 and subsequent model year standards, the FEL is the same as set forth in 40 CFR 86.008-10(a)(1).

[~~F~~G] A manufacturer may elect to include any or all of its medium- and heavy-duty Otto-cycle engine families in any or all of the emissions ABT programs for HDEs, within the restrictions described in section I.15 of these test procedures.

[~~G~~H] Idle carbon monoxide: For all Otto-cycle heavy-duty engines utilizing aftertreatment technology, and not certified to the on-board diagnostics requirements of title 13, CCR, §1968, et seq, as applicable, the CO emissions shall not exceed 0.50 percent of exhaust gas flow at curb idle.

2. Optional Standards for Complete Heavy-Duty Vehicles.

Manufacturers may request to group complete heavy-duty vehicles into the same test group as vehicles certifying to the LEV III exhaust emission standards and test procedures specified in title 13, CCR, §1961.2, so long as those complete heavy-duty Otto-cycle vehicles meet the most stringent LEV III standards to which any vehicle within that test group certifies.

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14. **Small-volume manufacturers certification procedures.** [§86.xxx-14]. [Note: A small volume manufacturer shall mean a California small volume manufacturer as defined in Section I.1.A., above. Any reference to 10,000 units shall mean 4,500 units in California based on a three year running average as defined in I.1.A., above.]

1. §86.094-14. ~~January 3, 1996~~ April 30, 2010. Amend as follows:

* * * *

~~2. §86.096-14. March 24, 1993. [n/a; pertains to evaporative requirements.]~~
2. §86.095-14. April 30, 2010. [No change.]
3. §86.098-14. April 6, 1994. [No change.]

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16. **Prohibition of defeat devices.** §86.004-16. ~~October 6, 2000~~ July 13, 2005. [No change.]

17. **Emission control diagnostic system for light-duty vehicles and trucks.** [§86.099-17; §86.005-17; §86.007-17] Delete; replace with: All heavy-duty Otto-cycle engines up to 14,000 pounds GVW must have an on-board diagnostic system as required in section 1968, et seq., title 13, CCR, as applicable.

* * * *

21. **Application for certification** [§86.xxx-21]
A. Federal provisions.
1. §86.004-21. October 6, 2000. [No change.]
2. §86.007-21. ~~October 6, 2000~~ August 30, 2006. [No change - diesel only.]

* * * *

26. **Mileage and service accumulation; emission measurements.** [§86.004-26] ~~October 6, 2000~~ July 13, 2005.

* * * *

28. **Compliance with emission standards.** [§86.xxx-28]
A. Federal provisions.
1. §86.004-28. ~~January 18, 2001~~ August 30, 2006. [No change.]
B. California provisions.

1. All dedicated methanol-fueled and fuel-flexible vehicles and engines shall comply with the requirements which are applicable to heavy-duty gasoline-fueled Otto-cycle vehicles and engines, except where otherwise noted. In particular, for fuel-flexible vehicles and engines, a manufacturer's proposed durability demonstration program, as required in sections ~~86.094-21~~ 86.004-21(b)(5)(i)(A), 86.007-21(b)(5)(i)(A), 86.001-23(b)(1)(ii), and ~~86.098-23~~ 86.007-23(b)(1)(ii), shall provide for the assessment of the durability of the engine in operation with methanol and gasoline, as well as intermediate mixtures of both fuels. A manufacturer's proposed mileage and service accumulation, as required in section ~~86.096-24~~ 86.001-24(c), shall be conducted on methanol.

* * * *

30. **Certification.** [§86.xxx-30].
1. ~~[~~§86.004-30~~]~~. October 6, 2000. [No change.]
2. §86.007-30. February 24, 2009. [No change.]

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38. **Maintenance instructions.** [§86.xxx-38]
1. §86.004-38. ~~October 21, 1997~~ June 27, 2003.

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2. §86.007-38. ~~January 18, 2001~~ June 29. 2004. [No change, except as noted above for §86.004-38 subparagraph (g)(1).]

3. §86.010-38. April 30, 2010. [No change, except as noted above for §86.004-38 subparagraph (g)(1).]

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Part II. OTHER REQUIREMENTS; TEST PROCEDURES

Subpart N~~,~~ - Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures

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86.1304~~-90~~ Section numbering; construction. ~~October 6, 2000~~ July 13, 2005.
86.1305-2004 Introduction; structure of subpart. October 6, 2000.
86.1305-2010 Introduction; structure of subpart. September 15, 2011.

* * * *

86.1313-94 Fuel specifications. September 5, 1997.
86.1313-98 Fuel specifications. February 18, 2000. [n/a diesel fuel specifications.]
86.1313-2004 Fuel specifications. January 18, 2001.
86.1313-2007 Fuel specifications. January 18, 2001 [n/a diesel fuel specifications.]

A. Federal Provisions.

Amend the federal fuel specifications as follows:

1. California Certification Gasoline Specification.

1.1 Certification Gasoline Fuel Specifications for the 2004 through 2019 Model Years.

Add the following subparagraph which reads: For 2004 through 2019 model engines certifying in accordance with these test procedures, g~~G~~asoline having the specifications listed below may be used in exhaust and evaporative emission testing as an option to the specifications referred to in 86.1313-94(a)(1) and in 86.1313-2004(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. For the 2015 through 2019 model years, gasoline having the specifications listed in Part II, Section A.1.2 may be used in exhaust and evaporative emission testing as an option to the specifications referred to in §86.113-94(a)(1), §86.113-04(a)(1), and this section A.1.1. If a manufacturer elects to certify a 2015 through 2019 model year engine using gasoline having the specifications listed in Part II, Section A.1.2, both exhaust and evaporative emission testing shall be conducted by the manufacturer with gasoline having the specifications listed in Part II, Section A.1.2, and the Executive Officer shall conduct exhaust and evaporative emission testing with gasoline having the specifications listed in Part II, Section A.1.2.

California Certification Gasoline Specifications for the 2004 through 2019 Model Years		
Fuel Property[(a)]	**Limit**	**Test Method** [(b)]
Octane (R+M)/2	91 (min)	D 2699-88, D 2700-88
Sensitivity	7.5 (min)	D 2699-88, D 2700-88
Lead	0-0.01g/gal (max); no lead added	§2253.4(c), title 13 CCR
Distillation Range:		§2263, title 13 CCR[(c)]
10% point	130-150 °F	
50% point [(d)]	200-210 °F	
90% point [(e)]	290-300 °F	
EP, maximum	390 °F	
Residue	2.0 vol. % (max)	
Sulfur	30-40 ppm by wt.	§2263, title 13 CCR
Phosphorous	0.005 g/gal (max)	§2253.4(c), title 13 CCR
RVP	6.7-7.0 psi	§2263, title 13 CCR
Olefins	4.0-6.0 vol. %	§2263, title 13 CCR
Total Aromatic Hydrocarbons	22-25 vol. %	§2263, title 13 CCR
Benzene	0.8-1.0 vol. %[(f)]	§2263, title 13 CCR
Multi-substituted Alkyl Aromatic Hydrocarbons	12-14 vol. %[(g)]	
MTBE	10.8-11.2 vol. %	§2263, title 13 CCR
Additives	Sufficient to meet requirements of §2257, title 13 CCR	
Copper Corrosion	No. 1	D 130-88
Gum, washed	3.0 mg/100 mL (max)	D 381-86
Oxidation Stability	1000 minutes (min)	D 525-88
Specific Gravity	Report [(h)]	
Heat of Combustion	Report [(h)]	
Carbon	Report wt. % [(h)]	
Hydrogen	Report wt. % [(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 §2263, title 13, CCR 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° F.

[e] The range for interlaboratory testing is 285-305° F.

[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.

1.2 Certification Gasoline Fuel Specifications for the 2020 and Subsequent Model Years.

Add the following subparagraph which reads: For 2020 and subsequent model engines, gasoline having the specifications listed below shall be used in exhaust and evaporative emission testing and the Executive Officer shall conduct exhaust and evaporative emission testing with gasoline having the specifications listed below.

California Certification Gasoline Specifications for the 2020 and Subsequent Model Years		
Fuel Property[a]	**Limit**	**Test Method [b]**
Octane (R+M)/2[i]	87-88.4; 91 (min)	D 2699-88, D 2700-88
Sensitivity	7.5 (min)	D 2699-88, D 2700-88
Lead	0-0.01g/gal (max); no lead added	§2253.4(c), title 13 CCR
Distillation Range:		§2263, title 13 CCR[c]
10% point	130-150 °F	
50% point [d]	205-215 °F	
90% point [e]	310-320 °F	
EP, maximum	390 °F	
Residue	2.0 vol. % (max)	
Sulfur	8-11 ppm by wt.	§2263, title 13 CCR
Phosphorous	0.005 g/gal (max)	§2253.4(c), title 13 CCR
RVP	6.9-7.2 psi	§2263, title 13 CCR
Olefins	4.0-6.0 vol. %	§2263, title 13 CCR
Total Aromatic Hydrocarbons	19.5-22.5 vol. %	§2263, title 13 CCR
Benzene	0.6-0.8 vol. %[f]	§2263, title 13 CCR
Multi-substituted Alkyl Aromatic Hydrocarbons	13-15 vol. %[g]	

MTBE	0.05 vol. %	§2263, title 13 CCR
Ethanol	9.8-10.2 vol. %	
Total Oxygen	3.3-3.7 wt. %	§2263, title 13 CCR
Additives	Sufficient to meet requirements of §2257, title 13 CCR	
Copper Corrosion	No. 1	D 130-88
Gum, washed	3.0 mg/100 mL (max)	D 381-86
Oxidation Stability	1000 minutes (min)	D 525-88
Specific Gravity	Report (h)	
Heat of Combustion	Report (h)	
Carbon	Report wt. % (h)	
Hydrogen	Report wt. % (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 §2263, title 13, CCR 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° F.

(e) The range for interlaboratory testing is 285-305° F.

(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.

(i) For vehicles/engines that require the use of premium gasoline as part of their warranty, the Octane ((R+M)/2) shall be a 91 minimum. All other certification gasoline specifications, as shown in this table, must be met. For all other vehicles/engines, the Octane ((R+M)/2) shall be 87-88.4.

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B. California Provisions.

1. 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 for a new clean fuel are not specifically set forth in paragraph 86.1313-94 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, the state board shall not establish certification specifications for the fuel unless the petitioner has demonstrated that:

(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 associated with toxic air contaminants, as determined pursuant to the procedures set forth in "California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels through 2014~~,~~" ~~as adopted September 17, 1993~~ or the “California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels in 2015 and Subsequent Years,” as applicable. 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.

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86.1321-94 Hydrocarbon analyzer calibration. ~~September 5, 1997~~ July 13, 2005.

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86.1333-2010 Transient test cycle generation. June 30, 2008.

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86.1342-94 Calculations; exhaust emissions. September 5, 1997.

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B. California Provisions.

1. Non-methane hydrocarbon emissions shall be measured in accordance with the "California Non-Methane Organic Gas Test Procedures," ~~as last amended July 30, 2002,~~ which is incorporated by reference in section 1956.8(d), title 13, CCR.

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Subpart P - Emission Regulations for New Gasoline-Fueled and Methanol-Fueled Otto-Cycle Heavy-Duty Engines and New Gasoline-Fueled and Methanol-Fueled Otto-Cycle Light-Duty Trucks; Idle Test Procedures.

86.1501~~-94~~ Scope~~,~~; applicability. ~~October 6, 2000~~ June 30, 2008.
86.1502~~-84~~ Definitions. ~~May 4, 1999~~ June 30, 2008.
86.1503~~-84~~ Abbreviations. ~~May 4, 1999~~ June 30, 2008.
~~86.1504-94 Section numbering; construction. June 30, 1995.~~
86.1505~~-94~~ Introduction; structure of subpart. ~~June 30, 1995~~ June 30, 2008.
86.1506~~-94~~ Equipment required and specifications; overview. ~~September 21, 1994~~ June 30, 2008.
86.1509~~-84~~ Exhaust gas sampling system. June 30, ~~1995~~ 2008.
86.1511~~-84~~ Exhaust gas analysis system. June 30, ~~1995~~ 2008.
86.1513~~-94~~ Fuel specifications. ~~September 21, 1994~~ June 30, 2008.
86.1514~~-84~~ Analytical gases. June 30, ~~1995~~ 2008.
86.1516~~-84~~ Calibration; frequency and overview. ~~November 16, 1983~~ June 30, 2008.
86.1519~~-84~~ CVS calibration. ~~November 16, 1983~~ June 30, 2008.
86.1522~~-84~~ Carbon monoxide analyzer calibration. ~~November 16, 1983~~ June 30, 2008.
86.1524~~-84~~ Carbon dioxide analyzer calibration. ~~November 16, 1983~~ June 30, 2008.
86.1526~~-84~~ Calibration of other equipment. ~~November 16, 1983~~ June 30, 2008.
86.1527~~-84~~ Idle test procedure; overview. ~~November 16, 1983~~ June 30, 2008.
86.1530~~-84~~ Test sequence; general requirements. ~~November 16, 1983~~ June 30, 2008.
86.1537~~-84~~ Idle test run. June 30, ~~1995~~ 2008.
86.1540~~-84~~ Idle exhaust sample analysis. ~~November 16, 1983~~ June 30, 2008.
86.1542~~-84~~ Information required. ~~December 10, 1984~~ June 30, 2008.
86.1544~~-84~~ Calculation; idle exhaust emissions. July 7, 1986 June 30, 2008.

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PART 1065 – ENGINE-TESTING PROCEDURES.

Subpart A – Applicability and General Provisions.

1065.1 Applicability. September 15, 2011.

1. Amend subparagraph (a) as follows:
    - 1.1. Introductory paragraph. [No change.]
    - 1.2. Subparagraphs (a)(1). [n/a]
    - 1.3. Amend subparagraph (a)(2) as follows: Model year 2010 and later heavy-duty highway engines we regulate under title 13, CCR, §1956.8. For earlier model years, manufacturers may use the test procedures in this part or those specified in 40 CFR part 86, subpart N, according to §1065.10, as modified by these test procedures.
    - 1.4. Subparagraphs (a)(3) through (a)(8). [n/a]
2. Subparagraph (b). [n/a]
3. Subparagraph (c) through (g). [No change.]

1065.2 Submitting information to EPA under this part. April 30, 2010.

1. Subparagraphs (a) through (d). [No change.]
2. Amend subparagraph (e) as follows: See title 13, CCR, section 91011 for provisions related to confidential information. Note that according to this section, emission data shall not be identified as confidential.
3. Subparagraph (f). [No change.]

1065.5 Overview of this part 1065 and its relationship to the standard-setting part. October 30, 2009.

1065.10 Other procedures. April 30, 2010.

1065.12 Approval of alternate procedures. June 30, 2008.

1065.15 Overview of procedures for laboratory and field testing. September 15, 2011.

1065.20 Units of measure and overview of calculations. September 15, 2011.

1065.25 Recordkeeping. July 13, 2005.

Subpart B – Equipment Specifications.

1065.101 Overview. June 30, 2008.

1065.110 Work inputs and outputs, accessory work, and operator demand. June 30, 2008.

1065.120 Fuel properties and fuel temperature and pressure. June 30, 2008.

1065.122 Engine cooling and lubrication. June 30, 2008.

1065.125 Engine intake air. September 15, 2011.

1065.127 Exhaust gas recirculation. July 13, 2005.

1065.130 Engine exhaust. June 30, 2008.

1065.140 Dilution for gaseous and PM constituents. September 15, 2011.

1065.145 Gaseous and PM probes, transfer lines, and sampling system components. April 30, 2010.

1065.150 Continuous sampling. July 13, 2005.

1065.170 Batch sampling for gaseous and PM constituents. September 15, 2011.

1065.190	PM-stabilization and weighing environments for gravimetric analysis. September 15, 2011.
1065.195	PM-stabilization environment for in-situ analyzers. June 30, 2008.

Subpart C – Measurement Instruments.

1065.201	Overview and general provisions. April 30, 2010.
1065.202	Data updating, recording, and control. July 13, 2005.
1065.205	Performance specifications for measurement instruments. September 15, 2011.

Measurement of Engine Parameters and Ambient Conditions

1065.210	Work input and output sensors. June 30, 2008.
1065.215	Pressure transducers, temperature sensors, and dewpoint sensors. June 30, 2008.

Flow-Related Measurements

1065.220	Fuel flow meter. June 30, 2008.
1065.225	Intake-air flow meter. September 15, 2011.
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1065.701	General requirements for test fuels. April 30, 2010.

A. Federal provisions.

1. Subparagraph (a). [No change.]

2. Amend subparagraph (b) as follows: *Fuels meeting alternative specifications.* We may allow you to use a different test fuel if you show us and we find that using it does not affect your ability to comply with all applicable emission standards using commercially available fuels.

3. Subparagraph (c). [No change.]

4. Amend subparagraph (d) as follows: *Fuel specifications*. The fuel parameters specified in this subpart depend on measurement procedures that are incorporated by reference.

5. Subparagraph (e). [No change.]

6. Subparagraph (f). [No change.]

B. California provisions.

* * * *

3. **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 for the new clean fuel are not specifically set forth in paragraph §86.1313-98 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, the state board shall not establish certification specifications for the fuel unless the petitioner has demonstrated that:

(1) Use of the new clean fuel in such existing motor vehicles would not increase emissions of NMHC, NOx, and CO, and the potential risk associated with toxic air contaminants, as determined pursuant to the procedures set forth in the "California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels through 2014~~,~~" ~~as adopted September 17, 1993~~ or the "California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels in 2015 and Subsequent Years," as applicable. In the case of fuel-flexible vehicles or dual-fuel vehicles that were not certified on the new clean fuel but are capable of being operated on it, exhaust and evaporative emissions from the use of the new clean fuel shall not increase compared to exhaust and evaporative emissions from the use of gasoline that complies with Title 13, Division 3, Chapter 5, Article 1, California Code of Regulations.

(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 sold commercially in California.

1065.703 Distillate diesel fuel. April 30, 2010. [n/a]
1065.705 Residual fuel. June 30, 2008.
1065.710 Gasoline. June 30, 2008.
1. Subparagraph (a). [No change.]
2. Delete subparagraph (b) and replace with the following:

(b)(1) **Certification Gasoline Fuel Specifications for the 2004 through 2019 Model Years.**

For 2004 through 2019 model engines certifying in accordance with these test procedures, gasoline having the specifications listed below may be used in exhaust and evaporative emission testing as an option to the specifications referred to in §1065.710. 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. For the 2015 through 2019 model years, gasoline having the specifications listed in the following section (b)(2), may be used in exhaust and evaporative emission testing as an option to the specifications referred to in §1065.710 and this section (b)(1). If a manufacturer elects to certify a 2015 through 2019 model year engine using gasoline having the specifications listed in the following section (b)(2), both exhaust and evaporative emission testing shall be conducted by the manufacturer with gasoline having the specifications listed in the following section (b)(2), and the Executive Officer shall conduct exhaust and evaporative emission testing with gasoline having the specifications listed in the following section (b)(2).

California Certification Gasoline Specifications for the 2004 through 2019 Model Years

Fuel Property[a]	**Limit**	**Test Method** [b]
Octane (R+M)/2	91 (min)	D 2699-88, D 2700-88
Sensitivity	7.5 (min)	D 2699-88, D 2700-88
Lead	0-0.01g/gal (max); no lead added	§2253.4(c), title 13 CCR
Distillation Range:		§2263, title 13 CCR[c]
10% point	130-150 °F	
50% point [d]	200-210 °F	
90% point [e]	290-300 °F	
EP, maximum	390 °F	
Residue	2.0 vol. % (max)	
Sulfur	30-40 ppm by wt.	§2263, title 13 CCR
Phosphorous	0.005 g/gal (max)	§2253.4(c), title 13 CCR
RVP	6.7-7.0 psi	§2263, title 13 CCR
Olefins	4.0-6.0 vol. %	§2263, title 13 CCR
Total Aromatic Hydrocarbons	22-25 vol. %	§2263, title 13 CCR
Benzene	0.8-1.0 vol. %[f]	§2263, title 13 CCR
Multi-substituted Alkyl Aromatic Hydrocarbons	12-14 vol. %[g]	

MTBE	10.8-11.2 vol. %	§2263, title 13 CCR
Additives	Sufficient to meet requirements of §2257, title 13 CCR	
Copper Corrosion	No. 1	D 130-88
Gum, washed	3.0 mg/100 mL (max)	D 381-86
Oxidation Stability	1000 minutes (min)	D 525-88
Specific Gravity	Report (h)	
Heat of Combustion	Report (h)	
Carbon	Report wt. % (h)	
Hydrogen	Report wt. % (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 §2263, title 13, CCR 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° F.

(e) The range for interlaboratory testing is 285-305° F.

(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.

(b)(2) **Certification Gasoline Fuel Specifications for the 2020 and Subsequent Model Years.**

For 2020 and subsequent model engines, gasoline having the specifications listed below shall be used in exhaust and evaporative emission testing and the Executive Officer shall conduct exhaust and evaporative emission testing with gasoline having the specifications listed below.

California Certification Gasoline Specifications for the 2020 and Subsequent Model Years

Fuel Property(a)	**Limit**	**Test Method** (b)
Octane (R+M)/2(i)	87-88.4; 91 (min)	D 2699-88, D 2700-88
Sensitivity	7.5 (min)	D 2699-88, D 2700-88
Lead	0-0.01g/gal (max); no lead added	§2253.4(c), title 13 CCR
Distillation Range:		§2263, title 13 CCR(c)
10% point	130-150 °F	

50% point (d)	205-215 °F	
90% point (e)	310-320 °F	
EP, maximum	390 °F	
Residue	2.0 vol. % (max)	
Sulfur	8-11 ppm by wt.	§2263, title 13 CCR
Phosphorous	0.005 g/gal (max)	§2253.4(c), title 13 CCR
RVP	6.9-7.2 psi	§2263, title 13 CCR
Olefins	4.0-6.0 vol. %	§2263, title 13 CCR
Total Aromatic Hydrocarbons	19.5-22.5 vol. %	§2263, title 13 CCR
Benzene	0.6-0.8 vol. %(f)	§2263, title 13 CCR
Multi-substituted Alkyl Aromatic Hydrocarbons	13-15 vol. %(g)	
MTBE	0.05 vol. %	§2263, title 13 CCR
Ethanol	9.8-10.2 vol. %	
Total Oxygen	3.3-3.7 wt. %	§2263, title 13 CCR
Additives	Sufficient to meet requirements of §2257, title 13 CCR	
Copper Corrosion	No. 1	D 130-88
Gum, washed	3.0 mg/100 mL (max)	D 381-86
Oxidation Stability	1000 minutes (min)	D 525-88
Specific Gravity	Report (h)	
Heat of Combustion	Report (h)	
Carbon	Report wt. % (h)	
Hydrogen	Report wt. % (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 §2263, title 13, CCR 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° F.

(e) The range for interlaboratory testing is 285-305° F.

(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.

[i] For vehicles/engines that require the use of premium gasoline as part of their warranty, the Octane ((R+M)/2) shall be a 91 minimum. All other certification gasoline specifications, as shown in this table, must be met. For all other vehicles/engines, the Octane ((R+M)/2) shall be 87-88.4.

1065.715 Natural gas. June 30, 2008.

1. Delete subparagraph (a) and replace with the following:

(a)(1) **Exhaust emission test fuel.** For dedicated, dual-fueled or hybrid electric vehicles which use natural gas, fuel used for exhaust and evaporative emission testing shall meet the specifications listed in section 2292.5, title 13, CCR, (Specifications for Compressed Natural Gas) as modified by the following:

Compressed Natural Gas Certification Test Fuel

Specification	Limit
Methane	90.0 ± 1.0 mole percent
Ethane	4.0 ± 0.5 mole percent
C_3 and higher hydrocarbon content	2.0 ± 0.3 mole percent
Oxygen	0.5 mole percent maximum
Inert gases (CO_2 + N_2)	3.5 ± 0.5 vol. percent

(a)(2) **Mileage accumulation fuel.** For dedicated, dual-fueled or hybrid electric vehicles which use natural gas, fuel used for service accumulation shall meet the specifications listed in section 2292.5, title 13, CCR (Specifications for Compressed Natural Gas).

2. Subparagraphs (b) through (d). [No change.]

1065.720 Liquefied petroleum gas. July 13, 2005.

1. Delete subparagraph (a) and replace with the following:

(a)(1) **Evaporative and exhaust emission test fuel.** For dedicated, dual-fueled or hybrid electric vehicles which use liquefied petroleum gas, fuel used for exhaust and evaporative emission testing shall meet the specifications listed in title 13, CCR, section 2292.6 (Specifications for Liquefied Petroleum Gas) as modified by the following:

Liquefied Petroleum Gas Certification Test Fuel

Specification	Limit
Propane	93.5 ± 1.0 volume percent
Propene	3.8 ± 0.5 volume percent
Butane and heavier components	1.9 ± 0.3 volume percent

(a)(2) Mileage accumulation fuel. For dedicated, dual-fueled or hybrid electric vehicles which use liquefied petroleum gas, fuel used for service accumulation shall meet the specifications listed in title 13, CCR, section 2292.6 (Specifications for Liquefied Petroleum Gas).

(a)(3) The specification range of the fuels to be used in this section (a) shall be measured in accordance with ASTM D2163-91 and reported in accordance with §86.094-21.

2. Subparagraphs (b) through (d). [No change.]

1065.740 Lubricants. July 13, 2005.
1065.745 Coolants. July 13, 2005.
1065.750 Analytical gases. September 15, 2011.
1065.790 Mass standards. September 15, 2011.

Subpart I –Testing with Oxygenated Fuels.

1065.801 Applicability. July 13, 2005.
1065.805 Sampling system. June 30, 2008.
1065.845 Response factor determination. April 30, 2010.
1065.850 Calculations. July 13, 2005.

Subpart K – Definitions and Other Reference Information.

1065.1001 Definitions. September 15, 2011.

1. Amend the definition of “Designated Compliance Officer” as follows: *Designated Compliance Officer* means the Executive Officer of the Air Resources Board or a designee of the Executive Officer.

1065.1005 Symbols, abbreviations, acronyms, and units of measure. September 15, 2011.
1065.1010 Reference materials. September 15, 2011.

California Environmental Protection Agency
AIR RESOURCES BOARD

CALIFORNIA NON-METHANE ORGANIC GAS TEST PROCEDURES

Adopted: July 12, 1991
Amended: September 22, 1993
Amended: June 24, 1996
Amended: August 5, 1999
Amended: July 30, 2002
Amended: March 22, 2012

Monitoring and Laboratory Division, Southern Laboratory Branch
Mobile Source Division
9528 Telstar Avenue
El Monte, California 91731

NOTE: Mention of any trade name or commercial product does not constitute endorsement or recommendation of this product by the Air Resources Board. Note: The proposed amendments to this document are shown in underline to indicate additions and strikeout to indicate deletions compared to the test procedures as last amended September 27, 2010. [No change] indicates proposed federal provisions that are also proposed for incorporation herein without change. Existing intervening text that is not amended in this rulemaking is indicated by “* * * *”.

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APPENDICES

Part 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), ultra-low-emission vehicles (ULEV), and super-ultra-low-emission vehicles (SULEV) 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 NMOG Mass Emissions

Appendix 1 List of Light-End and Mid-Range Hydrocarbons
Appendix 2 Definitions and Commonly Used Abbreviations
Appendix 3 References

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/mi) or milligrams per mile (mg/mi) for vehicles operated on the listed fuel:

Fuel	NMHC by FID	NMHC by GC	Alcohols	Carbonyls
Alcohol	X		X	X
CNG		X		X
Diesel	X			X
Gasoline	X			X
LPG	X			X

The specified analyses shall be performed in accordance with the following parts of this document:

NMHC by FID--	Part B.	Determination of Non-Methane Hydrocarbon Mass Emissions by Flame Ionization Detection
NMHC by GC--	Part D.	Determination of C_2 to C_5 Hydrocarbons in Automotive Source Samples by Gas Chromatography (Method No. 1002); and
	Part E.	Determination of C_6 to C_{12} Hydrocarbons in Automotive Source Samples by Gas Chromatography (Method No. 1003)
CARBONYLS--	Part F.	Determination of Aldehyde and Ketone Compounds in Automotive Source Samples by High Performance Liquid Chromatography (Method No. 1004)
ALCOHOLS --	Part C.	Determination of Alcohols in Automotive Source Samples by Gas Chromatography (Method No. 1001)

4. For those manufacturers that 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 E (Method Nos. 1004, 1001, and 1003). Analysis for alcohols shall be required only for vehicles that are operated on fuels containing alcohols.

5. 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 the "California Exhaust Emission Standards and Test Procedures for 1988-2000 Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" and in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles."

6. The mass of NMOG emissions shall be calculated in accordance with part 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.

PART B

DETERMINATION OF NON-METHANE HYDROCARBON MASS EMISSIONS BY FLAME IONIZATION DETECTION

1. INTRODUCTION

1.1 This procedure describes a method for determining 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.

1.2 All definitions and abbreviations are contained in Appendix 2 of these test procedures.

2. TOTAL HYDROCARBON MEASUREMENT

2.1 A FID is used to measure total hydrocarbon concentration in vehicle exhaust in accordance with the Code of Federal Regulations [Ref.1]. SAE Recommended Practices J254 [Ref. 2] and J1094a [Ref. 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[Ref. 4] shall be required. Other FID analyzer models shall be checked and adjusted, if necessary, to minimize any non-uniformity of relative response to different hydrocarbons.

3. METHANE MEASUREMENT

3.1 A GC combined with a FID constitute a methane analyzer and shall be used for direct measurement of methane concentrations. The SAE Recommended Practice J1151[Ref. 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 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:

$$r_{CH_4} = FID_{ppm}/SAM_{ppm}$$

where:

r_{CH_4} = FID methane response factor.
FID_{ppm} = FID reading in ppmC.
SAM_{ppm} = 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~~.~~ [Ref. 1].

5.2 ~~Non-Alcohol Fueled~~ All 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 Phase 2 gasoline, $CH_{1.94}$, where HCR = 1.94:
$CO_e = (1 - 0.01970 * CO_{2e} - 0.000323 * R_a) * CO_{em}$

c) For LPG, $CH_{2.64}$, where HCR = 2.64:
$CO_e = (1 - 0.02320 * CO_{2e} - 0.000323 * R_a) * CO_{em}$

d) For CNG, $CH_{3.78}$, where HCR = 3.78:
$CO_e = (1 - 0.02890 * CO_{2e} - 0.000323 * R_a) * CO_{em}$

5.2.4
$$DF = \frac{100 * \left(\frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)} \right)}{CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}}$$

(where fuel composition is $C_xH_yO_z$ as measured for the fuel used~~.~~; this expression is generally normalized so that x = 1)

a) For gasoline, $CH_{1.85}$, where x = 1, y = 1.85, and z = 0:
$DF = 13.47 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$

b) For Phase 2 gasoline, $CH_{1.94}$, x = 1, y = 1.94 and z = 0.017:
$DF = 13.29 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$

c) For LPG, $CH_{2.64}$, where x = 1, y = 2.64, and z = 0:
$DF = 11.68 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$

d) For CNG, $CH_{3.78}$, where x = 1, y = 3.78, and z = 0.016:
$DF = 9.83 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$

e) For E85, $CH_{2.7841}O_{0.3835}$, Where x = 1, y = 2.7841, and z = 0.3835:
$DF = 12.4253 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$

5.2.5 The density of the NMHC is determined using the carbon:hydrogen ratio of the fuel, $C_xH_yO_z$, according to the following equation:

$$NMHC_{dens} = (x * 12.01115 + y * 1.00797)(g/mole) * \left(\frac{28.316847 \text{ liter/ft3}}{24.055 \text{ liter/mole}}\right)$$

where: 12.01115 = atomic weight of carbon
1.00797 = atomic weight of hydrogen

~~**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~~
$$DF = \frac{100 * \left(\frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)}\right)}{CO_{2e} + (NMHC_e + CH_{4e} + CO_e + CH_3OH_e + HCHO_e) * 10^{-4}}$$

~~(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 + $HCHO_e$) * 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 = 12.02 / [CO_{2e} + ($NMHC_e$ + CH_{4e} + CO_e + CH_3OH_e + $HCHO_e$) * 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~~ $$DF = \frac{100 * \left(\frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)} \right)}{CO_{2e} + (NMHC_e + CH_{4e} + CO_e + C_2H_5OH_e + HCHO_e) * 10^{-4}}$$

~~(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 = 12.29 / [CO_{2e} + ($NMHC_e$ + CH_{4e} + CO_e + $C_2H_5OH_e$ + $HCHO_e$) * 10^{-4}]~~

~~5.5 All Vehicles~~

5.2.6~~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

5.2.7~~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 $$NMHC_{wm} = 0.43 * \left(\frac{NMHC_{mass1} + NMHC_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{NMHC_{mass3} + NMHC_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

7. SAMPLE CALCULATIONS

7.1 Given the following data for a gasoline vehicle operated on phase 2 certification fuel, $CH_{1.964}O_{0.0182}$, 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	21.928 ~~141.8~~	3.557 ~~8.6~~	3.667 ~~7.53~~	2.545 ~~5.27~~	94.758 ~~147.2~~	0.9581 ~~1.19~~	2745 ~~2846~~	3.610 ~~3.583~~	~~38~~
2	3.826 ~~13.0~~	3.533 ~~8.4~~	2.694 ~~5.68~~	2.490 ~~5.10~~	16.516 ~~20.8~~	0.5925 ~~0.80~~	4700 ~~4856~~	3.876 ~~3.848~~	~~38~~
3	4.242 ~~15.4~~	3.386 ~~8.9~~	2.769 ~~6.16~~	2.414 ~~5.20~~	11.524 ~~36.7~~	0.8225 ~~1.04~~	2738 ~~2839~~	3.611 ~~3.586~~	~~38~~

For Phase 1:

$NMHC_e$ = FID THC_e - (r_{CH_4} * CH_{4e})
= 21.928 ~~41.8~~ ppmC - (1.15 ~~1.04~~ * 3.667 ~~7.53~~ ppmC)
= 17.711 ~~33.97~~ ppmC

$NMHC_d$ = FID THC_d - (r_{CH_4} * CH_{4d})
= 3.557 ~~8.6~~ ppmC - (1.15 ~~1.04~~ * 2.545 ~~5.27~~ ppmC)
= 0.630 ~~3.12~~ 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 ppm~~
~~= 142.0 ppm~~

The numerator of the DF
= 100 * (x / (x + y/2 + 3.76 * (x + y/4 – z/2))
= 100 * (1 / 1 + 1.964 / 2 + 3.76 * (1 + 1.964 / 4 – 0.0182 / 2)
= 13.2381

DF = 13.2381 ~~13.47~~ ÷ [CO_{2e} + ($NMHC_e$ + CH_{4e} + CO_e) * 10^{-4}]

$$DF = \frac{13.2381}{0.9581 + (17.711\text{ ppmC} + 3.667\text{ ppmC} + 94.758\text{ ppmC}) * 10^{-4}}$$

~~$DF = \frac{13.47}{1.19\% + (33.97\text{ ppmC} + 7.53\text{ ppmC} + 142.0\text{ ppmC}) * 10^{-4}}$~~

= ~~11.15~~ 13.653

$NMHC_{conc}$ = $NMHC_e$ - $NMHC_d$ * [1 - (1 ÷ DF)]
~~= 33.97 ppmC - 3.12 ppmC * [1- (1÷11.15)]~~

= 17.711 ppmC – 0.630 ppmC * [1 - (1 ÷ 13.653)]
= 17.127 ~~31.13~~ ppmC

$$\text{NMHC}_{\text{dens}} = (\text{x} * 12.01115 + \text{y} * 1.00797)(g/mole) * \left(\frac{28.316847\text{liter/ft3}}{24.0547\text{liter/mole}}\right)$$

$\text{NMHC}_{\text{dens}}$ = (1 * 12.01115 + 1.964 *1.00797)* (28.316847/24.055)
= 16.470 g/ft^3

$\text{NMHC}_{\text{mass n}}$ = $\text{NMHC}_{\text{conc}}$ * $\text{NMHC}_{\text{dens}}$ * VMIX * 10^{-6}
= 17.127 ~~31.13~~ ppmC * 16.47~~33~~ g/ft^3 * 2745 ~~2846~~ ft^3 * 10^{-6}

$\text{NMHC}_{\text{mass 1}}$ = 0.7743 ~~1.45~~ g

Similarly, for Phase 2: $\text{NMHC}_{\text{mass 2}}$ = 0.0068 ~~0.33~~ g
and for Phase 3: $\text{NMHC}_{\text{mass 3}}$ = 0.0219 ~~0.27~~ g

Therefore,

$$\text{NMHC}_{\text{wm}} = 0.43 * \left(\frac{\text{NMHC}_{\text{mass1}} + \text{NMHC}_{\text{mass2}}}{\text{D}_{\text{phase1}} + \text{D}_{\text{phase2}}}\right) + 0.57 * \left(\frac{\text{NMHC}_{\text{mass3}} + \text{NMHC}_{\text{mass2}}}{\text{D}_{\text{phase3}} + \text{D}_{\text{phase2}}}\right)$$

~~$\text{NMHC}_{\text{wm}} = 0.43 * \left(\frac{1.45\,\text{g} + 0.33\,\text{g}}{3.583\text{ miles} + 3.848\text{ miles}}\right) + 0.57 * \left(\frac{0.27\,\text{g} + 0.33\,\text{g}}{3.586\text{ miles} + 3.848\text{ miles}}\right)$~~

$$\text{NMHC}_{\text{wm}} = 0.43 * \left(\frac{0.768\,\text{g} + 0.0068\,\text{g}}{3.610\text{ miles} + 3.876\text{ miles}}\right) + 0.57 * \left(\frac{0.0217\,\text{g} + 0.0068\,\text{g}}{3.611\text{ miles} + 3.876\text{ miles}}\right)$$

NMHC_{wm} = 0.047 ~~0.15~~ g/mile

7.2 Given the following data for a vehicle operating on 10~~85~~% ~~m~~ethanol and 90~~15~~% gasoline (E10 ~~M-85~~) $CH_{2.7841}O_{0.3835}$, calculate the weighted NMHC mass emission.

~~Test Phase~~	~~FID THC$_e$ (ppmC)~~	~~FID THC$_d$ (ppmC)~~	~~CH$_{4e}$ (ppmC)~~	~~CH$_{4d}$ (ppmc)~~	~~CH$_3$OH$_e$ (ppm)~~	~~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~~

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)
1	14.398	2.971	3.639	2.125	97.83	0.9203	3508	3.590
2	2.882	2.830	2.176	2.010	12.25	0.5935	6010	3.858
3	3.976	2.642	2.621	2.058	19.86	0.7624	3502	3.581

~~[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)~~
= 14.398 ~~88.5~~ ppmC - (1.15 ~~1.04~~ * 2.215 ~~17.76~~ ppmC) ~~- (0.66*72.9 ppmC)~~
= 10.213 ~~21.92~~ ppmC

$NMHC_d$ = FID THC_d - (r_{CH_4} * CH_{4d}) ~~- (r_{CH_3OH} * CH_3OH_d)~~
= 2.971 ~~5.5~~ ppmC - (1.15 ~~1.04~~ * 2.125 ~~2.82~~ ppmC) ~~- (0.66*0.0 ppmC)~~
= 0.527 ~~2.57~~ 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 = 13.511 ~~12.02~~ ÷ [CO_{2e} + ($NMHC_e$ + CH_{4e} + CO_e ~~+ CH_3OH_e + $HCHO_e$~~) * 10^{-4}]

$$= \frac{12.02}{1.28\% + (21.92\,ppmC + 17.76\,ppmC + 289.6\,ppmC + 72.9ppmC + 0.96ppmC) * 10^{-4}}$$

$$= \frac{13.511}{0.9203 + (10.213\,ppmC + 3.639\,ppmC + 97.83\,ppmC) * 10^{-4}}$$

= 14.505 ~~9.10~~

$NMHC_{conc}$ = $NMHC_e$ - $NMHC_d$ * [1 - (1 / DF)]
= 10.213 ~~21.92~~ ppmC – 0.527 ~~2.57~~ ppmC * [1 - (1 / 14.505 ~~9.10~~)]
= 9.722 ~~19.63~~ ppmC

$NMHC_{mass\ n}$ = $NMHC_{conc}$ * $NMHC_{dens}$ * VMIX * 10^{-6}

$NMHC_{mass\ 1}$ = 0.558 ~~0.91~~ g

Similarly, Phase 2: $NMHC_{mass\ 2} = 0.0$ g
and for Phase 3: $NMHC_{mass\ 3} =$ ~~0.10~~ 0.040 g

Therefore,

$$NMHC_{wm} = 0.43 * \left(\frac{NMHC_{mass1} + NMHC_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{NMHC_{mass3} + NMHC_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

~~$NMHC_{wm} = 0.43 * \left(\frac{0.91\,g + 0.00\,g}{3.570 \text{ miles} + 3.850 \text{ miles}} \right) + 0.57 * \left(\frac{0.10\,g + 0.00\,g}{3.586 \text{ miles} + 3.850 \text{ miles}} \right)$~~

$$NMHC_{wm} = 0.43 * \left(\frac{0.558\,g + 0.00\,g}{3.590 \text{ miles} + 3.858 \text{ miles}} \right) + 0.57 * \left(\frac{0.040\,g + 0.00\,g}{3.581 \text{ miles} + 3.858 \text{ miles}} \right)$$

~~$NMHC_{wm}$ = 0.06 g/mile~~

$NMHC_{wm}$ = 0.035 g/mile

Part C

DETERMINATION OF ALCOHOLS IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1001

1. INTRODUCTION

1.1 This document describes a method of sampling and analyzing automotive source samples ~~exhaust~~ for alcohols ~~in the range of 1 to 1200 µg per 15 mL of solution~~. ~~The "target" alcohols that shall be analyzed and reported by this method are methanol and ethanol. These alcohols, when measured in concentrations above the LOD, shall be reported~~.

1.2 This procedure is based on a method developed by the U. S. Environmental Protection Agency, (U.S. EPA) [Ref -6] which involves flowing diluted engine exhaust through deionized or purified water contained in glass impingers and analyzing this solution by gas chromatography-.

1.3 The "target" alcohols (compounds of interest) that shall be measured by this method are methanol and ethanol in the range of 1 to 1200 µg per 15 mL of impinger solution. These alcohols, when measured in concentrations above the LOD, shall be reported.

1.3.1 For the purpose of calculating NMOG for vehicles tested on exhaust emission test fuel containing ethanol (see Part G, Determination of NMOG Mass Emissions):

1.3.1.1 The only alcohol that needs to be reported from this method is ethanol.

1.3.1.2 The analysis of methanol is also within the scope of this analytical method and its measurement may provide meaningful information to the laboratory. However, its measurement is not required.

1.4 Other applicable forms of instrumentation and analytical techniques may be used if shown to yield results equivalent to those specified in this procedure and if approved in advance by the Executive Officer of the Air Resources Board.

1.5 All definitions and abbreviations are contained in Appendix 2 of these test procedures.

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 components is performed by a temperature-programmed capillary column. A FID is used for alcohol detection and quantification.

2.2 The computerized GC data system identifies the alcohol associated with each peak. The alcohol concentrations are determined by integrating the peak areas and using response factors determined from external standards.

3. INTERFERENCES AND LIMITATIONS

3.1 An ~~interferent~~ interfering compound is any component present in the sample with a retention time similar to that of any -target alcohol described in this method. To reduce interference error, proof of chemical identity may require periodic confirmations using an alternate method and/or instrumentation, e.g., GC/MS.

3.2 The concentration of the alcohols in the range of interest is stable for up to six days as long as the samples are sealed and refrigerated at a temperature below 40°F.

3.3 To avoid sample loss and/or contamination, samples should be analyzed or transferred from the impingers to tightly sealed storage bottles as soon as possible after collection.

4. INSTRUMENTATION AND APPARATUS

4.1 For each mode of the CVS test, two sampling impingers, each containing a known amount of deionized or purified water (e.g. 15 mL for this procedure), are used to contain the sample.

4.1.1 A temperature-programmable GC, equipped with a DB-Wax type ~~Megabore~~ column ~~(~~[typically 30 m, 0.53 mm ID (Megabore), 1.0 µ film thickness]~~)~~ and FID, is used. Other columns may be used, provided the alternate(s) can be demonstrated to the ARB to be equivalent or better with respect to precision, accuracy and resolution of all the target alcohols.

4.1.2 A liquid injection autosampler is required.

4.1.3 A PC-controlled data acquisition system for quantifying peak areas is required.

5. REAGENTS AND MATERIALS

5.1 Methanol shall have a purity of 99.9 percent, or be high performance liquid chromatography grade, EM Science or equivalent.

5.2 Ethanol shall be absolute, ACS reagent grade.

5.3 ASTM Type I purified or Type II deionized water shall be used.

5.4 Stock solutions are prepared gravimetrically or volumetrically by diluting methanol and ethanol with deionized or purified water, e.g., for this method a typical stock solution contains approximately 10 mg/mL of each target alcohol. Stock solutions must be replaced at least every six months.

5.4.1 A **calibration standard** within the expected concentration range of the samples is prepared by successive dilutions of the stock solution with deionized or purified water.~~; 3 to 50 µg/mL is typical, depending on fuel type. Calibration standards must be replaced at least every week.~~

5.4.1.1 Typical calibration standards range from 3 to 100 µg/mL for exhaust emission testing, depending on fuel type.

5.4.1.2 Evaporative emission testing may require calibration standards as high as 1000 µg/mL due to higher sample concentration.

5.4.1.3 Calibration standards must be replaced frequently to avoid degradation of the standard. Standards with concentrations of 100 µg/mL or less should be replaced weekly.

5.4.2 A **control standard** containing all target alcohols is prepared by successive dilutions of a stock solution different from that ~~of~~ used in Section 5.4.1. This standard, at an approximate concentration of the samples, is used to monitor the precision of the analysis of each target alcohol. Control standards must be replaced at least every week.

5.4.3 Standards used for linearity and LOD determinations (Section 8) are also prepared by successive dilutions of an appropriate level stock solution.

5.4.4 Standards may also be purchased (e.g., NIST).

5.4.5 All standards should be refrigerated at a temperature below 40°F during storage.

5.5 Gas requirements.

5.5.1 Air shall be “Zero” grade (<1 ppmC total hydrocarbon contamination) or better.

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 the graduated sampling impingers is filled with 15 mL of deionized or purified water.

6.2 The impingers are placed in an ice bath during the sample collection.

6.3 After sampling, the solution contained in each impinger is transferred to a vial and sealed.

6.3.1 Samples shall be refrigerated at a temperature below 40°F if immediate analysis is not feasible, or if reanalysis at a later date may be required.

6.4 One microliter aliquots of unmodified samples are injected via autosampler into a GC. ~~Suggested~~ Typical standard operating conditions for the GC are:

Column:	DB-Wax, 30 m, 0.53 mm ID, 1.0µ film thickness
Carrier gas flow:	Helium at 5 mL/min
Make-up gas flow:	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
Column 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

6.5 Samples containing compounds having concentrations above the documented range of instrument linearity must be diluted and reanalyzed.

6.6 The peak integrations are corrected as necessary in the data system. Any misplaced baseline segments are corrected in the reconstructed chromatogram.

6.7 The peak identifications provided by the computer are checked and corrected if necessary.

7. CALCULATIONS

7.1 The concentration of each target alcohol, in µg/mL, is determined by the following calculation that ~~compares~~ relates the sample peak area to ~~with~~ that of an external standard:

$$\text{Concentration } (\mu\text{g/mL})_{\text{sample}} = \text{ Peak Area}_{\text{sample}} \text{ x } \text{ Response Factor}$$

where the response factor (RF) is calculated during the calibration by:

$$\text{RF} = \frac{\text{Concentration}_{\text{standard}\,(\mu\text{g/mL})}}{\text{Peak Area}_{\text{standard}}}$$

7.2 Sample batches that span a broad concentration range (several orders of magnitude) should use more than one calibration level.

7.2.1 Each sample concentration would then be calculated by using a standard of similar concentration to calculate the response factor, as in Section 7.1.

7.2.2 A multipoint calibration curve calculated by the GC software (e.g., Varian Star 6.0) may be used instead of the one-point calibration described in Section 7.1.

7.3 This concentration is then used to calculate the total amount of alcohol in each impinger:

$$\text{Mass } (\mu\text{g}) = \text{Concentration } (\mu\text{g/mL}) \text{ x Impinger volume (mL)}$$

7.4 An internal standard method may also be used.

8. QUALITY CONTROL

8.1 Blank Run - A deionized or purified water blank is run each analysis day. All target alcohol concentrations from the blank analysis must be below the LOD before the analysis may proceed.

8.1.1 If the blank shows a peak greater than the limit of detection (LOD) in the region of interest, the source of the contamination must be investigated and remedied.

8.2 Calibration Run - The calibration standard is analyzed each analysis day to generate the response factor used to quantify the sample concentrations.

8.3 Control Standard Run - The quality control standard is analyzed at least once each analysis day. Measurements of all target alcohols in the control standard must fall within the control limits to ensure the validity of the sample analyses that day. 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 - A quality control chart is maintained for each analyte in the control standard. The control charts, used on a daily basis, establish that the method is "in-control". The following describes how to construct a typical control chart:

1. Obtain at least 20 daily control standard results;
2. Calculate the control standard mean concentration and standard deviation for the target analyte; and
3. Create a control chart for the target analyte by placing the concentration on the Y-axis and the date on the X-axis. Establish upper and lower warning limits at either two standard deviations (2s) or 5 percent, whichever is greater, above and below the average concentration. Establish ~~an~~ upper and lower control limits at either three standard deviations (3s) or 5 percent, whichever is greater, above and below the average concentration.
4. A control standard measurement is considered to be out-of-control when the analyzed value exceeds the control limit or two successive control standard measurements of the same analyte exceed the warning limit.
5. If 20 control standard results are not yet available to create a control chart (e.g., the control standard was expended and replaced with a different concentration standard prior to obtaining 20 points with the new standard), measurements must be within 10% of the theoretical concentration.

The measured concentrations of all target analytes contained in the control standard must be within the control limits ("in-control") for the sample results to be considered acceptable.

8.5 Duplicates - A duplicate analysis of one sample is performed at least once per analysis day. The relative percent difference (RPD) is calculated for each duplicate run:

$$\mathrm{RPD}(\%) = \frac{|\text{Difference between duplicate and original measurements}|}{\text{Average of duplicate and original measurements}} * 100$$

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 may be reanalyzed. If reanalysis is not feasible or if the criteria are still not met on reanalysis, all sample results for that analysis day are invalid.

8.6 Linearity - A multipoint calibration to confirm instrument linearity is performed for all target alcohols for new instruments, after making instrument modifications that can affect linearity, and at least once every year. The multipoint calibration consists of at least five concentration or mass loading levels, each above the LOD, 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.

8.7 Limit of Detection - The LOD for the target alcohols must be determined for new instruments, after making instrument modifications that can affect the LOD and at least once every year. To make the calculations, it is necessary to perform a multipoint calibration consisting of at least four “low” concentration levels, each above the expected LOD, with at least five replicate determinations of the lowest concentration standard. A linear regression is performed and the standard deviation (in area counts) of the lowest concentration standard determined. The standard deviation is converted to concentration units using the slope of the linear regression:

$$s = s_a \div m$$

where m is the slope of the linear regression, s is the standard deviation (in concentration units) of the lowest concentration standard and s_a is the standard deviation (in area counts) of the lowest concentration standard.

The LOD must be calculated using the following equation [Ref. 12]:

$$LOD = t * s$$

where s is the standard deviation (in concentration units) of at least five replicate determinations of the lowest concentration standard and t is the t-factor for 99 percent confidence for a one-sided normal (Gaussian) distribution. The number of degrees of freedom is equal to the number of replicates, minus one. An abbreviated t–table is:

Degrees of Freedom	t-value
4	3.7
5	3.4
6	3.1
7	3.0

The lowest standard must be of a concentration of one to five times the estimated LOD.

8.7.1 The maximum allowable LOD for each alcohol is 0.10 µg/mL. The calculated laboratory LOD must be equal to or lower than the maximum allowable LOD. All peaks identified as target compounds that are equal to or exceed the maximum allowable LOD must be reported. If the calculated laboratory LOD is less than the maximum allowable LOD, the laboratory may choose to set its reporting limit at the maximum allowable LOD, the calculated laboratory LOD, or any level in between.

8.7.2 For the purpose of calculating the total mass of all species, the concentrations of the compounds below the LOD are considered to be zero.

Part D

DETERMINATION OF C_2 TO C_5 HYDROCARBONS IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1002

1. INTRODUCTION

1.1 This document describes a gas chromatographic method of ~~analyzing~~ measuring C_2 to C_5 hydrocarbons (light-end hydrocarbons) in the ppbC range from automotive source samples. This method does not include sample collection procedures [Ref. 8]. The "target" hydrocarbons (compounds of interest) that shall be analyzed and reported by this method and Method 1003 are listed in Appendix 1. All compounds on this list, when measured in concentrations above the LOD, shall be measured and reported ("targeted") by either Method 1002 or Method 1003. Each laboratory should divide the list into light-end (Method 1002) and mid-range (Method 1003) hydrocarbons in the manner that best suits the laboratory instrumentation. All compounds on the list not targeted by Method 1002 must be targeted by Method 1003.

1.2 Other applicable forms of instrumentation and analytical techniques may be used if shown to yield results equivalent to those specified in this procedure and if approved in advance by the Executive Officer of the Air Resources Board.

1.3 All definitions and abbreviations are contained in Appendix 2 of these test procedures.

2. METHOD SUMMARY

2.1 This is a method intended for routine analysis.

2.2 The samples are received by the laboratory in ~~Tedlar~~ Kynar® bags, which are sub-sampled into a GC for separation and analysis.

2.3 The gas chromatographic analysis is performed on an Alumina (Al_20_3) PLOT column temperature programmed from 0^oC to 200^oC. An FID is used for detection and quantification.

2.4 The sample is injected into the GC by means of gas sampling valves. Separation of the sample hydrocarbon mixture into its components 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 compounds.

2.5 The computerized GC data acquisition system identifies the hydrocarbons associated with each peak. The hydrocarbon concentrations are determined by integrating the peak areas and using response factors determined from NIST-traceable standards.

3. INTERFERENCES AND LIMITATIONS

3.1 An ~~interferent~~ interfering compound is any component present in the sample with a retention time very similar to that of any target hydrocarbon described in this method. To reduce interference error, proof of chemical identity may require periodic confirmations using an alternate method and/or instrumentation, e.g., GC/MS, PID, different column, 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 photochemically induced reactions of any reactive hydrocarbons. The compound 1,3-butadiene, resulting mostly during cold-start testing, is unstable. Therefore all cold-start samples must be analyzed within 8 hours; all other samples must be analyzed within 24 hours, although analysis within 8 hours is recommended.

4. INSTRUMENTS AND APPARATUS

4.1 ~~Tedlar~~ Kynar® (polyvinylidene fluoride) bags, ~~2~~ 4 mil in thickness, nominally 5 to 10 liters in capacity and equipped with quick-connect fittings, are typically used to contain the samples. Other sample collection containers, such as bags made of Tedlar® (polyvinyl fluoride) film or nickel-coated stainless steel canisters, may be used, provided they are made of non-reactive material and do not cause sample loss or contamination.

4.2 For manual sub-sampling into a GC, a ground glass syringe is used to transfer gaseous samples from Tedlar bags to the GC sample inlet. For automated systems, a sample loop is used to transfer gaseous samples from the Tedlar bag to the sample inlet of the GC. Sample aliquot size is chosen based on considerations of instrument sensitivity and/or linearity.

4.3 A temperature-programmable GC equipped with a gas sampling valve system, a FID, and accessories is required.

4.4 An Alumina PLOT column (typically 50 m x 0.32 mm) is used. A wax precolumn is recommended to prevent water damage to the PLOT column. Other columns may be used, provided the alternate(s) can be demonstrated to the ARB to be equivalent or better with respect to precision, accuracy and resolution of all the target hydrocarbons.

4.5 A sample trap capable of being cryogenically cooled may be used.

4.6 Data acquisition software is used to integrate peak areas to determine hydrocarbon concentrations.

5. REAGENTS AND MATERIALS

5.1 Helium shall have a minimum purity of 99.995 percent. Higher purity helium may be required to achieve the LOD required by Section 8.7.1.

5.2 Hydrogen shall have a minimum purity of 99.995 percent.

5.3 Air shall be “Zero” grade (<1 ppmC total hydrocarbon contamination) or better.

5.4 Nitrogen shall have a minimum purity of 99.998 percent.

5.5 Calibration Standard - The quantitative calibration standard for all target hydrocarbons shall be propane at a concentration level between 0.25 and 1 ppm-mole and within the calculated linearity of the method. (See Section 8.6.) This propane standard must be a NIST-certified SRM or secondary NIST-traceable standard. A secondary standard is obtained by a comparison between a SRM and a candidate standard.

5.6 Control Standard - A quality control standard, containing at least ethene, propane, n-butane, and 2-methylpropene with concentrations between 0.2 and 3 ppmC based on a propane standard, is used for the following purposes:

1. Daily update of control charts, and
2. Daily determination of marker retention time windows.

5.7 A high concentration standard (higher than the calibration standard), containing the target hydrocarbons listed in Section 5.6, is used for linearity determinations. The high concentration standard must have concentrations verified against a NIST-traceable propane standard. (See Section 5.5 for the definition of NIST-traceable.) This verification can be performed at the laboratory performing the analysis.

5.8 A low concentration standard (one to five times the estimated LOD), containing the target hydrocarbons listed in Section 5.6, is used for LOD determinations. The low concentration standard must have concentrations verified against a NIST-traceable propane standard. (See Section 5.5 for the definition of NIST-traceable.) This verification can be performed at the laboratory performing the analysis.

5.8.1 In lieu of a low concentration standard, a higher concentration standard may be diluted.

5.9 Liquid nitrogen may be required 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.

6.2 ~~Suggested~~ Typical standard operating conditions for the automated gas chromatograph are:

Helium carrier gas flow ~~velocity~~:	~~30 cm/sec~~ 2.2 mL/min at 200^0C
Detector (0.010” FID)	
Temperature:	250^0C or higher
Nitrogen make-up gas flow:	sufficient such that the total flow of helium plus nitrogen is ~~30~~ 25 mL/min
Hydrogen gas flow:	~~30~~ 25 mL/min
Air flow:	300 mL/min
Range 12, attenuation 8 (or another suitable value)	
Sample loop/valve temperature:	150^0C (PLOT column)
Cryotrap temperature:	-180^0C (hold to trap hydrocarbons) 200^0C (heat to release) hydrocarbons)
Precolumn oven temperature:	50^0C
Analytical column valve oven temperature:	150^0C
Column Temperature Program:	0^0C (hold ~~3~~7 min)~~,~~ ~~10^0C/min to 200^0C (hold 15 min)~~ 5^0C/min to 200^0C 200^0C (hold 35 min)
~~Detector temperature~~:	~~250^0C~~
~~Injector temperature:~~	~~150^0C~~

6.3 For automated systems, connect the samples to the GC and begin the analytical process.

6.3.1 Samples may be injected manually by injecting an aliquot with a ground glass syringe.

6.4 Introduce the sample into the carrier gas stream through the injection valve.

6.5 Each separated component exits from the column into the FID where a response is generated.

6.6 Concentrations of hydrocarbons are calculated using data acquisition/ processing software that uses calibration data from the NIST-traceable propane calibration standard.

6.7 For compounds having concentrations above the documented range of instrument linearity, a smaller aliquot must be taken (for manual systems, a smaller syringe or smaller loop; for automated systems, a smaller loop) or the sample must be diluted.

6.8 The peak integrations are corrected as necessary in the data system. Any misplaced baseline segments are corrected in the reconstructed chromatogram.

6.9 The peak identifications provided by the computer are checked and corrected if necessary.

6.10 Target compounds that coelute are reported as the major component, as determined by the analysis of several samples by GC/MS or other methods. An exception to this is m- and p-xylene, where GC/MS data and fuel profiles are used to determine the relative contribution of each component to the peak. This method was used to determine the m- and p-xylene MIR value given in Appendix 1.

6.11 The Alumina PLOT column is programmed to 200°C to assure all compounds are eluted before the next run.

7. CALCULATIONS

7.1 The target hydrocarbon concentrations, in ppbC, are calculated by the data system using propane as an external standard.

$$\text{Concentration}_{\text{sample}}\ (\text{ppbC}) = \text{Peak Area}_{\text{sample}} \times \text{Response Factor}$$

where the response factor (RF) is calculated during daily calibration by:

$$\text{RF} = \frac{\text{Concentration of NIST-traceable propane standard, ppbC}}{\text{Area of propane peak}}$$

8. QUALITY CONTROL

8.1 Blank Run - A blank (pure nitrogen or helium) is run each analysis day. All target hydrocarbon concentrations from the blank analysis must be below the LOD before the analysis may proceed. As an alternative to a daily blank run, a daily partial blank check in tandem with a weekly blank run may be used. A partial blank check is defined as a check of the calibration standard run for contamination over all but the propane region of the chromatograph. The calibration standard must consist of only propane and make-up gas, with the concentration of all organic compounds except methane and propane below 2 percent of the propane standard concentration. The weekly blank run will provide a check on contamination in the propane region of the chromatograph.

8.1.1 If the blank shows a peak greater than the limit of detection (LOD) in the region of interest, the source of _contamination must be investigated and remedied.

8.2 Calibration Run - The calibration standard is analyzed each analysis day to generate the response factor used to quantify the sample concentrations.

8.3 Control Standard Run - The quality control standard is analyzed at least once each analysis day. Measurements of all compounds specified in Section 5.6 must fall within the control limits to ensure the validity of the sample analyses that day. 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 - A quality control chart is maintained for each component of the control standard listed in Section 5.6. The control charts, used on a daily basis, establish that the method is "in- control." The following describes how to construct a typical control chart:

1. Obtain at least 20 daily control standard results;
2. Calculate the control standard mean concentration and standard deviation for the target hydrocarbon; and
3. Create a control chart for the target hydrocarbon by placing the concentration on the Y-axis and the date on the X-axis. Establish upper and lower warning limits at either two standard deviations (2s) or 5 percent, whichever is greater, above and below the average concentration. Establish upper and lower control limits at either three standard deviations (3s) or 5 percent, whichever is greater, above and below the average concentration.
4. A control standard measurement is considered to be out-of-control when the analyzed value exceeds the control limit or two successive control standard measurements of the same analyte exceed the warning limit.
5. If 20 control standard measurements are not yet available to create a control chart (e.g., the control standard was expended and replaced prior to obtaining 20 points with the new standard), measurements must be within 10% of the certified concentration. If the control standard is not a NIST standard, the cylinder should be certified by the laboratory against a NIST standard.

The measured concentrations of all target hydrocarbons contained in the control standard must be within the control limits (in-control) for the sample results to be considered acceptable.

8.5 Duplicates - A duplicate analysis of one sample is performed at least once per analysis 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 specified 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 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 compounds specified in Section 5.6, the sample may be reanalyzed. If reanalysis is not feasible or if the criteria are still not met on reanalysis, all sample results for that analysis day are invalid.

8.6 Linearity - A multipoint calibration to confirm instrument linearity is performed for the target hydrocarbons in the control standard for new instruments, after making instrument modifications that can affect linearity, and at least once every year unless a daily check of the instrument response indicates that the linearity has not changed. To monitor the instrument response, a quality control chart is constructed, as specified in Section 8.4, except using calibration standard area counts rather than control standard concentrations. When the standard area counts are out-of-control, corrective action(s) must be taken before analysis may proceed. 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), each above the LOD, 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 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 LOD for the target hydrocarbons in the control standard must be determined ~~must be determined~~ for new instruments and after making instrument modifications that can affect linearity and/or sensitivity and at least once every year unless a daily check of the instrument response indicates that the LOD has not changed. To monitor the instrument response, a quality control chart is constructed, as specified in Section 8.4, except using calibration standard area counts rather than control standard concentrations. When the calibration standard area counts are out-of-control, investigation and/or corrective action(s) must be taken. To make the calculations, it is necessary to perform a multipoint calibration consisting of at least four "low" concentration levels, each above the LOD, with at least five replicate determinations of the lowest concentration standard. A linear regression is performed and the standard deviation is converted to concentration units using the slope of the linear regression:

$$s = s_a \div m$$

where m is the slope of the linear regression, s is the standard deviation (in concentration units) of the lowest concentration standard and s_a is the standard deviation (in area counts) of the lowest concentration standard.

The LOD must be calculated using the following equation [Ref. 12]:

$$\mathrm{LOD} = t * s$$

where s is the standard deviation (in concentration units) of at least five replicate determinations of the lowest concentration standard and t is the t-factor for 99 percent confidence for a one-sided normal (Gaussian) distribution. The number of degrees of freedom is equal to the number of replicates, minus one. An abbreviated t-table is:

Degrees of Freedom	t-value
4	3.7
5	3.4
6	3.1
7	3.0

The lowest standard must be of a concentration of one to five times the estimated LOD.

8.7.1 The maximum allowable LOD for each compound is 5 ppbC. The calculated laboratory LOD must be equal to or lower than the maximum allowable LOD. All peaks identified as target compounds that are equal to or exceed the maximum allowable LOD must be reported. If the calculated laboratory LOD is less than the maximum allowable LOD, the laboratory may choose to set its reporting limit at the maximum allowable LOD, the calculated laboratory LOD, or any level in between.

8.7.2 For the purpose of calculating the total mass of all species, the concentrations of all compounds below the LOD are considered to be zero.

8.8 Method No. 1002/Method No. 1003 Crossover Check - For each sample, a compound shall be measured by both Method No. 1002 and Method No. 1003. The crossover compound shall be a compound that can reasonably be expected to be found and measured by both methods in the laboratory performing the analysis. The results obtained by the two methods should be compared and an acceptance criteria set for the relative percent difference.

Part E

DETERMINATION OF C_6 TO C_{12} HYDROCARBONS IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1003

1. INTRODUCTION

1.1 This document describes a gas chromatographic method of ~~analyzing~~ measuring C_6 to C_{12} hydrocarbons (mid-range hydrocarbons) in the ppbC range from automotive source samples. This method does not include sample collection procedures [Ref. 7]. The target hydrocarbons (compounds of interest) that shall be analyzed and reported by this method and Method 1002 are listed in Appendix 1. All compounds on this list, when measured in concentrations above the LOD, shall be measured and reported ("targeted") by either Method 1002 or Method 1003. Each laboratory should divide the list into light-end (Method 1002) and mid-range (Method 1003) hydrocarbons in the manner that best suits the laboratory instrumentation. All compounds on the list not targeted by Method 1003 must be targeted by Method 1002.

1.2 Other applicable forms of instrumentation and analytical techniques may be used if shown to yield results equivalent to those specified in this procedure and if approved in advance by the Executive Officer of the Air Resources Board.

1.3 All definitions and abbreviations are contained in Appendix 2 of these test procedures.

2. METHOD SUMMARY

2.1 This is a method intended for routine analysis.

2.2 The samples are received by the laboratory in ~~Tedlar~~ Kynar® bags, which are sub-sampled into a GC for separation and analysis.

2.3 The gas chromatographic analysis is performed through a temperature-programmed capillary column. A FID is used for detection.

2.4 The sample is injected into the GC by means of gas sampling valves. Separation of the sample hydrocarbon mixture into its components 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 acquisition system identifies the hydrocarbons associated with each peak. The hydrocarbon concentrations are determined by integrating the peak areas and using a response factor determined from NIST-traceable standards.

3. INTERFERENCES AND LIMITATIONS

3.1 An ~~interferent~~ interfering compound is any component present in the sample with a retention time similar to that of any target hydrocarbon described in this method. To reduce interference error, proof of chemical identity may require periodic confirmations using an alternate method and/or instrumentation, e.g., GC/MS, PID, different column, etc.

3.2 The concentration of hydrocarbons in the range of interest is stable for at least 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 photochemically induced reactions of any reactive hydrocarbons. Samples must be analyzed within 24 hours.

4. INSTRUMENTATION AND APPARATUS

4.1 ~~Tedlar~~ Kynar® (polyvinylidene fluoride) bags, ~~2~~ 4 mil in thickness, nominally 5 to 10 liters in capacity and equipped with quick-connect fittings, are typically used to contain the samples. Other sample collection containers, such as bags made of Tedlar® (polyvinyl fluoride) film or nickel-coated stainless steel canisters, may be used, provided they are made of non-reactive material and do not cause sample loss or contamination.

4.2 For manual sub-sampling into a GC, a ground glass syringe is used to transfer gaseous samples from Tedlar bags to the GC sample inlet. For automated systems, a sample loop is used to transfer gaseous samples from the Tedlar bag to the sample inlet of the GC. Sample aliquot size is chosen based on considerations of instrument sensitivity and/or linearity.

4.3 The GC is equipped with a FID, and a gas sampling valve system.

4.4 A non-polar capillary column [e.g., ~~J&W~~ Varian DB-1 (methylsiloxane), typically 60 m x 0.32 mm ID, film thickness 1.0 µ] is used. Other columns may be used, provided the alternate(s) can be demonstrated to the ARB to be equivalent or better with respect to precision, accuracy and resolution of all the target hydrocarbons.

4.5 A sample trap capable of being cryogenically cooled may be used.

4.6 A computer-controlled data acquisition system is required for quantifying peak areas.

5. REAGENTS AND MATERIALS

5.1 Helium shall have a minimum purity of 99.995 percent. Higher purity helium may be required to achieve the LOD required by Section 8.7.1.

5.2 Hydrogen shall have a minimum purity of 99.995 percent.

5.3 Air shall be “Zero” grade (<1 ppmC total hydrocarbon contamination) or better.

5.4 Nitrogen shall have a minimum purity of 99.998 percent.

5.5 Calibration Standard - The quantitative calibration standard for all target hydrocarbons shall be propane at a concentration level between 0.25 and 1 ppm-mole and within the calculated linearity of the method. (See Section 8.6.) This propane standard must be a NIST-certified SRM or secondary NIST-traceable standard. A secondary standard is obtained by a comparison between a SRM and a candidate standard.

5.6 Control Standard - A quality control standard, containing at least n-hexane, n-octane, n-decane, benzene, toluene, and m- or p-xylene with concentrations between 0.2 and 1 ppmC based on a propane standard, is used for the following purposes:

1. Daily update of control charts, and
2. Daily determination of marker retention time windows.

5.7 A high concentration standard (higher than the calibration standard), containing the target hydrocarbons listed in Section 5.6, is used for linearity determinations. The high concentration standard must have concentrations verified against a NIST-traceable propane standard. (See Section 5.5 for the definition of NIST-traceable.) This verification can be performed at the laboratory performing the analysis.

5.8 A low concentration standard (one to five times the estimated LOD), containing the target hydrocarbons listed in Section 5.6, is used for LOD determinations. The low concentration standard must have concentrations verified against a NIST-traceable propane standard. (See Section 5.5 for the definition of NIST-traceable.) This verification can be performed at the laboratory performing the analysis.

5.8.1 In lieu of a low concentration standard, a higher concentration standard may be diluted.

5.9 Liquid nitrogen may be required to cool the cryogenic trap and column oven where applicable.

6. PROCEDURE

6.1 The gaseous sample is analyzed for the target hydrocarbons C_5 through C_{12}.

~~6.1 Typical operating conditions.~~

~~6.1.1 Suggested operating conditions for the manual GC are:~~

~~Helium carrier gas velocity: 30 cm/sec at 200°C~~
~~Nitrogen make-up gas flow: sufficient such that the total flow of helium plus nitrogen is 30 mL/min~~
~~Hydrogen gas flow (for FID): 30 mL/min~~
~~"Zero" air gas flow (for FID): 300 mL/min~~
~~Autozero FID 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~~.1.2~~ ~~Suggested~~ Typical operating conditions for the automated GC are:

Helium carrier gas flow flow ~~velocity~~: ~~30 cm/sec~~ 2.2 mL/min at 200°C
Detector (0.010" FID)
  Temperature: 275°C or higher
  Nitrogen make-up gas flow: sufficient such that the total flow of helium plus nitrogen is ~~30~~ 25 mL/min
  Hydrogen gas flow (for FID): ~~30~~ 25 mL/min
  "Zero" air gas flow (for FID): 300 mL/min
  Range 12, attenuation 8 (or another suitable value)
~~Sample~~ Autosampler valve temperature: 150°C
~~Detector temperature: 300°C~~
~~Injector temperature: 150°C~~
Cryotrap temperature: -180 °C (hold to trap hydrocabons)
200 °C (heat to release hydrocarbons)
Analytical column valve oven temperature: 150°C
Column temperature program: -40°C (hold 2.5 min)
3.6°C/min to 210°C
210°C (hold 5 min)
~~Initial temperature -50°C (5 min),~~
~~5°C/min to 50°C,~~
~~10°C/min to 200°C~~

6.2.1 Samples may be injected manually by injecting an aliquot with a ground glass syringe.

6.3~~2~~ Data Reduction

6.3~~2~~.1 The results are calculated from the FID responses.

6.3~~2~~.2 The results are examined to see that the peaks are correctly integrated.

6.3~~2~~.3 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.

6.3~~2~~.4 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 relative peak heights of the sample run (“fingerprint”) match the typical fingerprint seen in past sample runs.
4. Compare the relative retention times of the sample peaks with those of reference runs.
5. Any peak with a reasonable doubt is labeled 'Unidentified'.

6.3~~2~~.5 For compounds having concentrations above the documented range of instrument linearity, a smaller aliquot must be taken (for manual systems, a smaller syringe or smaller loop; for automated systems, a smaller loop) or the sample must be diluted.

6.3~~2~~.6 The concentrations of the hydrocarbons are calculated using data acquisition/ processing software which uses calibration data from a NIST-traceable propane calibration standard.

6.3~~2~~.7 Target compounds that coelute are reported as the major component, as determined by the analysis of several samples by GC/MS or other methods. An exception to this is m- and p-xylene, where GC/MS data and fuel profiles are used to determine the relative contribution of each component to the peak. This method was used to determine the m- and p-xylene MIR value given in Appendix 1.

7. CALCULATIONS

7.1 The target hydrocarbon concentrations, in ppbC, are calculated by the data system using propane as an external standard.

$$\text{Concentration}_{\text{sample}}\ (\text{ppbC}) = \text{Peak Area}_{\text{sample}} * \text{Response Factor}$$

where the Response Factor (RF) is calculated during daily calibration by:

$$\text{RF} = \frac{\text{Concentration of NIST} - \text{traceable propane standard, ppbC}}{\text{Area of propane peak}}$$

8. QUALITY CONTROL

8.1 Blank Run - A blank (pure nitrogen or helium) is run each analysis day. All target hydrocarbon concentrations from the blank analysis must be below the LOD before the analysis may proceed. As an alternative to a daily blank run, a daily partial blank check in tandem with a weekly blank run may be used. A partial blank check is defined as a check of the calibration standard run for contamination over all but the propane region of the chromatograph. The calibration standard must consist of only propane and make-up gas, with the concentration of all organic compounds except methane and propane below 2 percent of the propane standard concentration. The weekly blank run will provide a check on contamination in the propane region of the chromatograph.

8.1.1 If the blank shows a peak greater than the limit of detection (LOD) in the region of interest, the source of the contamination must be investigated and remedied.

8.2 Calibration Run - The calibration standard is analyzed each analysis day to generate the response factor used to quantify the sample concentrations.

8.3 Control Standard Run - The quality control standard is analyzed at least once each analysis day. Measurements of all compounds specified in Section 5.6 must fall within the control limits to ensure the validity of the sample analyses that day. 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 - A quality control chart is maintained for each component of the control standard listed in Section 5.6. The control charts, used on a daily basis, establish that the method is “in-control”. The following describes how to construct a typical control chart:

1. Obtain at least 20 daily control standard results,
2. Calculate the control standard mean concentration and standard deviation for the target hydrocarbon, and

3. Create a control chart for the target hydrocarbon by placing the concentration on the Y-axis and the date on the X-axis. Establish upper and lower warning limits at either two standard deviations (2s) or 5 percent, whichever is greater, above and below the average concentration. Establish upper and lower control limits at either three standard deviations (3s) or 5 percent, whichever is greater, above and below the average concentration.
4. A control standard measurement is considered to be out-of-control when the analyzed value exceeds the control limit or two successive control standard measurements of the same analyte exceed the warning limit.
5. If 20 control standard measurements are not yet available to create a control chart (e.g., the control standard was expended and replaced prior to obtaining 20 points with the new standard), measurements must be within 10% of the certified concentration. If the control standard is not a NIST standard, the cylinder should be certified by the laboratory against a NIST standard.

The measured concentrations of all target hydrocarbons contained in the control standard must be within the control limits (in-control) for the sample results to be considered acceptable.

8.5 Duplicates - A duplicate analysis of one sample is performed at least once per analysis day. The relative percent difference (RPD) is calculated for each duplicate run:

$$\mathrm{RPD}(\%) = \frac{|\text{ Difference between duplicate and original measurements }|}{\text{Average of duplicate and original measurements}} * 100$$

For each compound specified 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 compounds specified in Section 5.6, the sample may be reanalyzed. If reanalysis is not feasible or if the criteria are still not met on reanalysis, all sample results for that analysis day are invalid.

8.6 Linearity - A multipoint calibration to confirm instrument linearity is performed for all target hydrocarbons in the control standard for new instruments, after making instrument modifications that can affect linearity, and at least once every year unless a daily check of the instrument response indicates that the linearity has not changed. To monitor the instrument response, a quality control chart is constructed, as specified in Section 8.4, except using calibration standard area counts rather than control standard concentrations. When the standard area counts are out-of-control, corrective action(s) must be taken before analysis may proceed. 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), each above the LOD, 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 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 LOD for the target hydrocarbons in the control standard must be determined for new instruments and after making instrument modifications that can affect linearity and/or sensitivity and at least once every year unless a daily check of the instrument response indicates that the LOD has not changed. To monitor the instrument response, a quality control chart is constructed, as specified in Section 8.4, except using calibration standard area counts rather than control standard concentrations. When the calibration standard area counts are out-of-control, investigation and/or corrective action(s) must be taken. To make the calculations, it is necessary to perform a multipoint calibration consisting of at least four “low” concentration levels, each above the LOD, with at least five replicate determinations of the lowest concentration standard. A linear regression is performed and the standard deviation (in area counts) of the lowest concentration standard determined. The standard deviation is converted to concentration units using the slope of the linear regression:

$$s = s_a \div m$$

where m is the slope of the linear regression, s is the standard deviation (in concentration units) of the lowest concentration standard and s_a is the standard deviation (in area counts) of the lowest concentration standard.

The LOD must be calculated using the following equation [Ref. 12]:

$$LOD = t * s$$

where s is the standard deviation (in concentration units) of at least five replicate determinations of the lowest concentration standard and t is the t-factor for 99 percent confidence for a one-sided normal (Gaussian) distribution. The number of degrees of freedom is equal to the number of replicates, minus one. An abbreviated t-table is:

Degrees of Freedom	t-value
4	3.7
5	3.4
6	3.1
7	3.0

The lowest standard must be of a concentration of one to five times the estimated LOD.

8.7.1 The maximum allowable LOD for each compound is 5 ppbC. The calculated laboratory LOD must be equal to or lower than the maximum allowable LOD. All peaks identified as target compounds that are equal to or exceed the maximum LOD must be reported. If the calculated laboratory LOD is less than the maximum allowable LOD, the laboratory may choose to set its reporting limit at the maximum allowable LOD, the calculated laboratory LOD, or any level in between.

8.7.2. For the purpose of calculating the total mass of all species, the concentrations of all compounds below the LOD are considered to be zero.

8.8 Method No. 1002/Method No. 1003 Crossover Check - For each sample a compound shall be measured by both Method No. 1002 and Method No. 1003. The crossover compound shall be a compound that can reasonably be expected to be found and measured by both methods in the laboratory performing the analysis. The results of the two analyses should be compared and an acceptance criteria set for the relative percent difference.

Part F

DETERMINATION OF ALDEHYDE AND KETONE COMPOUNDS IN AUTOMOTIVE SOURCE SAMPLES BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

METHOD NO. 1004

1. INTRODUCTION

1.1 This document describes a method of analyzing automotive source samples ~~engine exhaust~~ for aldehyde and ketone compounds (carbonyls) using impingers, containing acidified 2,4-dinitrophenylhydrazine (DNPH)-absorbing solution, or DNPH-impregnated cartridges. Carbonyl masses ranging between 0.02 to 200 µg are measured by this method. The "target" carbonyls (compounds of interest) that shall be ~~analyzed~~ measured and reported by this method are listed in Appendix 1. All of these carbonyl compounds, when measured in concentrations above the LOD, shall be reported.

1.1.1 For the purpose of calculating NMOG for vehicles tested on exhaust emission test fuel containing ethanol (see Part G, Determination of NMOG Mass Emissions):

1.1.1.1 The only carbonyl compounds that need to be reported from this method are formaldehyde and acetaldehyde.

1.1.1.2 The additional carbonyls listed in Appendix 1 are within the scope of this analytical method and their measurement may provide meaningful information to the laboratory. However, their measurement is not required.

1.2 This procedure is derived from a method used by Hull [Ref. 10].

1.3 Other applicable forms of instrumentation and analytical techniques may be used if shown to yield results equivalent to those specified in this procedure and if approved in advance by the Executive Officer of the Air Resources Board.

1.4 All definitions and abbreviations are contained in Appendix 2 of these test procedures.

2. METHOD SUMMARY

2.1 The samples are received by the laboratory in sample collection cartridges or impingers. (See Section 4.2.) The DNPH reagent ~~absorbing solution (2,4-DNPH)~~

complexes the carbonyl compounds into their diphenylhydrazone derivatives. The cartridges are then extracted ~~eluted~~ with ~~5 mL~~ acetonitrile.

2.2 Separation and analysis are performed using a HPLC with an ultraviolet detector.

3. INTERFERENCES AND LIMITATIONS

3.1 An ~~interferent~~ interfering compound is any detectable compound present in the sample with a retention time very similar to that of any target carbonyl described in this method. To reduce interference error, proof of chemical identity may require periodic confirmations using an alternate method and/or instrumentation, e.g., alternative HPLC columns or mobile phase compositions.

3.2 If samples are not analyzed the same day as received, they must be refrigerated at a temperature below 40^{o}F.

3.2.1 Impinger solutions must first be transferred to glass bottles and sealed. ~~Refrigerated samples are stable for up to 30 days.~~

3.2.2 If cartridges are not immediately extracted they must be refrigerated.

3.2.3 Acrolein and crotonaldehyde have been shown to degrade in acidified DNPH cartridges; hence, it is recommended to extract the cartridges as soon as possible. The extract must be refrigerated.

3.2.4 Refrigerated cartridge sample extracts and impinger solutions are stable for up to 30 days.

~~3.3~~ ~~When using the DuPont Zorbax or Supelco's Supelcosil columns described in Section 4.1.5, methyl ethyl ketone (MEK) and butyraldehyde tend to coelute.~~

~~3.4~~ ~~When using the Delta Bond column described in Section 4.1.5, formaldehyde tends to coelute with an unknown, non-carbonyl compound, and the tolualdehyde isomers tend to coelute. The guard column for the Delta Bond column must also be changed frequently in order to prevent the coelution of butyraldehyde and methacrolein and to prolong the life of the column.~~

3.3 The presence of NOx in exhaust samples depletes DNPH in the cartridges. Laboratories should develop criteria to validate test results by ensuring that enough DNPH is left to trap the carbonyl compounds.

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 or pump module controller.

4.1.3 Temperature controller module for the column oven.

4.1.4 A liquid autosampler.

4.1.5 The ~~primary~~ system incorporates two ~~DuPont Zorbax ODS or~~ ~~Supelco's Supelcosil~~ LC-18 columns (e.g., Supelco's Supelcosil, typically 25cm x 4.6mm, 5µ silica gel particles) in tandem and a guard column (e.g., Supelco's Pelliguard, 2 cm long packed with LC18 5 µm pellicular beads). ~~The secondary system incorporates a Delta Bond AK (4.6 mm ID x 200 mm) packed column with a guard column 2 cm long packed with LC18 5 µm pellicular beads or equivalent).~~ Other columns may be used, provided the alternate(s) can be demonstrated to the ARB to be equivalent or better with respect to precision, accuracy and resolution of all target carbonyls.

4.1.6 An ultraviolet/visible (UV/VIS) detector.

4.1.7 Data system for peak integration.

4.2 Samples are collected ~~collection containers~~ ~~are~~ in glass impingers or DNPH-impregnated cartridges.

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 Methanol, HPLC grade (Burdick and Jackson or equivalent).

5.4 Acidified DNPH-Silica cartridges (Waters Corp. or equivalent).

5.5~~3~~ ~~2,4-~~DNPH, purified, Radian Corporation or equivalent. Unpurified DNPH must be 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.

5.6~~4~~ Sulfuric acid, or perchloric acid, analytical reagent grade~~,~~ (Baker Analyzed or equivalent).

5. 7~~5~~ The carbonyl/~~2,4-dinitrophenylhydrazone (~~DNPH~~)~~ complexes [Ref. 11] listed in Table F1 may be purchased (e.g., Radian Corporation, in 1.2 mL ampules) or prepared in the laboratory. In-house standards must be recrystallized at least three times from 95 percent ethanol.

TABLE F-1
PROPERTIES OF CARBONYL/~~2,4-~~DNPH COMPLEXES

Complex	Molecular Weight (g/mole)	Melting Point °C
formaldehyde	210.15	165-166
acetaldehyde	224.18	152-153
acrolein	236.19	165[1]
acetone	238.20	125-127
propionaldehyde	238.20	144-145
butyraldehyde	252.23	119-120
hexanaldehyde	280.28	106-107
benzaldehyde	286.25	240-242
methyl ethyl ketone	252.53	117-118
methacrolein	250.21	200-201
crotonaldehyde	250.21	185-188
valeraldehyde	266.26	107-108
m-tolualdehyde	300.27	212

5.8~~6~~ Stock Calibration Standard - A stock calibration standard is prepared by diluting the target carbonyl/~~2,4-~~DNPH complexes with acetonitrile. A typical stock calibration standard contains 3.0 µg/mL of each target carbonyl compound. Stock calibration standards of other concentrations may also be used.

5.9~~7~~ Working Standard - A working standard is prepared when required by diluting the stock calibration solution, making sure that the highest concentration of the standard is above the expected test level. Typically, the 3.0 µg/mL stock is diluted five times with acetonitrile in a volumetric flask to yield a 0.6 µg/mL solution.

5.10~~8~~ Control Standard - A quality control standard, containing all target carbonyls/~~2,4-~~DNPH complexes within the typical concentration range of real samples, is analyzed to monitor the precision of the analysis of each target carbonyl. The control standard may be purchased, prepared in the laboratory from a stock solution different from the calibration standard, or prepared by batch mixing old samples, spiking it with a stock solution of target compounds, and stirring for a minimum of 2 hours. If necessary, the solution is filtered using filter paper to remove precipitation. All target compounds except acrolein have been found to be stable in the control standard.

5.11~~9~~ Standards used for linearity and LOD determinations (Section 8) may be purchased or prepared by dilutions of an appropriate level stock solution.

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[1] This compound has been ~~known~~ shown to decompose.

6. **PROCEDURE**

6.1 For systems collecting the samples via impingers, an absorbing solution is prepared by dissolving 0.11 - 0.13 grams of recrystallized DNPH in 1 L of HPLC grade acetonitrile. The absorbing solution should be prepared at least every two weeks. Each batch of acetonitrile used in this procedure is checked for oxygenated impurities by adding it to a contaminant-free dilute solution of DNPH and analyzing by HPLC.

6.1.1 In the laboratory, pipette 15 mL of the DNPH absorbing solution into each of the 30 mL impingers for each emission test. Add 0.1 mL of 2.85 N sulfuric acid or 0.15 mL of 3.8 M perchloric acid to each impinger.

6.2 For systems collecting the samples via cartridges, DNPH-impregnated cartridges shall be sealed and refrigerated, at a temperature less than 40°F, upon receipt from manufacturer, until ready for use.

6.2.1 At the exhaust volumes being sampled (1 L/min), a back-up cartridge may be required for CVS phase 1 or other high-concentration sample but no back-up cartridge is needed for CVS phases 2 and 3 or other low-concentration samples.

6.3 After sampling uncap and place all impingers in preheated water at 70-80°C for 30 minutes (min) to complete derivatization. Heating is not required when using perchloric acid.

6.3.1 For cartridges, remove the caps and extract with 5 mL acetonitrile, running the extract into glass storage bottles.

6.4 Remove the impingers from the water bath and cool to room temperature. Replace any lost solvent by adding acetonitrile to the 15-mL mark.

6.4.1 Replacing lost solvent is not required when using an internal standard method (Section 7.4).

6.5 Transfer the solution from each impinger/cartridge to glass vials and seal with new septum screw caps.

6.6 Place the vials containing blank, working standard, control standard, and samples into the autosampler for subsequent injection into an HPLC. Suggested standard operating conditions for the HPLC are:

~~Primary~~ Typical System:
Columns: ~~4.6 mm ID x 250 mm x 1/4 inches OD Dupont Zorbax ODS or~~ Supelco Supelcosil (LC-18, 25cm x 4.6mm, 5µm silica gel particles), ~~–~~two columns in series, and a Supelco

Pelliguard ~~G~~guard column~~–~~ (2 cm long packed with C18 5 µm pellicular beads)
Column temperature: 40°C
Detector: UV/VIS at 360 nm
Sample volume: 10 µL
Solvent A: acetonitrile
Solvent B: ~~10 percent (volume/volume)~~ methanol ~~in water~~
Solvent C: water
Flow: 1.2 mL/min
Program:
50 percent A, 5~~0~~ percent B, 45 percent C 0 (initial time)
65 percent A, 3.5 percent B, 31.5 percent C 0 to 30 ~~2~~ min (linear ramp)
100 percent A, 0 percent B, 0 percent C ~~2~~ 30 to 40 ~~22~~ min (linear ramp)
100 percent A, 0 percent B, 0 percent C 40 to 42 min (hold)
50 percent A, 5~~0~~ percent B, 45 percent C ~~22~~ 42 to 45 ~~37~~ min (linear ramp)

~~Under the above configuration, methyl ethyl ketone and butyraldehyde tend to coelute. In order to report these compounds, it is necessary to analyze the samples using a secondary system. The tolualdehyde isomers (m-, p-, and o-) are separated using this configuration. The reporting of tolualdehyde is addressed in Section 7.4.~~

~~Secondary System:~~
~~Columns: Delta Bond AK C18 (4.6 mm ID x 200 mm x 1/4 in OD) packed column, Guard column - 2 cm long packed with C18 5 µm pellicular~~
~~Column temperature: 40°C~~
~~Detector: UV/VIS at 360 nm~~
~~Sample volume: 10 µL~~
~~Solvent A: acetonitrile~~
~~Solvent B: acetonitrile in water, 35 percent (v/v)~~
~~Flow: 1.5 mL/min~~
~~Program: 0 percent A, 100 percent B 0 (initial time)~~
~~23 percent A, 77 percent B 0 - 5.5 min~~
~~46 percent A, 54 percent B 5.5 - 13 min~~
~~0 percent A, 100 percent B 13 to 30 min~~

~~This secondary system is not used to report all compounds because formaldehyde tends to coelute with a non-carbonyl compound. If this coelution is resolved, the secondary system may be used alone to analyze all carbonyl compounds. The tolualdehyde isomers, however, are not separated with this configuration. The reporting of tolualdehyde is addressed in Section 7.4.~~

Data System: The outputs from the UV/VIS detector are sent to a PC-controlled data acquisition system.

6.7 If all target compounds are not separated using this configuration, a second HPLC with a different configuration must be used, in addition to the primary system, to separate the coeluting compounds.

6.8~~7~~ The peak integrations are corrected as necessary in the data system. Any misplaced baseline segments are corrected in the reconstructed chromatogram.

6.9~~8~~ Samples containing compounds having concentrations above the documented range of instrument linearity must be diluted and reanalyzed.

7. CALCULATIONS

7.1 For each target carbonyl, the carbonyl mass is calculated from its carbonyl/~~2,4-~~DNPH mass.

7.2 The mass of each carbonyl compound, per impinger or cartridge, is determined by the following calculation:

$$\text{Mass}_{\text{sample}} = \text{Peak Area}_{\text{sample}} * \text{Response Factor} * \text{Impinger}(\text{or Cartridge})\ \text{volume}(\text{mL}) * \text{B}$$

where B is the ratio of the molecular weight of the carbonyl compound to its 2,4-dinitrophenylhydrazone derivative and where the response factor (RF) for each carbonyl is calculated during the calibration by:

$$\text{RF} = \frac{\text{Concentration}_{\text{standard}}\ (\mu\text{g}\ \cancel{\text{2,4-}}\text{DNPH species/mL})}{\text{Peak Area}_{\text{standard}}}$$

7.3 For tolualdehyde, the sum of all isomers present is reported as m-tolualdehyde.

~~7.3.1 Under the conditions of the primary system in Section 6.6, the isomers are separated. The m-tolualdehyde response factor is applied to each peak and the sum reported as m-tolualdehyde.~~

~~7.3.2~~ Under the conditions of the ~~secondary~~ system described in Section 6.6, the isomers coelute. The m-tolualdehyde response factor is applied to the single tolualdehyde peak. This concentration is reported as m-tolualdehyde.

7.4 An internal standard method may also be used.

8. QUALITY CONTROL

8.1 Blank Runs

8.1.1 Reagent Blanks - The solvents used are of the highest HPLC grade and are tested for impurities when a new lot number is used. If this lot number is found to be acceptable, (no carbonyls present at concentrations at or above the LOD), daily blank analysis is not performed.

8.1.2 Carbonyl/~~2,4-~~DNPH Purity - The carbonyl/~~2,4-~~DNPHs are checked for purity by their melting points and their chromatograms (See Table F-1). Analysis of the solution of carbonyl/~~2,4-~~DNPH must yield only the peak of interest. No contaminant peaks above the LOD should be observed.

8.1.3 Field Blanks – One cartridge is analyzed as a field blank for each emission test. If the field blank shows a peak greater than the limit of detection (LOD) in the region of interest, the source of the contamination must be investigated and remedied.

8.1.4 Cartridge Blanks - At least one cartridge per batch is analyzed as a batch blank. If the cartridge blank shows a peak greater than the limit of detection (LOD) in the region of interest, the source of the contamination must be investigated and remedied.

8.2 Calibration Run - The calibration standard is analyzed each analysis day to generate the response factors used to quantify the sample concentrations.

8.3 Control Standard Run - The quality control standard is analyzed at least once each analysis day. Measurements of all target compounds in the control standard, except acrolein, must fall within the control limits to ensure the validity of the sample analyses that day. To meet this requirement, it may be necessary to rerun the calibration and control standards, and inspect and repair the HPLC.

8.4 Control Charts - A quality control chart is maintained for each component of the control standard. The control charts, used on a daily basis, establish that the method is "in- control." The following describes how to construct a typical control chart:

1. Obtain at least 20 daily control standard results,
2. Calculate the control standard mean concentration, and standard deviation(s) for the target analyte, and
3. Create a control chart for the target analyte by placing the concentration on the Y-axis and the date on the X-axis. Establish an upper warning limit and a lower warning limit at two standard deviations (2s) above and below the average concentration. Establish an upper control limit and a lower control limit at three standard deviations (3s) above and below the average concentration.
4. Due to the low variability of the carbonyl control standard measurements, a control standard measurement is considered to be out-of-control when the analyzed value exceeds either the 3s limit, or the range of ± 10% of the mean control measurement, whichever is greater, or if two successive control standard measurements of the same analyte exceed the 2s limit.

5. If 20 control standard measurements are not yet available to create a control chart (e.g., the control standard was expended and replaced prior to obtaining 20 points with the new standard), measurements must be within 10% of the assay (purchased) or theoretical (prepared in-house) concentration.

The measured concentrations of all target analytes contained in the control standard must be within the control limits (in-control) for the sample results to be considered acceptable. No control requirements have been established for acrolein, since it has been shown to degrade over time.

8.5 Duplicates - A duplicate analysis of one sample is performed at least once per analysis day. The relative percent difference (RPD) is calculated for each duplicate run:

$$\mathrm{RPD}(\%) = \frac{|\,\text{Difference between duplicate and original measurements}\,|}{\text{Average of duplicate and original measurements}} * 100$$

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 may be reanalyzed. If reanalysis is not feasible or if the criteria are still not met on reanalysis, all sample results for that analysis day are invalid.

8.6 Linearity - A multipoint calibration to confirm instrument linearity is performed for all target analytes for new instruments, after making instrument modifications that can affect linearity, and at least once every year. 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), each above the LOD, 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 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.

8.7 Limit of Detection - The LOD for the target analytes must be determined for new instruments, after making instrument modifications which can affect the LOD and at least once per year. To make the calculations, it is necessary to perform a multipoint calibration consisting of at least four “low” concentration levels, each above the LOD, with at least five replicate determinations of the lowest concentration standard. A linear regression is performed and the standard deviation (in area counts) of the lowest concentration standard determined. The standard deviation is converted to concentration units using the slope of the linear regression:

$$s = s_a \div m$$

where m is the slope of the linear regression, s is the standard deviation (in concentration units) of the lowest concentration standard and s_a is the standard deviation (in area counts) of the lowest concentration standard.

The LOD must be calculated using the following equation [Ref. 12]:

$$LOD = t * s$$

where s is the standard deviation (in concentration units) of at least five replicate determinations of the lowest concentration standard and t is the t-factor for 99 percent confidence for a one-sided normal (Gaussian) distribution. The number of degrees of freedom is equal to the number of replicates, minus one. An abbreviated t-table is:

Degrees of Freedom	t-value
4	3.7
5	3.4
6	3.1
7	3.0

The lowest standard must be of a concentration of one to five times the estimated LOD.

8.7.1 The maximum allowable LOD is 0.0075 µg/mL. The calculated laboratory LOD must be equal to or lower than the maximum allowable LOD. All peaks identified as target compounds that are equal to or exceed the maximum allowable LOD must be reported. If the calculated laboratory LOD is less than the maximum allowable LOD, the laboratory may choose to set its reporting limit at the maximum allowable LOD, the calculated laboratory LOD, or any level in between.

8.7.2 For the purpose of calculating the total mass of all species, the concentrations of the compounds below the LOD are considered to be zero.

Part G
DETERMINATION OF NMOG MASS EMISSIONS

1. INTRODUCTION

1.1 NMOG mass emissions consist of non-methane hydrocarbons and oxygenated hydrocarbons.

1.2 All definitions and abbreviations are set forth in Appendix 2 of these test procedures.

2. NMOG WEIGHTED MASS EMISSIONS

2.1 ~~NMOG weighted mass (wm) emissions shall be calculated as follows:~~

~~$NMOG_{wm} = \sum NMHC_{wm} + \sum ROH_{wm} + \sum RHO_{wm}$~~

Non-methane hydrocarbon weighted mass emissions ($NMHC_{wm}$) can be determined by either ~~(~~FID or GC. If the FID method is used to calculate $NMHC_{wm}$, refer to Part B of these test procedures entitled, "Determination of Non-Methane Hydrocarbon Mass Emissions by Flame Ionization Detection." If the GC method is used to calculate $NMHC_{wm}$, refer to section 4~~3~~, "Speciated Hydrocarbon Mass Emissions Calculation," contained herein. Carbonyl weighted mass emissions (RHO_{wm}) are to be calculated according to section 6~~5~~, "Carbonyl Mass Emissions Calculation," contained herein. For alcohol fueled vehicles, alcohol weighted mass emissions (ROH_{wm}) are to be calculated according to section 5~~4~~, "Alcohol Mass Emissions Calculation," contained herein. Dilution factors and mass emission are determined according to section 3, "Dilution Factors and Mass Emission Calculation," contained herein.

If the FID method is used to determine the non-methane hydrocarbon weighted mass emissions, the NMHC sample measurement includes contributions from any oxygenated hydrocarbons that may be present in the sample. Therefore, the FID NMHC measurement must be corrected for the presence of alcohols and carbonyl compounds, to give a resultant value called non-oxygenated non-methane hydrocarbons (NONMHC). This correction may take place at the concentration level, for each sample and ambient background, or at the mass level, after $NMHC_{mass}$ and $NMHC_{wm}$ have been calculated. (The two operations are mathematically equivalent.) For the calculations presented in this document, the oxygenate correction is presumed to take place after $NMHC_{mass}$ and $NMHC_{wm}$ have been calculated.

2.2 NMOG weighted mass (wm) emissions, using the FID method, shall be calculated as follows:

$$\left(\mathrm{NMOG_{wm}}\right)_{\mathrm{FID}} = \sum \mathrm{NONMHC_{wm}} + \sum \mathrm{ROH_{wm}} + \sum \mathrm{RHO_{wm}}$$

$\mathrm{NONMHC_{wm}}$ is calculated according to the following equations:

$$\mathrm{NONMHC_{wm}} = 0.43 * \left(\frac{\mathrm{NONMHC_{mass1}} + \mathrm{NONMHC_{mass2}}}{\mathrm{D_{phase1}} + \mathrm{D_{phase2}}}\right) + 0.57 * \left(\frac{\mathrm{NONMHC_{mass3}} + \mathrm{NONMHC_{mass2}}}{\mathrm{D_{phase3}} + \mathrm{D_{phase2}}}\right)$$

and

$$\mathrm{NONMHC_{mass\,n}} = \mathrm{NMHC_{mass\,n}} - \mathrm{NMHC_{dens}} * \sum\left(\frac{\mathrm{ROH_{mass\,n}}}{\mathrm{ROH_{dens}}}\right) * r_{\mathrm{ROH}} - \mathrm{NMHC_{dens}} * \sum\left(\frac{\mathrm{RHO_{mass\,n}}}{\mathrm{RHO_{dens}}}\right) * r_{\mathrm{RHO}}$$

where:

$\mathrm{NMHC_{mass\,n}} = \mathrm{NMHC_{conc}} * \mathrm{NMHC_{dens}}$

2.3 NMOG weighted mass (wm) emissions, using the GC method, shall be calculated as follows:

$$\left(\mathrm{NMOG_{wm}}\right)_{\mathrm{GC}} = \sum \mathrm{HC_{wm}} + \sum \mathrm{ROH_{wm}} + \sum \mathrm{RHO_{wm}}$$

In the GC method, the hydrocarbons are each measured individually and, therefore, the sum of species (∑HC) does not include methane or oxygenated compounds. Thus, this method does not need the corrections that the FID method requires.

3. **DILUTION FACTOR AND NMHC MASS EMISSION CALCULATION**

3.1 As shown in Part B, the dilution factor is determined using only the major constituents of the emission sample. The dilution factor is determined using the following equation:

$$\mathrm{DF} = \frac{100 * \left(\dfrac{x}{x + y/2 + 3.76 * \left(x + y/4 - z/2\right)}\right)}{\mathrm{CO_{2e}} + \left(\mathrm{NMHC_e} + \mathrm{CH_{4e}} + \mathrm{CO_e}\right) * 10^{-4}}$$

(where fuel composition is $C_xH_yO_z$ as measured for the fuel used; this expression is generally normalized so that x = 1)

3.2 The density of the NMHC is determined using the carbon:hydrogen ratio of the fuel, $C_xH_yO_z$, according to the following equation:

$$NMHC_{dens} = (x * 12.01115 + y * 1.00797)(g/mole) * \left(\frac{28.316847 liter/ft3}{24.0547 liter/mole}\right)$$

where: 12.01115 = atomic weight of carbon
1.00797 = atomic weight of hydrogen

a) For gasoline, $CH_{1.85}$, where x = 1, y = 1.85, and z = 0:
$DF = 13.47 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
$NMHC_{dens} = 16.33$

b) For Phase 2 gasoline, $CH_{1.94}O_{0.017}$, where x = 1, y = 1.94 and z = 0.017,
$DF = 13.295 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
$NMHC_{dens} = 16.44$

c) For LPG, $CH_{2.64}$, where x = 1, y = 2.64, z = 0:
$DF = 11.68 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
$NMHC_{dens} = 17.27$

d) For CNG, $CH_{3.78}O_{0.016}$, where x = 1, y = 3.78, and z = 0.016:
$DF = 9.83 / [[CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
$NMHC_{dens} = 18.63$

e) For E85, $CH_{2.7841}O_{0.3835}$, Where x = 1, y = 2.7841, and z = 0.3835:
$DF = 12.4253 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
$NMHC_{dens} = 17.44$

3.3 Sample Calculation

A flex-fuel vehicle using E85 fuel $CH_{2.7841}O_{0.3835}$, where x = 1, y = 2.7841, and z = 0.3835:

Test Phase	FID THC_e (ppmC)	CH_{4e} (ppmC)	CO_{2e} (%)	CO_e (ppm)	FID THC_d (ppmC)	CH_{4d} (ppmC)	CO_{2d} (%)	CO_d (ppm)	VMIX (ft^3)	$D_{phase\ n}$ (mile)
1	27.230	6.918	0.8564	117.801	3.532	2.261	0.0438	0.5224	3495	3.591
2	3.5459	2.357	0.5595	10.8229	3.476	2.247	0.4446	0.3322	5799	3.846
3	3.8510	2.590	0.7163	5.1538	3.396	2.188	0.4507	0.6752	3484	3.591

FID response factor of methane is experimentally determined for each individual FID. The value of 1.15 used here is for example only.

For phase 1:

$NMHC_e = FID\ THC_e - r_{CH_4} * CH_{4e}$

$= 27.230 - 1.15 * 6.918$
$= 19.274$ ppmC

$\mathrm{DF} = 12.4253 \;/\; [\mathrm{CO}_{2e} + (\mathrm{NMHC}_e + \mathrm{CH}_{4e} + \mathrm{CO}_e) * 10^{-4}]$
$= 12.4253 \;/\; [0.8564 + (19.274 + 6.918 + 117.801) * 10^{-4}]$
$= 14.2688$ ppmC

$\mathrm{NMHC}_d = \mathrm{FID\ THC}_d - r_{\mathrm{CH}_4} * \mathrm{CH}_{4d}$
$= 3.532 - 1.15 * 2.261$
$= 0.9319$ ppmC

$\mathrm{NMHC}_{conc} = \mathrm{NMHC}_e - \mathrm{NMHC}_{d*} (1 - 1/\mathrm{DF})$
$= 19.274 - 0.9319 * (1 - 1 / 14.2688)$
$= 18.407$ ppmC

$\mathrm{NMHC}_{mass1} = \mathrm{NMHC}_{conc} * \mathrm{NMHC}_{dens} * \mathrm{VMIX}_1 * 10^{-6}$

$= 18.407 * 17.44 * 3495 * 10^{-6}$
$= 1.1220$ g

Similarly, for Phase 2, DF $= 22.152$ and $\mathrm{NMHC}_{mass2} = 0$

Similarly, for Phase 3, DF $= 17.332$ and $\mathrm{NMHC}_{mass2} = 0.0026$ g

~~3~~4. SPECIATED HYDROCARBON MASS EMISSIONS CALCULATION

~~3~~4.1 INTRODUCTION

Vehicular exhaust emissions are measured according to the FTP [Ref. 1]. For each of the three phases of the FTP, a ~~tedlar~~ sample collection bag, ~~of 0.5 ft^3~~ nominally 5 to 10 liters in capacity, is used to collect a dilute exhaust sample. Sample collection bags may be made of Tedlar® (polyvinylfloride, or PVF), 2 mil in thickness, or of Kynar® or Solef® (polyvinylidenefloride, or PVDF), each 4 mil in thickness. 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. Since PVF and PVDF films contain plasticizer or volatile organic components, all of the films are conditioned in a vented oven at 250°F for 16 hours before made into sample bags. All bag samples are analyzed according to Method No. 1002 (Part D of these test procedures) and Method No. 1003 (Part E of these test procedures) 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.

~~3~~4.2 HC MASS EMISSIONS CALCULATION PER TEST PHASE

~~3~~4.2.1 $\mathrm{HC}_{mass\ n} = (\mathrm{HC}_{conc} * \mathrm{HC}_{dens} * \mathrm{VMIX} * 10^{-6}) \;/\; (\text{Carbon No.})$

~~3~~4.2.2 $HC_{conc} = HC_e - (HC_d * (1 - (1 / DF)))$
NOTE: If HC_{conc} is calculated to be less than zero, then $HC_{conc} = 0$.

~~3~~4.3. WEIGHTED HC MASS EMISSIONS CALCULATION

~~3~~4.3.1 $$HC_{wm} = 0.43 * \left(\frac{HC_{mass1} + HC_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{HC_{mass3} + HC_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

~~3~~4.4. SAMPLE CALCULATION

~~3~~4.4.1 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:

$DF = 13.47 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
(see section 3~~6~~, DF Calc.)

$NMHC_e = FID\ THC_e - (r_{CH_4} * CH_{4e})$
$= 98\ ppmC - (1.04 * 6\ ppmC)$
$= 92\ ppmC$

$CO = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$
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 .
$= (1 - (0.01925) * 1.2\% - 0.000323 * 28\%) * 280\ ppm$
$= 271\ ppm$

$DF = 13.47 / [1.2\% + (92\ ppmC + 6\ ppmC + 271\ ppm) * 10^{-4}]$
$= 10.89$

HC_{conc} = HC_e - (HC_d * (1 - (1 / DF)))
= 500 ppbC - (25 ppbC * (1 - (1 / 10.89)))
= 477 ppbC

Mol. Wt. of C_6H_6 = (6 * 12.01115) + (6 * 1.00797)
= 78.11472 g/mole

HC_{dens} = (Mol. Wt. * conversion of liter to ft^3) / (Mol. Vol.)
= (78.11472 g/mole * 28.316 liter/ft^3) / 24.055 liter/mole
= 91.952 g/ft^3

$HC_{mass\ n}$ = (HC_{conc} * HC_{dens} * VMIX * 10^{-6}) / (Carbon No.)

$HC_{mass\ 1}$ = (477 ppbC * 91.952 g/ft^3 * 2846 ft^3 * 10^{-6}) / 6
= 20.8 mg

Similarly, for Phase 2: Hc_{mass} = 5.7 mg

and for Phase 3: Hc_{mass} = 4.2 mg

Therefore,

$$HC_{wm} = 0.43 * \left(\frac{HC_{mass1} + HC_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{HC_{mass3} + HC_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

$$HC_{wm} = 0.43 * \left(\frac{20.8\,mg + 5.7\,mg}{3.584\ miles + 3.842\ miles} \right) + 0.57 * \left(\frac{4.2\,mg + 5.7\,mg}{3.586\ miles + 3.842\ miles} \right)$$

HC_{wm} = 2.3 mg/mile (benzene weighted mass emissions)

45. ALCOHOL MASS EMISSIONS CALCULATION

45.1. INTRODUCTION

Vehicular emissions are measured according to the (FTP [Ref. 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.

45.2. ALCOHOL MASS EMISSIONS CALCULATION PER TEST PHASE

45.2.1 $ROH_{mass\ n}$ = $(ROH_{conc} * ROH_{dens} * VMIX * 10^{-6})$ ~~/ (Carbon No.)~~

45.2.2 ROH_{conc} = $ROH_e - (ROH_d * (1 - (1 / DF)))$
NOTE: If ROH_{conc} is calculated to be less than zero, then $ROH_{conc} = 0$.

45.2.3 ROH_e = $(Imass_e / Ivol_e) * (\text{Mol. Vol.} / \text{Mol. Wt.})$

45.2.4 $Imass_e$ = $(Iconc_{e1} + Iconc_{e2})$ ~~$* Dens_{ROH}$~~ $* Ivol_r$

45.2.5 $Ivol_e$ = $Ivol_{em} * (293.16^{o}K / Itemp_e) * (P_B / 760 \text{ mm Hg})$

45.2.6 ROH_d = $(Imass_d / Ivol_d) * (\text{Mol. Vol.} / \text{Mol. Wt.})$

45.2.7 $Imass_d$ = $(Iconc_{d1} + Iconc_{d2})$ ~~$* Dens_{ROH}$~~ $* Ivol_r$

45.2.8 $Ivol_d$ = $Ivol_{dm} * (293.16^{o}K / Itemp_d) * (P_B / 760 \text{ mm Hg})$

45.3. WEIGHTED ALCOHOL MASS EMISSIONS CALCULATION

$$ROH_{wm} = 0.43 * \left(\frac{ROH_{mass1} + ROH_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{ROH_{mass3} + ROH_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

45.4 SAMPLE CALCULATION

45.4.1 Alcohol emissions from an ~~M85~~ E85 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~~ alcohol concentration in each impinger. This is the same vehicle test as the example in section 3.3. Calculate the weighted ~~me~~thanol mass emissions based on the following data, along with the data presented in section 3.3:

Test Phase	$Ivol_r$ (mL)	$Iconc_{e1}$ (µg/mL)	$Iconc_{e2}$ (µg/mL)	$Ivol_{em}$ (liter)	$Iconc_{d1}$ (µg/mL)	$Iconc_{d2}$ (µg/mL)	$Ivol_{dm}$ (liter)	$Itemp_e$ (°K)	$Itemp_d$ (°K)
1	15	4.984 ~~2.24~~	0.106 ~~0.05~~	8.18 ~~3.90~~	0 ~~0.07~~	0 ~~0.01~~	31.16 ~~13.50~~	294.26 ~~295~~	294.26 ~~294~~
2	15	0 ~~0.29~~	0 ~~0.06~~	14.65 ~~6.50~~	0 ~~0.07~~	0 ~~0.01~~	31.16 ~~13.50~~	294.26 ~~297~~	294.26 ~~294~~
3	15	0 0~~.32~~	0 ~~0.02~~	8.67 ~~4.00~~	0 ~~0.07~~	0 ~~0.01~~	31.16 ~~13.50~~	294.26 ~~298~~	294.26 ~~294~~

Test Phase	$D_{phase\ n}$ (mile)	DF	P_B (mm HG)	VMIX (ft3)
1	3.591	14.27	760	3495
2	3.846	22.15	760	5799
3	3.591	17.33	760	3484

~~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 (mmHg)~~	~~$HCHO_e$ (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~~

Ethanol

For Phase 1:

$Imass_e$ = $(Iconc_{e1} + Iconc_{e2})$ ~~$* Dens_{ROH}$~~ $* Ivol_r$

= (4.984 µg/mL + 0.106 µg/mL) * 15 mL

= 76.35 µg

~~= (2.24 µg/mL + 0.05 µg/mL) * 0.7914 g/mL * 15 mL * 10^6 µg/g~~

~~= 27.2 µg~~

Mol. Wt. of C_2H_5OH = (2 * 12.01115) + (6 * 1.00797) + (1 * 15.9994)

= 46.06952 g/mole

~~Mol. Wt. of CH_3OH = (1 * 12.01115) + (4 * 1.00797) + (1 * 15.9994)~~

~~= 32.0428 g/mole~~

$Ivol_e$ = $Ivol_{em}$ * (293/16° K / $Itemp_e$) * (P_B / 760 mm Hg)

= 8.18 liter * (293.16°K / 294.26° K) * (760 mm Hg / 760 mm Hg)

= 8.15 liters

~~= 3.90 liter * (293.16°K / 295° K) * (760 mm Hg / 760 mm Hg)~~

~~= 3.88 liter~~

ROH_e = ($Imass_e$ / $Ivol_e$) * (Mol. Vol. / Mol. Wt.)

= (76.35 μg / 8.15 liter) * (24.055 liter/mole / 46.06952 g/mole)
= 4.89 ppm

~~= $(27.2*10^{-6}$ g / 3.88 liter) * (24.055 liter/mole / 46.06952 g/mole)~~
~~= 5.27 ppmC~~

$Imass_d$ = $(Iconc_{d1} + Iconc_{d2})$ ~~* $Dens_{ROH}$~~ * $Ivol_r$
= (0 μg/mL + 0μg/mL) * 15 mL
= 0 μg

~~= (0.07 μg/mL + 0.01 μg/mL) * 0.7914 g/ml * 15 ml * 10^6 μg/g~~
~~= 0.95 μg~~

$Ivol_d$ = $Ivol_{dm}$ * (293.16° K / $Itemp_d$) * (P_B / 760 mm Hg)
= 31.16 liter * (293.16°K / 294.26°K) * (760 mm Hg / 760 mm Hg)
= 31.04 liters

~~= 13.50 liter * (293.16°K / 294°K) * (760 mm Hg / 760 mm Hg)~~
~~= 13.46 liter~~

ROH_d = ($Imass_d$ / $Ivol_d$) * (Mol. Vol. / Mol. Wt.)
= (0 μg / 31.46 liter) * (24.055 liter/mole / 46.06952 g/mole)
= 0 ppm

~~= $(0.95*10^{-6}$ g/ 13.46 liter) * (24.055 liter/mole / 32.0428 g/mole)~~
~~= 0.05 ppmC~~

DF = 14.2688 (as calculated in section 3.3)

~~$DF = \frac{12.02}{CO_{2e} + \left(NMHC_e + CH_{4e} + CO_e + ROH_e + HCHO_e\right)*10^{-4}}$~~
~~(see section 6, DF Calc.)~~

~~$NMHC_e$ = FID THC_e – (r_{CH_4} * CH_{4e}) - (r_{CH_3OH} * ROH_e)~~
~~= 82 ppmC - (1.04 * 9 ppmC) - (0.66 * 5.27 ppmC)~~
~~= 69 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 =~~ $$\frac{12.02}{1.5\% + \left(69\,\mathrm{ppmC} + 9\,\mathrm{ppmC} + 237\,\mathrm{ppmC} + 5.27\,\mathrm{ppmC} + 0.81\,\mathrm{ppm}\right) * 10^{-4}}$$

ROH_{conc} = ROH_e - (ROH_d * (1 - (1 / DF)))
= 4.89 ppm - (0 ppmC * (1 - (1 / 14.27)))
= 4.89 ppm

~~= 5.27 ppmC - (0.05 ppmC * (1 - (1 / 7.84)))~~
~~= 5.23 ppmC~~

ROH_{dens} = (Mol. Wt. * conversion of liter to ft^3) / (Mol. Vol.)
= (46.06952 g/mole * 28.316 liter/ft^3) / 24.055 liter/mole
= 54.23007808 g/ft^3

~~= (32.0428 g/mole * 28.316 liter/ft) / 24.055 liter/mole~~
~~= 37.719 g/ft^3~~

VMIX = 3495 ft^3 (from section 3.3)

$ROH_{mass\ n}$ = (ROH_{conc} * ROH_{dens} * VMIX * 10^{-6}) ~~/ (Carbon No.)~~
$ROH_{mass\ 1}$ = (4.89 ppmC * 54.23 g/ft^3 * 3495 ft^3 * 10^{-6})
= 0.93 g

~~= (5.23 ppmC * 37.719 g/ft^3 * 2834 ft^3 * 10^{-6}) / 1~~
~~= 0.56 g~~

Similarly, for Phase 2: $ROH_{mass\ 2}$ = 0 ~~0.08~~ g
and for Phase 3: $ROH_{mass\ 3}$ = 0 ~~0.08~~ g

Therefore,

$$\mathrm{ROH}_{wm} = 0.43 * \left(\frac{\mathrm{ROH}_{mass1} + \mathrm{ROH}_{mass2}}{\mathrm{D}_{phase1} + \mathrm{D}_{phase2}}\right) + 0.57 * \left(\frac{\mathrm{ROH}_{mass3} + \mathrm{ROH}_{mass2}}{\mathrm{D}_{phase3} + \mathrm{D}_{phase2}}\right)$$

$$\mathrm{ROH}_{wm} = 0.43 * \left(\frac{0.93\,\mathrm{g} + 0\,\mathrm{g}}{3.591\text{ miles} + 3.846\text{ miles}}\right) + 0.57 * \left(\frac{0\,\mathrm{g} + 0\,\mathrm{g}}{3.591\text{ miles} + 3.846\text{ miles}}\right)$$

$$\cancel{\mathrm{ROH}_{wm} = 0.43 *} \left(\frac{0.56\,\mathrm{mg} + 0.08\,\mathrm{mg}}{3.581\text{ miles} + 3.845\text{ miles}}\right) \cancel{+ 0.57 *} \left(\frac{0.08\,\mathrm{mg} + 0.08\,\mathrm{mg}}{3.583\text{ miles} + 3.845\text{ miles}}\right)$$

ROH_{wm} = 0.045 g/mile (ethanol weighted mass emissions)

~~ROH_{wm} = 0.05 g (methanol weighted mass emissions)~~

~~5~~6. CARBONYL MASS EMISSIONS CALCULATIONS

~~5~~6.1. INTRODUCTION

Vehicular emissions are measured according to the FTP [Ref. 1]. For each of the three phases of the FTP, a set of two impingers (or cartridges) is used to collect carbonyl emissions in the dilute exhaust. A fourth set of two impingers (or cartridges) is used to collect a composite dilution air (background) carbonyl sample from all three phases of the FTP. All impingers (or cartridges) are analyzed according to Method No. 1004 to determine the mass of individual carbonyl compounds in each impinger (or cartridge). The measured carbonyl masses are used in the following equations to calculate the weighted mass emissions of each carbonyl compound.

~~5~~6.2. CARBONYL MASS EMISSIONS CALCULATION PER TEST PHASE

~~5~~6.2.1 $\text{RHO}_{\text{mass n}} = (\text{RHO}_{\text{conc}} * \text{RHO}_{\text{dens}} * \text{VMIX} * 10^{-6})$

~~5~~6.2.2 $\text{RHO}_{\text{conc}} = \text{RHO}_{\text{e}} - (\text{RHO}_{\text{d}} * (1 - (1 / \text{DF})))$
NOTE: If RHO_{conc} is calculated to be less than zero, then $\text{RHO}_{\text{conc}} = 0$.

~~5~~6.2.3 $\text{RHO}_{\text{e}} = (\text{Imass}_{\text{e}} / \text{Ivol}_{\text{e}}) * (\text{Mol. Vol.} / \text{Mol. Wt.})$

~~5~~6.2.4 $\text{Imass}_{\text{e}} = \text{Iconc}_{\text{ce}} * \text{Ivol}_{\text{c}}$

~~5~~6.2.5~~4~~ $\text{Ivol}_{\text{e}} = \text{Ivol}_{\text{em}} * (293.16^{\text{o}}\text{K} / \text{Itemp}_{\text{e}}) * (\text{P}_{\text{B}} / 760 \text{ mm Hg})$

~~5~~6.2.6~~5~~ $\text{RHO}_{\text{d}} = (\text{Imass}_{\text{d}} / \text{Ivol}_{\text{d}}) * (\text{Mol. Vol.} / \text{Mol. Wt.})$

~~5~~6.2.7 $\text{Imass}_{\text{d}} = \text{Iconc}_{\text{cd}} * \text{Ivol}_{\text{c}}$

~~5~~6.2.8~~6~~ $\text{Ivol}_{\text{d}} = \text{Ivol}_{\text{dm}} * (293.16^{\text{o}}\text{K} / \text{Itemp}_{\text{d}}) * (\text{P}_{\text{B}} / 760 \text{ mm Hg})$

~~5~~6.3. WEIGHTED CARBONYL MASS EMISSIONS CALCULATION

$$\text{RHO}_{\text{wm}} = 0.43 * \left(\frac{\text{RHO}_{\text{mass1}} + \text{RHO}_{\text{mass2}}}{\text{D}_{\text{phase1}} + \text{D}_{\text{phase2}}} \right) + 0.57 * \left(\frac{\text{RHO}_{\text{mass3}} + \text{RHO}_{\text{mass2}}}{\text{D}_{\text{phase3}} + \text{D}_{\text{phase2}}} \right)$$

~~5~~6.4. SAMPLE CALCULATION

~~5~~6.4.1 Carbonyl emissions from ~~a CNG~~ an E85 vehicle are collected in three sets of dilute exhaust impingers and one set of dilution air impingers during the FTP. HPLC is used to determine the ~~formaldehyde~~ carbonyl mass in each impinger. This is the same vehicle test as the example in section 3.3. Calculate the weighted formaldehyde and acetaldehyde mass emissions based on the following data, along with the data presented in section 3.3:

Test Phase	$Ivol_c$ (ml)	Formaldehyde		$Ivol_{em}$ (liter)	Acetaldehyde		$Ivol_{dm}$ (liter)	$Itemp_e$ (°K)	$Itemp_d$ (°K)
		$Iconc_{ce}$ (µg/mL)	$Iconc_{cd}$ (µg/mL)		$Iconc_{ce}$ (µg/mL)	$Iconc_{cd}$ (µg/mL)			
1	4.4	0.387	0.006	8.47	4.114	0.006	8.23	294.26	294.26
2	4.4	0.048	0.016	15.35	0.013	0.009	13.88	294.26	294.26
3	4.4	0.016	0.006	9.01	0.012	0.005	8.16	294.26	294.26

~~Test Phase~~	~~$Ivol_r$ (mL)~~	~~$Imass_e$ (µg)~~	~~$Ivol_{em}$ (liter)~~	~~$Imass_d$ (µg)~~	~~$Ivol_{dm}$ (liter)~~	~~$Itemp_e$ (°K)~~	~~$Itemp_d$ (°K)~~
~~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	$D_{phase\ n}$ (mile)	DF	P_B (mm HG)	VMIX (ft3)
1	3.591	14.27	760	3495
2	3.846	22.15	760	5799
3	3.591	17.33	760	3484

~~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 (mmHg)~~
~~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~~

Formaldehyde

For Phase 1:

$Imass_e$ = $Iconc_{ce}$ * $Ivol_c$
= 0.387 µg/mL * 4.4 mL
= 1.70 µg

Mol. Wt. of HCHO = (1 * 12.01115) + (2 * 1.00797) + (1 * 15.9994)
= 30.0268 g/mole

$Ivol_e$ = $Ivol_{em}$ * (293/16° K / $Itemp_e$) * (P_B / 760 mm Hg)
= 8.47 liter * (293.16°K / 294.26°K) * (760 mm Hg / 760 mm Hg)
= 8.44 liter

~~= 8.49 liter * (293.16°K / 295°K) * (760 mm Hg / 760 mm Hg)~~
~~= 8.44 liter~~

RHO_e = ($Imass_e$ / $Ivol_e$) * (Mol. Vol. / Mol. Wt.)
= (1.70 µg / 8.44 liter) * (24.055 liter/mole / 30.0268 g/mole)
= 0.16 ppm

~~= ($2.45*10^{-6}$ g / 8.44 liter) * (24.055 liter/mole / 30.0268 g/mole)~~
~~= 233 ppb~~

$Imass_d$ = $Iconc_{cd}$ * $Ivol_c$
= 0.006 µg/mL * 4.4 mL
= 0.026 µg

$Ivol_d$ = $Ivol_{dm}$ * (293.16°K / $Itemp_d$) * (P_B / 760 mm Hg)
= 8.23 liter * (293.16°K / 294.26°K) * (760 mm Hg / 760 mm Hg)
= 8.20 liter

~~= 31.57 liter * (293.16°K / 292°K) * (760 mm Hg / 760 mm Hg)~~
~~= 31.70 liter~~

RHO_d = ($Imass_d$ / $Ivol_d$) * (Mol. Vol. / Mol. Wt.)
= (0.026 µg / 8.20 liter) * (24.055 liter/mole / 30.0268 g/mole)
= 0.00258 ppm

~~= ($0.17*10^{-6}$ g / 31.70 liter)*(24.055 liter/mole / 30.0268 g/mole)~~
~~= 4 ppb~~

DF = 14.2688

~~DF = 9.77 / [CO_{2e} + ($NMHC_e$ + CH_{4e} + CO^e) * 10^{-4}]~~
~~(see section 6, DF Calc.)~~

~~$NMHC_e$ = FID THC_e - (r_{CH_4} * CH_{4e})~~
~~= 132 ppmC - (1.04 * 108 ppmC)~~
~~= 20 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 - 0.02890 * 0.9% - 0.000323 * 68%) * 8 ppm~~
~~= 7.6 ppm~~

~~DF = 9.77 / [0.9% + (20 ppmC + 108 ppmC + 7.6 ppm) * 10^{-4}]~~
~~= 10.69~~

RHO_{conc} = RHO_e - (RHO_d * (1 - (1 / DF)))

= 0.162 ppm - (0.00258 ppm * (1 - (1 / 14.27)))
= 0.1596 ppm

~~= 233 ppb - (4 ppb * (1 - (1 / 10.69)))~~
~~= 229 ppb~~

RHO_{dens} = (Mol. Wt. * conversion of liter to ft^3) / (Mol. Vol.)
= (30.0268 g/mole * 28.316 liter/ft^3) / 24.055 liter/mole
= 35.35 g/ft^3

VMIX = 3495 ft^3

$RHO_{mass\ n}$ = (RHO_{conc} * RHO_{dens} * VMIX * 10^{-6})
$RHO_{mass\ 1}$ = (0.1596 ppm * 35.35 g/ft^3 * 3495 ft^3 * 10^{-6} * 1000 mg/g)
= 19.718 mg

~~= (229 ppb * 35.35 g/ft^3 * 2866 ft^3 * 10^{-6})~~
~~= 23.2 mg~~

Similarly, for Phase 2: $RHO_{mass\ 2}$ = 1.457 ~~6.6~~ mg
and for Phase 3: $RHO_{mass\ 3}$= 0.472 ~~12.7~~ mg

Therefore,

$$RHO_{wm} = 0.43 * \left(\frac{RHO_{mass1} + RHO_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{RHO_{mass3} + RHO_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

$$RHO_{wm} = 0.43 * \left(\frac{19.718\,mg + 1.457\,mg}{3.591\ miles + 3.846\ miles} \right) + 0.57 * \left(\frac{0.472\,mg + 1.457\,mg}{3.591\ miles + 3.846\ miles} \right)$$

~~$RHO_{wm} = 0.43 * \left(\frac{23.2\,mg + 6.6\,mg}{3.581\ miles + 3.845\ miles} \right) + 0.57 * \left(\frac{12.7\,mg + 6.6\,mg}{3.583\ miles + 3.845\ miles} \right)$~~

RHO_{wm} = 1.371 ~~3.2~~ mg/mi (formaldehyde weighted mass emissions)

Acetaldehyde

Similarly,

Phase 1: $RHO_{mass\ 1}$ = 212 mg
Phase 2: $RHO_{mass\ 2}$ = 0.165 mg
Phase 3: $RHO_{mass\ 3}$ = 0.329 mg

$$\mathrm{RHO_{wm}} = 0.43 * \left(\frac{212\,\mathrm{mg} + 0.165\,\mathrm{mg}}{3.591\ \mathrm{miles} + 3.846\ \mathrm{miles}} \right) + 0.57 * \left(\frac{0.329\,\mathrm{mg} + 0.165\,\mathrm{mg}}{3.591\ \mathrm{miles} + 3.846\ \mathrm{miles}} \right)$$

RHO$_{wm}$ = 0.0123 mg/mi (acetaldehyde weighted mass emissions)

5~~.4.2 Carbonyl emissions from a gasoline vehicle are collected in three sets of dilute exhaust cartridges and dilution air cartridges during the FTP. HPLC is used to determine the formaldehyde mass in each cartridge. Calculate the weighted formaldehyde mass emissions based on the following data:~~

~~Test Phase~~	~~Iconc$_{ee}$ (µg/mL)~~	~~Iconc$_{ed}$ (µg/mL)~~	~~Iconc$_{blk}$ (µg/mL)~~	~~Ivol$_{dm}$ (liter)~~	~~Ivol$_{em}$ (liter)~~	~~Itemp$_e$ (°K)~~	~~Itemp$_d$ (°K)~~
~~1~~	~~1.212~~	~~0.028~~	~~0.0~~	~~8.61~~	~~8.57~~	~~294.26~~	~~294.26~~
~~2~~	~~0.334~~	~~0.043~~	~~0.0~~	~~14.91~~	~~13.83~~	~~294.26~~	~~294.26~~
~~3~~	~~0.172~~	~~0.026~~	~~0.0~~	~~8.68~~	~~8.74~~	~~294.26~~	~~294.26~~

~~Test Phase~~	~~FID THC$_e$ (ppmC)~~	~~CH$_{4e}$ (ppmC)~~	~~CO$_{2e}$ (%)~~	~~CO$_{em}$ (ppm)~~	~~R$_a$ (%)~~	~~VMIX (ft^3)~~	~~D$_{phase\ n}$ (mile)~~	~~P$_B$ (mmHg)~~
~~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 all three phases Ivole = 4.4 mL~~

~~For Phase 1:~~

~~Imass$_d$ = (Iconc$_{ed}$ - Iconc$_{blk}$)*Ivol$_e$~~

~~Imass$_d$ = (0.028 - 0.0) µg/mL * 4.4 mL = 0.1232 µg~~

~~Imass$_e$ = (Iconc$_{ee}$ - Iconc$_{blk}$)*Ivol$_e$~~

~~Imass$_e$ = (1.212 - 0.0) µg/mL * 4.4 mL = 5.33 µg~~

~~Mol. Wt. of HCHO = (1 * 12.01115) + (2 * 1.00797) + (1 * 15.9994)~~
~~= 30.0265 g/mole~~

~~Ivol$_e$ = Ivol$_{em}$ * (293/16^{o} K / Itemp$_e$) * (P$_B$ / 760 mm Hg)~~

~~= 8.57 liter * (293.16°K / 294.26°K) * (760 mm Hg / 760 mm Hg)~~
~~= 8.54 liter~~

~~RHO_e = ($Imass_e$ / $Ivol_e$) * (Mol. Vol. / Mol. Wt.)~~
~~= ($5.33*10^{-6}$ g / 8.54 liter) * (24.055 liter/mole / 30.0265 g/mole)~~
~~= 500 ppb~~

~~$Ivol_d$ = $Ivol_{dm}$ * (293.16°K / $Itemp_d$) * (P_B / 760 mm Hg)~~
~~= 8.61 liter * (293.16°K / 294.26°K) * (760 mm Hg / 760 mm Hg)~~
~~= 8.58 liter~~

~~RHO_d = ($Imass_d$ / $Ivol_d$) * (Mol. Vol. / Mol. Wt.)~~
~~= ($0.1232*10^{-6}$g / 8.58 liter)*(24.055 liter/mole / 30.0265 g/mole)~~
~~= 11.5 ppb~~

~~DF = 9.77 / [CO_{2e} + ($NMHC_e$ + CH_{4e} + CO_e) * 10^{-4}]~~
~~(see section 6, DF Calc.)~~

~~$NMHC_e$ = FID THC_e – (r_{CH_4} * CH_{4e})~~
~~= 132 ppmC - (1.04 * 108 ppmC)~~
~~= 20 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 - 0.02890 * 0.9% - 0.000323 * 68%) * 8 ppm~~
~~= 7.6 ppm~~

~~DF = 9.77 / [0.9% + (20 ppmC + 108 ppmC + 7.6 ppm) * 10^{-4}]~~
~~= 10.69~~

~~RHO_{conc} = RHO_e – (RHO_d * (1 – (1 / DF)))~~
~~= 500 ppb - (11.5 ppb * (1 - (1 / 10.69)))~~
~~= 489.6 ppb (formaldehyde)~~

~~RHO_{dens} = (Mol. Wt. * conversion of liter to ft^3) / (Mol. Vol.)~~
~~= (30.0265 g/mole * 28.316 liter/ft^3) / 24.055 liter/mole~~
~~= 35.35 g/ft^3~~

~~$RHO_{mass\ n}$ = (RHO_{conc} * RHO_{dens} * VMIX * 10^{-6})~~

~~$RHO_{mass\ 1}$ = (489.6 ppb * 35.35 g/ft^3 * 2866 ft^3 * 10^{-6})~~
~~= 49.6 mg (formaldehyde)~~

~~Similarly, for Phase 2: $RHO_{mass\ 2}$ = 12.9 mg~~

~~and similarly for Phase 3: $RHO_{mass\ 3} = 5.6\ mg$~~

~~Therefore,~~

~~$RHO_{wm} = 0.43 * \left(\frac{RHO_{mass\,1} + RHO_{mass\,2}}{D_{phase\,1} + D_{phase\,2}}\right) + 0.57 * \left(\frac{RHO_{mass\,3} + RHO_{mass\,2}}{D_{phase\,3} + D_{phase\,2}}\right)$~~

~~$RHO_{wm} = 0.43 * \left(\frac{49.6\ mg + 12.9\ mg}{3.581 miles + 3.845\ miles}\right) + 0.57 * \left(\frac{5.6\ mg + 12.9\ mg}{3.583\ miles + 3.845\ miles}\right)$~~

~~$RHO_{wm} = 5.04$ mg/mi (formaldehyde weighted mass emissions)~~

~~6. DILUTION FACTOR CALCULATION~~

~~6.1. For Non-Alcohol Fueled Vehicles~~

~~6.1.1 $DF = \frac{100 * \left(\frac{x}{x + y/2 + 3.76 * (x + y/4 - z/2)}\right)}{CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}}$~~

~~(where fuel composition is $C_xH_yO_z$ as measured for the fuel used.)~~

~~6.1.2 $CO_e = (1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$~~

~~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:~~
~~$DF = 13.47 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}$~~
~~$CO_e = (1 - 0.01925 * CO_{2e} - 0.000323 * R_a) * CO_{em}$~~

~~b) For Phase 2 gasoline, $CH_{1.94}$, where x = 1, y = 1.94 and z = 0.017,~~
~~$DF = 13.29 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}$~~
~~$CO_e = (1 - 0.01970 * CO_{2e} - 0.000323 * R_a) * CO_{em}$~~

~~c) For LPG, $CH_{2.64}$, where x = 1, y = 2.64, z = 0:~~
~~$DF = 11.68 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}$~~
~~$CO_e = (1 - 0.02320 * CO_{2e} - 0.000323 * R_a) * CO_{em}$~~

~~d) For CNG, $CH_{3.78}$, where x = 1, y = 3.78, and z = 0.016:~~

~~DF = 9.83 / [[CO$_{2e}$ + (NMHC$_e$ + CH$_{4e}$ + CO$_e$) * 10^{-4}]~~
~~CO$_e$ = (1 - 0.02890 * CO$_{2e}$ - 0.000323 * R$_a$) * CO$_{em}$~~

~~6.2. **For Alcohol Fueled Vehicles**:~~

~~6.2.1~~

$$\mathrm{DF}=\frac{100*\left(\dfrac{x}{x+y/2+3.76*(x+y/4-z/2)}\right)}{\mathrm{CO}_{2e}+\left(\mathrm{NMHC}_{e}+\mathrm{CH}_{4e}+\mathrm{CO}_{e}+\mathrm{ROH}_{e}+\mathrm{HCHO}_{e}\right)*10^{-4}}$$

~~(where fuel composition is C$_x$H$_y$O$_z$ as measured for the fuel used.)~~

~~6.2.2 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$_3$OH, 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 = 12.02 / [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$_2$H$_5$OH, where x = 1, y = 3, and z = 0.5:~~
~~DF = 12.29 / [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$_{em}$~~

7 NONMHC MASS EMISIONS CALCULATION

7.1 Non-oxygenated non-methane hydrocarbon is calculated from the FID NMHC measurement using the following equation:

$$\mathrm{NONMHC}_{\mathrm{mass}}=\mathrm{NMHC}_{\mathrm{mass}}-\mathrm{NMHC}_{\mathrm{dens}}*\sum\left(\frac{\mathrm{ROH}_{\mathrm{mass}}}{\mathrm{ROH}_{\mathrm{dens}}}\right)*r_{\mathrm{ROH}}-\mathrm{NMHC}_{\mathrm{dens}}*\sum\left(\frac{\mathrm{RHO}_{\mathrm{mass}}}{\mathrm{RHO}_{\mathrm{dens}}}\right)*r_{\mathrm{RHO}}$$

7.1.1 For the purpose of calculating NMOG for vehicles tested on exhaust emission test fuel containing ethanol:

7.1.1.1 The only alcohol included in the above calculation is ethanol.

7.1.1.2 The only carbonyl compounds included in the above calculation are formaldehyde and acetaldehyde.

7.2 FID Response Factors:

FID response factors are experimentally determined for each individual FID. The following values are used in the sample calculations and are presented for example only.

Oxygenated species	Response factor* (*RF*)
methanol	0.85
ethanol	0.756
formaldehyde	0
acetaldehyde	0.5

* Response factors are normalized to propane, i.e., propane has a response factor of 1.000.

7.3 Sample Calculation

Continuing from the same E85 test used in the alcohol and carbonyl calculations:

Test Phase	$\text{NMHC}_{\text{mass n}}$ (g)	$\text{Ethanol}_{\text{mass n}}$ (g)	$\text{Formaldehyde}_{\text{massn}}$ (g)	$\text{Acetaldehyde}_{\text{mass n}}$ (g)
1	1.1220	0.09271	0.0197	0.212
2	0	0	0.001457	0.000165
3	0.0026	0	0.000472	0.000329

and

$\text{NMHC}_{\text{dens}} = 17.44\ \text{g/ft}^3$

$$\text{NONMHC}_{\text{mass1}} = \text{NMHC}_{\text{mass1}} - \text{NMHC}_{\text{dens}} * \sum\left(\frac{\text{ROH}_{\text{mass1}}}{\text{ROH}_{\text{dens}}}\right) * r_{\text{ROH}} - \text{NMHC}_{\text{dens}} * \sum\left(\frac{\text{RHO}_{\text{mass1}}}{\text{RHO}_{\text{dens}}}\right) * r_{\text{RHO}}$$

$$\begin{aligned}
\text{NONMHC}_{\text{mass1}} &= 1.1220 - 17.44\ \text{g/ft}^3 * (0.9271\ \text{g} / 27.116\ (\text{g/ft}^3)) * 0.756 \\
&\quad - 17.44\ \text{g/ft}^3 * (0.0197\ \text{g} / 35.350\ (\text{g/ft}^3)) * 0 \\
&\quad - 17.44\ \text{g/ft}^3 * (0.212\ \text{g} / 25.929\ (\text{g/ft}^3)) * 0.5 \\
&= 1.1220 - 0.4508 - 0 - 0.0713 \\
&= 0.5999\ \text{g}
\end{aligned}$$

$$\begin{aligned}
\text{NONMHC}_{\text{mass2}} &= 0 - 17.44\ \text{g/ft}^3 * (0\ \text{g} / 27.116\ (\text{g/ft}^3)) * 0.756 \\
&\quad - 17.44\ \text{g/ft}^3 * (0.001457\ \text{g} / 35.350\ (\text{g/ft}^3)) * 0 \\
&\quad - 17.44\ \text{g/ft}^3 * (0.000165\ \text{g} / 25.929\ (\text{g/ft}^3)) * 0.5 \\
&= 0 - 0 - 0 - 0.000055 \\
&= 0\ \text{g}
\end{aligned}$$

Note: Results that are less than zero are reported as zero.

$$\begin{aligned}\text{NONMHC}_{\text{mass3}} &= 0.0026 \;- 17.44\ \text{g/ft}^3 * (\ 0\ \text{g} / 27.116\ (\text{g/ft}^3)) * 0.756\\ &\qquad\quad - 17.44\ \text{g/ft}^3 * (\ 0.000472\ \text{g} / 35.350\ (\text{g/ft}^3)) * 0\\ &\qquad\quad - 17.44\ \text{g/ft}^3 * (\ 0.000329\ \text{g} / 25.929\ (\text{g/ft}^3)) * 0.5\\ &= 0.0026 \;- 0 - 0 - 0.000111\\ &= 0.00249\ \text{g}\end{aligned}$$

8 WEIGHTED HYDROCARBON MASS EMISSIONS CALCULATION

8.1 Weighted NMOG is determined using the following equation:

$$\text{NMOG}_{\text{wm}} = \sum \text{NONMHC}_{\text{wm}} + \sum \text{ROH}_{\text{wm}} + \sum \text{RHO}_{\text{wm}}$$

where:

$$\text{NONMHC}_{\text{wm}} = 0.43 * \left(\frac{\text{NONMHC}_{\text{mass1}} + \text{NONMHC}_{\text{mass2}}}{\text{D}_{\text{phase1}} + \text{D}_{\text{phase2}}} \right) + 0.57 * \left(\frac{\text{NONMHC}_{\text{mass3}} + \text{NONMHC}_{\text{mass2}}}{\text{D}_{\text{phase3}} + \text{D}_{\text{phase2}}} \right)$$

$$\text{ROH}_{\text{wm}} \;\; = \;\; 0.43 * \left(\frac{\text{ROH}_{\text{mass1}} + \text{ROH}_{\text{mass2}}}{\text{D}_{\text{phase1}} + \text{D}_{\text{phase2}}} \right) + 0.57 * \left(\frac{\text{ROH}_{\text{mass3}} + \text{ROH}_{\text{mass2}}}{\text{D}_{\text{phase3}} + \text{D}_{\text{phase2}}} \right)$$

$$\text{RHO}_{\text{wm}} = 0.43 * \left(\frac{\text{RHO}_{\text{mass1}} + \text{RHO}_{\text{mass2}}}{\text{D}_{\text{phase1}} + \text{D}_{\text{phase2}}} \right) + 0.57 * \left(\frac{\text{RHO}_{\text{mass3}} + \text{RHO}_{\text{mass2}}}{\text{D}_{\text{phase3}} + \text{D}_{\text{phase2}}} \right)$$

8.1.1 For the purpose of calculating NMOG for vehicles tested on exhaust emission test fuel containing ethanol:

8.1.1.1 The only alcohol included in the weighted NMOG calculation is ethanol.

8.1.1.2 The only carbonyl compounds included in the weighted NMOG calculation are formaldehyde and acetaldehyde.

8.2 Sample calculation

Continuing from the previous example:

Test Phase	$\text{NONMHC}_{\text{mass n}}$ (g)	$\text{Ethanol}_{\text{mass n}}$ (g)	$\text{Formaldehyde}_{\text{mass n}}$ (g)	$\text{Acetaldehyde}_{\text{mass n}}$ (g)	Distance (mile)
1	0.5999	0.9271	0.019718	0.212	3.591
2	0	0	0.001457	0.000165	3.846

3	0.00249	0	0.000472	0.000329	3.591

$$\text{NONMHC}_{\text{wm}} = 0.43 * \left(\frac{0.5999\ \text{g} + 0\ \text{g}}{3.591\ \text{miles} + 3.846\ \text{miles}} \right) + 0.57 * \left(\frac{0.00249\ \text{g} + 0\ \text{g}}{3.591\ \text{miles} + 3.846\ \text{miles}} \right)$$

$\text{NONMHC}_{\text{wm}}$ = 0.03488 g/mile
Similarly, $\text{Ethanol}_{\text{wm}}$ = 0.05360 g/mile
Similarly, $\text{Formaldehyde}_{\text{wm}}$ = 0.00137 g/mile
Similarly, $\text{Acetaldehyde}_{\text{wm}}$ = 0.01231 g/mile

With all the above information, the weighted mass emissions of non-methane organic gas can be calculated:

$$\text{NMOG}_{\text{wm}} = \sum \text{NONMHC}_{\text{wm}} + \sum \text{ROH}_{\text{wm}} + \sum \text{RHO}_{\text{wm}}$$

NMOG_{wm} = 0.03488 g/mile + 0.05360 g/mile + 0.00137 g/mile + 0.01231 g/mile
= 0.102 g/mile

APPENDIX 1

LIST OF COMPOUNDS

CAS #	COMPOUND	MIR
	Alcohols	
00067-56-1	methanol	~~0.71~~ 0.67
00064-17-5	ethanol	~~1.69~~ 1.53
	Light End and Mid-Range Hydrocarbons (Listed in approximate elution order)	
00074-85-1	ethene	~~9.08~~ 9.00
00074-86-2	ethyne	~~1.25~~ 0.95
00074-84-0	ethane	~~0.31~~ 0.28
00115-07-1	propene	~~11.58~~ 11.66
00074-98-6	propane	~~0.56~~ 0.49
00463-49-0	1,2-propadiene	~~12.16~~ 8.45
00074-99-7	1-propyne	~~6.45~~ 6.72
00075-28-5	2-methylpropane	~~1.35~~ 1.23
00115-11-7	2-methylpropene	~~6.35~~ 6.29
00106-98-9	1-butene	~~10.29~~ 9.73
00106-99-0	1,3-butadiene	~~13.58~~ 12.61
00106-97-8	n-butane	~~1.33~~ 1.15
00624-64-6	trans-2-butene	~~13.91~~ 15.16
00463-82-1	2,2-dimethylpropane	~~1.68~~ 0.67
00107-00-6	1-butyne	~~6.20~~ 6.11
00590-18-1	cis-2-butene	~~13.22~~ 14.24
00563-45-1	3-methyl-1-butene	6.99
00078-78-4	2-methylbutane	~~1.68~~ 1.45
00503-17-3	2-butyne	~~16.33~~ 16.32
00109-67-1	1-pentene	~~7.79~~ 7.21
00563-46-2	2-methyl-1-butene	~~6.51~~ 6.40
00109-66-0	n-pentane	~~1.54~~ 1.31
00078-79-5	2-methyl-1,3-butadiene	~~10.69~~ 10.61
00646-04-8	trans-2-pentene	~~10.23~~ 10.56
00558-37-2	3,3-dimethyl-1-butene	~~6.06~~ 5.82
00627-20-3	cis-2-pentene	~~10.24~~ 10.38
00689-97-4	1-buten-3-yne	~~11.09~~ 10.48
00513-35-9	2-methyl-2-butene	~~14.45~~ 14.08
00542-92-7	1,3-cyclopentadiene	~~7.61~~ 6.98
00075-83-2	2,2-dimethylbutane	~~1.33~~ 1.17
00142-29-0	cyclopentene	~~7.38~~ 6.77
00691-37-2	4-methyl-1-pentene	~~6.26~~ 5.68

CAS #	COMPOUND	MIR
00760-20-3	3-methyl-1-pentene	~~6.22~~ 6.14
00287-92-3	cyclopentane	~~2.69~~ 2.39
00079-29-8	2,3-dimethylbutane	~~1.14~~ 0.97
01634-04-4	1-methyl-tert-butyl-ether	~~0.78~~ 0.73
00691-38-3	4-methyl-cis-2-pentene	~~8.44~~ 8.12
00107-83-5	2-methylpentane	~~1.80~~ 1.50
00674-76-0	4-methyl-trans-2-pentene	~~8.44~~ 8.12
00096-14-0	3-methylpentane	~~2.07~~ 1.80
00763-29-1	2-methyl-1-pentene	~~5.18~~ 5.26
00592-41-6	1-hexene	~~6.17~~ 5.49
00110-54-3	n-hexane	~~1.45~~ 1.24
13269-52-8	trans-3-hexene	~~8.16~~ 7.57
07642-09-3	cis-3-hexene	~~8.22~~ 7.61
04050-45-7	trans-2-hexene	~~8.44~~ 8.62
00616-12-6	3-methyl-trans-2-pentene	~~8.44~~ 13.17
00625-27-4	2-methyl-2-pentene	~~12.28~~ 11.00
01120-62-3	3-methylcyclopentene	~~8.65~~ 5.10
07688-21-3	cis-2-hexene	~~8.44~~ 8.31
00637-92-3	1-ethyl-tert-butyl-ether	~~2.11~~ 2.01
00922-62-3	3-methyl-cis-2-pentene	~~8.44~~ 12.49
00590-35-2	2,2-dimethylpentane	~~1.22~~ 1.12
00096-37-7	methylcyclopentane	~~2.42~~ 2.19
00108-08-7	2,4-dimethylpentane	~~1.65~~ 1.55
00464-06-2	2,2,3-trimethylbutane	~~1.32~~ 1.11
07385-78-6	3,4-dimethyl-1-pentene	~~4.56~~ 4.84
00693-89-0	1-methylcyclopentene	~~13.95~~ 12.49
00071-43-2	benzene	~~0.81~~ 0.72
03404-61-3	3-methyl-1-hexene	4.56 ~~4.41~~
00562-49-2	3,3-dimethylpentane	~~1.32~~ 1.20
00110-82-7	cyclohexane	~~1.46~~ 1.25
00591-76-4	2-methylhexane	~~1.37~~ 1.19
00565-59-3	2,3-dimethylpentane	~~1.55~~ 1.34
00110-83-8	cyclohexene	~~5.45~~ 5.00
00589-34-4	3-methylhexane	~~1.86~~ 1.61
01759-58-6	trans-1,3-dimethylcyclopentane	~~2.15~~ 1.94
02532-58-3	cis-1,3-dimethylcyclopentane	~~2.15~~ 1.94
00617-78-7	3-ethylpentane	~~1.63~~ 1.90
00822-50-4	trans-1,2-dimethylcyclopentane	1.99
00592-76-7	1-heptene	~~4.56~~ 4.43
00540-84-1	2,2,4-trimethylpentane	~~1.44~~ 1.26
14686-14-7	trans-3-heptene	~~6.96~~ 6.32
00142-82-5	n-heptane	~~1.28~~ 1.07
02738-19-4	2-methyl-2-hexene	~~6.96~~ 9.47
03899-36-3	3-methyl-trans-3-hexene	~~6.96~~ 9.72
14686-13-6	trans-2-heptene	~~7.33~~ 7.14

CAS #	COMPOUND	MIR
00816-79-5	3-ethyl-2-pentene	~~6.96~~ 9.75
00107-39-1	2,4,4-trimethyl-1-pentene	~~3.45~~ 3.34
10574-37-5	2,3-dimethyl-2-pentene	~~6.96~~ 9.74
06443-92-1	cis-2-heptene	~~6.96~~ 7.16
00108-87-2	methylcyclohexane	~~1.99~~ 1.70
00590-73-8	2,2-dimethylhexane	~~1.13~~ 1.02
00107-40-4	2,4,4-trimethyl-2-pentene	~~5.85~~ 6.29
01640-89-7	ethylcyclopentane	~~2.27~~ 2.01
00592-13-2	2,5-dimethylhexane	~~1.68~~ 1.46
00589-43-5	2,4-dimethylhexane	~~1.80~~ 1.73
02815-58-9	1,2,4-trimethylcyclopentane	~~1.75~~ 1.53
00563-16-6	3,3-dimethylhexane	~~1.57~~ 1.24
00565-75-3	2,3,4-trimethylpentane	~~1.23~~ 1.03
00560-21-4	2,3,3-trimethylpentane	~~1.57~~ 1.02
00108-88-3	toluene	~~3.97~~ 4.00
00584-94-1	2,3-dimethylhexane	~~1.34~~ 1.19
00592-27-8	2-methylheptane	~~1.20~~ 1.07
00589-53-7	4-methylheptane	~~1.48~~ 1.25
00589-81-1	3-methylheptane	~~1.35~~ 1.24
15890-40-1	(1a,2a,3b)-1,2,3-trimethylcyclopentane	~~1.75~~ 1.63
00638-04-0	cis-1,3-dimethylcyclohexane	~~1.72~~ 1.52
02207-04-7	trans-1,4-dimethylcyclohexane	~~1.75~~ 1.47
03522-94-9	2,2,5-trimethylhexane	~~1.33~~ 1.13
02613-65-2	trans-1-methyl-3-ethylcyclopentane	~~1.75~~ 1.64
16747-50-5	cis-1-methyl-3-ethylcyclopentane	~~1.75~~ 1.64
00111-66-0	1-octene	~~3.45~~ 3.25
14850-23-8	trans-4-octene	~~5.90~~ 4.81
00111-65-9	n-octane	~~1.11~~ 0.90
13389-42-9	trans-2-octene	~~5.90~~ 6.00
02207-03-6	trans-1,3-dimethylcyclohexane	~~1.72~~ 1.52
07642-04-8	cis-2-octene	~~5.90~~ 4.81
01069-53-0	2,3,5-trimethylhexane	~~1.33~~ 1.22
02213-23-2	2,4-dimethylheptane	~~1.48~~ 1.38
02207-01-4	cis-1,2-dimethylcyclohexane	~~1.75~~ 1.41
01072-05-5	2,6-dimethylheptane	~~1.25~~ 1.04
01678-91-7	ethylcyclohexane	~~1.75~~ 1.47
00926-82-9	3,5-dimethylheptane	~~1.63~~ 1.56
00100-41-4	ethylbenzene	~~2.79~~ 3.04
03074-71-3	2,3-dimethylheptane	~~1.25~~ 1.09
00108-38-3	m-&p-xylene	~~8.49~~ 8.45
02216-34-4	4-methyloctane	~~1.08~~ 0.95
03221-61-2	2-methyloctane	~~0.96~~ 0.83
02216-33-3	3-methyloctane	~~1.25~~ 0.99
00100-42-5	styrene (ethenylbenzene)	~~1.95~~ 1.73
00095-47-6	o-xylene	~~7.49~~ 7.64

CAS #	**COMPOUND**	**MIR**
00124-11-8	1-nonene	~~2.76~~ 2.60
00111-84-2	n-nonane	~~0.95~~ 0.78
00098-82-8	(1-methylethyl)benzene	~~2.32~~ 2.52
15869-87-1	2,2-dimethyloctane	~~1.09~~ 0.83
04032-94-4	2,4-dimethyloctane	~~1.09~~ 1.03
02051-30-1	2,6-dimethyloctane	~~1.27~~ 1.08
00103-65-1	n-propylbenzene	~~2.20~~ 2.03
00620-14-4	1-methyl-3-ethylbenzene	~~6.61~~ 7.39
00622-96-8	1-methyl-4-ethylbenzene	~~6.61~~ 4.44
00108-67-8	1,3,5-trimethylbenzene	~~11.22~~ 11.76
00611-14-3	1-methyl-2-ethylbenzene	~~6.61~~ 5.59
00095-63-6	1,2,4-trimethylbenzene	~~7.18~~ 8.87
00124-18-5	n-decane	~~0.83~~ 0.68
00538-93-2	(2-methylpropyl)benzene	~~1.97~~ 2.36
00135-98-8	(1-methylpropyl)benzene	~~1.97~~ 2.36
00535-77-3	1-methyl-3-(1-methylethyl)benzene	~~5.92~~ 7.10
00526-73-8	1,2,3-trimethylbenzene	~~11.26~~ 11.97
00099-87-6	1-methyl-4-(1-methylethyl)benzene	~~5.92~~ 4.44
00496-11-7	2,3-dihydroindene (indan)	~~3.17~~ 3.32
00527-84-4	1-methyl-2-(1-methylethyl)benzene	~~5.92~~ 5.49
00141-93-5	1,3-diethylbenzene	~~5.92~~ 7.10
00105-05-5	1,4-diethylbenzene	~~5.92~~ 4.43
01074-43-7	1-methyl-3-n-propylbenzene	~~5.92~~ 7.10
01074-55-1	1-methyl-4-n-propylbenzene	~~5.92~~ 4.43
00135-01-3	1,2-diethylbenzene	~~5.92~~ 5.49
01074-17-5	1-methyl-2-n-propylbenzene	~~5.92~~ 5.49
01758-88-9	1,4-dimethyl-2-ethylbenzene	~~8.86~~ 7.55
00874-41-9	1,3-dimethyl-4-ethylbenzene	~~8.86~~ 7.55
00934-80-5	1,2-dimethyl-4-ethylbenzene	~~8.86~~ 7.55
02870-04-4	1,3-dimethyl-2-ethylbenzene	~~8.86~~ 10.15
01120-21-4	n-undecane (hendecane)	~~0.74~~ 0.61
00933-98-2	1,2-dimethyl-3-ethylbenzene	~~8.86~~ 10.15
00095-93-2	1,2,4,5-tetramethylbenzene	~~8.86~~ 9.26
01595-11-5	1-methyl-2-n-butylbenzene	~~5.35~~ 4.73
00527-53-7	1,2,3,5-tetramethylbenzene	~~8.86~~ 9.26
01074-92-6	1-(1,1-dimethylethyl)-2-methylbenzene	~~5.35~~ 4.73
00488-23-3	1,2,3,4-tetramethylbenzene	~~8.86~~ 9.26
00538-68-1	n-pentylbenzene	~~1.78~~ 2.12
00098-19-1	1-(1,1-dimethylethyl)-3,5-DMbenzene	~~7.33~~ 8.02
00091-20-3	naphthalene	~~3.26~~ 3.34
00112-40-3	n-dodecane	~~0.66~~ 0.55

CAS #	COMPOUND	MIR

Carbonyl Compounds

00050-00-0	formaldehyde	~~8.97~~ 9.46
00075-07-0	acetaldehyde	~~6.84~~ 6.54
00107-02-8	acrolein	~~7.60~~ 7.45
00067-64-1	acetone	~~0.43~~ 0.36
00123-38-6	propionaldehyde	~~7.89~~ 7.08
00123-72-8	butyraldehyde	~~6.74~~ 5.97
00066-25-1	hexanaldehyde	~~4.98~~ 4.35
00100-52-7	benzaldehyde	0.00
00078-93-3	methyl ethyl ketone (2-butanone)	~~1.49~~ 1.48
00078-85-3	methacrolein	~~6.23~~ 6.01
04170-30-3	crotonaldehyde	~~10.07~~ 9.39
00110-62-3	valeraldehyde	~~5.76~~ 5.08
00620-23-5	m-tolualdehyde	0.00

List of Compounds
(Listed by CAS number)

00050-00-0	formaldehyde
00064-17-5	ethanol
00066-25-1	hexanaldehyde
00067-56-1	methanol
00067-64-1	acetone
00071-43-2	benzene
00074-84-0	ethane
00074-85-1	ethene
00074-86-2	ethyne
00074-98-6	propane
00074-99-7	1-propyne
00075-07-0	acetaldehyde
00075-28-5	2-methylpropane
00075-83-2	2,2-dimethylbutane
00078-78-4	2-methylbutane
00078-79-5	2-methyl-1,3-butadiene
00078-85-3	methacrolein
00078-93-3	methyl ethyl ketone (2-butanone)
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	stryrene (ethenylbenzene)
00100-52-7	benzaldehyde
00103-65-1	n-propylbenzene
00105-05-5	1,4-diethylbenzene
00106-97-8	n-butane
00106-98-9	1-butene
00106-99-0	1,3-butadiene
00107-00-6	1-butyne
00107-02-8	acrolein
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
00109-66-0	n-pentane
00109-67-1	1-pentene
00110-54-3	n-hexane
00110-62-3	valeraldehyde
00110-82-7	cyclohexane
00110-83-8	cyclohexene
00111-65-9	n-octane
00111-66-0	1-octene
00111-84-2	n-nonane
00112-40-3	n-dodecane
00115-07-1	propene
00115-11-7	2-methylpropene
00123-38-6	propionaldehyde
00123-72-8	butyraldehyde
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
00142-29-0	cyclopentene
00142-82-5	n-heptane
00287-92-3	cyclopentane
00463-49-0	1,2-propadiene
00463-82-1	2,2-dimethylpropane
00464-06-2	2,2,3-trimethylbutane
00488-23-3	1,2,3,4-tetramethylbenzene
00496-11-7	2,3-dihydroindene (indan)
00503-17-3	2-butyne
00513-35-9	2-methyl-2-butene
00526-73-8	1,2,3-trimethylbenzene
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
00542-92-7	1,3-cyclopentadiene
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
00563-45-1	3-methyl-1-butene

00563-46-2	2-methyl-1-butene
00565-59-3	2,3-dimethylpentane
00565-75-3	2,3,4-trimethylpentane
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
00590-18-1	cis-2-butene
00590-35-2	2,2-dimethylpentane
00590-73-8	2,2-dimethylhexane
00591-76-4	2-methylhexane
00592-13-2	2,5-dimethylhexane
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
00620-23-5	m-tolualdehyde
00622-96-8	1-methyl-4-ethylbenzene
00624-64-6	trans-2-butene
00625-27-4	2-methyl-2-pentene
00627-20-3	cis-2-pentene
00637-92-3	1-ethyl-tert-butyl-ether
00638-04-0	cis-1,3-dimethylcyclohexane
00646-04-8	trans-2-pentene
00674-76-0	4-methyl-trans-2-pentene
00689-97-4	1-buten-3-yne
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-2-pentene
00822-50-4	trans-1,2-dimethylcyclopentane
00874-41-9	1,3-dimethyl-4-ethylbenzene
00922-62-3	3-methyl-cis-2-pentene
00926-82-9	3,5-dimethylheptane
00933-98-2	1,2-dimethyl-3-ethylbenzene
00934-80-5	1,2-dimethyl-4-ethylbenzene
01069-53-0	2,3,5-trimethylhexane
01072-05-5	2,6-dimethylheptane
01074-17-5	1-methyl-2-n-propylbenzene
01074-43-7	1-methyl-3-n-propylbenzene

01074-55-1	1-methyl-4-n-propylbenzene
01074-92-6	1-(1,1-dimethylethyl)-2-methylbenzene
01120-21-4	n-undecane (hendecane)
01120-62-3	3-methylcyclopentene
01595-11-5	1-methyl-2-n-butylbenzene
01634-04-4	1-methyl-tert-butyl-ether
01640-89-7	ethylcyclopentane
01678-91-7	ethylcyclohexane
01758-88-9	1,4-dimethyl-2-ethylbenzene
01759-58-6	trans-1,3-dimethylcyclopentane
02051-30-1	2,6-dimethyloctane
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
02216-34-4	4-methyloctane
02532-58-3	cis-1,3-dimethylcyclopentane
02613-65-2	trans-1-methyl-3-ethylcyclopentane
02738-19-4	2-methyl-2-hexene
02815-58-9	1,2,4-trimethylcyclopentane
02870-04-4	1,3-dimethyl-2-ethylbenzene
03074-71-3	2,3-dimethylheptane
03221-61-2	2-methyloctane
03404-61-3	3-methyl-1-hexene
03522-94-9	2,2,5-trimethylhexane
03899-36-3	3-methyl-trans-3-hexene
04032-94-4	2,4-dimethyloctane
04050-45-7	trans-2-hexene
04170-30-3	crotonaldehyde
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
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	(1a,2a,3b)-1,2,3-trimethylcyclopentane
16747-50-5	cis-1-methyl-3-ethylcyclopentane

APPENDIX 2

DEFINITIONS AND COMMONLY USED ABBREVIATIONS

I. The abbreviations and definitions set forth in this section apply to Parts A through G of these test procedures:

ASTM = American Society for Testing and Materials

Carbon No. = number of carbon atoms in the hydrocarbon or organic compound being measured.

CCR = California Code of Regulations

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.

CNG = compressed natural gas

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, %.

CVS = constant volume sampler

$D_{\text{phase n}}$ = the distance driven by the test vehicle on a chassis dynamometer during test phase n (where n is either 1, 2, or 3), mile.

~~Dens_{ROH} = density of alcohol, g/mL.~~

DF = dilution factor (see Dilution Factor Calculation).

FID = flame ionization detector

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-dueled engines) or ethanol (for ethanol-fueled engines) in the dilution exhaust as measured by the FID, ppmC.

FTP = Federal Test Procedure

GC = gas chromatograph

GC/MS = gas chromatography/mass spectrometry

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 specific in Method No. 1002 and Method No. 1003, ppbC.

$\text{HC}_{\text{mass n}}$ = mass emissions of an HC compound per test phase n (where n is either 1, 2, or 3), mg.

HC_{wm} = total weighted mass 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 = the hydrogen-to-carbon ratio for the fuel used.

HPLC = high performance liquid chromatography

$Iconc_{blk}$ = concentration of the blank cartridge, μg/mL

$Iconc_{cd}$ = total concentration of carbonyl compound extracted from both cartridges for the dilution air, μg/mL

$Iconc_{ce}$ = total concentration of carbonyl compound extracted from both cartridges for the diluted exhaust, μg/mL

$Iconc_{d1}$ = dilution air (background) alcohol concentration in the primary impinger for all three test phases as determined by the procedure specified in Method No. 1001, μg/mL.

$Iconc_{d2}$ = dilution air (background) alcohol concentration in the secondary impinger for all three test phases as determined by the procedure specified in Method No. 1001, μg/mL.

$Iconc_{e1}$ = dilute exhaust alcohol concentration in the primary impinger per test phase as determined by the procedure specified in Method No. 1001, μg/mL.

$Iconc_{e2}$ = dilute exhaust alcohol concentration in the secondary impinger per test phase as determined by the procedure specified in Method No. 1001, μg/mL.

$Imass_d$ = total mass of an alcohol or carbonyl compound collected from the dilution air (background) in both primary and secondary impingers/cartridges for all three test phases as determined by the procedure specified in Method No. 1001 (alcohol) or Method No. 1004 (carbonyl), μg.

$Imass_e$ = total mass of an alcohol or carbonyl compound collected from the dilute exhaust in both primary and secondary impingers/cartridges per test phase as determined by the procedure specified in Method No. 1001 (alcohol) or Method No. 1004 (carbonyl), μg.

$Itemp_d$ = dilution air temperature at the flowmeter inlet for impinger/cartridge sampling, ^{o}K.

$Itemp_e$ = dilute exhaust temperature at the flowmeter inlet for impinger/cartridge sampling, ^{o}K.

$Ivol_c$ = elution volume of the cartridge, mL
(For example, ~~T~~the cartridge is extracted with 5 mL acetonitrile, but 0.6 mL is retained in the cartridge, so the elution volume is 4.4 mL.)

$Ivol_d$ = total volume of dilution air (background) drawn through the impingers/cartridges 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) drawn through the impingers/cartridges for all three test phases as measured during testing, liter.

$Ivol_e$ = total volume of dilute exhaust drawn through the impingers/cartridges per test phase corrected to standard conditions (293.16^{o}K and 760 mm Hg), liter.

$Ivol_{em}$ = total volume of dilute exhaust drawn through the impingers/cartridges per test phase as measured during testing, liter.

$Ivol_r$ = volume of the reagent used in an impinger, mL.

LOD = limit of detection

LPG = liquified petroleum gas

Mol. Vol. = molecular volume which is 24.055 liter/mole at standard conditions (293.16^{o}K and 760 mm Hg).

Mol. Wt. = molecular weight of the compound being measured, g/mole.

NIST = National Institute of Standards and Technology

NMHC = non-methane hydrocarbons

$NMHC_{conc}$ = 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^{o}K and 760 mm Hg assuming a C:H ratio of 1:1.85 for gasoline; 16.78 g/ft^3 at 293.16^{o}K and 760 mm HG assuming a C:H ratio of 1:1.94 for Phase 2 reformulated gasoline; 19.52 g/ft^3 at 293.16^{o}K and 760 mm HG assuming a C:H ratio of 1:3.78 for natural gas; and 17.26 g/ft^3 for LPG at 293.16^{o}K and 760 mm Hg assuming a C:H ratio of 1:2.64), g/ft^3-.

$NMHC_e$ = 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.

$NONMHC_{mass\ n}$ = the mass emission of non-oxygenated non-methane hydrocarbon per test phase n (where n is either 1, 2, or 3), g.

$NONMHC_{wm}$ = the total weighted mass of non-oxygenated non-methane hydrocarbon per mile for all three phases of the FTP, g/mile.

NMOG = non-methane organic gases

P_B = barometric pressure during testing, mm Hg.

PID = photoionization detector

PLOT = porous layer open tubular

R_a = the relative humidity of the ambient air, %.

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 Part B, “Determination of NMHC by FID”).

$r_{C_2H_5OH}$ = the FID response factor to ethanol (same procedure for methanol response factor, see CFR 40, 86.121-90(c)).

r_{ROH} = the FID response factor to an alcohol

r_{RHO} = the FID response factor to carbonyl compound

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, ppm.

RHO_{d} = composite concentration of a carbonyl compound in the dilution air (background) for all three test phases, ppm.

RHO_{dens} = mass per unit volume of a carbonyl compound corrected to standard conditions (293.16^{o}K and 760 mm Hg), g/ft^{3}.

RHO_{e} = concentration of a carbonyl compound in the dilute exhaust per test phase, ppm.

$RHO_{mass\ n}$ = 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, ppm.

ROH_{d} = composite concentration of an alcohol compound in the dilution air (background) for all three test phases, ppm.

ROH_{dens} = mass per unit volume of an alcohol compound corrected to standard conditions (293.16^{o}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.

SAE = Society of Automotive Engineers

SRM = Standard Reference Material

VMIX = the total dilute exhaust volume measured per test phase and corrected to standard conditions (293.16^{o}K and 760 mm Hg), ft^{3}.

II. The following list is commonly used measurement abbreviations:

g = gram
µg = microgram
m = meter
cm = centimeter
µm = micrometer
µ = micron
L = liter
mL = milliliter
µL = microliter
ppb = parts per billion.
ppbC = parts per billion carbon equivalent.
ppm = parts per million.
ppmC = parts per million carbon equivalent.

APPENDIX 3

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 Hydrocarbons 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)

[6] U.S. Environmental Protection Agency, Characterization of Exhaust Emissions from Methanol and Gasoline Fueled Automobiles, EPA 460/3-82-004.

[7] 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.

[8] 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] U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, (Method T03-15) EPA-600/4-84-041 Research Triangle Park, North Carolina, April, 1989.

[10] Hull, L.A., Procedures for 2,4-Dinitrophenylhydrazone Aldehyde-Ketone Air Analysis, Internal Report at U.S. EPA.

[11] Shriner, R.L. and Fuson, R.C., Identification of Organic Compounds, 2nd. Ed., John Wiley and Sons, Inc., 1940, p. 143.

[12] Keith, L. H., Taylor, J.K., et al, “Principles of Environmental Analysis”, Analytical Chemistry, Vol. 55, No. 14, December 1983.

California Environmental Protection Agency
AIR RESOURCES BOARD

CALIFORNIA 2001 THROUGH 2014 MODEL CRITERIA POLLUTANT EXHAUST EMISSION STANDARDS AND TEST PROCEDURES AND ~~FOR~~ 2009 THROUGH 2016 ~~AND SUBSEQUENT~~ MODEL GREENHOUSE GAS EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

Adopted: August 5, 1999
Amended: December 27, 2000
Amended: July 30, 2002
Amended: September 5, 2003 (corrected February 20, 2004)
Amended: May 28, 2004
Amended: August 4, 2005
Amended: June 22, 2006
Amended: October 17, 2007
Amended: May 2, 2008
Amended: December 2, 2009
Amended: February 22, 2010
Amended: March 29, 2010
Amended: September 27, 2010
Amended: March 22, 2012

Note: The proposed amendments to this document are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions compared to the test procedures as last amended September 27, 2010. [No change] indicates proposed federal provisions that are also proposed for incorporation herein without change. Existing intervening text that is not amended in this rulemaking is indicated by "* * * *".

As Amended: March 22, 2012
Date of Hearing: January 26-27, 2012

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NOTE: This document is incorporated by reference in sections 1960.1(k) and 1961(d), title 13, California Code of Regulations (CCR). It contains the majority of the requirements necessary for certification of a passenger car, light-duty truck or medium-duty vehicle for sale in California, in addition to containing the exhaust emission standards and test procedures for these motor vehicles. However, reference is made in these test procedures to other ARB documents that contain additional requirements necessary to complete an application for certification. These other documents are designed to be used in conjunction with this document. They include:

1. "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" (incorporated by reference in section 1961.2, title 13, CCR);

~~1~~2. "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962, title 13, CCR);

~~2~~3. "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962.1, title 13, CCR);

~~3~~4. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1976(c), title 13, CCR);

~~4~~5. "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1978(b), title 13, CCR);

~~5~~6. OBD II (section 1968, et seq. title 13, CCR, as applicable);

~~6~~7. "California Smog Index Label Specifications for 2004 through 2009 Model Year Passenger Cars and Light-Duty Trucks" (incorporated by reference in section 1965, title 13, CCR);

~~7~~8. "California Environmental Performance Label Specifications for 2009 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles"" (incorporated by reference in section 1965, title 13, CCR);

~~8~~9. Warranty Requirements (sections 2037 and 2038, title 13, CCR);

~~9~~10. "Specifications for Fill Pipes and Openings of 1977 through 2014 Motor Vehicle Fuel Tanks" (incorporated by reference in section 2235, title 13, CCR);

11~~0~~. “Guidelines for Certification of 1983 through 2002 Model Year Federally Certified Light-Duty Motor Vehicles for Sale in California” (incorporated by reference in section 1960.5, title 13, CCR); ~~and~~

12. “Guidelines for Certification of 2003 and Subsequent Model Year Federally Certified Light-Duty Motor Vehicles for Sale in California” (incorporated by reference in section 1960.5, title 13, CCR);

13~~1~~. “California Non-Methane Organic Gas Test Procedures,” (incorporated by reference in section 1961(d), title 13, CCR); and~~.~~

14. “California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels through 2014,” (incorporated by reference in section 2317, title 13, CCR).

The section numbering conventions for this document are set forth in Part I, section A.3 on page A-2.

Amend "CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES, " as incorporated by reference in Title 13, California Code of Regulations, Section 1961(d) to read:

* * * *

CALIFORNIA 2001 THROUGH 2014 MODEL CRITERIA POLLUTANT EXHAUST EMISSION STANDARDS AND TEST PROCEDURES AND ~~FOR~~ 2009 THROUGH 2016 ~~AND SUBSEQUENT~~ MODEL GREENHOUSE GAS EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES

The provisions of Subparts B, C, and S, Part 86, Title 40, Code of Federal Regulations, as adopted or amended on May 4, 1999 or as last amended on such other date set forth next to the 40 CFR Part 86 section title listed below, and to the extent they pertain to exhaust emission standards and test procedures, are hereby adopted as the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for~~ 2009 through 2016 ~~and Subsequent~~ Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," with the following exceptions and additions.

PART I: GENERAL PROVISIONS FOR CERTIFICATION AND IN-USE VERIFICATION OF EMISSIONS

A. General Applicability

1. §86.1801 Applicability.

1.1 §86.1801-01. December 6, 2002. Amend as follows:

1.1.1 Amend subparagraph (a) as follows: Except as otherwise indicated, the provisions of this subpart apply to new 2001 through 2016 ~~and later~~ model year Otto-cycle and diesel-cycle passenger cars, light-duty trucks and medium-duty vehicles, including alternative fuel and hybrid electric vehicles. In cases where a provision applies only to a certain vehicle group based on its model year, vehicle class, motor fuel, engine type, or other distinguishing characteristics, the limited applicability is cited in the appropriate section or paragraph.

* * * *

1.2 §86.1801-12. ~~As proposed at 74 Fed. Reg. 49454, 49752 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. Amend as follows:

* * * *

1.2.9 Subparagraph (i) [No change, except that this subparagraph shall only apply to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~, in accordance with section E of these test procedures.]

1.2.10 Subparagraph (j) [No change, except that this subparagraph shall only apply to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~, in accordance with section E of these test procedures.]

1.2.11 Subparagraph (k) [No change, except that this subparagraph shall only apply to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program, in accordance with section E of these test procedures.]

* * * *

B. Definitions, Acronyms and Abbreviations

1. §86.1803 Definitions.

1.1 §86.1803-01. February 26, 2007. [No change, except as otherwise noted below.]

1.2 §86.1803-01. ~~As proposed at 74 Fed. Reg. 49454, 49753 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. [No change, except as otherwise noted below.] The version of §86.1803-01 as incorporated by this section B.1.2 shall only apply to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~, in accordance with section E of these test procedures.

2. California Definitions.

* * * *

"**All-Electric Range Test**" means a test sequence used to determine the range of an electric or hybrid electric vehicle without the use of its auxiliary power unit. The All-Electric Range Test is described in the "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes."

* * * *

“**Hybrid electric vehicle**” or “**HEV**” means any vehicle that can draw propulsion energy from both of the following on-vehicle sources of stored energy: 1) a consumable fuel and 2) an energy storage device such as a battery, capacitor, or flywheel. ~~which is included in the definition of a “series hybrid electric vehicle,” a “parallel hybrid electric vehicle,” or a “battery assisted combustion engine vehicle.”~~

* * * *

“Intermediate Volume Manufacturer” means any 2009 through 2016 ~~and subsequent~~ model year manufacturer with California sales between 4,501 and 60,000 new light- and medium-duty vehicles based on the average number of vehicles sold for the three previous consecutive model years for which a manufacturer seeks certification. For a manufacturer certifying for the first time in California, model year sales shall be based on projected California sales. A manufacturer’s California sales shall consist of all vehicles or engines produced by the manufacturer and delivered for sale in California, except that vehicles or engines produced by the manufacturer and marketed in California by another manufacturer under the other manufacturer’s nameplate shall be treated as California sales of the marketing manufacturer.

For purposes of applying the 2009 through 2016 ~~and subsequent~~ model year Greenhouse Gas requirements for intermediate volume manufacturers, the annual sales from different firms shall be aggregated in the following situations: (1) vehicles produced by two or more firms, each one of which either has a greater than 10% equity ownership in another or is more than 10% owned by another; or (2) vehicles produced by any two or more firms if a third party has equity ownership of greater than 10% in each firm.

* * * *

“2012 through 2016 MY National greenhouse gas program” or “2012 through 2016 MY National greenhouse gas final rule” means the national program that applies to new 2012 through 2016 model year passenger cars, light-duty trucks, and medium-duty passenger vehicles as ~~proposed~~ adopted by the U.S. Environmental Protection Agency ~~at 74 Fed. Reg. 49454, 49748 (September 28, 2009) and adopted by EPA~~ on April 1, 2010~~,~~ (75 Fed. Reg. 25324, 25677 (May 7, 2010)) ~~[insert page] (April [insert date], 2010)~~, as incorporated in and amended by these test procedures.

* * * *

~~“**Parallel hybrid electric vehicle**” means any vehicle that allows power to be delivered to the driven wheels by either a combustion engine and/or by a battery powered electric motor.~~

* * * *

~~“**Series hybrid electric vehicle**” means any vehicle that 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~~.

* * * *

"**Small volume manufacturer**" means any manufacturer whose projected or combined California sales of passenger cars, light-duty trucks, medium-duty vehicles, heavy-duty vehicles and heavy-duty engines in its product line are fewer than 4,500 units based on the average number of vehicles sold for the three previous consecutive model years for which a manufacturer seeks certification. A manufacturer's California sales shall consist of all vehicles or engines produced by the manufacturer and delivered for sale in California, except that vehicles or engines produced by the manufacturer and marketed in California by another manufacturer under the other manufacturer's nameplate shall be treated as California sales of the marketing manufacturer. ~~Beginning with~~ For the 2009 through 2016 model years, the annual sales from different firms shall be aggregated in the following situations: (1) vehicles produced by two or more firms, one of which is 10% or greater part owned by another; or (2) vehicles produced by any two or more firms if a third party has equity ownership of 10% or more in each of the firms; or (3) vehicles produced by two or more firms having a common corporate officer(s) who is (are) responsible for the overall direction of the companies; or (4) vehicles imported or distributed by all firms where the vehicles are manufactured by the same entity and the importer or distributor is an authorized agent of the entity.

* * * *

"**Zero-emission vehicle**" or "**ZEV**" means any vehicle certified to the zero-emission standards set forth in the "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes."

* * * *

C. General Requirements for Certification

1. §86.1805 Useful Life.

* * * *

1.3 §86.1805-12. ~~As proposed at 74 Fed. Reg. 49454, 49755 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. [No change, except that this section §86.1805-12 shall only apply to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~, in accordance with section E of these test procedures.]

* * * *

3. §86.1807 Vehicle Labeling.

* * * *

3.3 California Labeling Requirements.

* * * *

3.3.2. For all 2004 ~~and subsequent~~ through 2014 model-year vehicles (except zero-emission vehicles (ZEVs)), the tune-up label shall also contain the following information lettered in the English language in block letters and numerals which shall be of a color that contrasts with the background of the label. For all 2015 and 2016 model-year vehicles, the tune-up label shall conform to the requirements set forth in section C.3 of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles." ~~:~~

* * * *

(b) Identification of the Exhaust Emission Control System, including but not limited to:

ADSTWC - Hydrocarbon Adsorbing Three-Way Catalyst;
AIR - Secondary Air Injection (Pump);

* * * *

* EHOC - Electrically Heated Oxidation Catalyst;
* EHTWC - Electrically Heated Three-Way Catalyst;

* * * *

* FFS - Flexible Fuel Sensor;

* * * *

~~* Pending confirmation as SAE protocol~~

Abbreviations used shall be in accordance with SAE J1930, ~~JUN 1993~~ October 2008, including the above nomenclature unless the Executive Officer approves a more current version of SAE J1930. ~~The Executive Officer shall recommend abbreviations for components not listed in SAE J1930, JUN 1993~~. For components not listed in SAE J1930, the manufacturer shall request Executive Officer approval of the abbreviations to be used for the components. Executive Officer approval shall be based on the consistency of the abbreviation with existing terminology used for the component in the applicable industry, ability to provide appropriate distinction from other similar components, and ability to be deciphered intuitively by users of the label.

* * * *

5. §86.1809 Prohibition of Defeat Devices.

* * * *

5.2 §86-1809-10. February 26, 2007. ~~As proposed at 74 Fed. Reg. 49454, 49755 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg. [insert page] (April [insert date], 2010).~~ [No change except that ~~requirements applicable to the Air Conditioning Idle Test shall only apply to vehicles certifying to the National greenhouse gas program, and~~ subparagraph (e) shall apply to vehicles subject to the California TLEV, LEV, ULEV and SULEV standards.]

5.3 §86-1809-12. May 7, 2010. [No change except that requirements applicable to the Air Conditioning Idle Test shall only apply to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program, and subparagraph (e) shall apply to vehicles subject to the California LEV, ULEV and SULEV standards.]

D. §86.1810 General standards; increase in emissions; unsafe conditions; waivers

1. §86.1810-01. December 8, 2005. Amend §86.1810-01 as follows:

This section applies to model year 2001 through 2016 ~~and later~~ light-duty vehicles, light-duty trucks, and medium-duty vehicles fueled by gasoline, diesel, methanol, ethanol, natural gas and liquefied petroleum gas fuels. Multi-fueled vehicles (including bi-fueled, dual-fueled and flexible-fueled vehicles) shall comply with all requirements established for each consumed fuel (or blend of fuels in the case of flexible-fueled vehicles). This section also applies to hybrid electric vehicles. The standards of this subpart apply to both certification and in-use vehicles unless otherwise indicated.

* * * *

1.1 Measurement of Hydrocarbon Emissions.

1.1.1 Except as otherwise indicated in these test procedures, for vehicles fueled by gasoline, methanol, ethanol, natural gas, or liquefied petroleum gas and certified to the Tier 1 standards, hydrocarbon emissions shall mean non-methane hydrocarbons (NMHC) and shall be measured in accordance with Part B (Determination of NMHC Emissions by Flame Ionization Detection) of the "California Non-Methane Organic Gas Test

Procedures.~~,~~” ~~as incorporated by reference in Part II, section A.100.5.4 of these test procedures.~~ For vehicles fueled by gasoline, methanol, ethanol, natural gas, or liquefied petroleum gas and certified to the TLEV, LEV, ULEV and SULEV standards, hydrocarbon emissions shall mean non-methane organic gases (NMOG) and shall be measured in accordance with the “California Non-Methane Organic Gas Test Procedures.” ~~as incorporated by reference in Part II, section A.100.5.4 of these test procedures.~~

1.1.2 For diesel vehicles, NMOG shall mean non-methane hydrocarbons and shall be measured in accordance with Part B of the “California Non-Methane Organic Gas Test Procedures.~~,~~” ~~as incorporated by reference in Part II, section A.100.5.4 of these test procedures.”~~

1.1.3 For vehicles certifying to the SFTP standards set forth in Section E.1.2.1 of these test procedures, hydrocarbon emissions shall be measured as follows: for PCs and LDTs certified to the Tier 1 exhaust standards, hydrocarbon emissions shall be measured in accordance with the “California Non-Methane Hydrocarbon Test Procedures,” as last amended May 15, 1990, which is incorporated herein by reference. For PCs and LDTs certified to the TLEV exhaust standards hydrocarbon emissions shall be measured in accordance with Part B (Determination of Non-Methane Hydrocarbon Mass Emissions by Flame Ionization Detection) of the “California Non-Methane Organic Gas Test Procedures.~~,~~” ~~as incorporated by reference in Part II, section A.100.5.4 of these test procedures.~~ For alcohol-fueled vehicles certifying to the standards in Section E.1.2.1., “Non-Methane Hydrocarbons” shall mean “Organic Material Non-Methane Hydrocarbon Equivalent.”

2. Supplemental FTP General Provisions for California.

2.1 Amend 40 CFR §86.1810-01(i) as follows:

* * * *

2.1.2 ~~Subparagraph (4) [No change.]~~ Delete subparagraph (4); replace with: The SFTP standards apply to PCs and LDTs certified on alternative fuels. The standards also apply to the gasoline and diesel fuel operation of fuel-flexible PCs and LDTs, and dual-fuel PCs and LDTs.

* * * *

2.1.6 Delete subparagraph (8); replace with: **Small Volume Provisions.** Small volume manufacturers of PCs, LDTs, and MDVs shall certify 100% of their PC and LDT fleet in 2004 through 2014 ~~and subsequent~~ model years, and 100% of their MDV fleet in 2005 through 2014 ~~and subsequent~~ model years under the supplemental FTP requirements.

* * * *

3. §86.1810-09. ~~As proposed at 74 Fed. Reg. 49454, 49755 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ July 6, 2011 ~~[insert page] (April [insert date], 2010)~~. [No change, except that the amendments to §86.1810-01 set forth in D.1 and D.2 shall apply.]

E. California Exhaust Emission Standards.

Delete 40 CFR §§86.1811 through 86.1819, except that for model years 2012 through 2016, a manufacturer may demonstrate compliance with the requirements of sections E.2.5 and E.3.2 by demonstrating compliance with §86.1818.12 ~~as proposed at 74 Fed. Reg. 49454, 49755 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ (July 6, 2011) ~~[insert page] (April [insert date], 2010)~~.

* * * *

The procedures for meeting the ZEV phase-in requirements and for earning ZEV credits are contained in the "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes."

* * * *

1. Exhaust Emission Standards.

1.1 FTP Exhaust Emission Standards for Light- and Medium-Duty Vehicles.

The exhaust emission standards set forth in this section refer to the exhaust emitted over the driving schedule set forth in title 40, CFR, Subparts B and C, except as amended in these test procedures.

* * * *

1.1.2 **LEV II Exhaust Standards.** The following LEV II standards represent the maximum exhaust emissions for the intermediate and full useful life from new 2004 through 2014 ~~and subsequent~~ model-year LEVs, ULEVs, and SULEVs, including fuel-flexible, bi-fuel and dual fuel vehicles when operating on the gaseous or alcohol fuel they are designed to use. Prior to the 2004 model year, a manufacturer that produces vehicles meeting these standards has the option of certifying the vehicles to the standards, in which case the vehicles will be treated as LEV II vehicles for purposes of the fleet-wide phase-in requirements.

LEV II Exhaust Mass Emission Standards for New 2004 through 2014 ~~and Subsequent~~ Model LEVs, ULEVs, and SULEVs in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes

Vehicle Type	Durability Vehicle Basis (mi)	Vehicle Emission Category	NMOG (g/mi)	Carbon Monoxide (g/mi)	Oxides of Nitrogen (g/mi)	Formaldehyde (mg/mi)	Particulates (g/mi)
All PCs; LDTs 8,500 lbs. GVWR or less Vehicles in this category are tested at their loaded vehicle weight.	50,000	LEV	0.075	3.4	0.05	15	n/a
		LEV, Option 1	0.075	3.4	0.07	15	n/a
		ULEV	0.040	1.7	0.05	8	n/a
	120,000	LEV	0.090	4.2	0.07	18	0.01
		LEV, Option 1	0.090	4.2	0.10	18	0.01
		ULEV	0.055	2.1	0.07	11	0.01
		SULEV	0.010	1.0	0.02	4	0.01
	150,000 (optional)	LEV	0.090	4.2	0.07	18	0.01
		LEV, Option 1	0.090	4.2	0.10	18	0.01
		ULEV	0.055	2.1	0.07	11	0.01
		SULEV	0.010	1.0	0.02	4	0.01
MDVs 8,501 - 10,000 lbs. GVWR Vehicles in this category are tested at their adjusted loaded vehicle weight.	120,000	LEV	0.195	6.4	0.2	32	0.12
		ULEV	0.143	6.4	0.2	16	0.06
		SULEV	0.100	3.2	0.1	8	0.06
	150,000 (Optional)	LEV	0.195	6.4	0.2	32	0.12
		ULEV	0.143	6.4	0.2	16	0.06
		SULEV	0.100	3.2	0.1	8	0.06

Vehicle Type	Durability Vehicle Basis (mi)	Vehicle Emission Category	NMOG (g/mi)	Carbon Monoxide (g/mi)	Oxides of Nitrogen (g/mi)	Formaldehyde (mg/mi)	Particulates (g/mi)
MDVs 10,001-14,000 lbs. GVWR Vehicles in this category are tested at their adjusted loaded vehicle weight.	120,000	LEV	0.230	7.3	0.4	40	0.12
		ULEV	0.167	7.3	0.4	21	0.06
		SULEV	0.117	3.7	0.2	10	0.06
	150,000 (Optional)	LEV	0.230	7.3	0.4	40	0.12
		ULEV	0.167	7.3	0.4	21	0.06
		SULEV	0.117	3.7	0.2	10	0.06

1.2 Supplemental Federal Test Procedure (“SFTP”) Exhaust Emission Standards for Light- and Medium-Duty Vehicles.

* * * *

1.2.2 The following standards represent the maximum SFTP exhaust emissions at 4,000 miles for new 2001 through 2014 ~~and subsequent~~ model LEVs, ULEVs, and SULEVs in the passenger car and light-duty truck class, and new 2003 through 2014 ~~and subsequent~~ model year LEV, ULEV and SULEV medium-duty vehicles less than 8,500 pounds gross vehicle weight rating:

SFTP EXHAUST EMISSION STANDARDS FOR LEVS, ULEVS, AND SULEVS IN THE PASSENGER CAR, LIGHT-DUTY TRUCK, AND MEDIUM-DUTY VEHICLE CLASSES

(grams per mile)

Vehicle Type**	Gross Vehicle Weight Rating (lbs.)	~~LVW/ALVW~~ Test Weight (lbs.)	US06 Test*		A/C Test*	
			NMHC + NOx	CO	NMHC + NOx	CO
PC Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 lbs.).	All	All	0.14	8.0	0.20	2.7
LDT ~~LDT~~ Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 lbs.).	< 6000 lbs.	0-3750 lbs. ~~(LVW)~~	0.14	8.0	0.20	2.7
		3751-5750 lbs. ~~(LVW)~~	0.25	10.5	0.27	3.5
MDV ~~MDV~~ Vehicles in this category are tested at their adjusted loaded vehicle weight (average of curb weight and GVWR).	6,001-8,500 lbs.	3751-5750 lbs. ~~(ALVW)~~	0.40	10.5	0.31	3.5
		5751-8500 lbs. ~~(ALVW)~~	0.60	11.8	0.44	4.0

* For certification purposes, testing shall be conducted at 4000 miles ±250 miles or at the mileage determined by the manufacturer for emission-data vehicles.

** The following definitions apply for purposes of this SFTP standards table only:

"LDT" (light-duty truck) is any motor vehicle rated at 6,000 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.

"MDV" (medium-duty ~~truck~~ vehicle) is any motor vehicle having a manufacturer's gross vehicle weight rating of greater than 6,000 pounds and less than 14,001 pounds, except passenger cars and light-duty trucks. Vehicles with a gross vehicle weight rating over 8,500 pounds are exempted from the requirements of this subsection.

1.3 NMOG Standards for Fuel-Flexible, Bi-Fuel and Dual-Fuel Vehicles Operating on Gasoline.

* * * *

1.3.2 **LEV II Standards for 2004 through 2014 ~~and Subsequent~~ Model Year Bi-fuel, Fuel-Flexible and Dual Fuel Vehicles Operating on Gasoline.** The applicable exhaust mass emission standards for NMOG when certifying the vehicle for operation on gasoline (as specified in Part II, Section A. paragraph 100.3.1) are:

LEV II NMOG Standards for Bi-Fuel, Fuel-Flexible and Dual-Fuel Vehicles Operating on Gasoline (g/mi)

Vehicle Type	Vehicle Emission Category	Durability Vehicle Basis	
		50,000 mi	120,000 mi
All PCs; LDTs, 0-8500 lbs. GVWR	LEV	0.125	0.156
	ULEV	0.075	0.090
	SULEV	0.010	0.040
MDVs, 8501-10,000 lbs. GVWR	LEV	n/a	0.230
	ULEV	n/a	0.167
	SULEV	n/a	0.117
MDVs, 10,001-14,000 lbs. GVWR	LEV	n/a	0.280
	ULEV	n/a	0.195
	SULEV	n/a	0.143

* * * *

1.5 Cold CO Standards.

The following standards represent the 50,000 mile cold temperature exhaust carbon monoxide emission levels from new 2001 through 2014 ~~and subsequent~~ model-year passenger cars, light-duty trucks, and medium-duty vehicles:

2001 THROUGH 2014 ~~AND SUBSEQUENT~~ MODEL-YEAR COLD TEMPERATURE CARBON MONOXIDE EXHAUST EMISSIONS STANDARDS FOR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

(grams per mile)

Vehicle Type	Carbon Monoxide
All PCs, LDTs 0-3750 lbs. LVW	10.0
LDTs 3751 lbs. LVW - 8500 lbs. GVWR LEV I and Tier 1 MDVs 8,500 lbs. GVWR and less	12.5

These standards are applicable to vehicles tested in accordance with 40 CFR Part 86 Subpart C, as modified in Part II, Section B of these test procedures at a nominal temperature of 20°F (-7°C). Natural gas vehicles, diesel-fueled vehicles, and medium-duty vehicles with a gross vehicle weight rating greater than 8,500 lbs. are exempt from these standards.

* * * *

1.7 Requirements for Vehicles Certified to the Optional 150,000 Mile Standards.

* * * *

(b) Requirement to Generate a Partial ZEV Allowance. A manufacturer that certifies to the 150,000 mile SULEV standards shall also generate a partial ZEV allocation according to the criteria set forth in section C.3 of the "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes."

* * * *

1.12 When a Federally-Certified Vehicle Model is Required in California.

1.12.1 **Basic Requirement.** Whenever a manufacturer federally-certifies a 2004 through 2014 ~~or subsequent~~ model-year passenger car, light-duty truck or medium-duty vehicle model to the standards for a particular emissions bin that are more stringent than the standards for an applicable California vehicle emissions category, the equivalent California model may only be certified to (i) the California standards for a vehicle emissions category that are at least as stringent as the standards for the corresponding federal emissions bin, or (ii) the exhaust emission standards to which the federal model is certified. However, where the federal exhaust emission standards for the particular emissions bin and the California standards for a vehicle emissions category are equally stringent, the California model may only be certified to either the California standards for that vehicle emissions category or more stringent California standards. The federal emission bins are those contained Tables S04-1 and S04-2 of 40 CFR section 86.1811-04(c) as adopted February 10, 2000. The criteria for applying this requirement are set forth in Part I. Section H.1 of these test procedures.

* * * *

1.13 Emission Standard for Fuel-Fired Heaters. Whenever a manufacturer elects to utilize an on-board fuel-fired heater on any passenger car, light-duty truck or medium-duty vehicle, the heater must meet the LEV II ULEV standards for passenger cars and light-duty trucks less than 8,500 pounds GVW set forth in Section E.1.1.2 of these test procedures. The exhaust emissions from the fuel-fired heater shall be determined in accordance with the “California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes” and the “California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes.” On-board fuel-fired heaters may not be operable at ambient temperatures above 40^{o}F.

1.14 Greenhouse Gas Emission Requirements. The greenhouse gas emission levels from new 2009 through 2016 ~~and subsequent~~ model year passenger cars, light-duty trucks, and medium-duty passenger vehicles shall not exceed the requirements set forth in Section E.2.5 of these test procedures. Light-duty trucks from 3751 lbs. LVW – 8500 lbs. GVWR that are certified to the Option 1 LEV II NOx Standard in Section E.1.1.2 of these test procedures are exempt from these greenhouse gas emission requirements, however, passenger cars, light-duty trucks 0-3750 lbs. LVW, and medium-duty passenger vehicles are not eligible for this exemption.

2. Emission Standards Phase-In Requirements for Manufacturers

2.1 Fleet Average NMOG Requirements for Passenger Cars and Light-Duty Trucks.

2.1.1 The fleet average non-methane organic gas exhaust mass emission values from the passenger cars and light-duty trucks produced and delivered for sale in California each model year by a manufacturer other than a small volume manufacturer or an independent low volume manufacturer shall not exceed:

FLEET AVERAGE NON-METHANE ORGANIC GAS EXHAUST MASS EMISSION REQUIREMENTS FOR LIGHT-DUTY VEHICLE WEIGHT CLASSES
(50,000 mile Durability Vehicle Basis)

Model Year	Fleet Average NMOG (g/mi)	
	All PCs; LDTs 0-3750 lbs. LVW	LDTs 3751 lbs. LVW - 8500 lbs. GVWR
2001	0.070	0.098
2002	0.068	0.095
2003	0.062	0.093
2004	0.053	0.085
2005	0.049	0.076
2006	0.046	0.062
2007	0.043	0.055
2008	0.040	0.050
2009	0.038	0.047
2010-2014[1] ~~+~~	0.035	0.043

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[1] For the 2014 model year only, a manufacturer may comply with the fleet average NMOG+NOx values in the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," in lieu of complying with the NMOG fleet average values in this table. A manufacturer must either comply with the NMOG+NOx fleet average requirements for both its PC/LDT1 fleet and its LDT2/MDPV fleet or comply with the NMOG fleet average requirements for both its PC/LDT1 fleet and its LDT2/MDPV fleet. A manufacturer must calculate its fleet average NMOG+NOx values using the applicable full useful life standards.

2.1.2 Calculation of Fleet Average NMOG Value.

2.1.2.1 Basic Calculation.

(a) Each manufacturer's PC and LDT1 fleet average NMOG value for the total number of PCs and LDT1s produced and delivered for sale in California shall be calculated as follows:

(Σ [Number of vehicles in a test group x applicable emission standard] +
Σ [Number of hybrid electric vehicles in a test group x HEV NMOG factor])÷
Total Number of Vehicles Produced, Including ZEVs and HEVs

(b) Each manufacturer's LDT2 fleet average NMOG value for the total number of LDT2s produced and delivered for sale in California shall be calculated as follows:

(Σ [Number of vehicles in a test group x applicable emission standard] +
Σ [Number of hybrid electric vehicles in a test group x HEV NMOG factor]) ÷
Total Number of Vehicles Produced, Including ZEVs and HEVs

The applicable emission standards to be used in the above equations are as follows:

Model Year	**Emission Category**	**Emission Standard Value**	
		All PCs; LDTs 0-3750 lbs. LVW	**LDTs 3751-5750 lbs. LVW**
2001 through 2014 model year ~~and subsequent~~ (AB 965 vehicles only)	All	Federal Emission Standard to which Vehicle is Certified	Federal Emission Standard to which Vehicle is Certified
2001 - 2003	Tier 1	0.25	0.32
2001 - 2006 model year vehicles certified to the "LEV I" standards in E.1.1.1 (For TLEVs, 2001 - 2003 model years only)	TLEVs	0.125	0.160
	LEVs	0.075	0.100
	ULEVs	0.040	0.050
Model Year	**Emission Category**	**All PCs; LDTs 0-3750 lbs. LVW**	**LDTs 3751 lbs. LVW - 8500 lbs. GVWR**
2001 through 2014 ~~and subsequent~~ model year vehicles certified to the "LEV II" standards in E.1.1.2	LEVs	0.075	0.075
	ULEVs	0.040	0.040
	SULEVs	0.01	0.01
2001 through 2014 ~~and subsequent~~ vehicles certified to the optional 150,000 mile "LEV II" standards for PCs and LDTs in E.1.1.2	LEVs	0.064	0.064
	ULEVs	0.034	0.034
	SULEVs	0.0085	0.0085

2.1.2.2 **HEV NMOG Factor.** The HEV NMOG factor for light-duty vehicles is calculated as follows:

LEV HEV Contribution Factor = 0.075 - [(Zero-emission VMT Factor) x 0.035]
ULEV HEV Contribution Factor = 0.040 - [(Zero-emission VMT Factor) x 0.030]

where Zero-emission VMT Factor for HEVs is determined in accordance with Section C.3 of the "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission

Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes."

* * * *

2.1.3 **Phase-in Requirements for Small Volume Manufacturers.**

(a) In 2001 through 2006 model years, a small volume manufacturer shall not exceed a fleet average NMOG value of 0.075 g/mi for PCs and LDTs from 0-3750 lbs. LVW or 0.100 g/mi for LDTs from 3751-5750 lbs. LVW calculated in accordance with subsection E.2.1.2. In 2007 through 2014 ~~and subsequent~~ model years, a small volume manufacturer shall not exceed a fleet average NMOG value of 0.075 for PCs and LDTs from 0-3750 lbs. LVW or 0.075 for LDTs from 3751 lbs. LVW - 8,500 lbs. GVW calculated in accordance with subsection E.2.1.2.

* * * *

2.1.5 **Treatment of ZEVs.** ZEVs classified as LDTs (>3750 lbs. LVW) that have been counted toward the ZEV requirement for PCs and LDTs (0-3750 lbs. LVW) as specified in Section C of the "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," shall be included in this equation.

* * * *

2.3 Medium-Duty Low-Emission Vehicle Phase-In Requirements.

2.3.1 (a) A manufacturer of MDVs, other than a small volume manufacturer, shall certify an equivalent percentage of its MDV fleet according to the following phase-in schedule:

Model Year	Vehicles Certified to Section E.1.1 (%)		Vehicles Certified to title 13 CCR Section 1956.8(g) or (h) (%)		
	LEV	ULEV	Tier 1	LEV	ULEV
2001	80	20	100	0	0
2002	70	30	0	100	0
2003	60	40	0	100	0
2004 through 2014 ~~+~~	40	60	0	0	100

*   *   *   *

(c) **Phase-In Requirements for LEV II MDVs**. For the 2004 through 2006 model years, a manufacturer, other than a small volume manufacturer must phase-in at least one test group per model year to the MDV LEV II standards. All 2007 through 2014 ~~and subsequent~~ model year MDVs, including those produced by a small volume manufacturer, are subject to the LEV II MDV standards. Beginning in the 2005 model year, all medium-duty engines certified to the optional medium-duty engine standards in title 13, CCR §1956.8(c) or (h), including those produced by a small volume manufacturer, must meet the standard set forth in title 13, CCR §1956.8(c) or (h), as applicable. A manufacturer that elects to certify to the Option 1 or Option 2 federal standards as set forth in 40 CFR §86.005-10(f) is not subject to these phase-in requirements.

2.3.2 **Identifying a Manufacturer's MDV Fleet**. For the 2001 through 2014 ~~and subsequent~~ model years, each manufacturer's MDV fleet shall be defined as the total number of California-certified MDVs produced and delivered for sale in California. The percentages shall be applied to the manufacturer’s total production of California-certified medium-duty vehicles delivered for sale in California. For the 2005 through 2014 ~~and subsequent~~ model years, a manufacturer that elects to certify engines to the optional medium-duty engine standards in title 13, CCR, §1956.8(c), or (h) shall not count those engines in the manufacturer’s total production of California-certified medium-duty vehicles for purposes of this subparagraph.

2.4 Implementation Schedules for SFTP Emission Standards

2.4.1 A manufacturer of PCs and of LDTs certified to the Tier 1 and TLEV standards as set forth in Section E.1 of these test procedures, except a small volume manufacturer, shall certify a minimum percentage of its PC and LDT fleet according to the following phase-in schedule.

Model Year	Percentage of PC and LDT Fleet
2001	25
2002	50
2003	85
2004 through 2014 ~~and subsequent~~	100

* * * *

2.4.2 (a) A manufacturer of PCs, LDTs, and MDVs certified to the LEV, ULEV and SULEV standards as set forth in Section E.1 of these test procedures, except a small volume manufacturer, shall certify a minimum percentage of its PC and LDT fleet, and a minimum percentage of its MDV fleet, according to the following phase-in schedule.

Model Year	Percentage	
	PC, LDT	MDV
2001	25	NA
2002	50	NA
2003	85	25
2004	100	50
2005 through 2014 ~~and subsequent~~	100	100

* * * *

2.5 Fleet Average Greenhouse Gas Requirements for Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles.

2.5.1(i) The fleet average greenhouse gas exhaust mass emission values from passenger cars, light-duty trucks, and medium-duty passenger vehicles that are produced and delivered for sale in California each model year by a large volume manufacturer shall not exceed:

FLEET AVERAGE GREENHOUSE GAS
EXHAUST MASS EMISSION REQUIREMENTS FOR
PASSENGER CAR, LIGHT-DUTY TRUCK, AND MEDIUM-DUTY
PASSENGER VEHICLE WEIGHT CLASSES[1]
(4,000 mile Durability Vehicle Basis)

Model Year	*Fleet Average Greenhouse Gas Emissions (grams per mile CO_2-equivalent)*	
	All PCs; LDTs 0-3750 lbs. LVW	*LDTs 3751 lbs. LVW - 8500 lbs. GVWR; MDPVs*
2009	323	439
2010	301	420
2011	267	390
2012	233	361
2013	227	355
2014	222	350
2015	213	341
2016~~+~~	205	332

[1] Each manufacturer shall demonstrate compliance with these values in accordance with Section E.2.5.2.

2.5.1.1 For each model year, a manufacturer must demonstrate compliance with the fleet average requirements in this section E.2.5.1 based on one of two options applicable throughout the model year, either:

Option 1: the total number of passenger cars, light-duty trucks, and medium-duty passenger vehicles that are certified to the California exhaust emission standards in section 1961.1, title 13, CCR, and are produced and delivered for sale in California; or

Option 2: the total number of passenger cars, light-duty trucks, and medium-duty passenger vehicles that are certified to the California exhaust emission standards in section 1961.1, title 13, CCR, and are produced and delivered for sale in California, the District of Columbia, and all states that have adopted California's greenhouse gas emission standards for that model year pursuant to Section 177 of the federal Clean Air Act (42 U.S.C. § 7507).

2.5.1.1.1 For the 2009 and 2010 model years, a manufacturer that selects compliance Option 2 must notify the Executive Officer of that selection in writing within 30 days of the effective date of the amendments to this section 2.5.1.1. or must comply with Option 1.

2.5.1.1.2 For the 2011 through 2016 ~~and later~~ model years, a manufacturer that selects compliance Option 2 must notify the Executive Officer of that selection in writing prior to the start of the applicable model year or must comply with Option 1.

* * * *

2.5.1(ii) For the 2012 through 2016 model years, a manufacturer may elect to demonstrate compliance with this section E.2.5 by demonstrating compliance with the 2012 through 2016 MY National greenhouse gas program as follows:

2.5.1.1 A manufacturer that selects compliance with this option E.2.5.1(ii) must notify the Executive Officer of that selection, in writing, prior to the start of the applicable model year or must comply with E.2.5.1(i).

2.5.1.2 The manufacturer must submit to ARB a copy of the Model Year CAFE report that it submitted to EPA as required under 40 CFR §86-1865-12 ~~as proposed at 74 Fed. Reg. 49454, 49760 (September 28, 2009) and adopted by EPA on April 1, 2010, (75 Fed. Reg.~~ (May 7, 2010) ~~[insert page] (April [insert date], 2010)~~, for demonstrating compliance with the 2012 through 2016 MY National greenhouse gas program and the EPA determination of compliance. These must be submitted within 30 days of receipt of the EPA determination of compliance, for each model year that a manufacturer selects compliance with this option E.2.5.1(ii).

2.5.1.3 The manufacturer must provide to the Executive Officer separate values for the number of vehicles produced and delivered for sale in California, the District of Columbia, and each individual state that has adopted California's greenhouse gas emission standards for that model year pursuant to Section 177 of the federal Clean Air Act (42 U.S.C. § 7507). and

2.5.1.~~3~~4 If a manufacturer has outstanding greenhouse gas debits at the end of the 2011 model year, as calculated in accordance with E.3.2, the manufacturer must submit to the Executive Officer a plan for offsetting all outstanding greenhouse gas debits by using greenhouse gas credits earned under the 2012 through 2016 MY National greenhouse gas program before applying those credits to offset any 2012 through 2016 MY National greenhouse gas program debits. Upon approval of the plan by the Executive Officer, the manufacturer may demonstrate compliance with this section E.2.5 by demonstrating compliance with the 2012 through 2016 MY National greenhouse gas program. Any California debits not offset by the end of the 2016 model year 2012 through 2016 MY National greenhouse gas program reporting period are subject to penalties as provided in section E.3.2.

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2.5.2.2 **Calculation of Greenhouse Gas Values for Bi-Fuel Vehicles, Fuel-Flexible Vehicles, Dual-Fuel Vehicles, and Grid-connected Hybrid Electric Vehicles.** For bi-fuel, fuel-flexible, dual-fuel, and grid-connected hybrid electric vehicles, a manufacturer shall calculate a grams per mile average CO_2-equivalent value for each GHG vehicle test group, in accordance with Section E.2.5.2.1 of these test procedures, based on exhaust mass emission tests when the vehicle is operating on gasoline or diesel, as applicable.

2.5.2.2.1 **Optional Alternative Compliance Mechanisms.** Beginning with the 2010 model year, a manufacturer that demonstrates that a bi-fuel, fuel-flexible, dual-fuel, or grid-connected hybrid electric GHG vehicle test group will be operated in use in California on the alternative fuel shall be eligible to certify those vehicles using this optional alternative compliance procedure, upon approval of the Executive Officer.

(a) To demonstrate that bi-fuel, fuel-flexible, dual-fuel, or grid-connected hybrid electric vehicles within a GHG vehicle test group will be operated in use in California on the alternative fuel, the manufacturer shall provide data that shows the previous model year sales of such vehicles to fleets that provide the alternative fuel on-site, or, for grid-connected hybrid electric vehicles, to end users with the capability to recharge the vehicle on-site. This data shall include both the total number of vehicles sales that were made to such fleets or end users with the capability to recharge the vehicle on-site and as the percentage of total GHG vehicle test group sales. The manufacturer shall also provide data demonstrating the percentage of total vehicle miles traveled by the bi-fuel, fuel-flexible, dual-fuel, or grid-connected hybrid electric vehicles sold to each fleet or to end users with the capability to recharge the vehicle on-site in the previous model year using the alternative fuel and using gasoline or diesel, as applicable.

(b) For each GHG vehicle test group that receives approval by the Executive Officer under Section E.2.5.2.2.1(a), a grams per mile CO_2-equivalent value shall be calculated as follows:

$$CO_2\text{-equivalent value} = [A \times E \times B \times C] + [(1 - (A \times E \times B)) \times D]$$

where: A = the percentage of previous model year vehicles within a GHG vehicle test group that were operated in use in California on the alternative fuel during the previous calendar year;

B = the percentage of miles traveled by “A” during the previous calendar year;

C = the CO_2-equivalent value for the GHG vehicle test group, as calculated in Section E.2.5.2.1, when tested using the alternative fuel;

D = the CO_2-equivalent value for the GHG vehicle test group, as calculated in Section E.2.5.2.1, when tested using gasoline or diesel, as applicable; and

E = 0.9 for grid-connected hybrid electric vehicles or

E = 1 for bi-fuel, fuel-flexible, and dual-fuel vehicles.

The Executive Officer may approve use of a higher value for "E" for a grid-connected hybrid electric vehicle GHG vehicle test group if a manufacturer demonstrates that the vehicles can reasonably be expected to maintain more than 90 percent of their original battery capacity over a 200,000 mile vehicle lifetime. The manufacturer may demonstrate the appropriateness of a higher value either by providing data from real world vehicle operation; or by showing that these vehicles are equipped with batteries that do not lose energy storage capacity until after 100,000 miles; or by offering 10 year/150,000 mile warranties on the batteries.

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2.5.3 **Requirements for Intermediate Volume Manufacturers.**

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2.5.3.3 In the 2016 ~~and subsequent~~ model year~~s~~, an intermediate volume manufacturer shall either:

(a) not exceed a fleet average greenhouse gas emissions value of 233 g/mi for PCs and LDT1s and 361 g/mi for LDT2s and MDPVs, or

(b) not exceed a fleet average greenhouse gas value of 0.75 times the baseline fleet average greenhouse gas value for PCs and LDT1s or 0.82 times the baseline fleet average greenhouse gas value for LDT2s and MDPVs, as calculated in Section E.2.5.3.2.

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2.5.4 **Requirements for Small Volume Manufacturers and Independent Low Volume Manufacturers.**

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2.5.4.3 In the 2016 ~~and subsequent~~ model year~~s~~, a small volume manufacturer and an independent low volume manufacturer shall either:

(a) not exceed the fleet average greenhouse gas emissions value calculated for each GHG vehicle test group for which a comparable vehicle is sold by a large volume manufacturer, in accordance with Section E.2.5.4; or

(b) not exceed a fleet average greenhouse gas emissions value of 233 g/mi for PCs and LDT1s and 361 g/mi for LDT2s and MDPVs; or

(c) upon approval of the Executive Officer, if a small volume manufacturer demonstrates a vehicle model uses an engine, transmission, and emission control system that is identical to a configuration certified for sale in California by a large volume manufacturer, those small volume manufacturer vehicle models are exempt from meeting the requirements in paragraphs E.2.5.4.3(a) and (b) of this Section.

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3. Calculation of Credits/Debits

3.1 Calculation of NMOG Credits/Debits

3.1.1 Calculation of NMOG Credits for Passenger Cars and Light-Duty Trucks.

3.1.1.1 In 2001 through 2014 ~~and subsequent~~ model years, a manufacturer that achieves 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, Including ZEVs and HEVs).

A manufacturer with 2001 through 2014 ~~and subsequent~~ model year 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 the 2001 through 2006 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. and LDTs 3751 lbs. LVW - 8500 lbs. GVWR shall be summed together. For the 2007 through 2014 ~~and subsequent~~ model years, the total g/mi NMOG credits or debits earned for PCs and LDTs 0-3750 lbs. LVW and for LDTs 3751 lbs. LVW - 8500 lbs. GVWR shall be summed together. The resulting amount shall constitute the g/mi NMOG credits or debits accrued by the manufacturer for the model year.

3.1.2 **Calculation of Vehicle Equivalent NMOG Credits for Medium-Duty Vehicles.** In 2001 through 2014 ~~and subsequent~~ model years, a manufacturer that produces and delivers for sale in California MDVs in excess of the equivalent requirements for LEVs, ULEVs and/or SULEVs certified to the exhaust emission standards set forth in section E.1 of these test procedures or to the exhaust emission standards set forth in section 1956.8(h), title 13, CCR 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:

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3.1.2.1 The MDV HEV VEC allowance is calculated as follows:

1 + [(LEV standard - ULEV standard) x (Zero-emission VMT Allowance) ÷ LEV standard] for LEVs;
1 + [(ULEV standard - SULEV standard) x (Zero-emission VMT Allowance) ÷ ULEV standard] for ULEVs;
1 + [(SULEV standard - ZEV standard) x (Zero-emission VMT Allowance) ÷ SULEV standard] for SULEVs;

where “Zero-emission VMT Allowance” for an HEV is determined in accordance with Section C.3 of the “California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes” and the “California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes.”

* * * *

3.1.2.4 For a manufacturer that elects to certify engines to the optional medium-duty engine standards in title 13, CCR §1956.8(c) or (h), all such 2005 through 2014 ~~and subsequent~~ model year engines used in MDVs, including those produced by a small volume manufacturer, shall be subject to the emissions averaging provisions applicable to heavy-duty diesel or Otto-cycle engines as set forth in the “California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines,” or the “California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines, incorporated by reference in title 13, CCR, §1956.8(b) or (d), as applicable.

3.1.3 Procedure for Offsetting NMOG Debits.

3.1.3.1 A manufacturer shall equalize emission debits by earning g/mi NMOG emission credits or VECs in an amount equal to the g/mi NMOG debits or VEDs, or by submitting a commensurate amount of g/mi NMOG credits or VECs to the Executive Officer that were earned previously or acquired from another manufacturer. For 2001 through 2003 and for 2007 through 2014 ~~and subsequent~~ model years, manufacturers shall equalize emission debits by the end of the following model year. For 2004 through 2006 model years, a manufacturer shall equalize NMOG debits for PCs and LDTs and LEV II MDVs within three model years and prior to the end of the 2007 model year. If emission debits are not equalized within the specified time period, the manufacturer shall be subject to the Health and Safety Code §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 §43211, the number of passenger cars and light-duty trucks 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 and LDTs 3751 lbs. LVW - 8500 lbs. GVWR applicable for the model year in which the debits were first incurred and the number of medium-duty vehicles not meeting the state board's emission standards shall be equal to the amount of VEDs incurred.

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3.2 Calculation of Greenhouse Gas Credits/Debits.

3.2.1 Calculation of Greenhouse Gas Credits for Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles.

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3.2.1.2 In the 2009 through 2016 ~~and subsequent~~ model years, a manufacturer that achieves fleet average Greenhouse Gas values lower than the fleet average Greenhouse Gas requirement for the corresponding model year shall receive credits in units of g/mi Greenhouse Gas determined as:

[(Fleet Average Greenhouse Gas Requirement) - (Manufacturer's Fleet Average Greenhouse Gas Value)] x (Total No. of Vehicles Produced and Delivered for Sale in California, Including ZEVs and HEVs).

3.2.2 A manufacturer with 2009 through 2016 ~~and subsequent~~ model year fleet average Greenhouse Gas values greater than the fleet average requirement for the corresponding model year shall receive debits in units of g/mi Greenhouse Gas equal to the amount of negative credits determined by the aforementioned equation. For the 2009 through 2016 ~~and subsequent~~ model years, the total g/mi Greenhouse Gas credits or debits earned for PCs and LDT1s and for LDT2s and MDPVs shall be summed together. The resulting amount shall constitute the g/mi Greenhouse Gas credits or debits accrued by the manufacturer for the model year.

3.2.3 Procedure for Offsetting Greenhouse Gas Debits.

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3.2.3.2 Greenhouse Gas emission credits earned in the 2000 through 2008 model years shall be treated as if they were earned in the 2011 model year and shall retain full value through the 2012 model year. Greenhouse Gas emission credits earned in the 2009 through 2016 ~~and subsequent~~ model years shall retain full value through the fifth model year after they are earned. The value of any credits earned in the 2000 through 2008 model years that not used to equalize debits accrued in the 2009 through 2012 model years shall be discounted by 50% at the beginning of the 2013 model year, shall be discounted to 25% of its original value if not used by the beginning of the 2014 model year, and will have no value if not used by the beginning of the 2015 model year. Any credits earned in the 2009 through 2016 ~~and subsequent~~ model years that are not used by the end of the fifth model year after they are accrued shall be discounted by 50% at the beginning of the sixth model year after being earned, shall be discounted to 25% of its original value if not used by the beginning of the seventh model year after being earned, and will have no value if not used by the beginning of the eighth model year after being earned.

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F. Requirements and Procedures for Durability Demonstration

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4. §86.1823 Durability demonstration procedures for exhaust emissions.

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4.2 §86.1823-08. ~~As proposed at 74 Fed. Reg. 49454, 49757 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ September 15, 2011 ~~[insert page] (April [insert date], 2010)~~. [No change, except that ~~the amendments to §86.1823-01 set forth in F.4.1 shall apply, and~~ subparagraph (m) applies only to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program.]

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G. Procedures for Demonstration of Compliance with Emission Standards

1. §86.1827 Test Group Determination.

1.1 §86.1827-01. ~~As proposed at 74 Fed. Reg. 49454, 49758 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. [No change, except that subparagraphs (a)(5) and (f) shall only apply to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program.]

*　　*　　*　　*

3. §86.1829 Durability data and emission data testing requirements; waivers.

3.1 §86.1829-01. ~~As proposed at 74 Fed. Reg. 49454, 49758 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. Amend as follows:

*　　*　　*　　*

3.1.3 Amend (b)(1)(iii)(G) as follows: For the 2012 model year only, in lieu of testing a vehicle for N2O emissions, a manufacturer may provide a statement in its application for certification that such vehicles comply with the applicable standards. Such a statement must be based on previous emission tests, development tests, or other appropriate information and good engineering judgment. This subparagraph (b)(1)(iii)(G) only applies to vehicles certifying to the 2012 through 2016 MY National greenhouse gas program.

3.1.4 Amend (b)(4)(i) as follows: All 2001 through 2016 ~~and subsequent~~ model-year emission-data vehicles shall be required to be tail-pipe tested at 4,000 miles or at the mileage at which the vehicle is stabilized as determined in §86.1827-01 and demonstrate compliance with the California Inspection and Maintenance ("I/M") emission standards as specified in the "Mandatory Exhaust Emissions Inspection Standards and Test Procedures," title 16, California Code of Regulations, Section 3340.42. A manufacturer shall have the option of using the I/M test procedures in place at the time of certification or, if the I/M test procedures have been amended within two years of the time of certification, a manufacturer may use the preceding procedures. 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° F. The manufacturer shall, in accordance with good engineering practices, attest that such test vehicles will meet the requirements of this section when preconditioned and tested at ambient temperatures from 35° to 68° F.

* * * *

3.4 Greenhouse Gas Testing Requirements.

A manufacturer shall demonstrate compliance with the greenhouse gas requirements each year by testing one vehicle per each test group that represents the vehicle configuration that is expected to be "worst-case" for greenhouse gas emissions, as calculated in Section E.2.5.2.1, subject to approval by the Executive Officer. A manufacturer may test additional vehicles within the test group that represent vehicle configuration with lower greenhouse gas emissions values than the "worst-case" configuration. All vehicles shall be tested using both the FTP and Highway Test Procedures as modified in Part II of these test procedures. A manufacturer may use emissions data from tests it conducts as part of the Corporate Average Fuel Economy Program (CAFE), in accordance with 40 CFR Part 600 – Fuel Economy and Greenhouse Gas Exhaust Emissions of Motor Vehicles, to demonstrate compliance with the greenhouse gas requirements, once those data have been judged acceptable by the U.S. Environmental Protection Agency. A manufacturer that elects to use CAFE Program emissions data to demonstrate compliance with the greenhouse gas requirements must use all of the data that is used by the U.S. Environmental Protection Agency to determine a manufacturer's corporate average fuel economy for the applicable model year, and may forego testing of the "worst-case" configuration.

* * * *

4. §86.1830~~-01~~ Acceptance of Vehicles for Testing. ~~January 17, 2006. [No change.]~~

4.1 §86.1830-01. January 17, 2006. [No change.]

5. §86.1831~~-01~~ Mileage accumulation requirements for test vehicles. ~~January 17, 2006. [No change.]~~

5.1 §86.1831-01. January 17, 2006. [No change.]

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8. §86.1834 Allowable maintenance.

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8.2 HEVs.

~~(a)~~ The manufacturer shall equip the vehicle with a maintenance indicator consisting of a light that 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; and (iv) other parameters critical for determining battery condition.

~~(b) The manufacturer shall equip "off-vehicle charge capable HEVs" with a useful life indicator for the battery system consisting of a light that 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 Urban Driving Schedule portion of the All-Electric Range Test (see the "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes").~~

9. §86.1835~~-01~~ Confirmatory certification testing. ~~April 13, 2001. [No change.]~~
9.1 §86.1835-01. May 7, 2010. [No change.]

*   *   *   *

12. §86.1838 Small volume manufacturers certification procedures. ~~January 17, 2006.~~

12.1 §86.1838-01. ~~December 6, 2002~~ January 17, 2006. [No change, except that the reference to 15,000 units shall mean 4,500 units in California and the reference to 14,999 units shall mean 4,499 units in California.]

*   *   *   *

H. Certification, Information and Reporting Requirements.

1. §86.1841 Compliance with emission standards for the purpose of certification

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1.2 For 2012 through 2016 model year vehicles certifying to the 2012 through 2016 MY National greenhouse gas program, §86.1841-01~~, as proposed at 74 Fed. Reg. 49454, 49758~~

~~(September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ (July 6, 2011) ~~[insert page] (April [insert date], 2010),~~ shall apply. Changes specified under section H.1.1 shall also apply for this section H.1.2.

* * * *

1.5 **Certification of a Federal Vehicle in California.** Whenever a manufacturer federally-certifies a 2004 through 2014 ~~or subsequent~~ model-year passenger car, light-duty truck or medium-duty vehicle model to the standards for a particular emissions bin that are more stringent than the standards for an applicable California vehicle emissions category, the equivalent California model may only be certified to (i) the California standards for a vehicle emissions category that are at least as stringent as the standards for the corresponding federal emissions bin, or (ii) the exhaust emission standards to which the federal model is certified. However, where the federal exhaust emission standards for the particular emissions bin and the California standards for a vehicle emissions category are equally stringent, the California model may only be certified to either the California standards for that vehicle emissions category or more stringent California standards. The federal emission bins are those contained Tables S04-1 and S04-2 of 40 CFR section 86.1811-04(c) as adopted February 10, 2000. A California vehicle model is to be treated as equivalent to a federal vehicle model if all of the following characteristics are identical:

(a) Vehicle make and model;
(b) Cylinder block configuration (e.g., L-6, V-8);
(c) Displacement;
(d) Combustion cycle;
(e) Transmission class;
(f) Aspiration method (e.g., naturally aspirated, turbocharged); and
(g) Fuel (e.g., gasoline, natural gas, methanol).

The comparative stringency of the standards for the federal exhaust emissions bin and for the California vehicle emissions category shall be based on a comparison of the sum of the 100,000, 120,000, or 150,000 mile standards for NMOG and NOx.

1.5.1 If a federally-certified vehicle model is certified in California in accordance with subparagraph 1.45, the model shall be subject to the federal requirements for exhaust emissions, SFTP emissions, cold CO emissions and highway NOx. The vehicle model shall be subject to all other California requirements including evaporative emissions, OBD II, greenhouse gas emissions, and emissions warranty, except that a 2004 or earlier model-year vehicle in the federal heavy light-duty truck or medium-duty passenger vehicle classes may at the manufacturer's option be subject to the federal requirements for evaporative emissions and OBD II.

1.5.2 Prior to certification of a 2004 through 2014 ~~or subsequent~~ model-year vehicle, a manufacturer must submit information sufficient to enable the Executive Officer to determine whether there is a federally-certified vehicle model for that model year that is equivalent to the California vehicle model based on the criteria listed in subparagraph 1.45.

1.5.3 If the Executive Officer determines that there is a federally-certified vehicle model for that model year that is equivalent to the California vehicle model, the following information shall be submitted with the Part I or Part II Application for Certification as set forth below:

(a) Part I Application for Certification: (i) Evidence of federal certification including, but not limited to, federal certification exhaust emission levels and compliance with federal SFTP, cold CO and highway NOx emission levels; and (ii) evidence of compliance with California evaporative emission requirements, California OBD II requirements, and California greenhouse gas requirements or, where permitted under Section 1.~~4~~5.1 for a 2004 or earlier model-year vehicle, evidence of federal certification evaporative emission levels and compliance with federal OBD II requirements.

* * * *

1.5.7 The requirements in Section H.1.~~4~~5 do not apply in the case of a federally-certified vehicle model that is only marketed to fleet operators for applications that are subject to clean fuel fleet requirements established pursuant to section 246 of the federal Clean Air Act (42 U.S.C. sec. 7586). In addition, the Executive Officer shall exclude from the requirements a federally-certified vehicle model where the manufacturer demonstrates to the Executive Officer's reasonable satisfaction that the model will primarily be sold or leased to clean fuel fleet operators for such applications, and that other sales or leases of the model will be incidental to marketing to those clean fuel fleet operators.

1.5.8 A manufacturer may certify a passenger car, light-duty truck or medium-duty vehicle to federal exhaust emission standards pursuant to Section H.1.~~4~~5 prior to the 2004 model year.

* * * *

3. §86.1843 General information requirements

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3.2 Alternative Fuel Information.

For ~~TLEVs, LEVs, ULEVs, and SULEVs~~ passenger cars, light-duty trucks, and medium-duty vehicles not certified exclusively on gasoline or diesel, except for vehicles that use hydrogen fuel, the manufacturer shall submit projected California sales and fuel economy data nineteen months prior to January 1 of the model year for which the vehicles are certified. For vehicles that use hydrogen fuel, the manufacturer shall submit projected California sales and leases, fuel economy data, vehicle fuel pressure rating, name of air basin(s) where vehicles will be delivered for sale or lease, and number of vehicles projected to be delivered to each air basin, thirty-three months prior to January 1 of the model year for which the vehicles are certified. For calendar year 2012 only, the manufacturer of vehicles that use hydrogen fuel shall submit projected California sales and leases, fuel economy data, vehicle fuel pressure rating, name of air basin(s) where vehicles will be delivered for sale or lease, and number of vehicles projected to be delivered to each air basin, twenty-nine months prior to January 1 of the model year for which the vehicles are certified.

* * * *

4. §86.1844 Information Requirements: Application for Certification and Submittal of Information Upon Request.

4.1 §86.1844-01. ~~February 26, 2007~~ September 15, 2011. Amend as follows:

* * * *

4.1.2 Modify §86.1844-01(d) as follows:

(a) Delete §86.1844-01(d)(9).

(b) Delete §86.1844-01(d)(15)(ii) and replace it with the following: For vehicles with fuel fired heaters, a manufacturer must include the information specified in this section H.4.4.

(~~b~~c) Add the following requirement: A description of each greenhouse gas test vehicle including the criteria listed in Section G.2.4. and any additional information used by a manufacturer to demonstrate a "worst-case" vehicle configuration used to comply with the requirements of Section G.2.4.

* * * *

4.2 OBD Requirements.

For 2001 through 2016 ~~and subsequent~~ model-year passenger cars, light-duty trucks and medium-duty vehicles, information shall be submitted in the application for certification according to the requirements of section 1968, et seq., title 13, CCR, as applicable.

4.3 HEVs.

For HEVs, the information required in the "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 ~~and Subsequent~~ Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," must be supplied with the Part I application for certification.

* * * *

4.5 Greenhouse Gas Reporting Requirements.

* * * *

(b) For the 2012 through 2016 model years, a manufacturer that elects to demonstrate compliance with the requirements of sections E.2.5 and E.3.2 by demonstrating compliance with the 2012 through 2016 MY National greenhouse gas program must submit all data to the Executive Officer in accordance with the reporting requirements as required under section E.2.5.1(ii) and 40 CFR §86.1865-12~~, as proposed at 74 Fed. Reg. 49454, 49760 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg. 25324, 25691 [insert page] (April [insert date], 2010)~~.

(c) All data submitted in accordance with this section H.4.5, must be submitted electronically and organized in a format specified by the Executive Officer to clearly demonstrate compliance with the fleet average greenhouse gas exhaust emission requirements in section E.2.5 or 40 CFR §86.1865-12 ~~as proposed at 74 Fed. Reg. 49454, 49760 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg. 25324, 25691 [insert page] (April [insert date], 2010)~~, as applicable.

I. In-Use Compliance Requirements and Procedures

1. §86.1845 Manufacturer in-use verification testing requirements.

* * * *

1.2 §86.1845-04. ~~As proposed at 74 Fed. Reg. 49454, 49758 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. Amend as follows:

* * * *

2. §86.1846 Manufacturer in-use confirmatory testing requirements.

2.1 §86.1846-01. ~~As proposed at 74 Fed. Reg. 49454, 49759 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. [No Change.]

* * * *

J. Procedural Requirements

* * * *

3. §86.1848-10 Certification. ~~As proposed at 74 Fed. Reg. 49454, 49759 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ July 6, 2011 ~~[insert page] (April [insert date], 2010)~~. [No change, except that this version of §86.1848-10 shall only apply to vehicles certifying under the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years.~~]

*   *   *   *

9. §86.1854-12 Prohibited acts. ~~As proposed at 74 Fed. Reg. 49454, 49759 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. [No change.]

*   *   *   *

14. §86.1863-07 Optional Chassis Certification for Diesel Vehicles. ~~June 17, 2003~~ September 15, 2011. [No change]
15. §86.1865-12 How to comply with the fleet average CO_2 standards. ~~As proposed at 74 Fed. Reg. 49454, 49760 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ September 15, 2011 ~~[insert page] (April [insert date], 2010)~~. [No change, except that this section shall only apply to vehicles certifying under the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~.]
16. §86.1866-12 CO_2 fleet average credit programs. ~~As proposed at 74 Fed. Reg. 49454, 49763 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ July 6, 2011 ~~[insert page] (April [insert date], 2010)~~. [No change, except that this section shall only apply to vehicles certifying under the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~.]
17. §86.1867-12 Optional early CO_2 credit programs. ~~As proposed at 74 Fed. Reg. 49454, 49766 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ July 6, 2011 ~~[insert page] (April [insert date], 2010)~~. [No change, except that this section shall only apply to vehicles certifying under the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~.]

PART II: CALIFORNIA EXHAUST AND PARTICULATE EMISSION TEST PROCEDURES FOR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

This part describes the equipment required and the procedures necessary to perform gaseous and particulate exhaust emission tests (40 CFR Part 86, Subpart B); cold temperature test procedures (40 CFR Part 86, Subpart C); the California 50°F test procedure; the development of reactivity adjustment factors; and the supplemental federal test procedure (40 CFR Part 86, Subpart B) on passenger cars, light-duty trucks, and medium-duty vehicles.

A. 40 CFR Part 86, Subpart B - Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles and New Light-Duty Trucks and New Otto-Cycle Complete Heavy-Duty Vehicles; Test Procedures.

* * * *

100.2 Equipment and Facility Requirements.

* * * *

86.111-94 Exhaust gas analytical-system. ~~As proposed at 74 Fed.Reg. 49454, 49748 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed.Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~.

* * * *

100.3 Certification Fuel Specifications.

* * * *

100.3.2 Certification Diesel Fuel Specifications.

* * * *

100.3.2.2 Certification Diesel Fuel Specifications for the 2007 through 2016 ~~and Subsequent~~ Model Years.

Amend subparagraphs §86.113-07(b)(2) and (b)(3) as follows:

(b)(2) Except as noted below, petroleum fuel for diesel vehicles meeting the specifications referenced in 40 CFR §86.113-07(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. The petroleum fuel used in exhaust emission testing may meet the specifications listed below, or substantially equivalent specifications approved by the Executive Officer, as an option to the specifications in 40 CFR §86.113-07(b)(2). Where a manufacturer elects pursuant to this subparagraph to conduct exhaust emission testing using the specifications of 86.113-94(b)(2) and in §86.113-07(b)(2), or the specifications listed below, the Executive Officer shall conduct exhaust emission testing with the diesel fuel meeting the specifications elected by the manufacturer.

California Certification Diesel Fuel Specifications
For the 2007 through 2016 ~~and Subsequent~~ Model Years

Fuel Property	**Limit**	**Test Method** [(a)]
Natural Cetane Number	47-55	D 613-86
Distillation Range		§2282(g)(3), title 13, CCR
IBP	340-420 °F	
10% point	400-490 °F	
50% point	470-560 °F	
90% point	550-610 °F	
EP	580-660 °F	
API Gravity	33-39°	D 287-82
Total Sulfur	7-15 ppm	§2282(g)(3), title 13, CCR
Nitrogen Content	100-500 ppmw	§2282(g)(3), title 13, CCR
Total Aromatic Hydrocarbons	8-12 vol. %	§2282(g)(3), title 13, CCR
Polycyclic Aromatic Hydrocarbons	1.4 wt. % (max)	§2282(g)(3), title 13, CCR
Flashpoint	130 °F (max)	D 93-80
Viscosity @ 40°F	2.0-4.1 centistokes	D 445-83

(a) ASTM specifications unless otherwise noted. A reference to a subsection of §2282, title 13, CCR, means the test method identified in that subsection for the particular property. 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 of the specified method.

* * * *

100.3.9 Identification of New Clean Fuels to be Used in Certification Testing.

* * * *

(a) If the proposed new clean fuel may be used to fuel existing motor vehicles, the state board shall not establish certification specifications for the fuel unless the petitioner has demonstrated that:

(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 associated with toxic air contaminants, as determined pursuant to the procedures set forth in “California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels through 2014.~~,~~” ~~as adopted September 17, 1993.~~ 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.

* * * *

100.5 Test Procedures and Data Requirements.

86.127-00 Test procedures; overview. May 4, 1999. ~~As proposed at 74 Fed. Reg. 49454, 49748 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg. [insert page] (April [insert date], 2010).~~
86.127-12 Test procedures; overview. May 7, 2010.

* * * *

86.130-00 Test sequence; general requirements. October 22, 1996.

100.5.2 California test sequence; general requirements.

100.5.2.1 Delete subparagraph (a) of §86.130-00 and replace with:

For purposes of determining conformity with 50°F test requirements, the procedures set forth in Part II, Section C. For all hybrid electric vehicles and all 2001 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~~ 2001 and Subsequent Model Motor Vehicles” as incorporated by reference in section 1976, title 13, CCR shall apply.

* * * *

86.132-00 Vehicle preconditioning. October 22, 1996.

100.5.3 California Vehicle Preconditioning Requirements.

100.5.3.1 Add the following subparagraph: For all hybrid electric vehicles and all 2001 ~~2000~~ and subsequent model-year vehicles subject to running loss and useful life evaporative emission standards, the preconditioning sequence for the Federal Test Procedure specified in “California Evaporative Emission Standards and Test Procedures for 2001 ~~1978~~ and Subsequent Model Motor Vehicles” as incorporated by reference in section 1976, title 13, CCR shall apply.

In addition, the preconditioning sequence for the SFTP described in subparagraphs (n) and (o) of paragraph 86.132-00 shall apply.

* * * *

86.135-00 Dynamometer procedure. October 22, 1996. [No change, except that the amendments to §86.135-90, 70 FR 72917 (December 8, 2005), shall apply.]

86.135-12~~00~~ Dynamometer procedure. ~~As proposed at 74 Fed. Reg. 49454, 49749 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. [No change.]

* * * *

86.144-94 Calculations; exhaust emissions. July 13, 2005.

100.5.4 Calculations; exhaust emissions.

100.5.4.1 The exhaust emission calculations for California are set forth in the “California Non-Methane Organic Gas Test Procedures.~~,~~” ~~which is incorporated by reference in section 1961(d), title 13, CCR.~~

* * * *

86.165-12 Air Conditioning idle test procedure. ~~As proposed at 74 Fed. Reg. 49454, 49749 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ July 6, 2011 ~~[insert page] (April [insert date], 2010)~~. [No change, except that this section shall only apply to vehicles certifying under the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~.]

86.166-12 Method for calculating emissions due to air conditioning leakage. ~~As proposed at 74 Fed. Reg. 49454, 49750 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg.~~ May 7, 2010 ~~[insert page] (April [insert date], 2010)~~. [No change, except that this section shall only apply to vehicles certifying under the 2012 through 2016 MY National greenhouse gas program ~~for the 2012 through 2016 model years~~.]

~~86.167-12 N_2O measurement devices. As proposed at 74 Fed. Reg. 49454, 49751 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg. [insert page] (April [insert date], 2010). [No change, except that this section shall only apply to vehicles certifying under the National greenhouse gas program for the 2012 through 2016 model years.]~~

~~86.168-12 Interference verification for N_2O analyzers. As proposed at 74 Fed. Reg. 49454, 49752 (September 28, 2009) and adopted by EPA on April 1, 2010, 75 Fed. Reg. [insert page] (April [insert date], 2010). [No change, except that this section shall only apply to vehicles certifying under the National greenhouse gas program for the 2012 through 2016 model years.]~~

B. Subpart C - Emission Regulations for 1994 and Later Model Year Gasoline-Fueled New Light-Duty Vehicles, ~~and~~ New Light-Duty Trucks and New Medium-Duty Passenger Vehicles; Cold Temperature Test Procedures.

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State of California
AIR RESOURCES BOARD

CALIFORNIA ENVIRONMENTAL PERFORMANCE LABEL SPECIFICATIONS FOR 2009 AND SUBSEQUENT MODEL YEAR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY PASSENGER VEHICLES

Adopted: May 2, 2008
Amended: March 22, 2012

Note: The proposed amendments to this document are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions compared to the test procedures as last adopted May 2, 2008.

As Amended: March 22, 2012
Date of Hearing: January 26-27, 2012

State of California
AIR RESOURCES BOARD

California Environmental Performance Label Specifications

1. Prohibition.

(a) The sale and registration in this state of any certified new 2009 and subsequent model passenger car, light-duty truck, and medium-duty passenger vehicle manufactured on or after January 1, 2009 to which an Environmental Performance label has not been affixed in accordance with these procedures is prohibited. Affixing the Environmental Performance (EP) label to a vehicle manufactured before January 1, 2009 in lieu of the Smog Index Label is optional, however, each such label optionally affixed and not meeting all specifications herein, is prohibited.

(b) Affixing the Federal Fuel Economy and Environment Label in accordance to 40 CFR Parts 85, 86, and 600 as promulgated on July 6, 2011 is deemed compliant with the Environmental Performance label requirements.

(c) Neighborhood electric vehicles (NEVs) are not permitted to affix a Federal Fuel Economy and Environment Label. NEVs are not required to have an Environmental Performance label, however the EP label can be optionally affixed to a NEV.

2. Requirements.

(a) Environmental Performance Label:

(1) Except as provided in paragraph 2.(a)(5) or 2.(b), a stand-alone Environmental Performance label made of paper or plastic must be securely affixed in a location specified in section 43200 of the Health and Safety Code.

(2) The Environmental Performance label must display the global warming score for the vehicle, as specified in paragraph **3. Global Warming Score** of these specifications.

(3) The Environmental Performance label must display the smog score for the vehicle, as specified in paragraph **4. Smog Score** of these specifications.

(4) The Environmental Performance label may be expanded to include bar coding information, if and only if all requirements for the Environmental

Performance label are maintained and the bar coding information is placed outside the 4 x 6 inch label perimeter.

(5) The Environmental Performance label may instead be placed on labeling feedstock that displays stock numbers and other vehicle related consumer information. If exercising this option, the following color ranges of green, as selected from the Pantone Formula Guide, product #GP1201 (2007), which is incorporated by reference herein, must not be used on the label feedstock within a 2-inch perimeter outside the label's border:

(A) PMS 320 (C or U) through PMS 378 (C or U)
(B) PMS 3242 (C or U) through PMS 3435 (C or U)
(C) PMS 560 (C or U) through PMS 562 (C or U)
(D) PMS 567 (C or U) through PMS 569 (C or U)

(6) The Environmental Performance label must take the form as set forth in paragraph **6. Environmental Performance Label Format Requirements** and Attachment A of these specifications.

(b) Alternate Environmental Performance Label: An alternate Environmental Performance label, which is reduced in size, may be used, if and only if the following requirements are met:

(1) The alternate label is placed or incorporated within the new vehicle Monroney sticker required by the Automobile Information Disclosure Act (15 U.S.C. 1232), as provided by the vehicle manufacturer.

(2) The alternate label must display the global warming score for the vehicle, as specified in paragraph **3. Global Warming Score** of these specifications.

(3) The alternate label must display the smog score for the vehicle, as specified in paragraph **4. Smog Score** of these specifications.

(4) The following color ranges of green, as selected from the Pantone Formula Guide, product #GP1201 (2007), which is incorporated by reference herein, must not be used on the Monroney sticker within a 2-inch perimeter outside the label's border:

(A) PMS 320 (C or U) through PMS 378 (C or U)
(B) PMS 3242 (C or U) through PMS 3435 (C or U)
(C) PMS 560 (C or U) through PMS 562 (C or U)
(D) PMS 567 (C or U) through PMS 569 (C or U)

(5) The alternate label must take the form as set forth in paragraph **7. Alternate Environmental Performance Label Format Requirements** and Attachment B of these specifications.

3. Global Warming Score

(a) The global warming emissions value used to determine a vehicle's global warming score must be measured and calculated as follows:

(1) If California has received a waiver of federal preemption under the Clean Air Act, Section 209(b), to enforce Title 13, California Code of Regulations, Section 1961.1 as noticed in the Federal Register, then the global warming emissions value is the CO_2-equivalent combined value as calculated in accordance with Title 13, California Code of Regulations, Section 1961.1(a)(1)(B) and certified pursuant thereto.

(2) If California has not received a waiver of federal preemption under the Clean Air Act, Section 209(b), to enforce Title 13, California Code of Regulations, Section 1961.1 as noticed in the Federal Register, then the global warming emissions value is the CO_2-equivalent combined value as calculated using the following method:

(A) If the vehicle is not equipped with an air conditioning system, then the CO_2-equivalent combined value is calculated using this equation:

CO_2-equivalent combined value = [(0.55 x CO_2-city + 0.45 x CO_2-highway) + 2] x Fuel Adjustment Factor

(B) If the vehicle is equipped with an air conditioning system, then the CO_2-equivalent combined value is calculated using this equation:

CO_2-equivalent combined value = [(0.55 x CO_2-city + 0.45 x CO_2-highway) + 25 – (A/C-direct + A/C-indirect)] x Fuel Adjustment Factor

Where:

i. "CO_2-city" and "CO_2-highway" values are the vehicle's grams per mile city and highway CO_2 measured emissions reported to ARB in accordance with the August 29, 2007, ARB Mailout, MSO #2007-03, and incorporated by reference herein.

ii. "A/C-direct" is a credit for an A/C system that qualifies as a "low-leak" system. The A/C-direct default value is zero for A/C systems that do not qualify as a "low-leak" system. To qualify as a "low-leak" A/C system that uses HFC-134a as the refrigerant, the following requirements apply and the Executive Officer will review submitted demonstrations for approval:

1. The manufacturer must demonstrate via engineering evaluation that the A/C system minimizes overall refrigerant leakage by:

    a. Minimizing the number of fitting and joints.
    b. Limiting the use of single O-rings for pipe and hose connections.
    c. Using lowest permeability hose for containment of the refrigerant.
    d. Minimizing leakage from compressor shaft seal and housing seals.

2. Annual leakage refrigerant emissions are measured and determined in accordance with SAE International standard J2727 (Rev. Jul. 2007), incorporated by reference herein. If the A/C system is determined to be a “low-leak” system in accordance with paragraphs 3.(a)(2)(B)ii.1. and 2. Above and if approved by the Executive Officer, the A/C-direct credit is then calculated using the following equation:

    A/C-direct = 6 – SAE J2727 measured annual refrigerant leakage in grams x 1300 / 12,000

iii. For an A/C system that uses a refrigerant with a Global Warming Potential ≤ 150 times that of CO_2, the A/C-direct credit is equal to 6 grams/mile.

iv. “A/C-indirect” is a credit for an A/C system that qualifies as an “improved” system. The A/C-indirect default value is zero for A/C systems that do not qualify as an “improved” system. To qualify as an “improved” system that uses CO_2, HFC-134a, HFC-152a, or other halocarbon refrigerant, the following requirements apply and the Executive Officer will review submitted demonstrations for approval:

1. The manufacturer demonstrates using test data in an engineering evaluation that the A/C system achieves lower A/C-indirect emissions than the default value of 17 grams/mile.
2. The system manages outside and re-circulated air balance to achieve comfort, demisting, and safety requirements, based on factors such as temperature, humidity, pressure, and level of fresh air in the passenger compartment in order to minimize compressor usage.

3. The system is optimized for energy efficiency by utilizing state-of-the-art high efficiency evaporators, expansion devices, condensers, and other components.
4. The system has external controls that adjust the evaporative temperature to minimize the necessity of reheating cold air to satisfy occupant comfort. If the A/C system is determined to be an "improved" system in accordance with paragraphs 3.(a)(2)(B)iv.1. through 4. Above and if approved by the Executive Officer, the A/C-indirect credit is calculated using the following equation:

A/C-indirect = 17 – Compressor Displacement in cubic centimeters x 5 / 100

v. "Fuel Adjustment Factor" is the upstream greenhouse gas emission adjustment factor for various fuels and is assigned the following values:

Fuel Type	Fuel Adjustment Factor
Gasoline	1.00
Diesel	1.00
Natural Gas	1.03
LPG	0.89
E85	0.74

(C) Vehicles that use electricity or hydrogen as their only fuel source are exempt from testing and submission of greenhouse gas data for calculating CO_2-equivalent combined values. Such vehicles will be assigned a default CO_2-equivalent combined value as follows:

Vehicle Type	CO_2-equivalent combined value (g/mile)
Battery Electric	130
Hydrogen Internal Combustion	290
Hydrogen Fuel Cell Electric	210

(b) The average new vehicle CO_2-equivalent combined value is projected to be 360 grams per mile and will be assigned a global warming score of 5.

(c) The global warming scores in the following table apply to all:

(1) passenger cars,

(2) light-duty trucks 0-8500 lbs. GVW, except trucks 3751 lbs. LVW to 500 lbs. GVW that are certified to Option 1 LEV II NOx standard, pursuant to Title 13, California Code of Regulations, Section 1961(a)(1), and

(3) medium-duty passenger vehicles 8501-9999 lbs. GVW:

Grams per mile CO_2-equivalent combined	Global Warming Score
Less than 200	10
200-239	9
240-279	8
280-319	7
320-359	6
360-399	5
400-439	4
440-479	3
480-519	2
520 and up	1

4. Smog Score

(a) The average new vehicle NMOG + NOx certification value is projected to be closest to an Ultra-Low-Emission Vehicle (ULEV) certification and is assigned a smog score of 5, regardless of actual average certified values.

(b) The smog scores in the following table apply to 2009 and subsequent model year passenger cars and light-duty trucks 0-8500 lbs. GVW and medium-duty passenger vehicles 8501-9999 lbs. GVW, as certified pursuant to Title 13, California Code of Regulations, Section 1961(a)(1):

California Emissions Category– Federal Bins	NMOG + NOx (g/mile)	Smog Score
ZEV – Bin 1	0.0	10
PZEV	0.030	9
SULEV – Bin 2	0.030	8
Bin 3	0.085	7
Bin 4	0.110	6
ULEV	0.125	5
LEV – Bin 5	0.160	4
[LEV (option 1) – Bin 6] and [SULEV (MDPV)]	0.190 – 0.200	3

Bin 7	0.240	2
ULEV (MDPV) – Bin 8a	0.325	1

5. **Bi-Fuel, Fuel Flexible, and Dual-Fuel Vehicles**. Notwithstanding Title 13, California Code of Regulations, Section 1961.1(a)(1)(B)2., the global warming score and smog score are based on exhaust mass emission tests when the vehicle is operating on gasoline or diesel.

6. **Environmental Performance Label Format Requirements.** Detailed printing requirements and a sample label are given in Attachment A of this specification and apply to the label requirements of paragraph 2.(a) of these specifications. Unless otherwise stated, a dimensional tolerance of plus or minus 0.039 inches (1.0 millimeter) applies to printer and label feedstock alignment.

(a) Environmental Performance label:

(1) Must be rectangular in shape 6 inches wide x 4 inches high.

(2) Must be white, outlined with a 3 point green line and have a 0.5 inch high section of green at the top and a 1 inch high section of green at the bottom.

(b) Label information. The following item numbers correspond with the table numbers and sample label reference numbers in Attachment A. The information on each label must meet the following requirements:

(1) The color for the prescribed green as specified in Attachment A is PMS 347 (C or U) selected from the Pantone Formula Guide, Product # GP1201 (2007), incorporated by reference, herein. When printing in 4 color process the color build for the prescribed green is:

Cyan 100
Magenta 0
Yellow 86
Black 3

When printing in 3 color process the color build for the prescribed green is:

Red 0
Green 161
Blue 96

(2) “Environmental Performance” is the title of the label. This title must be centered in the top section of green. See Attachment A for font, size and color requirements.

(3) The phrase “Protect the environment, choose vehicles with higher scores:” must appear under the top section of green. This phrase must be centered with a 9-point gap between the phrase and the top section of green. See Attachment A for font, size and color requirements.

(4) “Global Warming Score” is a title that must always appear over its respective scale. This title must start 2 picas from the left edge of the label and the bottom of the title must start 8 picas from the top edge of the label. See Attachment A for font, size and color requirements.

(5) The number for the Global Warming Score is variable and must be centered over the block it represents on the global warming scale. The bottom of the number must start 6 points above the block it represents. Scores are determined in paragraph **3. Global Warming Score**. Vehicles certified to Option 1 LEV II NOx standard, pursuant to Title 13, California Code of Regulations, Section 1961(a)(1), are exempt from this requirement. See Attachment A for font, size and color requirements.

(6) The number 1 must appear flush left with and underneath each scale line. The top of the number must start 4 points below the bottom of the scale line. The number 1 represents the lowest score a vehicle can get on each scale. See Attachment A for font, size and color requirements.

(7) “Average new vehicle” must appear as shown in the sample label, under both scales at the center point of the fifth block (or where the fifth block would normally be), and must be marked by a triangle (item 15 in Attachment A). The top of this phrase must start 14 points below the bottom of the scale line. See Attachment A for font, size and color requirements.

(8) The following statement must appear as shown in the sample label, in the lower section of green on the label: “Vehicle emissions are a primary contributor to global warming and smog. Scores are determined by the California Air Resources Board based on this vehicle’s measured emissions. Please visit **www.DriveClean.ca.gov** for more information.” This statement must be left justified and start 2 picas from the left edge and the bottom of the phrase must be 9 points above the bottom edge of the label. The third row of text must end after the word “visit” and drop

down to a fourth line of text to allow room for item 17, the ARB logotype. See Attachment A for font, size and color requirements.

(9) The words “higher scores:” must be bolded. See Attachment A for font, size and color requirements.

(10) “Smog Score” is a title that must always appear over its respective scale. This title must be flush left with its scale line, starting 21.75 picas from the left edge of the label and the bottom of the title must start 8 picas from the top edge of the label. See Attachment A for font, size and color requirements.

(11) The number for the Smog Score is variable and must appear centered over the block it represents on the smog scale. The bottom of the number must start 6 points above the block it represents. Scores are determined in paragraph **4. Smog Score**. See Attachment A for font, size and color requirements.

(12) Squares on the scales. Each square represents a single score on the scale and must rest on top of the scale line. For example: If a vehicle scores a 5, on a given scale, there will be five squares to represent that score. The first square must be flush left with the scale line (Attachment A item 13) and the tenth square must be flush right with the scale line, therefore maintaining a distance of exactly 3 points between squares, even when not all ten squares are present. See Attachment A for size and color requirements.

(13) The scale line must appear on both scales and must be a consistent length. The left scale line must start 2 picas from the left edge of the label and the bottom of the scale line must be 2 inches below the top edge of the label. The right scale line must end 2 picas from the right edge of the label and the bottom of the scale line must be 2 inches below the top edge of the label. See Attachment A for length, stroke and color requirements.

(14) The number 10 must appear flush right with and underneath each scale line. The top of the number must start 4 points below the bottom of the scale line. The number 10 represents the highest score a vehicle can get on each scale. See Attachment A for font, size and color requirements.

(15) An upright equilateral triangle must appear under both scale lines at the center point of the fifth block (or where the fifth block would normally be) on both scale lines representing where the average new vehicle falls on

each scale. The top of the triangle must start at, and touch, the bottom of the scale line. See Attachment A for size and color requirements.

(16) The title “Cleanest” must appear flush right with and underneath each scale line. The top of the title must start 15 points below the bottom of the scale line. This title must always be bold. See Attachment A for font, size and color requirements.

(17) The California Environmental Protection Agency / Air Resources Board logotype must appear in the lower right hand corner as shown in the sample label. The dividing line must end 18 points from the right edge of the label and the bottom of the line must be 21 points above the bottom edge of the label. The top phrase must be flush left with the dividing line and the bottom phrase must start 4 points beyond the left edge of the dividing line and end 5 points beyond the right end of the dividing line. There must be a 3-point gap above and a 3-point gap below the dividing line and each corresponding phrase. See Attachment A for font, size and color requirements.

(18) The Drive Clean website (**www.DriveClean.ca.gov**) must always appear bold within Item 8. See Attachment A for font, size and color requirements.

(19) Vehicles capable of operating on more than one fuel must display the following statement: “Using alternative fuels may improve scores. See www.DriveClean.ca.gov”. This statement must be centered with a 9-point gap between the statement and the bottom section of green. See Attachment A for font, size and color requirements.

7. Alternate Environmental Performance Label Format Requirements. Detailed printing requirements and a sample alternate label are given in Attachment B of this specification and apply to the label requirements of paragraph 2.(b) of these specifications. Unless otherwise stated, a dimensional tolerance of plus or minus 0.039 inches (1.0 millimeter) applies to printer and label feedstock alignment.

(a) Alternate Environmental Performance labels:

(1) Must be rectangular in shape with a minimum size of 4.5 inches wide by 2.5 inches high.

(2) Must be white, outlined with a 3 point green line and have a 0.3125 inch high section of green at the top and a 0.667 inch high section of green at the bottom.

(b) Label information. The following item numbers correspond with the table numbers and sample alternate label reference numbers in Attachment B. The information on each label must meet the following requirements:

(1) The color for the prescribed green as specified in Attachment B is PMS 347 (C or U) selected from the Pantone Formula Guide, Product # GP1201 (2007), incorporated by reference, herein. When printing in 4 color process the color build for the prescribed green is:

Cyan 100
Magenta 0
Yellow 86
Black 3

When printing in 3 color process the color build for the prescribed green is:

Red 0
Green 161
Blue 96

(2) "Environmental Performance" is the title of the label. This title must be centered in the top section of green. See Attachment B for font, size and color requirements.

(3) The phrase "Protect the environment, choose vehicles with higher scores:" must appear under the top section of green. This phrase must be centered with a 5-point gap between the phrase and the top section of green. See Attachment B for font, size and color requirements.

(4) "Global Warming Score" is a title that must always appear over its respective scale. This title must start 1.5 picas from the left edge and the bottom of the title must start 5 picas from the top edge of the label. See Attachment B for font, size and color requirements.

(5) The number for the Global Warming Score is variable and must be centered over the block it represents on the global warming scale. The bottom of the number must start 4 points above the block it represents. Scores are determined in paragraph **3. Global Warming Score**. Vehicles certified to Option 1 LEV II NOx standard, pursuant to Title 13, California Code of Regulations, Section 1961(a)(1), are exempt from this requirement. See Attachment B for font, size and color requirements.

(6) The number 1 must appear flush left with and underneath each scale line. The top of the number must start 3 points below the bottom of the scale line. The number 1 represents the lowest score a vehicle can get on each scale. See Attachment B for font, size and color requirements.

(7) "Average new vehicle" must appear as shown in the sample alternate label, under both scales at the center point of the fifth block (or where the fifth block would normally be), and must be marked by a triangle (item 15 in Attachment B). The top of this phrase must start 10 points below the bottom of the scale line. See Attachment B for font, size and color requirements.

(8) The following statement must appear as shown in the sample alternate label, in the lower section of green on the label: "Vehicle emissions are a primary contributor to global warming and smog. Scores are determined by the California Air Resources Board based on this vehicle's measured emissions. Please visit **www.DriveClean.ca.gov** for more information." This statement must be left justified and start 1 pica from the left edge and the bottom of the phrase must be 6 points above the bottom edge of the label. The third row of text must end after the word "visit" and drop down to a fourth line of text to allow room for item 17, the ARB logotype. See Attachment B for font, size and color requirements.

(9) The words "higher scores:" must be bolded. See Attachment B for font, size and color requirements.

(10) "Smog Score" is a title that must always appear over its respective scale. This title must be flush left with its scale line, starting 15.67 picas from the left edge of the label and the bottom of the title must start 5 picas from the top edge of the label. See Attachment B for font, size and color requirements.

(11) The number for the Smog Score is variable and must appear centered over the block it represents on the smog scale. The bottom of the number must start 4 points above the block it represents. Scores are determined in paragraph **4. Smog Score**. See Attachment B for font, size and color requirements.

(12) Squares on the scales. Each square represents a single score on the scale and must rest on top of the scale line. For example: If a vehicle scores a 5, on a given scale, there will be five squares to represent that score. The first square must be flush left with the scale line (Attachment B, item 13) and the tenth square must be flush right with the scale line, therefore maintaining a distance of exactly 2 points between squares, even when not all ten squares are present. See Attachment B for size and color requirements.

(13) The scale line must appear on both scales and must be a consistent length. The left scale line must start 1.5 picas from the left edge of the label and the bottom of the scale line must be 7.5 picas below the top edge of the label. The right scale line must end 1.5 picas from the right edge of the label and the bottom of the scale line must be 7.5 picas below the top edge of the label. See Attachment B for length, stroke and color requirements.

(14) The number 10 must appear flush right with and underneath each scale line. The top of the number must start 3 points below the bottom of the scale line. The number 10 represents the highest score a vehicle can get on each scale. See Attachment B for font, size and color requirements.
(15) An upright equilateral triangle must appear under both scale lines at the center point of the fifth block (or where the fifth block would normally be) on both scale lines, representing where the average new vehicle falls on each scale. The top of the triangle must start at, and touch, the bottom of the scale line. See Attachment B for size and color requirements.
(16) The title “Cleanest” must appear flush right with and underneath each scale line. The top of the title must start 12 points below the bottom of the scale line. This title must always be bold. See Attachment B for font, size and color requirements.
(17) The California Environmental Protection Agency / Air Resources Board logotype must appear in the lower right hand corner as shown in the sample alternate label. The dividing line must end 7 points from the right edge of the label and the bottom of the dividing line must be 14 points above the bottom edge of the label. The top phrase must be flush left with the dividing line and the bottom phrase must be flush left with the dividing line. There must be a 2-point gap above and a 2-point gap below the dividing line and each corresponding phrase. See Attachment B for font, size and color requirements.
(18) The Drive Clean website (**www.DriveClean.ca.gov**) must always appear bold within Item 8. See Attachment B for font, size and color requirements.
(19) Vehicles capable of operating on more than one fuel must display the following statement: “Using alternative fuels may improve scores. See www.DriveClean.ca.gov”. This statement must be centered with a 5-point gap between the statement and the bottom section of green. See Attachment B for font, size and color requirements.

8. **Severability**. Each provision of these specifications is severable, and in the event that any provision or part(s) thereof are held to be invalid, the remainder of these specifications remain in full force and effect.

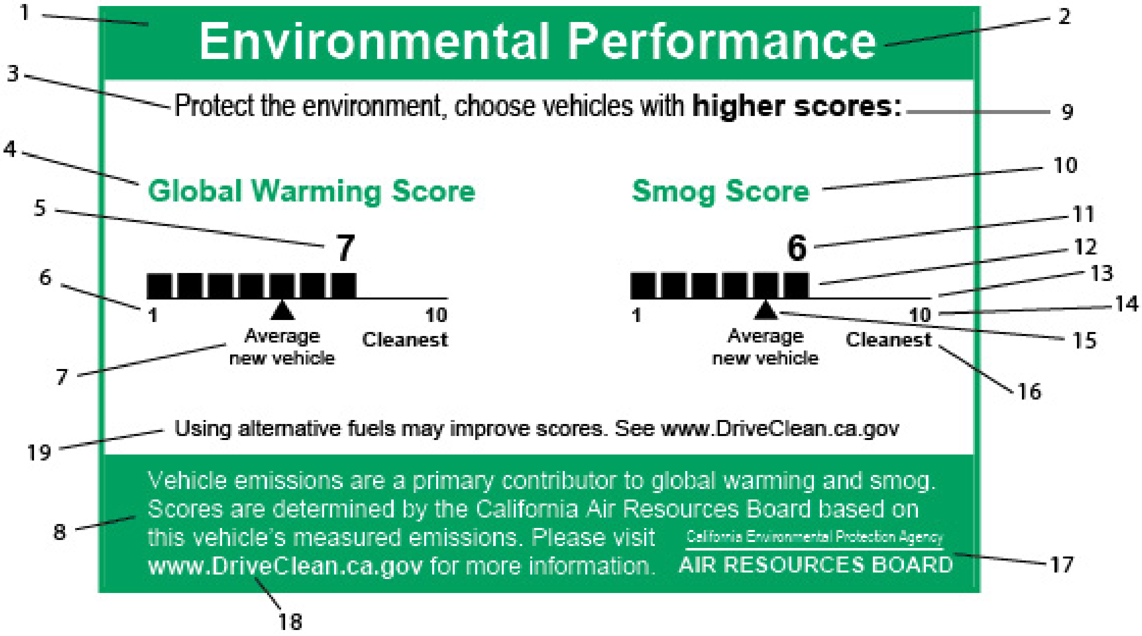
ATTACHMENT A

ENVIRONMENTAL PERFORMANCE LABEL STYLE REQUIREMENTS

1	Label Background 6 x 4 inches whole; top green: 6 x 0.5 inches; Bottom green: 6 x1 inches; green stroke: 3 points; Color: PMS 347 (C or U)
2	font: Arial Bold; size: 25 points; color: knocked out of green (appears white)
3	font: Arial Narrow; size: 15 points; color: Black
4,10	font: Arial Bold; size: 15 points; color: PMS 347 (C or U)
5, 11	font: Arial Bold; size: 18 points; color: Black
6, 14	font: Arial Bold; size: 10 points; color: Black
7	font: Arial Regular; size/leading: 10/12 points; color: Black
8	font: Arial Regular; size/leading: 12/14 points; color: knocked out of green (appears white)
9	font: Semi-bold Arial Bold; size: 15 points; color: Black
12	size: 12 x 12 points; color: Black; distance: 3 points apart
13	Scale Line: length: 147 points; stroke: 1 point; color: Black
15	size: 12 points each side; color: Black
16	font: Arial Bold; size: 10 points; color: Black
17	California Environmental Protection Agency / Air Resources Board logotype: Top Row: font: Arial Narrow; size: 8 points (Title Case) Bottom Row: font: Arial Bold; size: 11 points (All Caps) Line weight: 1 point; length: 126 points Color for all: knocked out of green (appears white)
18	**www.DriveClean.ca.gov**: Font: Arial Bold Size: 12 points Color: knocked out of green (appears white)
19	Alternative fuel phrase: font: Arial Regular; size: 11 points; color: Black

Sample

Environmental Performance Label



Environmental Performance

Protect the environment, choose vehicles with **higher scores:**

Global Warming Score

7

1 10

Average new vehicle

Cleanest

Smog Score

6

1 10

Average new vehicle

Cleanest

Using alternative fuels may improve scores. See www.DriveClean.ca.gov

Vehicle emissions are a primary contributor to global warming and smog. Scores are determined by the California Air Resources Board based on this vehicle's measured emissions. Please visit **www.DriveClean.ca.gov** for more information.

California Environmental Protection Agency

AIR RESOURCES BOARD

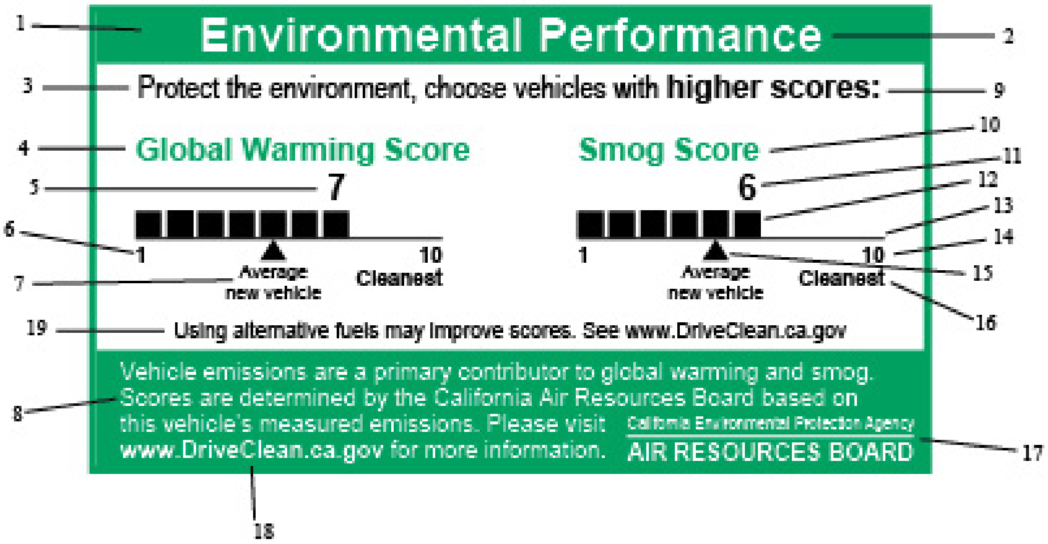
ATTACHMENT B

ALTERNATE
ENVIRONMENTAL PERFORMANCE LABEL STYLE REQUIREMENTS

1	Label Background 4.5 x 2.5 inches whole; top green: 4.5 x 0.3125 inches; Bottom green: 4.5 x 0.667 inches; green stroke: 3 points; Color: PMS 347 (C or U)
2	font: Arial Bold; size: 18 points; color: knocked out of green (appears white)
3	font: Arial Narrow; size: 12 points; color: Black
4, 10	font: Arial Bold; size: 12 points; color: PMS 347 (C or U)
5, 11	font: Arial Bold; size: 13 points; color: Black
6, 14	font: Arial Bold; size: 8 points; color: Black
7	font: Arial Regular; size/leading: 7/8 points; color: Black
8	font: Arial Regular; size/leading: 9/10 points; color: knocked out of green (appears white)
9	font: Arial Bold; size: 12 points; color: Black
12	size: 10 x 10 points; color: Black; distance: 2 points apart
13	scale Line: length: 118 points; stroke: 1 point; color: Black
15	size: 10 points each side; color: Black
16	font: Arial Bold; size: 8 points; color: Black
17	California Environmental Protection Agency / Air Resources Board logotype: Top Row: font: Arial Narrow; size: 7 points (Title Case) Bottom Row: font Arial Bold; size: 9 points (All Caps) Line weight: 1.0 points; line length: 110 points Color for all: knocked out of green (appears white)
18	**www.DriveClean.ca.gov**: Font: Arial Bold; Size/ leading: 9/10 points; Color: knocked out of green (appears white)
19	Alternative fuel phrase: font: Arial Regular; size: 8 points; color: Black

Sample

Alternate Environmental Performance Label



Environmental Performance

Protect the environment, choose vehicles with **higher scores:**

Global Warming Score 7

1 Average new vehicle 10 Cleanest

Smog Score 6

1 Average new vehicle 10 Cleanest

Using alternative fuels may improve scores. See www.DriveClean.ca.gov

Vehicle emissions are a primary contributor to global warming and smog. Scores are determined by the California Air Resources Board based on this vehicle's measured emissions. Please visit www.DriveClean.ca.gov for more information.

California Environmental Protection Agency
AIR RESOURCES BOARD

State of California
AIR RESOURCES BOARD

CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

Adopted: August 5, 1999
Amended: June 22, 2006
Amended: October 17, 2007
Amended: December 2, 2009
Amended: September 27, 2010
Amended: March 22, 2012

Note: Proposed amendments to this document are shown in underline to indicate additions and in ~~strikeout~~ to indicate deletions compared to the test procedures as last amended September 27, 2010.

NOTE: This document is incorporated by reference in section 1976(c), title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certification of motor vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles" (incorporated by reference in section 1961(d), title 13, CCR);

2. "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles" (incorporated by reference in section 1961.2 (d), title 13, CCR);

~~2.~~ 3. "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962(e), title 13, CCR);

~~3.~~ 4. "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962.1(h), title 13, CCR);

~~4.~~ 5. "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1978(b), title 13, CCR);

~~5.~~ 6. "California Exhaust Emission Standards and Test Procedures for 1987 through 2003 Model Heavy-Duty Otto-Cycle Engines and Vehicles," as incorporated by reference in section 1956.8(d), title 13, CCR;

~~6.~~ 7. "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines," as incorporated by reference in section 1956.8(d), title 13, CCR.

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Section Page No.

CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

The provisions of Title 40, Code of Federal Regulations (CFR), Part 86, Subparts A and B (as adopted or amended as of July 1, 1989); Subpart S (as adopted or amended on May 4, 1999); and, such sections of these Subparts as last amended on such other date set forth next to the 40 CFR Part 86 section title listed below, insofar as those subparts pertain to evaporative emission standards and test procedures, are hereby adopted as the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Years," with the following exceptions and additions:

PART I. GENERAL CERTIFICATION REQUIREMENTS FOR EVAPORATIVE EMISSIONS

A. 40 CFR §86.1801-01 Applicability.

1.1. These evaporative standards and test procedures are applicable to all new 2001 and subsequent model gasoline-, liquefied petroleum- and alcohol-fueled passenger cars, light-duty trucks, medium-duty vehicles, heavy-duty vehicles, hybrid electric vehicles (including fuel-flexible, dual fuel and bi-fuel vehicles, and 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles), and motorcycles. These standards and test procedures do not apply to motor vehicles that are exempt from exhaust emission certification, dedicated petroleum-fueled diesel vehicles, dedicated compressed natural gas-fueled vehicles, or hybrid electric vehicles that have sealed fuel systems which can be demonstrated to have no evaporative emissions. A manufacturer may elect to certify 2009 through 2011 model-year off-vehicle charge capable hybrid electric vehicles using these provisions. In cases where a provision applies only to a certain vehicle group based on its model year, vehicle class, motor fuel, engine type, or other distinguishing characteristics, the limited applicability is cited in the appropriate section.

1.2. For general certification purposes, and except as otherwise noted in these test procedures, the requirements set forth in the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," the "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," the "California Exhaust Emission Standards and Test Procedures for

2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," and the "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," shall apply to light- and medium-duty vehicles; the "California Exhaust Emission Standards and Test Procedures for 1987 through 2003 Model Heavy-Duty Otto-Cycle Engines and Vehicles," and the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines," shall apply to heavy-duty vehicles; and, section 1958, title 13, CCR shall apply to motorcycles.

1.3. Approval of vehicles that are not exhaust emission tested using a chassis dynamometer pursuant to section 1961, title 13, CCR shall be based on an engineering evaluation of the system and data submitted by the applicant.

1.4. Reference to light-duty trucks in the federal CFR shall mean light-duty trucks and medium-duty vehicles. Regulations concerning methanol in the Title 40, CFR Part 86, shall mean methanol and ethanol, except as otherwise indicated in these test procedures.

1.5. The term "[no change]" means that these test procedures do not modify the applicable federal requirement.

1.6. In those instances where the testing conditions or parameters are not practical or feasible for vehicles operating on LPG fuel, the manufacturer shall provide a test plan that provides equal or greater confidence in comparison to these test procedures. The test plan must be approved in advance by the Executive Officer.

B. Definitions, Acronyms, Terminology

1. These test procedures incorporate by reference the definitions set forth in the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," and~~,~~ the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," including the incorporated definitions from the Code of Federal Regulations. In addition, the following definitions apply:

1.1. "Non-integrated refueling canister-only system" means a subclass of a non-integrated refueling emission control system, where other non-refueling related evaporative emissions from the vehicle are stored in the fuel tank, instead of in a vapor storage unit(s).

1.2. “Sealed fuel system” means a non-liquid phase fuel system, on-board a vehicle, that stores, delivers, and meters the fuel under a very high pressure, and which inherently has no evaporative-related emissions, due to design specifications that eliminate the escape of any fuel vapors, under normal vehicle operations.

1.3. “2-gram breakthrough” means the point at which the cumulative quantity of hydrocarbons emitted from a stabilized canister vapor storage unit, during the loading process of the unit, is equal to 2 grams.

C. Useful Life

1. §86.1805-01. Delete. For vehicles certified to the emission standards in section I.E.1.(a), "useful life" shall have the same meaning as provided in section 2112, title 13, CCR. For vehicles certified to the emission standards in sections I.E.1.(c), ~~and~~ I.E.1.(d), and I.E.1.(e), the "useful life" shall be 15 years or 150,000 miles, whichever first occurs.

D. General Standards; increase in emissions; unsafe conditions; waivers

1. Light- and Medium-Duty Vehicles.

1.1. Amend §86.1810-01 (December 8, 2005) as follows:

(a) through (g). [The provisions of these paragraphs are contained in the “California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,” and the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles.”]

(h) For alcohol vehicles, hydrocarbon evaporative emissions shall be expressed as OMHCE.

(i) [No change.]

(j) Evaporative Emissions general provisions.

(1) The evaporative standards in section E. of this part apply equally to certification and in-use vehicles and trucks.

(2) For certification testing only, a manufacturer may conduct testing to quantify a level of stabilized non-fuel evaporative emissions for an individual certification test vehicle. Testing may be conducted on a representative vehicle to determine the non-fuel evaporative emission characteristics of the certification test vehicle. The demonstration must be submitted for advance approval by the Executive Officer and include a description of the sources of vehicle non-fuel evaporative emissions, the methodology for the quantification of the non-fuel emissions, an estimated non-fuel emission decay rate, and the stabilized non-fuel emission level. The demonstrated stabilized level of non-fuel evaporative emissions may be used in place of the test vehicle non-fuel evaporative emissions and be combined with the vehicle fuel evaporative emissions to determine compliance with the evaporative emission standard.

(3) [No change.]

(4) [No change.]

(k) through (n) [The provisions of these paragraphs are contained in the "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Year Motor Vehicles."]

(o) through (p). [The provisions of these paragraphs are contained in the “California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles~~.~~" and the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles.”]

2. Heavy-Duty Vehicles. Approval of heavy-duty vehicles over 14,000 lbs. GVWR and incomplete medium-duty vehicles 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 systems.

E. Emission Standards

1. Evaporative Emission Standards for 2001 and Subsequent Model Year Vehicles Other Than Motorcycles.

(a) For the 2001 through 2005 model year vehicles identified below, tested in accordance with the test procedure sequence set forth in Part III, the maximum projected total hydrocarbon evaporative emissions are:

Class of Vehicle	Running Loss (grams per mile)	Three-Day Diurnal + Hot Soak (grams per test)	Two-Day Diurnal + Hot Soak (grams per test)
Passenger Cars, Light-Duty Trucks	0.05	2.0	2.5
Medium-Duty Vehicles (6,001 - 8,500 lbs. GVWR)			
with fuel tanks < 30 gallons	0.05	2.0	2.5
with fuel tanks ≥ 30 gallons	0.05	2.5	3.0
Medium-Duty Vehicles (8,501 - 14,000 lbs. GVWR)	0.05	3.0 (1)	3.5
	0.05	2.0 (2)	3.5
Heavy-Duty Vehicles (over 14,000 lbs. GVWR)	0.05	2.0	4.5
Hybrid Electric PCs, LDTs and MDVs	0.05	2.0	2.5

(1) The standards in this row apply to medium-duty vehicles certified according to the exhaust standards in section 1961, title 13, CCR.

(2) The standards in this row apply to incomplete medium-duty vehicles certifying to the exhaust standards in section 1956.8, title 13, CCR.

(b) Zero emission vehicles shall produce zero fuel evaporative emissions under any and all possible operational modes and conditions.

(c) For 2001 through 2014 model year vehicles, ~~T~~ the optional zero-fuel evaporative emission standards for the three-day and two-day diurnal-plus-hot-soak tests are 0.35 grams per test for passenger cars, 0.50 grams per test for light-duty trucks 6,000 lbs. GVWR and under, and 0.75 grams per test for light-duty trucks from 6,001 to 8,500 lbs. GVWR, to account for vehicle non-fuel evaporative emissions (resulting from paints, upholstery, tires, and other vehicle sources). Vehicles demonstrating compliance with these evaporative emission standards shall also have zero (0.0) grams of fuel evaporative emissions per test for the three-day and two-day diurnal-plus-hot-soak tests. The "useful life" shall be 15 years or 150,000 miles, whichever occurs first. In lieu of demonstrating compliance with the zero (0.0) grams of fuel evaporative emissions per test over the three-day and two-day diurnal-plus-hot-soak tests, the manufacturer may submit for advance Executive Officer approval a test plan to demonstrate that the vehicle has zero (0.0) grams of fuel evaporative emissions throughout its useful life.

Additionally, in the case of a SULEV vehicle for which a manufacturer is seeking a partial ZEV credit, the manufacturer may prior to certification elect to have measured fuel evaporative emissions reduced by a specified value in all certification and in-use testing of the vehicle as long as measured mass exhaust emissions of NMOG for the vehicle are increased in all certification and in-use testing. The measured fuel evaporative emissions shall be reduced in increments of 0.1 gram per test, and the measured mass exhaust emissions of NMOG from the vehicle shall be increased by a gram per mile factor, to be determined by the Executive Officer, for every 0.1 gram per test by which the measured fuel evaporative emissions are reduced. For the purpose of this calculation, the evaporative emissions shall be measured, in grams per test, to a minimum of three significant figures.

(d) For the 2004 ~~and subsequent~~ through 2014 model motor vehicles identified below, tested in accordance with the test procedure sequence set forth in Part III, the maximum projected total hydrocarbon evaporative emissions are:

Vehicle Type	Hydrocarbon Standards[1][2]		
	Running Loss (grams per mile)	Three-Day Diurnal + Hot Soak (grams per test)	Two-Day Diurnal + Hot Soak (grams per test)
Passenger Cars	0.05	0.50	0.65
Light-Duty Trucks (under 8,501 lbs. GVWR)			
6,000 lbs. GVWR and under	0.05	0.65	0.85
6,001 - 8,500 lbs. GVWR	0.05	0.90	1.15
Medium-Duty Vehicles (8,501 - 14,000 lbs. GVWR)	0.05	1.00	1.25
Heavy-Duty Vehicles (over 14,000 lbs. GVWR)	0.05	1.00	1.25

(1) (a) These evaporative emission standards shall be phased-in beginning with the 2004 model year. Each manufacturer, except small volume manufacturers, shall certify at a minimum the specified percentage of its vehicle fleet to the evaporative emission standards in this table or the optional zero-evaporative emission standards in section I.E.1.(c) according to the schedule set forth below. For purposes of this paragraph (a), each manufacturer's vehicle fleet consists of the total projected California sales of the manufacturer's gasoline-fueled, liquefied petroleum-fueled and alcohol-fueled passenger cars, light-duty trucks, medium-duty vehicles, and heavy-duty vehicles.

Model Year	*Minimum Percentage of Vehicles Certified to the Standards in Sections I.E.1.(c) and I.E.1.(d)*
2004	40
2005	80
2006 and subsequent	100

A small volume manufacturer shall certify 100 percent of its 2006 and subsequent model vehicle fleet to the evaporative emission standards in the table or the optional zero-evaporative emission standards in section I.E.1.(c).

All 2004 through 2005 model-year motor vehicles which are not subject to these standards or the standards in section E.1.(c) pursuant to the phase-in schedule shall comply with the requirements of section I.E.1.(a).

(b) A manufacturer may use an "Alternative or Equivalent Phase-in Schedule" to comply with the phase-in requirements. An "Alternative Phase-in" is one that achieves at least equivalent emission reductions by the end of the last model year of the scheduled phase-in. Model-year emission reductions shall be calculated by multiplying the percent of vehicles (based on the manufacturer's projected California sales volume of the applicable vehicle fleet) meeting the new requirements per model year by the number of model years implemented prior to and including the last model year of the scheduled phase-in. The "cumulative total" is the summation of the model-year emission reductions (e.g., the three model-year 40/80/100 percent phase-in schedule would be calculated as: (40%*3 years) + (80%*2 years) + (100%*1 year) = 380). The required cumulative total for the phase-in of these standards is 380 emission reductions. Any alternative phase-in that results in an equal or larger cumulative total than the required cumulative total by the end of the last model year of the scheduled phase-in shall be considered acceptable by the Executive Officer only if all vehicles subject to the phase-in comply with the respective requirements in the last model year of the required phase-in schedule. A manufacturer shall be allowed to include vehicles introduced before the first model year of the scheduled phase-in (e.g., in the previous example, 10 percent introduced one year before the scheduled phase-in begins would be calculated as: (10%*4 years) = 40) and added to the cumulative total.

(c) These evaporative emission standards do not apply to zero-emission vehicles.

(2) In-use compliance whole vehicle testing shall not begin until the motor vehicle is at least one year from the production date and has accumulated a minimum of 10,000 miles. For vehicles introduced prior to the 2007 model year, in-use compliance standards of 1.75 times the "Three-Day Diurnal + Hot-Soak" and "Two-Day Diurnal + Hot-Soak" gram per test standards shall apply for only the first three model years of an evaporative family certified to a new standard.

(e) For 2015 and subsequent model motor vehicles, the following evaporative emission requirements apply:

(i) A manufacturer must certify all vehicles subject to this section to the emission standards specified in either Option 1 or Option 2 below.

(A) Option 1. The total hydrocarbon evaporative emissions from 2015 and subsequent model motor vehicles, tested in accordance with the test procedure sequence set forth in Part III, shall not exceed:

Vehicle Type	Hydrocarbon Emission Standards		
	Running Loss (grams per mile)	Three-Day Diurnal + Hot Soak and Two-Day Diurnal + Hot Soak	
		Whole Vehicle (grams per test)	Fuel Only(1) (grams per test)
Passenger Cars	0.05	0.350	0.0
Light-Duty Trucks 6,000 lbs. GVWR and under	0.05	0.500	0.0
Light-Duty Trucks 6,001 - 8,500 lbs. GVWR	0.05	0.750	0.0
Medium-Duty Passenger Vehicles	0.05	0.750	0.0
Medium-Duty Vehicles (8,501 - 14,000 lbs. GVWR)	0.05	0.750	0.0
Heavy-Duty Vehicles (over 14,000 lbs. GVWR)	0.05	0.750	0.0

(1) In lieu of demonstrating compliance with the fuel-only emission standard (0.0 grams per test) over the three-day and two-day diurnal plus hot soak tests, a manufacturer may, with advance Executive Officer approval, demonstrate compliance through an alternate test plan.

(B) Option 2. The total hydrocarbon evaporative emissions from 2015 and subsequent model motor vehicles, tested in accordance with the test procedure sequence set forth in Part III, shall not exceed:

Vehicle Type	Hydrocarbon Emission Standards		
	Running Loss (grams per mile)	Highest Whole Vehicle Diurnal + Hot Soak(1)(2)(3) (grams per test)	Canister Bleed(4) (grams per test)
Passenger Cars; and Light-Duty Trucks 6,000 lbs. GVWR and under, and 0 - 3,750 lbs. LVW	0.05	0.300	0.020
Light-Duty Trucks 6,000 lbs. GVWR and under, and 3,751 – 5,750 lbs. LVW	0.05	0.400	0.020
Light-Duty Trucks 6,001 - 8,500 lbs. GVWR; and Medium-Duty Passenger Vehicles	0.05	0.500	0.020
Medium-Duty Vehicles (8,501 - 14,000 lbs. GVWR); and Heavy-Duty Vehicles (over 14,000 lbs. GVWR)	0.05	0.600	0.030

(1) The manufacturer shall determine compliance by selecting the highest whole vehicle diurnal plus hot soak emission value of the Three-Day Diurnal Plus Hot Soak Test and of the Two-Day Diurnal Plus Hot Soak Test.

(2) Fleet-Average Option for the Highest Whole Vehicle Diurnal Plus Hot Soak Emission Standard Within Each Emission Standard Category. A manufacturer may optionally comply with the highest whole vehicle diurnal plus hot soak emission standards by using fleet-average hydrocarbon emission values. To participate, a manufacturer must utilize the fleet-average option for all of its emission standard categories and calculate a separate fleet-average hydrocarbon emission value for each emission standard category. The emission standard categories are as follows: (1) passenger cars and light-duty trucks 6,000 pounds GVWR and under, and 0 - 3,750 pounds LVW; (2) light-duty trucks 6,000 pounds GVWR and under, and 3,751 – 5,750 pounds LVW; (3) light-duty trucks 6,001 - 8,500 pounds GVWR and medium-duty passenger vehicles; and (4) medium-duty and

heavy-duty vehicles. The fleet-average hydrocarbon emission value for each emission standard category shall be calculated as follows:

$$\sum_{i=1}^{n} [(\text{number of vehicles in the evaporative family})_i \text{ X } (\text{family emission limit})_i] \div \sum_{i=1}^{n} (\text{number of vehicles in the evaporative family})_i$$

where "n" = a manufacturer’s total number of Option 2 certification evaporative families within an emission standard category for a given model year;

“number of vehicles in the evaporative family” = the number of vehicles produced and delivered for sale in California in the evaporative family;

"family emission limit" = the numerical value selected by the manufacturer for the evaporative family that serves as the emission standard for the evaporative family with respect to all testing, instead of the emission standard specified in this section I.E.1.(e)(i)(B). The family emission limit shall not exceed 0.500 grams per test for passenger cars; 0.650 grams per test for light duty trucks 6,000 pounds GVWR and under; 0.900 grams per test for light-duty trucks 6,001 - 8,500 pounds GVWR; and 1.000 grams for medium-duty passenger vehicles, medium-duty vehicles, and heavy-duty vehicles. In addition, the family emission limit shall be set in increments of 0.025 grams per test.

(3) Calculation of Hydrocarbon Credits or Debits for the Fleet-Average Option.

(A) Calculation of Hydrocarbon Credits or Debits. For each emission standard category in the model year, a manufacturer shall calculate the hydrocarbon credits or debits, as follows:

[(Applicable Hydrocarbon Emission Standard for the Emission Standard Category) – (Manufacturer’s Fleet-Average Hydrocarbon Emission Value for the Emission Standard Category)] X (Total Number of Affected Vehicles)

where “Total Number of Affected Vehicles” = the total number of vehicles in the evaporative families participating in the fleet-average option, which are produced and delivered for sale in California, for the emission standard category of the given model year.

A negative number constitutes hydrocarbon debits, and a positive number constitutes hydrocarbon credits accrued by the manufacturer for the given model year. Hydrocarbon credits earned in a given model year shall retain full value through the fifth model year after they are earned. At the beginning of the sixth model year, the hydrocarbon credits will have no value.

(B) Procedure for Offsetting Hydrocarbon Debits. A manufacturer shall offset hydrocarbon debits with hydrocarbon credits for each emission standard category within three model years after the debits have been incurred. If total hydrocarbon debits are not equalized within three model years after they have been incurred, the manufacturer shall be subject to the Health and Safety Code section 43211 civil penalties 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 hydrocarbon 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 hydrocarbon debits for the model year in the emission standard category by the applicable hydrocarbon emission standard for the model year in which the debits were first incurred.

Additionally, to equalize the hydrocarbon debits that remain at the end of the three model year offset period: (1) hydrocarbon credits may be exchanged between passenger cars and light-duty trucks 6,000 pounds GVWR and under and 0-3,750 pounds LVW, and light-duty trucks 6,000 pounds GVWR and under and 3,751-5,750 pounds LVW and (2) hydrocarbon credits may be exchanged between light-duty trucks 6,001-8,500 pounds GVWR and medium-duty passenger vehicles, and medium-duty vehicles and heavy-duty vehicles.

(4) Vehicle Canister Bleed Emission. Compliance with the canister bleed emission standard shall be determined based on the Bleed Emission Test Procedure described in section III.D.12. of these procedures and demonstrated on a stabilized canister system. Vehicles with a non-integrated refueling canister-only system are exempt from the canister bleed emission standard.

(ii) Phase-In Schedule. For each model year, a manufacturer shall certify, at a minimum, the specified percentage of its vehicle fleet to the evaporative emission standards set forth in section I.E.1.(e)(i), according to the implementation schedule set forth below. For the purpose of this section I.E.1.(e)(ii), the manufacturer's vehicle fleet consists of the vehicles produced and delivered for sale by the manufacturer in California that are subject to the emission standards in section I.E.1.(e)(i). All 2015 through 2022 model motor vehicles that are not subject to these standards pursuant to the phase-in schedule shall comply with the requirements for 2004 through 2014 model motor vehicles, as described in section I.E.1.(d).

Model Years	*Minimum Percentage of Vehicle Fleet*(1)(2)
2015, 2016, and 2017	Average of vehicles certified to section I.E.1.(c) in model years 2012, 2013, and 2014(3)(4)
2018 and 2019	60
2020 and 2021	80
2022 and subsequent	100

(1) For the 2018 through 2022 model years only, a manufacturer may use an alternate phase-in schedule to comply with the phase-in requirements. An alternate phase-in schedule must achieve equivalent compliance volume by the end of the last model year of the scheduled phase-in (2022). The compliance volume is the number calculated by multiplying the percent of vehicles (based on the manufacturer's projected sales volume of all vehicles) meeting the new requirements in each model year by the number of years implemented prior to and including the last model year of the scheduled phase-in, then summing these yearly results to determine a cumulative total. The cumulative total of the five year (60/60/80/80/100) scheduled phase-in set forth above is calculated as follows: (60*5 years) + (60*4 years) + (80*3 years) + (80*2 years) + (100*1 year) = 1040. Accordingly, the required cumulative total for any alternate phase-in schedule of these emission standards is 1040. The Executive Officer shall consider acceptable any alternate phase-in schedule that results in an equal or larger cumulative total by the end of the last model year of the scheduled phase-in (2022).

(2) Small volume manufacturers are not required to comply with the phase-in schedule set forth in this table. Instead, they shall certify 100 percent of their 2022 and subsequent model year vehicle fleet to the evaporative emission standards set forth in section I.E.1.(e)(i)(A) or section I.E.1.(e)(i)(B).

(3) The percentage of vehicle fleet averaged across the 2015, 2016, and 2017 model years shall be used to determine compliance with this requirement.

(4) The minimum percentage required in the 2015, 2016, and 2017 model years is determined by averaging the percentage of vehicles certified to the emission standards in section I.E.1.(c) in each of the manufacturer's 2012, 2013, and 2014 model motor vehicle fleets. For the purpose of calculating this average, a manufacturer shall use the percentage of vehicles produced and delivered for sale in California for the 2012, 2013, and 2014 model years. A manufacturer may calculate this average percentage using the projected sales for these model years in lieu of actual sales.

(iii) Carry-Over of 2014 Model-Year Evaporative Families Certified to the Zero-Fuel Evaporative Emission Standards. A manufacturer may carry over 2014 model motor vehicles certified to the zero-fuel (0.0 grams per test) evaporative emission standards set forth in section I.E.1.(c) through the 2018 model year and be considered compliant with the requirements of section I.E.1.(e). If the manufacturer chooses to participate in the fleet-average option for the highest whole vehicle diurnal plus hot soak emission standard, the following family emission limits are assigned to these evaporative families for the calculation of the manufacturer's fleet-average hydrocarbon emission value.

Vehicle Type	Highest Whole Vehicle Diurnal + Hot Soak (grams per test)
Passenger Cars	0.300
Light-Duty Trucks 6,000 lbs. GVWR and under, and 0 - 3,750 lbs. LVW	0.300
Light-Duty Trucks 6,000 lbs. GVWR and under, and 3,751 – 5,750 lbs. LVW	0.400
Light-Duty Trucks 6,001 - 8,500 lbs. GVWR	0.500

(iv) Pooling Provision. The following pooling provision applies to the fleet-average option for the Highest Whole Vehicle Diurnal Plus Hot Soak Emission Standard in section I.E.1.(e)(i)(B). and to the phase-in requirements in section I.E.1.(e)(ii).

(A) For the fleet-average option set forth in section I.E.1.(e)(i)(B), a manufacturer must demonstrate compliance, for each model year, based on one of two options applicable throughout the model year, either:

Pooling Option 1: the total number of passenger cars, light-duty trucks, medium-duty passenger vehicles, medium-duty vehicles, and heavy-duty vehicles that are certified to the California evaporative emission standards in section I.E.1.(e)(i)(B), and are produced and delivered for sale in California; or

Pooling Option 2: the total number of passenger cars, light-duty trucks, medium-duty passenger vehicles, medium-duty vehicles, and heavy-duty vehicles that are certified to the California evaporative emission standards in section I.E.1.(e)(i)(B), and are produced and delivered for sale in California, the District of Columbia, and all states that have adopted California's evaporative emission standards set forth in section I.E.1.(e)(i) for that model year pursuant to section 177 of the federal Clean Air Act (42 U.S.C. § 7507).

(B) For the phase-in requirements in section I.E.1.(e)(ii), a manufacturer must demonstrate compliance, for each model year, based on one of two options applicable throughout the model year, either:

Pooling Option 1: the total number of passenger cars, light-duty trucks, medium-duty passenger vehicles, medium-duty vehicles, and heavy-duty vehicles that are certified to the California evaporative emission standards in section I.E.1.(e)(i), and are produced and delivered for sale in California; or

Pooling Option 2: the total number of passenger cars, light-duty trucks, medium-duty passenger vehicles, medium-duty vehicles, and heavy-duty vehicles that are certified to the California evaporative emission standards in section I.E.1.(e)(i), and are produced and delivered for sale in California, the District of Columbia, and all states that have adopted California's evaporative emission standards set forth in section I.E.1.(e)(i) for that model year pursuant to section 177 of the federal Clean Air Act (42 U.S.C. § 7507).

(C) A manufacturer that selects Pooling Option 2 must notify the Executive Officer of that selection in writing prior to the start of the applicable model year or must comply with Pooling Option 1. Once a manufacturer has selected Pooling Option 2, that selection applies unless the manufacturer selects Option 1 and notifies the Executive Officer of that selection in writing before the start of the applicable model year.

(D) When a manufacturer is demonstrating compliance using Pooling Option 2 for a given model year, the term "in California" as used in section I.E.1.(e) means California, the District of Columbia, and all states that have adopted California's evaporative emission standards for that model year pursuant to Section 177 of the federal Clean Air Act (42 U.S.C. § 7507).

(E) A manufacturer that selects Pooling Option 2 must provide to the Executive Officer separate values for the number of vehicles in each evaporative family produced and delivered for sale in the District of Columbia and for each individual state within the average.

(v) Optional Certification for 2014 Model Motor Vehicles. A manufacturer may optionally certify its 2014 model motor vehicles to the evaporative emission standards set forth in section I.E.1.(e)(i), using the test fuel specified in section III.F.2.

2. Evaporative Emission Standards for 2001 and Subsequent Model Year Motorcycles. The maximum projected evaporative emission standards for 2001 and subsequent model gasoline-fueled motorcycles are:

Motorcycle Class	Hydrocarbons (grams per test)
Class I and Class II (50-279 cc)	2.0
Class III (280 cc and greater)	2.0

PART II. DURABILITY DEMONSTRATION

A. Light- and Medium-Duty Vehicles

1. Evaporative/refueling emission family determination. §86.1821-01 [No change.]

2. Durability Demonstration Procedures for Evaporative Emissions

2.1. §86.1824-01 Amend as follows:

(a) and (b) Delete.
(c) [No change.]
(d) Delete.
(e) [No change.]

2.2. For all passenger cars, light-duty trucks and chassis-certified medium-duty vehicles subject to the standards specified in section I.E. of these test procedures, demonstration of system durability and determination of three-day diurnal plus hot soak, two-day diurnal plus hot soak, and running loss emission deterioration factors ("evaporative DFs") for each evaporative/refueling 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 drivetrain, 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.

2.3. Prior to commencement of a durability program, the manufacturer shall propose a method for durability testing and for determination of evaporative DFs for each evaporative/refueling family. The 4,000 and full useful life mile test points (or their equivalent) used in determining a DF must be within the standards of section I.E. or data will not be acceptable for use in the calculation of a DF, except for the following provision. For evaporative families certified to the emission standards in section I.E.(e)(i)(B) that utilize the fleet-average option, the 4,000 and full useful life mile test points for the highest whole vehicle diurnal plus hot soak emissions may exceed the emission standards of section I.E.(e)(i)(B) but must be less than the maximum allowed family emission limits set forth in footnote (2) of the table in section I.E.(e)(i)(B). A manufacturer is not required to obtain a new approval to use a previously approved evaporative emission durability procedure. The Executive Officer shall review the method, and shall approve it if it meets the following requirements:

2.3.1. 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, or 150,000 miles) of typical customer use.

2.3.2. 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.

2.3.3. 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.

2.4. (a) In addition to the requirements of section II.A.2.3. above, for evaporative/refueling families subject to testing for exhaust emission durability, at least one evaporative emission test shall be conducted at 5,000, 40,000, 70,000, and 100,000 mile test points for all passenger car, and light-duty truck durability vehicles and at 5,000, 40,000, 70,000, 90,000, and 120,000 mile test points for all medium-duty durability vehicles. For all vehicles subject to the useful life requirement of 150,000 miles or 15 years for exhaust emissions, at least one evaporative emission test shall also be conducted at the 150,000 mile test point if the durability vehicle will be tested for exhaust emissions at the 150,000 mileage point. 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 different intervals as determined by the manufacturer using good engineering judgment. Evaporative emission testing may be performed at corresponding exhaust emission mileage points as set forth in section F.4. (40 CFR §86.1823) of the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles~~."~~ and the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles." The 4,000 and full useful life mile test points (or their equivalent) used in determining a DF must be within the standards of section I.E. or data will not be acceptable for use in the calculation of a DF, except for the following provision. For evaporative families certified to the emission standards in section I.E.(e)(i)(B) that utilize the fleet-average option, the 4,000 and full useful life mile test points for the highest whole vehicle diurnal plus hot soak emissions may exceed the emission standards in section I.E.(i)(B), but must be less than the maximum allowed family emission limits set forth in footnote (2) of the table in section I.E.(e)(i)(B).

(b) For evaporative families subject to the requirements of section II.A.2.4.(a), manufacturers may demonstrate compliance by conducting an exhaust and evaporative emission test sequence at the end of the useful life of the exhaust durability data vehicle if the procedure set forth in section II.A.2.3. includes on-road, useful life deterioration on the evaporative test vehicle. The evaporative test vehicle used to meet the criteria in section II.A.2.3. must be deteriorated based on typical customer use throughout the applicable useful life. The manufacturer may perform unscheduled maintenance on the evaporative test vehicle at the final test point only upon prior Executive Officer approval, which shall be granted if the Executive Officer determines that the exhaust emission control system will not be affected, and the manufacturer demonstrates that the effectiveness of the evaporative emission control system is not diminished. The unscheduled maintenance must be conducted in accordance with 40 CFR §86.1834-01 as amended by the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," and the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles."

2.5. The evaporative DFs determined under section II.A.2.4., if any, shall be averaged with the evaporative DFs determined under section II.A.2.3. to determine a single evaporative DF for each evaporative/refueling family. Evaporative DFs shall be generated for the running loss test and for the hot soak and the diurnal test in the three-day diurnal sequence, and for the hot soak and the diurnal test in the two-day diurnal sequence. The manufacturer may carry-across the DF generated in the three-day diurnal sequence to the two-day diurnal sequence if the manufacturer can demonstrate that the DF generated in the three-day diurnal sequence is at least as great as the DF generated in the two-day diurnal sequence.

3. Assigned DFs

3.1. §86.1826-01. [No change.]

3.2. A small volume manufacturer, as defined in section 1900(b), title 13, CCR, ~~Any manufacturer~~ may request to certify evaporative/refueling families using assigned DFs ~~for a combined total of 4,500 projected annual California sales of passenger cars, light-duty trucks, medium-duty vehicles, and heavy-duty engines per manufacturer regardless of total sales~~.

3.3. Assigned DFs shall be used only where specific evaporative durability data do not exist. 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 that evaporative emission control system(s) developed or adapted for the particular vehicle will be durable and comply with the applicable emission standards for the vehicle's useful life. In evaluating any information provided, all relevant test data and design factors shall be considered, including but not limited to: canister nominal working capacity and location, purge strategy, method of purge control, fuel tank capacity, variables affecting fuel temperature (use of fuel return, material, shape of fuel tank, distance of fuel tank from road surface and distance from exhaust pipe, total underbody airflow), fuel and vapor hose materials, use of sensors and auxiliary control devices, technical comparison to an evaporative emission control system and the durability of any evaporative emission control system components that may have been used in other vehicle applications. The assigned DFs shall be applied only to entire evaporative/refueling families.

3.3.1. 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. Evaporative emission control durability may include special in-house specifications.

3.4. The criteria for evaluating assigned DFs for evaporative/refueling families are the same as those for exhaust families. However, in determining evaporative/refueling family DFs these test procedures 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, the Executive Officer may grant assigned DFs for either (or both) the durability vehicle DF or the bench DF.

3.5. The use of ~~A~~assigned DFs for bench test requirements does not depend upon the ~~4,500~~small volume manufacturer maximum sales limit (as defined in section 1900(b), title 13, CCR)~~. The assigned bench DF~~ and is applicable only to evaporative emission control systems which are similar to those used by the manufacturer for 1998 or later model-year vehicles and where an evaporative DF was determined.

4. Emission Data Vehicle Selection

4.1. §86.1828-01 [No change.]

4.2. 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.

5. Durability and Emission Testing Requirements; waivers

5.1. §86.1829-01 (December 8, 2005). [No change, except as otherwise noted.]

5.2. References to the "EPA" shall mean the Executive Officer of the Air Resources Board.

5.3. The optional provision for a manufacturer to provide a statement of compliance in lieu of a demonstration of compliance with the supplemental two-day diurnal plus hot soak emission standard for certification purposes, as contained in §86.1829-01(b)(2)(iii), shall be applicable to gasoline- and ethanol-fueled passenger cars, light-duty trucks, and medium-duty vehicles, including hybrid electric, fuel-flexible, dual fuel, and bi-fuel vehicles. Heavy-duty vehicles over 14,000 lbs. GVWR and incomplete medium-duty vehicles shall comply with the requirements of section I.D.2.

5.4. For purposes of certification, a 2012 and subsequent off-vehicle charge capable hybrid electric vehicle shall demonstrate the capability to purge its evaporative canister(s) during the exhaust emission test of the supplemental two-day diurnal plus hot soak emission test sequence.

5.4.1. This capability shall be demonstrated through compliance with the supplemental two-day diurnal plus hot soak emission standard, using the test sequence as specified in section III.D.3.1.18., except that the battery state-of-charge setting prior to the standard three-phase exhaust test shall be at the lowest level allowed by the manufacturer in order to maximize the cumulative amount of the auxiliary power unit activation during the three-phase exhaust test. Performance of this demonstration shall be in addition to the demonstration of compliance with the supplemental two-day diurnal plus hot soak emission standard required under section I.E.1., using the test sequence specified in section III.D.3.1.18.

5.4.2. In lieu of conducting the demonstration described in section II.A.5.4.1., a manufacturer may optionally conduct an engineering evaluation that demonstrates the evaporative emission control system's capability to purge its evaporative canister(s) during the exhaust emission test of the supplemental two-day diurnal plus hot soak emission test sequence. Such an evaluation shall be submitted to the Executive Officer, if requested. The manufacturer shall provide a statement of compliance in the certification application to indicate that the evaporative emission control system will purge the system's evaporative canister(s) during the supplemental two-day diurnal plus hot-soak test sequence. The evaluation would include, but not be limited to, canister type, canister volume, canister working capacity, fuel tank volume, fuel tank geometry, fuel delivery system, description of the input parameters and software strategy used to control canister purge, and nominal purge flow volume (i.e., amount of bed volumes) achieved by a test vehicle after completing the exhaust test of a supplemental two-day diurnal plus hot soak emission test sequence.

5.4.2.1. In lieu of the optional engineering demonstration specified in section II.A.5.4.2., manufacturers of 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems may attest that the system's canister(s) shall have attained a purged condition when the vehicle has consumed at least 85% of its nominal fuel tank capacity.

5.4.2.1.1. This provision shall apply to such non-integrated refueling canister-only systems that inherently allow only refueling vapors to be stored in the canister(s); and, in which the inherent battery-charge operational mode characteristics cause the canister(s) to experience only either no purge or partial purge during the supplemental two-day diurnal plus hot soak test sequence.

5.4.2.1.2. The manufacturer shall provide the following statement in the application for certification, "The canisters in all vehicles equipped with the [indicate a specific evaporative/refueling family] shall have attained a purged condition when the vehicles have consumed at least 85% of their nominal fuel tank capacity. Assurance with this performance is based on the particular design specifications of the evaporative/refueling family, other inherent battery-charge operational mode characteristics of the vehicle's related systems, and other knowledge possessed by the manufacturer. Providing this assurance relieves the manufacturer of conducting a separate engineering evaluation for demonstrating the evaporative/refueling family's capability of purging its canister(s) during a supplemental two-day diurnal plus hot soak emission test sequence in which the battery state-of-charge setting is at the lowest level allowed by the manufacturer."

5.4.2.2. The manufacturer shall provide the specific information that supports its assurance of the system's performance with these requirements when requested by the Executive Officer.

5.4.2.3. The Executive Officer may withdraw the allowance to use the provision specified in section II.A.5.4.2.1., when information, including but not limited to~~,~~ that obtained from in-use vehicle testing, indicates non-compliance by the applicable evaporative/refueling family with the requirement.

B. Motorcycles

1. Durability Requirements. Certification of a motorcycle evaporative emission control system requires that the manufacturer demonstrate the durability of each evaporative emission control system family.

1.1. The motorcycle manufacturer can satisfy the vehicle durability testing requirements by performing an evaporative emission test at each scheduled exhaust emission test (40 CFR §86.427-78) during the motorcycle exhaust emission certification test (40 CFR §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 (40 CFR §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 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 section II.B.1.1., above.

(iv) The extrapolated useful life and total test distance emissions shall be less than the applicable evaporative emission standards of section I.E.2. 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 family. The Executive Officer shall review the method, and shall approve it if it is similar to the requirements specified below. Any reference to 4,000 miles and 50,000 miles shall mean total test distance and useful life distance, respectively, as defined in section II.B.1.1. for the appropriate engine displacement class.

The manufacturer shall propose in its preliminary application for certification a method for durability testing and for determination of a DF for each evaporative family. The 4,000 and 50,000 mile test points (or their equivalent) used in determining the DF must be within the standards of section II.B1.1. 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.

(vi) The DF determined under section II.B.1.1.(iii) shall be averaged with the DF determined under section II.B.1.1.(v) to determine a single evaporative emission DF for each evaporative family. For those motorcycles that do not require exhaust emission control system durability testing, the evaporative emission control system DF shall be determined under section II.B.1.1.(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 section I.E.2.

(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 section.

(B) Manufacturers of Class III motorcycles using an assigned evaporative emission control system DF pursuant to section II.B.1.1.(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 section shall be construed as an exemption from the exhaust emission standards and test procedures applicable pursuant to section 1958, title 13, CCR or section IV.4.(ii) of these test procedures.

(viii) The emission label (40 CFR §86.413-78) shall identify the evaporative emission family.

1.2. 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 on 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 2001 and Subsequent Model Motor Vehicles," and on the basis of those tests, are in conformance with the aforementioned standards and test procedures."

1.3. The definitions for motorcycle evaporative emission families as set forth in EPA’s MSAPC Advisory Circular No. 59, section D shall apply.

PART III. EVAPORATIVE EMISSION TEST PROCEDURES FOR LIGHT- AND MEDIUM-DUTY VEHICLES

A. Instrumentation

The instrumentation necessary to perform evaporative emission testing is described in 40 CFR 86.107-90. The following language is applicable in lieu of 40 CFR §86.107-90(a)(1):

1. Diurnal Evaporative Emission Measurement Enclosure

1.1. 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 provide a nominal total flow rate of 0.8 ± 0.2 ft^3/min per ft^3 of the nominal enclosure 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 and alcohol 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 air circulation blower(s), plus any additional blowers if needed, shall also maintain a minimum wind speed of 5 mph under the fuel tank of the test vehicle. The Executive Officer may adjust wind speed and location to ensure sufficient air circulation around the fuel tank. The wind speed requirement may be satisfied by consistently using a blower configuration that has been demonstrated to meet a broad 5-mph air flow in the vicinity of the vehicle's fuel tank, subject to verification by the Executive Officer.

1.1.1. 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 and with a thermocouple located underneath the vehicle where it would provide a temperature measurement representative of the temperature of the air under the fuel tank. 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 as modified by section III.D.10. (diurnal breathing loss test) of these procedures within an instantaneous tolerance of ± 3.0°F and an average tolerance of ± 2.0°F as measured by the vehicle underbody thermocouple, and within an instantaneous tolerance of ± 5.0°F as measured by the side wall thermocouples. 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.

1.2. The 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 alcohols (if the enclosure is used for alcohol-fueled vehicles). The enclosure shall be insulated to enable the test temperature profile to be achieved with a heating/cooling system which has 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.

1.3. The enclosure shall be equipped with features which provide for the effective enclosure volume to expand and contract in response to both the temperature changes of the air mass in the enclosure, and any fluctuations in the ambient barometric pressure during the duration of the test. Either a variable volume enclosure or a fixed volume enclosure may be used for diurnal emission testing.

1.3.1. The variable volume enclosure shall have the capability of latching or otherwise constraining the enclosed volume to a known, fixed value, V_n. The V_n shall be determined by measuring all pertinent dimensions of the enclosure in its latched configuration, including internal fixtures, based on a temperature of 84°F, to an accuracy of ± 1/8 inch (0.5 cm) and calculating the net V_n to the nearest 1 ft^3. In addition, V_n shall be measured based on a temperature of 65°F and 105°F. The latching system shall provide a fixed volume with an accuracy and repeatability of $0.005xV_n$. 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 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 $\pm 0.07xV_n$ 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 ± 2.0 inches H_2O.

1.3.2. The fixed volume enclosure shall be constructed with rigid panels that maintain a fixed enclosure volume, which shall be referred to as V_n. V_n shall be determined by measuring all pertinent dimensions of the enclosure including internal fixtures to an accuracy of ± 1/8 inch (0.5 cm) and calculating the net V_n to the nearest 1 ft^3. The enclosure shall be equipped with an outlet flow stream that withdraws air at a low, constant rate and provides makeup air as needed, or by reversing the flow of air into and out of the enclosure in response to rising or falling temperatures. If inlet air is added continuously throughout the test, it must be filtered with activated carbon to provide a relatively constant hydrocarbon and alcohol level. Any method of volume accommodation shall maintain the differential between the enclosure internal pressure and the barometric pressure to a maximum value of ±2.0 inches of water. The equipment shall be capable of measuring the mass of hydrocarbon, and alcohol (if the enclosure is used for alcohol-fueled vehicles) in the inlet and outlet flow streams with a resolution of 0.01 gram. A bag sampling system may be used to collect a proportional sample of the air withdrawn from and admitted to the enclosure. Alternatively, the inlet and outlet flow streams may be continuously analyzed using an on-line Flame Ionization Detector (FID) analyzer and integrated with the flow measurements to provide a continuous record of the mass hydrocarbon and alcohol removal.

1.4. An online computer system or stripchart recorder shall be used to record the following parameters during the diurnal evaporative emissions test sequence:

-Enclosure internal air temperature
-Diurnal ambient air temperature specified profile as defined in 40 CFR §86.133-90 as modified in section III.D.10. (diurnal breathing loss test).
-Vehicle fuel tank liquid temperature
-Enclosure internal pressure
-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
    -enclosure sample reading
    -zero gas and span gas readings

1.4.1. 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.

1.5. 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.

2. Running Loss Measurement Facility

2.1. For all types of running loss measurement test facilities, the following shall apply:

2.1.1. 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 §86.108-00 with the following addition to §86.108-00(d):

> Another dynamometer configuration may be used for running loss testing if approved in advance by the Executive Officer based on a demonstration that measured running loss emissions are equivalent to the emissions using the single-roll electric dynamometer described in 86.108-00(b)(2).

-A fuel tank temperature management system which meets the requirements specified in section III.A.2.1.3.

-A running loss fuel vapor hydrocarbon analyzer which meets the requirements specified in 40 CFR §86.107-90(a)(2)(i) and a running loss fuel vapor alcohol analyzer which meets the requirements specified in 40 CFR §86.107-90(a)(2)(ii).

-A running loss test data recording system which meets the requirements specified in section III.A.2.1.4.

2.1.2. 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 set point refers to the internal test facility air temperature.

-Using a full range test facility temperature management system with heating and cooling capabilities.

2.1.3. Cell/enclosure temperature management shall be measured 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 at least up to 30 mph throughout the driving cycle. The fan outlet may discharge airflow to both the vehicle radiator air inlet(s) and the vehicle underbody. An additional fan, not to exceed 8,000 cfm, may be used to discharge airflow from the front of the vehicle directly to the vehicle underbody to control fuel temperatures.

2.1.3.1. 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, if applicable, the fuel tank vapor (T_{vap}) temperature profile of the test vehicle within a tolerance of ± 5°F throughout the running loss driving cycle and ± 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 section III.C.1. (40 CFR §86.129-80) 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 section III.C.1. (40 CFR §86.129-80). 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 liquid temperature profile throughout the test. If applicable, the vapor temperature shall match the reference on-road vapor temperature profile within ± 5.0°F throughout the test and ± 3.0°F during the final 120 second idle period. The system shall be designed to avoid heating or cooling of the fuel tank vapor space in a way that would cause vapor temperature behavior to be unrepresentative of the vehicle's on-road vapor profile. The system shall provide a discharge airflow up to 4,000 cfm. With advance Executive Officer approval, the system may provide a discharge airflow with a maximum of 6,000 cfm.

2.1.3.2. Blowers or fans shall be used to mix the enclosure contents during evaporative emission testing. The blowers or fans shall have a total capacity of at least 1.0 ft^3/min per ft^3 of 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 and alcohol stratification.

2.1.3.3. The temperature of the air supplied to the outlet duct shall be within a range of 90°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.

2.1.3.4. Direct fuel heating may be used to control fuel temperatures for vehicles under exceptional circumstances in which airflow alone is insufficient to control fuel temperatures. The heating system must not cause hot spots on the tank wetted surface that could cause local overheating of the fuel. Heat must not be applied to the vapor in the tank above the liquid fuel, nor near the liquid-vapor interface.

2.1.4. 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, if applicable, vapor space (T_{vap}) temperatures
-Vehicle coolant temperature
-Vehicle fuel tank headspace pressure
-Reference on-road fuel tank temperature profile developed according to section III.C.1. (40 CFR §86.129-80)
-Dynamometer rear roll speed (if applicable)
-FID output voltage recording the following parameters for each sample analysis:
    -zero gas and span gas adjustments
    -zero gas reading
    -dilute sample bag reading (if applicable)
    -dilution air sample bag reading (if applicable)
    -zero gas and span gas readings

-methanol sampling equipment data:
    -the volumes of deionized water introduced into each impinger
    -the rate and time of sample collection
    -the volumes of each sample introduced into the gas chromatograph
    -the flow rate of carrier gas through the column
    -the column temperature
    -the chromatogram of the analyzed sample

2.2. If an enclosure, or atmospheric sampling, running loss facility is used, the following requirements (in addition to those in section III.A.2.1. above) shall also be applicable:

2.2.1. 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 (if the enclosure is used for alcohol-fueled vehicles). One surface should be of flexible, impermeable, and non-reactive material to allow for minor volume changes, resulting from temperature changes.

2.2.2. In the event an artificial cooling or heating system is used, the surface temperature of the heat exchanging elements shall be a minimum of 70.0^{o}F.

2.2.3. The enclosure shall be equipped to supply air to the vehicle, at a temperature of 105 ± 5^{o}F, from sources outside of the running loss enclosure directly into the operating engine's air intake system. Supplemental air requirements shall be supplied by drawing air from the engine intake source.

2.3. If a point source running loss measurement facility (cell) is used, the following requirements (in addition to those in section III.A.2.1. above) shall also be applicable:

2.3.1. The running loss vapor collection system shall be configured to collect all running loss emissions from each of the discrete emissions sources, which include 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 discrete vehicle emissions source, 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^{o}F and 200.0^{o}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 emissions source shall be placed in proximity to the source as necessary to capture any fuel vapor emissions without significantly affecting flow or pressure of the normal action of the source. The collector inlets shall be designed to interface with the configuration and orientation of each specific source. 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 1. For those vapor vent designs which are not compatible with such collector configurations and other emissions sources, the vehicle manufacturer shall supply a collector which is configured to interface with the vapor vent design or the specific emissions source 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 vapors emitted from the source.

2.3.2. 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 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 collection system(s) instead of vehicle exhaust flow. The system shall be configured and operated to meet the following requirements:

2.3.2.1. 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 collection system from the specified discrete emissions source. The total volume of the mixture of running loss emissions and dilution air shall be measured, and a continuously proportionated sample of volume shall be collected for analysis. Mass emissions shall be determined from the sample concentration and total flow over the test period.

2.3.2.2. 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^{o}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^{o}F during the entire test. The temperature measuring system shall have an accuracy and precision of ± 2^{o}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.

2.3.2.3. 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^{o}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.

2.3.3. The on-line computer system or strip-chart recorder specified in section III.A.2.1.4. shall be used to record the following additional parameters during the running loss test sequence, if applicable:

-CFV (if used) inlet temperature and pressure
-PDP (if used) inlet temperature and pressure and differential pressure
-Running loss vapor collection system low flow alarm events

2.4. 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.

3. Hot Soak Evaporative Emission Measurement Enclosure

3.1. 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 alcohol (if the enclosure is used for 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. For the first 5 minutes, the ambient temperature shall be maintained at 105°F ± 10°F. The enclosure shall be equipped with an internal air circulation blower(s). The blower(s) shall be sized to provide a nominal total flow rate within a range of 0.8 ± 0.2 ft^3/min per ft^3 of V_n. The inlets and outlets of the blower(s) shall be configured to provide a well dispersed air circulation pattern that produces effective internal mixing and avoids significant temperature or hydrocarbon and alcohol 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. 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 set point of the cooling system adjusted to a value not lower than 105.0°F, where the cooling system set point refers to the internal enclosure air temperature.

-Using a full range enclosure temperature management system with heating and cooling capabilities.

3.2. In the event an artificial cooling or heating system is used, the surface temperature of the heat exchanging elements shall be a minimum of 70.0°F.

3.3. The requirements in 40 CFR §86.107-90(a)(4) shall not apply.

B. Calibrations

1. Evaporative emission enclosure calibrations are specified in 40 CFR §86.117-90. Methanol measurements may be omitted when methanol-fueled vehicles will not be tested in the evaporative enclosure. Amend 40 CFR §86.117-90 to include an additional section III.B.1.1., to read:

1.1. 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 (HC) and methanol retention check and calibration. Calibration for HC and methanol may be conducted in the same test run or in sequential test runs.

1.1.1. 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 enclosure shall be maintained at a nominal temperature of 105.0°F throughout the four hour period. Variable volume enclosures may be operated in either the latched volume configuration, or with the variable volume feature active. Fixed volume enclosures shall be operated with inlet and outlet flow streams closed. The allowable enclosure background emissions of HC and/or methanol as calculated according to 40 CFR §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}) and the initial methanol concentration reading (C_{CH3OHi}) is taken and the four hour background measurement period begins.

1.1.2. The initial determination of enclosure internal volume shall be performed according to the procedures specified in section III.A.1.3. If the enclosure will be used for hot soak determination, the determination of enclosure internal volume shall also be performed based on 105°F.

1.1.3. The HC and methanol measurement and retention checks shall evaluate the accuracy of enclosure HC and methanol mass measurements and the ability of the enclosure to retain trapped HC and methanol. 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 and/or methanol shall be injected into the enclosure and an initial enclosure mass measurement(s) shall be made. The enclosure shall be subjected to the temperature cycling specified in section III.D.10.3.7. of these procedures (revising 40 CFR §86.133-90(l)) for a 24 hour period. The temperature cycle shall begin at 105ºF (hour 11) and continue according to the schedule until a full 24-hour cycle is completed. A final enclosure mass measurement(s) shall be made. The following procedure shall be performed prior to the introduction of the enclosure into service and following any modifications or repairs to the enclosure that may impact the integrity of this enclosure; otherwise, the following procedure shall be performed on a monthly basis. (If six consecutive monthly retention checks are successfully completed without corrective action, the following procedure may be determined quarterly thereafter as long as no corrective action is required.)

1.1.3.1. Zero and span the HC analyzer.

1.1.3.2. Purge the enclosure until a stable enclosure HC level is attained.

1.1.3.3. 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 diurnal cycle over a 24 hour period according to the profile specified in section III.D.10.3.7. of these procedures (revising 40 CFR §86.133-90). Close the enclosure door. On variable volume enclosures, latch the enclosure to the enclosure volume measured at 105°F. On fixed volume enclosures, close the outlet and inlet flow streams.

1.1.3.4. When the enclosure temperature stabilizes at 105.0°F ± 3.0°F seal the enclosure; measure the enclosure background HC concentration (C_{HCe1}) and/or background methanol concentration (C_{CH3OH1}) and the temperature (T_1), and pressure (P_1) in the enclosure.

1.1.3.5. Inject into the enclosure a known quantity of propane between 2 to 6 grams and/or a known quantity of methanol in gaseous form between 2 to 6 grams. For evaporative emission enclosures that will be used for testing motor vehicles certified to the reduced evaporative standards in sections I.E.1.(c) and (d), use a known amount of propane or gaseous methanol between 0.5 to 1.0 grams. The injection method shall use a critical flow orifice to meter the propane and/or methanol at a measured temperature and pressure for a measured time period. Techniques which provide an accuracy and precision of ± 0.5 percent of the injected mass are also acceptable. Allow the enclosure internal HC and/or methanol concentration to mix and stabilize for up to 300 seconds. Measure the enclosure HC concentration (C_{HCe2}) and/or the enclosure methanol concentration (C_{CH3OH2}). For fixed volume enclosures, measure the temperature (T_2) and pressure in the enclosure (P_2). On variable volume enclosures, unlatch the enclosure. On fixed volume enclosures, open the outlet and inlet flow streams. 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.

1.1.3.6. For fixed volume enclosures, calculate the initial recovered HC mass (M_{HCe1}) according to the following formula:

$$M_{HCe1} = (3.05 \times V \times 10^{-4} \times [P_2 (C_{HCe2} - rC_{CH3OH2})/T_2 - P_1 (C_{HCe1} - rC_{CH3OH1})/T_1])$$

where:

V is the enclosure volume at 105°F (ft^3)
P_1 is the enclosure initial pressure (inches Hg absolute)
P_2 is the enclosure final pressure (inches Hg absolute)
C_{HCen} is the enclosure HC concentration at event n (ppm C)
C_{CH3OHn} is the enclosure methanol concentration calculated according to 40 CFR §86.117-90 (d)(2)(iii) at event n (ppm C)
r is the FID response factor to methanol
T_1 is the enclosure initial temperature (°R)
T_2 is the enclosure final temperature (°R)

1.1.3.6.1. For variable volume enclosures, calculate the initial recovered HC mass and initial recovered methanol mass according to the equations used above except that P_2 and T_2 shall equal P_1 and T_1.

1.1.3.6.2. Calculate the initial recovered methanol mass (M_{CH3OH1}) according to 40 CFR §86.117-96(d)(1), as amended March 24, 1993.

1.1.3.6.3. If the recovered HC mass agrees with the injected mass within 2.0 percent and/or the recovered methanol mass agrees with the injected mass within 6.0 percent, continue the test for the 24-hour temperature cycling period. If the recovered mass differs from the injected mass by greater than the acceptable percentage(s) for HC and/or methanol, repeat the enclosure concentration measurement in section III.B.1.1.3.5. and recalculate the initial recovered HC mass (M_{HCe1}) and/or methanol mass (M_{CH3OH1}). If the recovered mass based on the latest concentration measurement agrees within the acceptable percentage(s) of the injected mass, continue the test for the 24-hour temperature cycling period and substitute this second enclosure concentration measurement for C_{HCe2} and/or C_{CH3OH2} in all subsequent calculations. In order to be a valid calibration, the final measurement of C_{HCe2} and C_{CH3OH2} 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.

1.1.3.7. At the completion of the 24 hour temperature cycling period, measure the final enclosure HC concentration (C_{HCe3}) and/or the final enclosure methanol concentration (C_{CH3OH3}). For fixed-volume enclosures, measure the final pressure (P_3) and final temperature (T_3) in the enclosure.

1.1.3.7.1. For fixed volume enclosures, calculate the final recovered HC mass (M_{HCe2}) as follows:

$$M_{HCe2} = [3.05 \text{ x } V \text{ x } 10^{-4} \text{ x}(P_3\,(C_{HCe3} - rC_{CH3OH3})/T_3 - P_1\,(C_{HCe1} - rC_{CH3OH1})/T_1)] + M_{HC,out} - M_{HC,\,in}$$

where:

V is the enclosure volume at 105°F (ft^3)
P_1 is the enclosure initial pressure (inches Hg absolute)

P_3 is the enclosure final pressure (inches Hg absolute)
C_{HCe3} is the enclosure HC concentration at the end of the 24-hour temperature cycling period (ppm C)
C_{CH3OH3} is the enclosure methanol concentration at the end of the 24-hour temperature cycling period, calculated according to 40 CFR §86.117-90(d)(2)(iii) (ppm C)
r is the FID response factor to methanol
T_1 is the enclosure initial temperature (^oR)
T_3 is the enclosure final temperature (^oR)
$M_{HC,out}$ is mass of HC exiting the enclosure, (grams)
$M_{HC,in}$ is mass of HC entering the enclosure, (grams)

1.1.3.7.2. For variable volume enclosures, calculate the final recovered HC mass and final recovered methanol mass according to the equations used above except that P_3 and T_3 shall equal P_1 and T_1 , and $M_{HC,\ out}$ and $M_{HC,\ in}$ shall equal zero.

1.1.3.7.3. Calculate the final recovered methanol mass (M_{CH3OH2}) according to 40 CFR §86.117-96(d)(1), as amended March 24, 1993.

1.1.3.8. If the calculated final recovered HC mass for the enclosures is not within 3 percent of the initial enclosure mass or the calculated final recovered methanol mass for the enclosures is not within 6 percent of the initial enclosure mass, then action shall be required to correct the error to the acceptable level.

1.2. The running loss equipment shall be calibrated as follows:

1.2.1. 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.

1.2.2. The running loss HC analyzer shall be calibrated according to the requirements of 40 CFR §86.121- 90.

1.2.3. 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 in 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 collector configured to collect vapors from the source 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.

1.2.4. In the event the running loss test is conducted using the atmospheric sampling measurement technique, the following procedure shall be used for the enclosure calibration:

1.2.4.1. The initial and periodic determination of enclosure background emissions shall be conducted according to the procedures specified in 40 CFR §86.117-90(a)(1) through (a)(6). The enclosure shall be maintained at a nominal temperature of 105.0°F throughout the four hour period. The allowable enclosure background emissions as calculated according to 40 CFR §86.117-90 (a)(7) shall not be greater than 0.2 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 is taken.

1.2.4.2. The initial determination of enclosure internal volume shall be performed according to the procedures specified in 40 CFR §86.117-90 (b).

1.2.4.3. The enclosure shall meet the calibration and retention requirements of 40 CFR §86.117-90(c). The 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 enclosure.

1.2.5. Hot soak enclosure. The hot soak enclosure calibration consists of the following parts: initial and periodic determination of enclosure background emissions, initial determination of enclosure volume, and periodic HC and methanol retention check and calibration. The hot soak enclosure calibration shall be conducted according to the method specified in section III.B.1.1. with a retention check of 4 hours at 105°F or the method specified in section III.B.1.2.4. If the hot soak enclosure is also for diurnal testing, the 4 hour retention check at 105°F may be replaced by the 24 hour diurnal retention check.

1.2.6. Diurnal and hot soak enclosure HC analyzer. The HC analyzers used for measuring the diurnal and hot soak samples shall be calibrated according to the requirements of 40 CFR §86.121-90.

1.2.7. 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.

C. Road Load Power, Test Weight, Inertia Weight Class, and Running Loss Fuel Tank Temperature Profile Determination

Amend 40 CFR §86.129-80 to include an additional section III.C.1. to read:

1. 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. If a vehicle has more than one fuel tank, a profile shall be established for each tank. If manufacturers use a vehicle model to develop a profile to represent multiple vehicle models, the vehicle model selected must have the greatest expected fuel liquid temperature and fuel vapor temperature increase during driving of all of the vehicle models it will represent. Manufacturers must select test vehicles with any available vehicle options that could increase fuel temperature during driving, such as any feature that limits underbody air flow. 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:

1.1. 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 ± 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 with the desired NYCC vehicle speed versus time trace as defined in Part 86, Appendix I of the CFR, amended as of March 24, 1993, 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

1.1.1. The data recording system shall provide a time resolution of 1 second, and an accuracy of ± 1 mph, ± 2.0^{o}F, and ± 1.0 inches H_2O. The temperature and pressure signals may be recorded at intervals of up to 30 seconds.

1.2. The temperature profile determination shall be conducted during ambient conditions which include:

- ambient temperature above 95^{o}F and increasing or stable (± 2^{o}F)
- sunny or mostly sunny with a maximum cloud cover of 25 percent
- wind conditions calm to light with maximum sustained wind speeds of 15 mph; temporary gusts of wind between 15 and 25 mph may occur up to 5 percent of the total driving time
- road surface temperature (T_{sur}) at least 30^{o}F above T_{amb} or at least 135^{o}F, whichever is less

1.2.1. The track surface temperature shall be measured with an embedded sensor, a portable temperature probe, or an infrared pyrometer which can provide an accuracy of ± 2.0^{o}F. Temperatures must be measured on a surface representative of the surface where the vehicle is driven. 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.

1.2.2. Prior to the start of the profile generation, the fuel tank may be artificially heated to the ambient temperature to a maximum of 105^{o}F. The vehicle may be soaked in a temperature-controlled enclosure. Fans blowing ambient air may be used to help control fuel temperatures. Engine idling may not be used to control fuel temperatures. If the fuel tank is artificially heated, the liquid fuel temperature and the vapor temperature must be stabilized for at least one hour at the ambient temperature within ± 2^{o}F to a maximum of 105^{o}F before the profile generation begins. If the allowance for a lower initial fuel temperature established in section III.D.7. is used, the fuel in the test vehicle may not be stabilized at a temperature higher than the established lower initial temperature.

1.2.3. Tank pressure shall not exceed 10 inches of water 30 seconds after the start of the engine until the end of engine operation during the temperature profile determination unless a pressurized system is used and the manufacturer demonstrates in a separate test that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the running loss fuel tank temperature profile determination.

1.3. The vehicle fuel tank shall be drained and filled to 40 percent of the nominal tank capacity with fuel meeting the requirements of section III.D.1. of these procedures. For all hybrid electric vehicles, except for 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, the battery state-of-charge shall be set at a level such that the auxiliary power unit would be activated by the vehicle's control strategy within 30 seconds of starting the first UDDS of the fuel tank temperature profile determination test sequence. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operating throughout the fuel tank temperature profile determination. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, the battery state-of-charge shall be set at the level that results when the battery state-of-charge is initially set at the highest level allowed by the manufacturer and then decreased, as applicable, by the performance of a standard three-phase exhaust test, 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. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, the vehicle shall be either only pushed or towed to avoid disturbing the battery state-of-charge setting. 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 one UDDS cycle, then two NYCCs, and another UDDS cycle. The end of each UDDS cycle and the end of the two NYCCs 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 specified in 40 CFR §86.128-79 except for the following:

> Revise subparagraph (c) to include: Idle modes may be run with automatic transmission in "Neutral" and shall be placed in "Drive" with the wheels braked at least 5 seconds before the end of the idle mode. Manual transmission may be in "Neutral" with the clutch engaged and shall be placed in gear with the clutch disengaged at least 5 seconds before the end of the idle mode.

1.3.1. 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.

1.4. 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
- Time and temperature of fuel tank heating, if applicable
- 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})

1.5. The two UDDS and two NYCC driving traces shall be verified to meet the speed tolerance requirements of 40 CFR 86.115-78 (b)(1), amended as follows:

1.5.1. Revise subparagraph (v) to read: When conducted to meet the requirements of 40 CFR §86.129, up to three additional occurrences of speed variations greater than the tolerance are acceptable, provided they occur for less than 15 seconds on any occasion. All speed variations must be clearly documented as to the time and speed at that point in relation to the driving schedule.

1.5.2. Add subparagraph (vi) to read: When conducted to meet the requirements of 40 CFR §86.129 and §86.132, the speed tolerance shall be as specified above, except that the upper and lower limits shall be 4 mph.

1.6. The following temperature conditions shall be verified:

$(T_{amb1}) \geq 95.0^{o}F$
$(T_{amb2}) \geq (T_{amb1} - 2.0^{o}F)$
$(T_{sur(n)} - T_{amb\,(n)}) \geq 30.0^{o}F$

where n is the incremental measurements in time.

or $T_{sur} > 135^{o}F$

1.7. 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 section III.C.1.3.

1.8. If all of these requirements are met, the following calculations shall be performed:

$T_{corr} = T_{(i)} - T_o$

where: $T_{(i)}$ is the liquid fuel temperature (°F) or vapor fuel temperature (°F) during the drive where i is the incremental measurements in time.

T_o is the corresponding liquid fuel temperature (°F) or vapor fuel temperature (°F) observed at the start of the specified driving schedule

1.8.1. The individual tank liquid (T_{liq}) and vapor space (T_{vap}) temperatures recorded during the test run shall be adjusted by arithmetically adding the corresponding temperature correction (T_{corr}) adjustment calculated above to 105°F. If T_o is higher than the corresponding ambient temperature by 2°F, the temperature correction shall be determined by the above equation plus the difference in T_o and the corresponding ambient temperature.

1.9. 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°F.

D. Test Procedure

The test sequence described in 40 CFR §86.130 through §86.140 shall be performed with the following modifications:

1. General Requirements

1.0. The following language shall be applicable in lieu of 40 CFR §86.130-78:

1.1. The test sequence shown in Figure 2 (Figure 3A or 3B for hybrid electric vehicles) describes the steps encountered as the vehicle undergoes the three-day diurnal sequence and the supplemental two-day diurnal sequence to determine conformity with the standards set forth. Methanol measurements may be omitted when methanol-fueled vehicles will not be tested in the evaporative enclosure. Ethanol shall be accounted for via measurement or mass adjustment factor, using the methods described in this test procedure, for vehicles tested with the gasoline set forth in part II, section A.100.3.1.2. of the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles.” Ambient temperature levels encountered by the test vehicle throughout the entire duration of this test sequence shall not be less than 68°F nor more than 86°F, unless otherwise specified. 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 temperature tolerance of a soak period may be waived for up to 10 minutes to allow purging of the enclosure or transporting the vehicle into the enclosure.

1.2. If tests are invalidated after collection of emission data from previous test segments, the test may be repeated to collect only those data points needed to complete emission measurements. Compliance with emission standards may be determined by combining emission measurements from these different test runs. If any emission measurements are repeated, the new measurements supersede previous values.

1.3. The three-day diurnal test sequence shown in Figure 2 (and Figure 3A or 3B for hybrid electric vehicles) is briefly described as follows:

1.3.1. For 2001 through 2008 model-year hybrid electric vehicles, the manufacturer may elect to perform the All-Electric Range Test (as indicated in Figure 3A or 3B, as applicable) pursuant to the "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," prior to the initial fuel drain and fill step in this test sequence.

1.3.2. For 2009 and subsequent model-year hybrid electric vehicles, a manufacturer may elect to perform the All-Electric Range Test separately from the test sequences specified under these evaporative emission test procedures, and pursuant to the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes,"

1.4. For 2001 through 2011 model-year vehicles, the fuel tank shall be initially drained and filled to the prescribed tank fuel volume of 40 percent of the manufacturer's nominal fuel tank capacity, as specified in 40 CFR §86.1803-01, in preparation for the vehicle preconditioning.

1.5. For 2001 through 2011 model-year vehicles, the vehicle preconditioning drive shall be performed in accordance with 40 CFR §86.132-90, except that following the initial fuel drain and fill step in this test sequence, as specified in 40 CFR §86.132-90(a)(1), an initial preconditioning soak period of a minimum of 6 hours shall be provided to allow the vehicle to stabilize to ambient temperature prior to the preconditioning drive. Vehicles performing consecutive tests at a test point with the same fuel specification and while remaining under laboratory ambient temperature conditions for at least 6 hours, may eliminate both the initial fuel drain and fill and vehicle soak. In such cases, each subsequent test shall begin with the preconditioning drive.

1.5.1. Following the vehicle preconditioning drive, a second fuel drain and fill step shall be performed, in accordance with 40 CFR §86.132-90(a)(1), The fuel tank shall be filled to the prescribed tank fuel volume of 40 percent of the manufacturer's nominal fuel tank capacity, as specified in 40 CFR §86.1803-01.

1.6. For 2012 and subsequent model-year vehicles, the vehicle preconditioning shall be performed in accordance with 40 CFR §86.132-00, except as amended by section III.D.3.

1.6.1. For a 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicle, the vehicle preconditioning drive shall include at least one complete UDDS performed entirely under a charge-sustaining mode of operation, The battery state-of-charge net change tolerance provisions specified in section F.10., of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" shall not apply.

1.7. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, the following exceptions apply.

1.7.1. After completion of the vehicle preconditioning drive, the second fuel drain and tank refill step specified in 40 CFR §86.132-00(f)(1) shall be replaced by the 95% tank fill step specified in 40 CFR 86.153-98(d).

1.7.2. After completion of the second fuel drain and tank refill step, the initial testing state of the canister shall be established by purging while performing either the chassis dynamometer procedure or the test track procedure, as described in subparagraphs (d)(1) and (d)(2) of 40 CFR 86.153-98. For vehicles equipped with dual fuel tanks that can be individually selected or isolated, the required volume of fuel shall be driven out of one tank, the second tank shall be selected as the fuel source, and the required volume of fuel shall be driven out of the second tank. A manufacturer shall plan for interruptions in the vehicle drivedowns due to factors such as work schedules, driver relief, and test equipment considerations, using good engineering practice.

1.7.3. With advance Executive Officer approval, a manufacturer may optionally elect to bench purge the canister either during the initial soak period, specified in 40 CFR §86.132-00(c)(1), or after the vehicle preconditioning drive step specified in section III.D.1.6.1., in lieu of performing the second fuel drain/fill and vehicle drivedown steps specified in sections III.D.1.7.1. and III.D.1.7.2. Approval by the Executive Officer shall be based upon assurance that the canister will be bench purged by an equivalent volume of air corresponding to a consumption of 85%, or less as determined by the manufacturer, of the manufacturers' nominal fuel tank capacity, and that the characteristics of the purge flow through the canister, such as flow rates, shall be representative of flow that occurs under the specified vehicle drivedown UDDS cycles. Within 60 minutes of completing the bench purging, the fuel drain and fill step specified in section III.D.1.7.4. shall be performed.

1.7.4. Within 60 minutes of completing the vehicle drivedown, a third fuel drain and fill step shall be performed in which the fuel tank shall be filled to a prescribed tank fuel volume of 10 percent of the manufacturer’s nominal fuel tank capacity, determined to the nearest one-tenth of a U.S. gallon (0.38 liter) with the specified fuel. The manufacturer may isolate the canister using any method that does not compromise the integrity of the system. A description of the canister isolation method shall be included in the manufacturer’s certification application. When the refueling canister is isolated from its system, fuel vapors shall be allowed to be vented from the fuel tank, as appropriate, during this fill step.

1.7.5 After completion of the third fuel drain and fill step, a second vehicle soak period of not less than 6 hours and not more than 24 hours shall be performed.

1.7.6. After completion of the second vehicle soak period, the fuel-tank-refill canister-loading step specified in section III.D.3.3.6. shall be performed.

1.7.7. After completion of the canister loading, a fourth drain and fill step shall be performed, as specified in section III.D.3.3.6.13.

1.7.8. After completion of the fourth drain and fill step, a third preconditioning soak period of not less than 12 hours and not more than 36 hours shall be performed.

1.7.9. After completion of the 12-to-36 hour preconditioning soak period, a test vehicle shall proceed to the exhaust emission test specified in section III.D.1.11.

1.7.10.When conducting only an exhaust emission test sequence, a manufacturer may elect to perform the canister preconditioning and loading method specified in sections III.D.1.9., III.D.1.10., and III.3.3.4., in lieu of the canister loading method specified in sections III.D.1.7.6. and III.D.3.3.6. Under such an election, the exceptions specified in sections III.D.1.7.4., III.D.1.7.5, and III.D.1.7.6. shall not apply.

1.7.10.1. The Executive Officer may elect to use either canister loading method when conducting exhaust emission testing for certification confirmatory testing and in-use compliance purposes.

1.8. A second preconditioning soak period of not less than 12 hours and not more than 36 hours shall be performed prior to the exhaust emission test.

1.9. During the 12-to-36 hour soak specified in section III.D.1.8 above, the vehicle's evaporative control canister shall be purged with a volume of air equivalent to 300 carbon canister bed volumes at a flow rate of 48 SCFH (22.7 slpm).

1.10. The evaporative control canister shall then be loaded using a butane-nitrogen mixture.

1.11. Perform exhaust emission tests in accordance with procedures as provided in “California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,” the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,” and these procedures.

1.12. For 2001 through 2008 model-year hybrid electric vehicles, a four-phase exhaust test shall be performed as shown in Figure 3A pursuant to the "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.12.1. For 2009 and subsequent model-year hybrid electric vehicles, a manufacturer may elect to perform the four-phase exhaust emission test separately from the test sequence specified under these evaporative emission test procedures, and pursuant to the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.12.2. When a four-phase exhaust test is performed with the evaporative emission test sequence as shown in Figure 3A, the evaporative emission test sequence shall begin at the second drain and fill step in the test sequence, after the four-phase exhaust test is completed. The ensuing standard three-phase exhaust test shall then be performed without exhaust emission sampling.

1.12.3. For 2001 through 2008 model-year hybrid electric vehicles, the four-phase exhaust testing may be performed in conjunction with evaporative testing, as shown in Figure 3B, with advance Executive Officer approval if the manufacturer is able to provide data demonstrating compliance with evaporative emission standards using the standard three-phase test.

1.12.4. For 2001 through 2008 model-year hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test shall be performed pursuant to the supplemental requirements specified in section E.6.1.6. of the "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.12.5. For 2009 and subsequent model-year hybrid electric vehicles, except for 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test shall be performed pursuant to the supplemental requirements specified in section E.6.1.5 of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.12.6. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test shall be at the highest level allowed by the manufacturer in order to eliminate or minimize the cumulative amount of the auxiliary power unit activation during either of the ensuing three-phase exhaust or running loss tests. This requirement shall be applicable regardless of a vehicle’s ability to allow, or not to allow, manual activation of the auxiliary power unit. If off-vehicle charging is required to increase the battery state-of-charge for the proper setting, then this charging shall occur during the 12-to-36 hour soak period. The battery state-of-charge net change tolerance provisions specified in section F.10., of the “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes” shall not apply.

1.13. Upon completion of the hot start test, the vehicle shall be parked in a temperature controlled area between one to six hours to stabilize the fuel temperature at 105°F for one hour. Artificial cooling or heating of the fuel tank may be induced to achieve a fuel temperature of 105°F. The initial fuel and, if applicable, vapor temperatures for the running loss test may be less than 105°F with advance Executive Order approval if the manufacturer is able to provide data demonstrating initial temperatures at least 3°F lower than the required 105°F starting temperature.

1.14. 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.

1.15. The hot soak enclosure test shall then be performed at an enclosure ambient temperature of 105°F.

1.16. Upon completion of the hot soak enclosure test, the vehicle shall be soaked for not less than 6 hours and not more than 36 hours. For at least the last 6 hours of this period, the vehicle shall be soaked at 65°F.

1.17. A three-day diurnal test shall be performed in a variable temperature enclosure.

1.18. The supplemental two-day diurnal sequence in Figure 2 (and Figure 3A or 3B for hybrid electric vehicles) shall be conducted according to sections III.D.1.4. through III.D.1.17., with the following exceptions:

1.18.1. Sections III.D.1.9., III.D.1.12., III.D.1.13., and III.D.1.14., shall not apply,

1.18.2. In section III.D.1.15., the ambient temperature of the hot soak test is conducted at an ambient temperature between 68°F and 86°F at all times.

1.18.3. In section III.D.1.17., the diurnal test will consist of a two-day test.

1.18.4. For 2001 through 2008 model-year hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase exhaust test in the supplemental two-day diurnal test sequence shall be performed pursuant to the supplemental requirements specified in section E.6.1.6. of the "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.18.5. For 2009 and subsequent model-year hybrid electric vehicles, except for 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test in the supplemental two-day diurnal test sequence shall be performed pursuant to the supplemental requirements specified in section E.6.1.5 of the “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes.”

1.18.6. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase exhaust test in the supplemental two-day diurnal sequence shall be at the highest level allowed by the manufacturer in order to eliminate or minimize the cumulative amount of the auxiliary power unit activation during either of the ensuing three-phase exhaust or running loss tests. This requirement shall be applicable regardless of a vehicle’s ability to allow, or not to allow, manual activation of the auxiliary power unit. If off-vehicle charging is required to increase the battery state-of-charge for the proper setting, then this charging shall occur during the 12-to-36 hour soak period. The battery state-of-charge net change tolerance provisions specified in section F.10., of the “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes” shall not apply.

1.18.7. Emission sampling is not required for the standard three-phase exhaust test performed in the supplemental two-day diurnal test sequence shown in Figure 3A.

1.19. The Executive Officer may conduct certification confirmatory tests and in-use compliance tests of 2012 and subsequent off-vehicle charge capable hybrid electric vehicles using any of the following battery state-of-charge levels:

1.19.1. As specified in sections III.D.1.12.6. or III.D.1.18.6., as applicable.

1.19.2. At the lowest level allowed by the manufacturer.

1.19.3. At any level in-between the levels indicated by sections III.D.1.19.1. and III.D.1.19.2., above, if applicable.

2. Vehicle Preparation

2.0. Amend 40 CFR §86.131-90 to read:

2.1. Prepare the fuel tank(s) for recording the temperature(s) of the prescribed test fuel liquid and, if applicable, fuel vapor according to the requirements of section III.C.1.1. (40 CFR §86.129-80). Measurement of the fuel vapor temperature is optional. If vapor temperature is not measured, the measurement of the fuel tank pressure is not required.

2.2. If applicable, 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.

2.3. 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.

2.4. 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.

2.5. For vehicles to be tested for running loss emissions, prepare the exhaust system by sealing and/or plugging all detectable sources of exhaust gas leaks. The exhaust system shall be tested or inspected to ensure that detectable exhaust hydrocarbons are not emitted into the running loss enclosure during the running loss test.

3. Vehicle Preconditioning

3.1.1. For supplemental vehicle preconditioning requirements for 2001 through 2008 model-year hybrid electric vehicles, refer to the "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

3.1.2. For supplemental vehicle preconditioning requirements for 2009 and subsequent model-year hybrid electric vehicles, refer to the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

3.2. The following language shall be applicable in lieu of 40 CFR §86.132-90(a)(4) for 2001 through 2011 model-year vehicles; and, in lieu of 40 CFR §86.132-00(e) for 2012 and subsequent model-year vehicles.

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.

3.3. The following language shall be applicable in lieu of 40 CFR §86.132-90(b) for 2001 through 2011 model-year vehicles. For 2012 and subsequent model-year vehicles, the vehicle preconditioning shall be performed in accordance with 40 CFR §86.132-00(f) through (j), except when amended by the following language.

3.3.1. Within five minutes of completion of vehicle preconditioning drive, the vehicle shall be driven off the dynamometer to a work area. For hybrid electric vehicles following battery state-of-charge setting, the vehicle shall only be pushed or towed to avoid disturbing the battery state-of-charge setting.

3.3.2. Except for 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, the fuel tank(s) of the prepared vehicle shall undergo the second fuel drain and fill step of the test sequence, with the applicable test fuel, as specified in section III.F. of these procedures, to the prescribed tank fuel volume of 40 percent of the manufacturer’s nominal fuel tank capacity, as defined in 40 CFR §86.1803-01. The vehicle shall be refueled within 1 hour of completion of the preconditioning drive.

3.3.2.1. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, the exceptions specified in sections III.D.1.7.1 through III.D.1.7.10., shall apply, along with the applicable test fuel specified in section III.F.

3.3.3. Following the second fuel drain and fill described in section III.D.3.3.2. above, the test vehicle shall be allowed to soak for a period of not less than 12 and not more than 36 hours prior to the exhaust emissions test. Except for 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, during the soak period, the canister shall be connected to a pump or compressor and loaded with butane as described in section III.D.3.3.4. below for the three-day diurnal sequence and in section III.D.3.3.5. below for the supplemental two-day diurnal sequence. For all vehicles subjected to exhaust emissions testing only, the canister loading procedure as set forth in section III.D. 3.3.4. below shall be used. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, the canister shall be loaded according to the fuel-tank-refill canister-loading method specified in section III.D.3.3.6., for both the three-day diurnal sequence and the supplemental two-day diurnal sequence.

3.3.3.1. For methanol-fueled and flexible-fueled vehicles, canister preconditioning shall be performed with a fuel vapor composition representative of that which the vehicle would generate with the fuel mixture used for the current test. Manufacturers shall develop a procedure to precondition the canister, if the vehicle is so equipped for the different fuel. The procedure shall represent a canister loading equivalent to that specified in section III.D.3.3.4. below for the three-day diurnal sequence and in section III.D.3.3.5. below for the supplemental two-day diurnal sequence and shall be approved in advance by the Executive Officer.

3.3.4. For the three-day diurnal sequence, the evaporative emissions storage canister(s) shall be preloaded with an amount of butane equivalent to 1.5 times the nominal working capacity. For vehicles with multiple canisters in a series configuration, the set of canisters must be preconditioned as a unit. For vehicles with multiple canisters in a parallel configuration, each canister shall be preconditioned separately. For vehicles equipped with a non-integrated refueling emission control system, the non-integrated canisters shall be preconditioned for the three-day diurnal test sequence according to the procedure in section III.D.3.3.5.1. All 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles equipped with non-integrated refueling canister-only systems shall be preconditioned for the three-day diurnal test sequence according to the procedure specified in section III.D.3.3.6., unless a manufacturer is conducting only an exhaust emission test sequence, in which case the optional canister preconditioning and loading method allowed by section III.D.1.7.10. may apply. If a vehicle is designed to actively control evaporative or refueling emissions without a canister, the manufacturer shall devise an appropriate preconditioning procedure subject to the approval of the Executive Officer. If canisters on both certification and production vehicles are equipped with purge and load service ports, the service port shall be used for the canister preconditioning. The nominal working capacity of a carbon canister shall be established by determining the mass of butane required to load a stabilized canister to a

2-gram breakthrough. The 2-gram breakthrough is defined as the point at which the cumulative quantity of hydrocarbons emitted is equal to 2 grams, as defined in section I.B.1.3. The determination of nominal capacity shall be based on the average capacity of no less than five canisters which are in a stabilized condition. For stabilization, each canister must be cycled no less than 10 times and no more than 100 times to a 2-gram breakthrough with a 50/50 mixture by volume of butane and nitrogen, at a rate of 15 ± 2 grams butane per hour. Each canister loading step must be preceded by canister purging with 300 canister bed volume exchanges at 48 SCFH. The following procedure shall be used to preload the canister:

3.3.4.1. Prepare the evaporative emission canister(s) for the canister purging and loading operation. The canister shall not be removed from the vehicle, unless access to the canister in its normal location is so restricted that purging and loading can only reasonably be accomplished by removing the canister from the vehicle. 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 50 ± 25 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 carbon canister bed volume exchanges.

3.3.4.1.2. 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 butane shall be loaded into the canister at a rate of 15 ± 2 grams of butane per hour. If the canister loading at this rate takes longer than 12 hours, a manufacturer may determine a new rate, based on completing the canister loading in no less than 12 hours. A Critical Flow Orifice (CFO) butane injection device, a gravimetric method, or electronic mass flow controllers shall be used to fulfill the requirements of this step. The time of completion of the canister loading activity shall be recorded. Manufacturers shall disclose to the Executive Officer their canister loading procedure. The protocol may not allow for the replacement of components. In addition, the Executive Officer may require that the manufacturer demonstrate that the procedure does not unduly disturb the components of the evaporative system.

3.3.4.1.3. Reconnect the evaporative emission canister(s), if applicable.

3.3.5. For the supplemental two-day diurnal sequence, the evaporative emission storage canister(s) shall be loaded to the point of breakthrough using the method specific in either section III.D.3.3.5.1. or section III.D.3.3.5.2. For vehicles with multiple canisters in a series configuration, the set of canisters must be preconditioned as a unit. For vehicles with multiple canisters in a parallel configuration, each canister shall be preconditioned separately. For vehicles equipped with a non-integrated refueling emission control system, the non-integrated canisters shall be preconditioned for the supplemental two-diurnal test sequence according to the procedure in section III.D.3.3.5.1. Breakthrough may be determined by emission measurement in an enclosure or by measuring the weight gain of an auxiliary evaporative canister connected downstream of the vehicle's canister, in which case, the following references to the enclosure can be ignored. The auxiliary canister shall be well purged with ambient air of humidity controlled to 50±25 grains per pound of dry air prior to loading. Breakthrough is defined as the point at which the cumulative quantity of hydrocarbons emitted is equal to 2 grams, as defined in section I.B.1.3.

3.3.5.1. The following procedure provides for loading of the canister to breakthrough with a mixture composed of 50 percent butane and 50 percent nitrogen by volume. If the canisters on both certification and production vehicles are equipped with purge and load service ports, the service port shall be used for the canister preconditioning.

3.3.5.1.1. Prepare the evaporative/refueling emission canister(s) for the canister loading operation. The canister shall not be removed from the vehicle, unless access to the canister in its normal location is so restricted that loading can only reasonably be accomplished by removing the canister from the vehicle. Special care shall be taken during this step to avoid damage to the components and the integrity of the fuel system. The evaporative emission enclosure shall be purged for several minutes. The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the canister loading procedure. If not already on, the evaporative enclosure mixing fan shall be turned on at this time. Place the vehicle in the sealed enclosure and measure emissions with the FID.

3.3.5.1.2. Load the canister with a mixture composed of 50/50 mixture by volume of butane and nitrogen at a rate of 40 ± 2 grams butane per hour. As soon as the canister reaches breakthrough, the vapor source shall be shut off.

3.3.5.1.3. Reconnect the evaporative/refueling emission canister, if applicable.

3.3.5.2. The following procedure provides for loading the canister with repeated diurnal heat builds to breakthrough.

3.3.5.2.1. The evaporative emission enclosure shall be purged for several minutes. The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the diurnal heat builds. If not already on, the evaporative enclosure mixing fan shall be turned on at this time. The average temperature of the dispensed fuel shall be 60 ± 12°F. Within one hour of being refueled, the vehicle shall be placed, with the engine shut off, in the evaporative emission enclosure. The fuel tank temperature sensor shall be connected to the temperature recording system. A heat source, specified in 40 CFR §86.107-90(a)(4), shall be properly positioned with respect to the fuel tank(s) and connected to the temperature controller.

3.3.5.2.2. The fuel may be artificially heated or cooled to the starting diurnal temperature of 65°F. Turn off purge blower (if not already off); close and seal enclosure doors; and initiate measurement of the hydrocarbon level in the enclosure. When the fuel temperature reaches 65°F, start the diurnal heat build. The diurnal heat build should conform to the following function to within ± 4°F:

$$F = T_o \pm 0.4t$$

F is the fuel temperature, °F
T_o is the initial temperature, °F
t is the time since beginning of test, minutes

3.3.5.2.3. As soon as breakthrough occurs or when the fuel temperature reaches 105°F, whichever occurs first, the heat source shall be turned off, the enclosure doors shall be unsealed and opened. If breakthrough has not occurred by the time the fuel temperature reaches 105°F, the heat source shall be removed from the vehicle, the vehicle shall be removed (with the engine still off) from the evaporative emission enclosure and the entire procedure outlined above shall be repeated until breakthrough occurs.

3.3.5.2.4. After breakthrough occurs, the fuel tank(s) of the prepared vehicle shall be drained and filled with test fuel, as specified in section III.F. of these procedures, to the "tank fuel volume" defined in 40 CFR §86.1803-01. The fuel shall be stabilized to a temperature within ± 3°F of the lab ambient temperature before beginning the driving cycle for the exhaust emission test.

3.3.6. After the soak period specified in section III.D.1.7.5., is completed, the canister for a 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicle equipped with a non-integrated refueling canister-only system shall be preconditioned and loaded according to the following steps. Prior to conducting the applicable test sequence, the canister shall have already achieved a stabilized state, such as is accomplished using the stabilization method described in section III.D.3.3.4. Good engineering practice and safety considerations, such as, but not limited to, adequate ventilation and appropriate electrical groundings, shall apply.

3.3.6.1. Ambient temperature levels encountered by the test vehicle throughout these steps shall not be less than 68ºF (20ºC) or more than 86ºF (30ºC).

3.3.6.2. The test vehicle shall be approximately level, during the performance of these steps, to prevent abnormal fuel distribution.

3.3.6.3. In order to be moved, the test vehicle shall be pushed, as necessary, without starting its engine, throughout the performance of these steps~~,~~.

3.3.6.4. The test vehicle shall be allowed to soak for a minimum of 6 hours and a maximum of 24 hours, at 80ºF ±3ºF (27ºC ±1.7ºC), prior to starting the fuel-tank-fill canister-loading step. The refueling canister shall remain isolated from its system during this soak period, in order to prevent any abnormal purging or loading of it during this soak period.

3.3.6.5. The refueling canister shall not be isolated from its system during the fuel-tank-refill canister-loading step.

3.3.6.6. The test vehicle's fuel fill pipe cap shall be removed.

3.3.6.7. The dispensed fuel temperature recording system shall be started.

3.3.6.8. The fuel nozzle shall be inserted into the fill pipe neck of the test vehicle, to its maximum penetration, and the refueling operation shall start. The plane of the nozzle's handle shall be approximately perpendicular to the floor. The fuel shall be dispensed at a temperature of 67ºF ±3.0ºF (19.4ºC ±1.7ºC), and at a dispensing rate of 9.8 gal/min ±0.3 gal/min (37.1 liter/min ±1.1 liter/min). When this refueling operation is conducted by the Executive Officer, a dispensing rate that is not less than 4.0 gal/min (15.1 liter/min) may be used.

3.3.6.9. The fuel flow shall continue until the refueling nozzle automatic shut-off is activated. The amount of fuel dispensed must be at least 85 percent of the nominal fuel tank volume, determined to the nearest one-tenth of a U.S. gallon (0.38 liter). If an automatic nozzle shut-off occurs prior to this point, the dispensing shall be reactivated within 15 seconds, and fuel dispensing continued as needed. A minimum of 3 seconds shall elapse between any automatic nozzle shutoff and the subsequent resumption of fuel dispensing.

3.3.6.10. As soon as possible after completing the refilling step, remove the fuel nozzle from the fill pipe neck, and replace the test vehicle's fuel fill pipe cap.

3.3.6.11. The refueling canister shall be isolated from its system as soon as possible after completing the refilling step.

3.3.6.12. For vehicles equipped with more than one fuel tank, the steps described in this section shall be performed for each fuel tank.

3.3.6.13. After the fuel-tank-refill canister-loading process is completed, a fourth fuel drain and fill step shall be performed. The fuel tank shall be filled to the prescribed fuel thank volume of 40 percent of the manufacturer's nominal fuel tank capacity, as specified in 40 CFR §86.1803-01. When the refueling canister is isolated from its system, fuel vapors shall be allowed to be vented out of the fuel tank, as appropriate, during this refilling step. The required fuel tank volume of 40 percent may be accomplished by using a measured drain of the fuel tank, in place of the specified complete fuel tank drain and fill step.

3.3.6.14. Upon completion of the fourth fuel drain and fill step, the test vehicle shall proceed to the 12-to-36 hour preconditioning soak step which is performed prior to the three-phase exhaust cold start test step. The canister shall not be isolated from its system during this soak step, and shall not be isolated from its system from this point onward in the test sequence.

3.3.6.15. The Executive Officer may approve modifications to this fuel-tank-refill canister-loading method when such modifications are supported by good engineering judgment, and do not reduce the stringency of the method.

3.4. As allowed under the provisions of section III.G. of these test procedures, a manufacturer may propose, for Executive Officer approval, the use of an alternative method to precondition canisters in lieu of the methods required under sections III.D.3.3.4.; III.D.3.3.5.1.; and, III.D.3.3.5.2., and III.D.3.3.6. The Executive Officer may conduct certification confirmatory tests and in-use compliance tests with the either the alternative canister loading method or the methods specified in sections III.D.3.3.4; III.D.3.3.5.1.; III.D.3.3.5.2.; and, III.D.3.3.6, as applicable.

4. Dynamometer Procedure.

4.1. To be conducted according to 40 CFR §86.135-90 (December 8, 2005).

4.2. For 2001 through 2008 model-year hybrid electric vehicles, the dynamometer procedure shall be performed pursuant to the "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

4.3. For 2009 and subsequent model-year hybrid electric vehicles, the dynamometer procedure shall be performed pursuant to the "California Exhaust Emission Standards and Test Procedures for 2009 Subsequent Model Zero-Emission Vehicles and Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

5. Engine Starting and Restarting.

5.1. Amend 40 CFR §86.136-90 to read as follows:

5.1.1. Revise subparagraph (c) to read: Except for hybrid electric vehicles, if the vehicle does not start after the manufacturer's recommended cranking time (or 10 continuous seconds in the absence of a manufacturer's recommendation), cranking shall cease for the period recommended by the manufacturer (or 10 seconds in the absence of a manufacturer's recommendation). This may be repeated for up to three start attempts. If the vehicle does not start after three attempts, the reason for failure to start shall be determined. The gas flow measuring device on the CVS (usually a revolution counter) or CFV shall be turned off and the sampler selector valves, including the alcohol sampler, placed in the "standby" position during this diagnostic period. In addition, either the CVS should be turned off, or the exhaust tube disconnected from the tailpipe during the diagnostic period. If failure to start is an operational error, the vehicle shall be rescheduled for testing from a cold start.

6. Dynamometer Test Run, Gaseous and Particulate Emissions.

6.1. To be conducted according to 40 CFR §86.137-90.

6.2. For 2001 through 2008 model-year hybrid electric vehicles, the dynamometer test run, gaseous and particulate emissions shall be performed pursuant to the "California Exhaust Emission Standards and Test Procedures for 2005 – 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

6.3. For 2009 and subsequent model-year hybrid electric vehicles, the dynamometer test run, gaseous and particulate emissions shall be performed pursuant to the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

7. Vehicle Fuel Tank Temperature Stabilization

7.1. Immediately after the hot transient exhaust emission test, the vehicle shall be soaked in a temperature controlled area between one hour to six hours, until the fuel and, if applicable, vapor temperatures are stabilized at 105°F ± 3°F for one hour. This is a preparatory step for the running loss test. Cooling or heating of the fuel tank may be induced to bring the fuel to 105°F. The fuel heating rate shall not exceed 5°F in any 1-hour interval. Higher fuel heating rates are allowed with Executive Officer approval if the 5°F per hour heating rate is insufficient to heat the fuel to 105°F in the allowed soak time. The vehicle fuel temperature stabilization step may be omitted on vehicles whose tank fuel and, if applicable, vapor temperatures are already at 105°F upon completion of the exhaust emission test.

7.2. The initial fuel and, if applicable, vapor temperatures for the running loss test may be less than 105°F with advance Executive Officer approval if the manufacturer is able to provide data justifying initial temperatures at least 3°F lower than the required 105°F starting temperature. The test data shall include the maximum fuel temperatures experienced by the vehicle during an extended parking event and after a UDDS cycle and be conducted on a day which meets the ambient conditions specified in section III.C.1.2., except the ambient temperature must be at least 105°F. During the profile generation, the temperature offset shall apply.

7.3. 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.

8. Running Loss Test

8.0. 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 shall be maintained at 105°F ± 5°F maximum and within ± 2°F on average throughout the running loss test sequence. Control of the vapor temperature throughout the test to follow the vapor temperature profile generated according to the procedures in section III.C. is optional. In those instances where vapor temperature is not controlled to follow the profile, the measurement of the fuel tank pressure is not required, and sections III.D.8.1.10. and III.D.8.2.5. below shall not apply. In the event that a vehicle exceeds the applicable emission standard during confirmatory testing or in-use compliance testing, and the vapor temperature was not controlled, the manufacturer may, utilizing its own resources, test the vehicle to demonstrate if the excess emissions are attributable to inadequate control of vapor temperature. If the vehicle has more than one fuel tank, the fuel temperature in each tank shall follow the profile generated in section III.C. If a warning light or gauge indicates that the vehicle's engine coolant has overheated, the test run may be stopped.

8.1. If running loss testing is conducted using an enclosure which incorporates atmospheric sampling equipment, the manufacturer shall perform the following steps for each test:

8.1.1. The running loss enclosure shall be purged for several minutes immediately prior to the test. If at any time the concentration of hydrocarbons, of alcohol, or of alcohol and hydrocarbons exceeds 15,000 ppm C, the enclosure should be immediately purged. This concentration provides at least a 4:1 safety factor against the lean flammability limit.

8.1.2. Place the drive wheels of the vehicle on the dynamometer without starting the engine.

8.1.3. Attach the exhaust tube to the vehicle tailpipe(s).

8.1.4. The test vehicle windows and the luggage compartments shall be closed.

8.1.5. 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. 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 as much as possible, windows shall be closed, and air conditioning system (if so equipped) shall be operated according to the requirements of section III.C. (§86.129-80 (d)(3)). Vehicle coolant temperature shall be monitored to ensure adequate vehicle coolant air to the radiator intake(s). The temperature recording system and the hydrocarbon and alcohol emission data recording system shall be started.

8.1.6. Close and seal enclosure doors.

8.1.7. When the ambient temperature is 105°F ± 5°F, the running loss test shall begin. Analyze enclosure atmosphere for hydrocarbons and alcohol at the beginning of each phase of the test (i.e., each UDDS and 120 second idle; the two NYCCs and 120 second idle) and record. This is the background hydrocarbon concentration, herein denoted as $C_{HCa(n)}$ for each phase of the test and the background methanol concentration, herein denoted as $C_{CH3OHa(n)}$ for each phase of the test. The methanol sampling must start simultaneously with the initiation of the hydrocarbon analysis and continue for 4.0 ± 0.5 minutes. Record the time elapsed during this analysis. If the 4 minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate Gas Chromatography analysis, rapidly collect the methanol sample in a bag and then bubble the bag sample through the impingers at the specified flow rate. The time elapsed between collection of the bag sample and flow through the impingers should be minimized to prevent any losses.

8.1.8. The vehicle shall be driven through one UDDS, then two NYCCs and followed by one UDDS. Each UDDS and the NYCC driving trace shall be verified to meet the speed tolerance requirements of 40 CFR §86.115-78 (b) as modified by III.C. The end of each UDDS cycle and the two NYCCs 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 specified in §86.128-79, modified by section III.C.1.3.

8.1.8.1. The fuel tank liquid temperature during the dynamometer drive shall be controlled within ± 3°F of the fuel tank temperature profile obtained on the road according to the procedures in section III.C. (40 CFR §86.129-80) for the same vehicle platform/powertrain/fuel tank configuration. If applicable, the fuel tank vapor temperature throughout the running loss test shall agree with the corresponding vapor temperature with a tolerance of ± 5°F. A running loss test with a fuel tank vapor temperature that exceeded the corresponding vapor temperature profile by more than the ± 5°F tolerance may be considered valid if test results comply with the applicable running loss evaporative emission standards. In addition, 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°F. For testing conducted by the Executive Officer, vapor temperatures may be cooler than the specified tolerances without invalidating test results. The fuel tank temperatures shall be monitored at a frequency of at least once every 15 seconds.

8.1.9. For engine starting and restarting, the provisions of §86.136-90(a) and (e) shall apply. If the vehicle does not start after the manufacturer's recommended cranking time or 10 continuous seconds in the absence of a manufacturer's recommendation, cranking shall cease for the period recommended by the manufacturer or 10 seconds in the absence of a manufacturer's recommendation. This may be repeated for up to three start attempts. If the vehicle does not start after these three attempts, cranking shall cease and the reason for failure to start shall be determined. If the failure is caused by a vehicle malfunction, corrective action of less than 30 minutes duration may be taken (according to 40 CFR §86.1830-01), and the test continued, provided that the ambient conditions to which the vehicle is exposed are maintained at 105°F ± 5°F. When the engine starts, the timing sequence of the driving schedule shall begin. If the vehicle cannot be started, the test shall be voided.

8.1.10. Tank pressure shall not exceed 10 inches of water during the running loss test unless a pressurized system is used and the manufacturer demonstrates in a separate test that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the test. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, a manufacturer shall demonstrate in either a separate test or an engineering evaluation, that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the test. Transitory incidents of the pressure exceeding 10 inches of water, not greater than 10 percent of the total driving time, shall be acceptable during the running loss test if the manufacturer can demonstrate that the tank pressure does not exceed 10 inches of water during in-use operation. 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.

8.1.11. The FID hydrocarbon analyzer shall be zeroed and spanned immediately prior to the end of each phase of the test.

8.1.12. Analyze the enclosure atmosphere for hydrocarbons and for alcohol following each phase. This is the sample hydrocarbon concentration, herein denoted as $C_{HCs(n)}$ for each phase of the test and the sample alcohol concentration, herein denoted as $C_{CH3OHs\ (n)}$ for each phase of the test. The sample hydrocarbon and alcohol 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 72 ± 2 minutes after the test begins. The elapsed time of this analysis shall be recorded.

8.1.13. Turn off the vehicle cooling fan and the vehicle underbody fan if used. The test vehicle windows and luggage compartment shall be opened. This is a preparatory step for the hot soak evaporative emission test.

8.1.14. 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.

8.2. 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:

8.2.1. The running loss test shall be conducted in a test cell meeting the specifications of 40 CFR §86.107-90 (a)(1) as modified by section III.A.2. of these procedures. Ambient temperature in the running loss test cell shall be maintained at 105 ± 5^{o}F maximum and within ± 2^{o}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^{o}F of the initial liquid fuel temperature calculated according to section III.C.1.5. (40 CFR §86.129-80) before the running loss test may proceed.

8.2.2. 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 as much as possible, windows shall be closed, and air conditioning system (if so equipped) shall be operated according to the requirements of section III.C.1.3. (40 CFR §86.129-80). Vehicle coolant temperature shall be monitored to ensure adequate vehicle coolant air to the radiator intake(s).

8.2.3. The vehicle shall be operated on the dynamometer over one UDDS, two NYCCs, and one UDDS. Each UDDS and NYCC driving trace shall be verified to meet the speed tolerance requirements of 40 CFR §86.115-78 (b) as modified by section III.C. Idle periods of 120 seconds shall be added to the end of each of the UDDS and to the end of the two NYCCs. The transmission may be operated according to the specifications of 40 CFR §86.128-79 as modified by section III.C.1.3. Engine starting and restarting shall be conducted according to section III.D.8.1.9.

8.2.4. The fuel tank liquid temperature during the dynamometer drive shall be controlled within ± 3°F of the fuel tank liquid temperature profile obtained on the road according to the procedures in section III.C. (40 CFR §86.129-80) for the same vehicle platform/powertrain/fuel tank configuration. If applicable, the fuel tank vapor temperature throughout the running loss test shall agree with the corresponding vapor temperature with a tolerance of ± 5°F. A running loss test with a fuel tank vapor temperature that exceeded the corresponding vapor temperature profile by more than the ± 5°F tolerance may be considered valid if test results comply with the applicable running loss evaporative emission standards. In addition, 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°F. For testing conducted by the Executive Officer, vapor temperatures may be cooler than the specified tolerances without invalidating test results. The fuel tank temperatures shall be monitored at a frequency of at least once every 15 seconds.

8.2.5. Tank pressure shall not exceed 10 inches of water during the running loss test unless a pressurized system is used and the manufacturer demonstrates in a separate test that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the test. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, a manufacturer shall demonstrate in either a separate test or an engineering evaluation, that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the test. Transitory incidents of the pressure exceeding 10 inches of water, not greater than 10 percent of the total driving time, shall be acceptable during the running loss test if the manufacturer can demonstrate that the tank pressure does not exceed 10 inches of water during in-use operation. 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.

8.2.6. After the test vehicle is positioned on the dynamometer, the running loss vapor collection system shall be properly positioned at the specified discrete emissions sources, which include 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 1. Other designated places, if any, where fuel vapor can escape, shall also be included.

8.2.7. The running loss vapor collection system may be connected to the PDP-CVS or CFV bag collection system. Otherwise, running loss vapors shall be sampled continuously with analyzers meeting the requirements of §86.107-90(a)(2).

8.2.8. 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.

8.2.9. The sample bags shall be analyzed within 20 minutes of their respective sample collection phases, as described in 40 CFR §86.137-90(b)(15).

8.2.10. After the completion of the final 120 seconds, turn off the vehicle cooling fan and the vehicle underbody fan if used.

8.3. Manufacturers may use an alternative running loss test procedure if it provides an equivalent demonstration of compliance. The use of an alternative procedure also requires the prior approval of the Executive Officer. The Executive Officer may conduct confirmatory testing or in-use compliance testing using either the running loss measurement enclosure incorporating atmospheric sampling equipment or in a test cell utilizing point source sampling equipment, as specified in section III.A.2. (40 CFR §86.107-90(a)(1)), in conjunction with the procedures as outlined in either section III.D.8.1. or III.D.8.2. of this test procedure, or using the manufacturer's approved alternative running loss test procedure for a specific evaporative family.

9. Hot Soak Test

9.1. Amend the first paragraph of 40 CFR §86.138-90 as follows: For the three-day diurnal sequence, the hot soak evaporative emission test shall be conducted immediately following the running loss test. The hot soak test shall be performed at an ambient temperature of 105°F ± 10.0°F for the first 5 minutes of the test. The remainder of the hot soak test shall be performed at 105°F ± 5.0°F and ± 2.0°F on average.

9.2. Revise subparagraph (a) to read: If the hot soak test is conducted in the running loss enclosure, the final hydrocarbon and alcohol concentration for the running loss test, calculated in section III.D.11.3.1.(b), shall be the initial hydrocarbon concentration (time = 0 minutes) C_{HCe1} and the initial alcohol concentration (time=0 minutes) $C_{CH3OHe1}$ for the hot soak test. If the vehicle must be transported to a different enclosure, sections III.D.9.3. through III.D.9.7., as modified below, shall be conducted.

9.3. Revise subparagraph (d) to include: Analyze the enclosure atmosphere for hydrocarbons and alcohol and record. This is the initial (time=0 minutes) hydrocarbon concentration, C_{HCe1} and the initial (time=0 minutes) alcohol concentration, $C_{CH3OHe1}$, required in section III.D.11.3.1.(a).

9.4. Revise subparagraph (e) to read: If the hot soak test is not conducted in the running loss enclosure, the vehicle engine compartment cover shall be closed, the cooling fan shall be moved, the vehicle shall be disconnected from the dynamometer and exhaust sampling system, and then driven at minimum throttle to the vehicle entrance of the enclosure.

9.5. Revise subparagraph (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 two minutes of engine shutdown and within seven minutes after the end of 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.

9.6. Revise subparagraph (j) to read: The 60 ± 0.5 minutes hot soak begins when the enclosure door(s) are sealed or when the running loss test ends if the hot soak test is conducted in the running loss enclosure.

9.7. For the supplemental two-day diurnal test sequence, the hot soak test shall be conducted immediately following the hot start exhaust test. The hot soak test shall be performed at an ambient temperature between 68 to 86°F at all times.

9.8. The hot soak test shall be conducted according to 40 CFR §86.138-90, as revised by sections III.D.9.2. through III.D.9.7.

10. Diurnal Breathing Loss Test

10.1. A three-day diurnal test shall be performed in a variable temperature enclosure, described in section III.A.1. 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 alcohol, unless specific instructions for ethanol are noted.

10.2. If testing indicates that a vehicle design may result in fuel temperature responses during enclosure testing that are not representative of in-use summertime conditions, the Executive Officer may adjust air circulation and temperature during the test as needed to ensure that the test sufficiently duplicates the vehicle's in-use experience.

10.3. Revise 40 CFR §86.133-90 to read as follows:

10.3.1. Revise subparagraph (a)(1) to read: Upon completion of the hot soak test, the test vehicle shall be soaked for not less than 6 hours and not more than 36 hours. For at least the last 6 hours of this period, the vehicle shall be soaked at 65°F ± 3°F. The diurnal breathing loss test shall consist of three 24-hour test cycles.

10.3.2. Omit subparagraph (f).

10.3.3. Omit subparagraph (i).

10.3.4. Revise subparagraph (j) to read: Prior to initiating the emission sampling:

10.3.5. Revise subparagraph (k) to read: Emission sampling shall begin within 10 minutes of closing and sealing the doors, as follows:

10.3.6. Revise subparagraph (k)(3) to read: Start diurnal heat build and record time. This commences the 24 hour ± 2 minute test cycle.

10.3.7. Revise subparagraph (l) to read: For each 24-hour cycle of the diurnal breathing loss test, the ambient temperature in the enclosure shall be changed in real time as specified in the following table:

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(^{o}F)	65.0	66.6	72.6	80.3	86.1	90.6	94.6	98.1	101.2	103.4	104.9	105.0	104.2
Hour	13	14	15	16	17	18	19	20	21	22	23	24	--
(^{o}F)	101.1	95.3	88.8	84.4	80.8	77.8	75.3	72.0	70.0	68.2	66.5	65.0	--

10.3.8. Omit subparagraph (m).

10.3.9. Revise subparagraph (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. Analyze the enclosure atmosphere for hydrocarbons and alcohol and record. This is the final hydrocarbon concentration, C_{HCe2}, and the final alcohol concentration, $C_{CH3OHe2}$, in section III.D.11.3.1.(c) which modifies 40 CFR §86.143-90, for this test cycle. The time (or elapsed time) of this analysis shall be recorded. The procedure, commencing with subparagraph (k)(1) shall be repeated until three consecutive 24-hour tests are completed. The data from the test cycle yielding the highest diurnal hydrocarbon mass shall be used in evaporative emissions calculations as required by section III.D.11.3.1.(c). which modifies 40 CFR §86.143-90.

10.3.10. Revise subparagraph (q) to read: Upon completion of the final 24-hour test cycle, and after the final alcohol sample has been collected, the enclosure doors shall be unsealed and opened.

10.3.11. Omit subparagraph (r).

10.3.12. Add subparagraph (t) to read: For hybrid electric vehicles 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 auxiliary power unit will activate solely for the purposes of purging the canister of hydrocarbon vapor.

10.3.13. Add subparagraph (u) 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 three-day 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.

10.3.14. Add subparagraph (v) 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. For 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, a manufacturer may satisfy this requirement under the optional provision specified in section II.A.5.4.2.

10.15. The two-day diurnal test shall be performed in an enclosure, described in section III.A.1. of this test procedure. The test consists of two 24-hour diurnals. The test procedure shall be conducted according to 40 CFR §86.133-90, revised by sections III.D.10.3.1. through III.D.10.3.14., except that only two consecutive 24-hour diurnals shall be performed. For the purposes of this diurnal breathing loss test, all references to methanol shall be applicable to alcohol, unless specific instructions for ethanol are noted.

11. Calculations: Evaporative Emissions

11.0. Revise 40 CFR §86.143-90 as follows:

11.1. Revise subparagraph (a) to read: The calculation of the net hydrocarbon plus ethanol (or methanol) mass change in the enclosure is used to determine the diurnal, hot soak, and running loss mass emissions. If the emissions also include alcohol components other than methanol and ethanol~~ and other alcohol components~~, the manufacturer shall determine an appropriate calculation(s) which reflect characteristics of the alcohol component similar to the equations below, subject to the Executive Officer approval. The mass changes are calculated from initial and final hydrocarbon and ~~me~~thanol concentrations in ppm carbon, initial and final enclosure ambient temperatures, initial and final barometric pressures, and net enclosure volume using the ~~following~~ equations of this section III.D.11. Diurnal, hot soak, and running loss mass emissions for methanol-fueled vehicles shall be conducted according to 40 CFR §86.143-96, as amended August 23, 1995.

11.2. Revise subparagraph (a)(1) to read:

~~Methanol calculations shall be conducted according to 40 CFR §86.143-96(b)(1)(i), as amended March 24, 1993.~~

For ethanol in an enclosure:

$$M_{C2H5OH} = (V_n - 50) \times \left[\frac{(C_{S1f} \times AV_{1f}) + (C_{S2f} \times AV_{2f})}{V_{Ef}}\right] - \left[\frac{(C_{S1i} \times AV_{1i}) + (C_{S2i} \times AV_{2i})}{V_{Ei}}\right] + (M_{C2H5OHout} - M_{C2H5OHin})$$

where: M_{C2H5OH} is the ethanol mass emissions (µg)

V_n is the enclosure nominal volume. (ft^3)

C_S is the GC concentration of sample (µg/ml)

AV is the volume of absorbing reagent in impinger (ml)

V_E is the volume of sample withdrawn (ft^3). Sample volumes must be corrected for differences in temperature to be consistent with determination of V_n, prior to being used in the equation.

i = initial sample

f = final sample

1 is the first impinger

2 is the second impinger

$M_{C2H5OH,\ out}$ is the mass of ethanol exiting the enclosure from the beginning of the cycle to the end of the cycle; this only applies to diurnal testing in fixed-volume enclosures (µg); For variable-volume enclosures, $M_{C2H5OH,\ out}$ is zero

$M_{C2H5OH,\ in}$ is the mass of ethanol entering the enclosure from the beginning of the cycle to the end of the cycle; this only applies to diurnal testing in fixed-volume enclosures (µg); For variable-volume enclosures, $M_{C2H5OH,\ in}$ is zero

The enclosure ethanol mass (M_{C2H5OH}) determined from the equation above goes into the equations of subsequent sections to calculate the total mass emissions, where $M_{C2H5OHhs}$ is the ethanol mass emissions from the hot soak test, $M_{C2H5OHdi}$ is the ethanol mass emissions from the diurnal test, and $M_{C2H5OHrl(n)}$ is the ethanol mass emissions from the running loss test for phase n of the test. For diurnal testing, this calculation shall be made for each 24-hour diurnal period.

11.3. Revise subparagraph (a)(2) to read:

11.3.1. For hydrocarbons in an enclosure:

(a) ~~Hot soak HC mass.~~Hot soak and diurnal testing in an enclosure: For fixed volume enclosures, the ~~hot soak~~ enclosure hydrocarbon mass is determined as:

$$M_{HC\cancel{hs}} = [2.97x\ (V_n - 50)\ x10^{-4}\ x\ \{P_f\ (C_{HCe2} - rC_{C\underline{2}H\underline{5}\cancel{3}OHe2})/T_f - P_i\ (C_{HCe1} - rC_{C\underline{2}H\underline{5}\cancel{3}OHe1})/T_i\}]\ \underline{+\ M_{HC,\ out} - M_{HC,\ in}}$$

where: $M_{HC\cancel{hs}}$ is the ~~hot soak~~ HC mass emissions (grams)

V_n is the enclosure nominal volume ~~if the running loss enclosure is used or the enclosure volume at 105°F if the diurnal enclosure is used~~. (ft^3)

P_i is the initial barometric pressure (inches Hg)

P_f is the final barometric pressure (inches Hg)

C_{HCe2} is the final enclosure hydrocarbon concentration including FID response to ~~m~~ethanol in the sample (ppm C)

C_{HCe1} is the initial enclosure hydrocarbon concentration including FID response to ~~m~~ethanol in the sample (ppm C)

$C_{C\underline{2}H\underline{5}\cancel{3}OHe2}$ is the final ~~m~~ethanol concentration ~~calculated according to §86.143-90 (a)(2)(iii)~~ (ppm C equivalent)

$$= \frac{2.088 \times 10^{-3} \times T_f}{P_f \times V_E} \times \left[\left(C_{S1f} \times AV_{1f}\right) + \left(C_{S2f} \times AV_{2f}\right)\right]$$

$C_{C2H5\cancel{3}OHe1}$ is the initial ~~m~~ethanol concentration ~~calculated according to §86.143-90(a)(2)(iii)~~ (ppm C equivalent)

$$= \frac{2.088 \times 10^{-3} \times T_i}{P_i \times V_E} \times \left[\left(C_{S1i} \times AV_{1i}\right) + \left(C_{S2i} \times AV_{2i}\right)\right]$$

r is the FID response factor to ~~m~~ethanol

T_i is the initial enclosure temperature (°R)

T_f is the final enclosure temperature (°R)

V_E is the volume of sample withdrawn (ft^3). Sample volumes must be corrected for differences in temperature to be consistent with determination of V_n, prior to being used in the equation.

C_S is the GC concentration of sample (µg/ml)

AV is the Volume of absorbing reagent in impinger (ml)

1 is the first impinger

2 is the second impinger

i = initial sample

f = final sample

$M_{HC, out}$ is the mass of hydrocarbon exiting the enclosure from the beginning of the cycle to the end of the cycle; this only applies to diurnal testing in fixed-volume enclosures (grams)

$M_{HC, in}$ is the mass of hydrocarbon entering the enclosure from the beginning of the cycle to the end of the cycle; this only applies to diurnal testing in fixed-volume enclosures (grams)

For vehicles tested in an enclosure with the gasoline set forth in part II, section A.100.3.1.2. of the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles” only, measured ethanol values can be omitted so long as the resultant M_{HC} is multiplied by 1.08. If this option is used, then all terms accounting for ethanol in the applicable equations of this section III.D.11 (including ethanol concentration values of the above equation) shall equal zero.

The enclosure HC mass (M_{HC}) determined from the equation above goes into the equations of subsequent sections to calculate the total mass emissions, where M_{HChs} is the HC mass emissions from the hot soak test, M_{HCdi} is the HC mass emissions from the diurnal test, and $M_{HCrl(n)}$ is the HC mass emissions from the running loss test for phase n of the test if the enclosure method is used for running loss testing. For diurnal testing, this calculation shall be made for each 24-hour diurnal period.

For variable volume enclosures, calculate the ~~hot soak~~ enclosure HC mass ($M_{HC\cancel{hs}}$) according to the equation used above except that P_f and T_f shall equal P_i and T_i and $M_{HC, out}$ and $M_{HC, in}$ shall equal zero.

(b) Running loss ~~HC~~ mass. The running loss HC mass per distance traveled is defined as:

$$M_{HCrlt} = (M_{HCrl(1)} + M_{HCrl(2)} + M_{HCrl\cancel{1}(3)})/(D_{rl(1)} + D_{rl(2)} + D_{rl(3)})$$

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)

The running loss ethanol mass per distance traveled is defined as:

$$M_{C2H5OHrlt} = (M_{C2H5OHrl(1)} + M_{C2H5OHrl(2)} + M_{C2H5OHrl(3)})/(D_{rl(1)} + D_{rl(2)} + D_{rl(3)})$$

where: $M_{C2H5OHrlt}$ is the total running loss ethanol mass per distance traveled (grams ethanol per mile)

$M_{C2H5OHrl(n)}$ is the running loss ethanol mass for phase n of the test (grams ethanol)

For the point-source method:

Hydrocarbon emissions:

$M_{HCrl(n)} = (C_{HCs(n)} - C_{HCa(n)}) \times 16.88 \times V_{mix} \times 10^{-6}$

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)

16.88 is the density of pure vapor at 68°F (grams/ft^3)

V_{mix} is the total dilute CVS volume (std. ft^3)

and: V_{mix} is calculated per 40 CFR §86.144-90

~~Me~~Ethanol emissions:

$M_{C2H5\cancel{3}OHrl(n)} = (C_{C2H5\cancel{3}OHs(n)} - C_{C2H5\cancel{3}OHa(n)}) \times \cancel{37.74}54.25 \times V_{mix}$

where: $C_{C2H5\cancel{3}OHs(n)}$ is the sample bag ~~m~~ethanol concentration for phase n of the test (ppm C equivalent)

$C_{C2H5\cancel{3}OHa(n)}$ is the background bag concentration for phase n of the test (ppm C equivalent)

~~37.71~~54.25 is the density of pure vapor at 68°F (grams/ft^3)

V_{mix} is the total dilute CVS volume (std. ft^3)

and: V_{mix} is calculated per 40 CFR §86.144-90

For vehicles tested for running loss using the point source method with the gasoline set forth in part II, section A.100.3.1.2. of the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and

Medium-Duty Vehicles" only, measured ethanol values can be omitted so long as the resultant $M_{HCrl(n)}$ is multiplied by 1.08. If this option is used, then all terms accounting for ethanol in the applicable equations of this section III.D.11 shall equal zero and both $C_{HCs(n)}$ and $C_{HCa(n)}$ in the above equation shall include the FID response to ethanol (the FID response to ethanol shall not be subtracted).

For the enclosure method:

$M_{HCrl(n)}$ is the running loss HC mass for phase n of the test (grams HC) and shall be determined by the ~~same~~ method ~~as the hot soak hydrocarbon mass emissions determination~~ specified in section III.D.11.3.1.(a).

~~(c) Diurnal mass. For fixed volume enclosures, the HC mass for each of the three diurnals is defined for an enclosure as:~~

~~$M_{HCd} = [2.97x(V - 50)x10^{-4}x\{P_f (C_{HCe2} - rC_{CH3OHe2})/T_f - P_i (C_{HCe1} - rC_{CH3OHe1})/T_i \}] + M_{HC, out} - M_{HC, in}$~~

~~where: M_{HCd} is the diurnal HC mass emissions (grams)~~

~~V is the enclosure volume at 65° F (ft^3)~~

~~P_i is the initial barometric pressure (inches Hg)~~

~~P_f is the final barometric pressure (inches Hg)~~

~~C_{HCe2} is the final enclosure hydrocarbon concentration including FID response to methanol in the sample (ppm C)~~

~~C_{HCe1} is the initial enclosure hydrocarbon concentration including FID response to methanol in the sample (ppm C)~~

~~$C_{CH3OHe2}$ is the final methanol concentration calculated according to 40 CFR §86.143-90 (a)(2)(iii)~~

~~$C_{CH3OHe1}$ is the initial methanol concentration calculated according to 40 CFR §86.143-90 (a)(2)(iii)~~

~~r is the FID response factor to methanol~~

~~T_i is the initial enclosure temperature (°R)~~

~~T_f is the final enclosure temperature (°R)~~

~~$M_{HC,\ out}$ is the mass of hydrocarbon exiting the enclosure from the beginning of the cycle to the end of the cycle (grams)~~

~~$M_{HC,\ in}$ is the mass of hydrocarbon entering the enclosure from the beginning of the cycle to the end of the cycle (grams)~~

~~For variable volume enclosures, calculate the HC mass for each of the three diurnals (M_{HCd}) according to the equation used above except that P_f and T_f shall equal P_i and T_i and $M_{HC,\ out}$ and $M_{HC,\ in}$ shall equal zero.~~

11.3.2. Revise subparagraph (a)(3) to read:

The total mass emissions shall be adjusted as follows:

(1) $M_{hs} = M_{HChs} + (14.2284/\cancel{32.042}\underline{23.034}) \times 10^{-6}\ M_{C\underline{2}H\underline{5}\cancel{3}OHhs}$

(2) $M_{di} = M_{HCdi} + (14.3594/\cancel{32.042}\underline{23.034}) \times 10^{-6} M_{C\underline{2}H\underline{5}\cancel{3}OHdi}$

(3) $M_{rl} = M_{HCrlt} + (14.2284/\cancel{32.042}\underline{23.034}) \times 10^{-6}\ M_{C\underline{2}H\underline{5}\cancel{3}OHrlt}$

11.3.3. Revise subparagraph (b) to read: The final evaporative emission test results reported shall be computed by summing the adjusted evaporative emission result determined for the hot soak test (M_{hs}) and the highest 24-hour result determined for the diurnal breathing loss test (M_{di}). The final reported result for the running loss test shall be the adjusted emission result (M_{r1}), expressed on a grams per mile basis.

12. Bleed Emission Test Procedure (BETP)

12.1. Carbon Canister System Stabilization. The carbon canister system shall be stabilized to a 4,000-mile test condition using one of the following methods:

12.1.1. Stabilization on a vehicle. The canister system shall be installed on a representative vehicle, and the vehicle shall be driven for 4,000 miles using the gasoline set forth in part II., section A.100.3.1.2. of the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles.” The last part of this drive shall consist of an Urban Dynamometer Driving Schedule (UDDS), specified in appendix I of 40 CFR §86.

12.1.2. Carbon Canister System Purge/Load Cycling with Fuel Vapor. The carbon canister system shall be cycle aged no less than 10 cycles using the gasoline referenced in section III.D.12.1.1 by loading the canister system to 2-gram breakthrough with either a mixture of fuel vapor and nitrogen (50 ± 15 percent fuel vapor by volume) or a mixture of fuel vapor and air (50 ± 15 percent fuel vapor by volume), at a fuel vapor fill rate of 40 to 80 grams per hour. Each loading is followed by purging the canister system with 300 canister bed volume exchanges at 0.8 cfm.

12.1.3. Alternative Carbon Canister System Purge/Load Cycling with Fuel Vapor. The carbon canister system shall be aged no less than 10 cycles using the gasoline referenced in section III.D.12.1.1 by loading and purging the carbon canister system with a method approved in advance by the Executive Officer. The alternative method shall be demonstrated to yield test results equivalent to or more stringent than, those resulting from the use of the method set forth in section III.D.12.1.1 or III.D.12.1.2.

12.2. Fuel Tank Drain/Fill and Soak. A fuel tank that represents the worst case as determined by engineering evaluation shall be drained and filled to 40 percent with the gasoline referenced in section III.D.12.1.1. The tank shall be soaked for a minimum of 6 hours to a maximum of 72 hours at 65 ± 3°F. The canister system load (section III.D.12.3) and soak (section III.D.12.4) can be performed in series or in parallel with the 6 to 72 hour fuel tank soak.

12.3. Carbon Canister System Loading. The canister system shall be loaded according to the canister loading procedure in the supplemental two-day diurnal sequence, as specified in sections III.D.3.3.5. through III.D.3.3.5.1.2. This procedure requires loading the canister with a 50/50 mixture by volume of butane and nitrogen at a rate of 40 grams butane per hour to a 2-gram breakthrough.

12.4. Carbon Canister System Soak. The canister system shall then be soaked for a minimum of 1 hour.

12.5. Carbon Canister System Purge. The carbon canister system shall be purged using one of the following methods:

12.5.1. The canister system shall be attached to a vehicle and driven on the drive cycle of the supplemental two-day diurnal sequence, as specified in section III.D.6., to purge the canister system.

12.5.2. Alternatively, the canister system may be purged at a rate and volume in a laboratory simulation, based on an engineering evaluation, to represent the net mass of hydrocarbons desorbed from the canister system during the drive cycle of the supplemental two-day diurnal sequence, as specified in section III.D.6.

12.6. Connection of Carbon Canister System and Fuel Tank. The canister system load port shall be connected to the fuel tank vent port of the otherwise sealed fuel tank and soaked for a minimum of 12 hours and a maximum of 36 hours at 65 ± 3°F. The canister system purge (engine) port shall be plugged for the remainder of the bleed emissions test.

12.7. Two-Day Diurnal Temperature Cycling. The fuel tank and canister system shall be cycled between 65°F and 105°F according to the two-day diurnal test in section III.D.10.15.

12.7.1. If using Method A (section III.D.12.8.1.) for the hydrocarbon capture method, temperature cycling and hydrocarbon capture shall occur in an environmental chamber. This chamber shall provide air circulation over the fuel tank as described in section III.A.1.1. Also, chamber temperature shall be measured and controlled as described in section III.A.1.1.1, except the wall thermocouples shall be approximately level with the fuel tank, and the fuel tank thermocouple shall measure the air within 10 inches of the exposed portion of the fuel tank. In addition, the chamber shall be insulated to enable the test temperature profile to be achieved with a heating/cooling system which has surface temperatures in the enclosure no less than 25.0°F below the minimum diurnal temperature specification.

12.7.2. If using Method B (section III.D.12.8.2.) for the hydrocarbon capture method, temperature cycling and hydrocarbon capture shall occur in a diurnal evaporative emission measurement enclosure. An enclosure as described in section III.A.1. shall be used, except that thermocouples shall be arranged per section III.D.12.7.1. and the enclosure shall be of sufficient size to contain the fuel tank and canister system.

12.7.3. If using Method C (section III.D.12.8.3.) for the hydrocarbon capture method, temperature cycling and hydrocarbon capture shall occur either in an environmental chamber as described in section III.D.12.7.1 or in a diurnal evaporative emission measurement enclosure as described in section III.D.12.7.2.

12.8. Hydrocarbon Capture Methods. Either Method A, Method B, or Method C shall be used to capture the hydrocarbon emissions from the carbon canister.

12.8.1. Method A. A Tedlar or equivalent bag of sufficient size to be able to capture the volume of air coming from the canister system during the diurnal shall be attached to the air tube of the test canister system. The bag shall be such a size as to not cause back pressure in the canister and impede vapor flow from the canister. This bag shall stay attached until the fuel reaches peak temperature (approximately 12 hours into the diurnal cycle). Each sample bag shall be analyzed as described in section III.D.12.9.1. within 20 minutes of the sample collection. During the cooling back to the minimum temperature, the air tube can be left open or connected to a new Tedlar or equivalent bag with a sufficient amount of zero air in it to allow air to pass back and forth through the canister system and bag, while not allowing pressure/vacuum to occur in the canister. If air tube is left open, a new Tedlar or equivalent bag shall be attached to the air tube at minimum fuel temperature (approximately 24 hours into the diurnal cycle). This step shall be repeated for each 24-hour diurnal period.

12.8.2. Method B. The outlet of the test canister system shall be open to the diurnal evaporative emission measurement enclosure, as described in section III.A.1., to measure hydrocarbon~~s~~ emissions. The pressure inside the enclosure shall not impede or assist flow through the canister system. This enclosure shall to be sized appropriately to achieve a minimum resolution of ± 5 mg at a total hydrocarbon concentration of 10 mg/total enclosure volume.

12.8.3. Method C. The canister emissions shall be continuously analyzed using a FID and integrated with continuous flow measurements to provide the mass of hydrocarbon emissions from the canister for each 24-hour diurnal period. Method C may be used subject to advance approval by the Executive Officer. Approval would require proof that all canister emissions are routed to the FID and that pressure inside the enclosure does not impede or assist flow through the canister system.

12.9. Hydrocarbon Mass Determination. There is no requirement to separately measure for alcohol emissions in this bleed emission test.

12.9.1. If using Method A (section III.D.12.8.1.) for the hydrocarbon capture method, the FID hydrocarbon analyzer shall be zeroed and spanned coinciding with each sample per 40 CFR §86.140. The removed bags shall be filled to a constant volume with Zero Air and evacuated into a FID through a sample pump to determine the concentration of hydrocarbons. The hydrocarbon mass for each 24-hour period shall then be calculated using the following equation:

$$M_{HC} = 16.88 \times \mathrm{V}_{\mathrm{BAG}} \times \mathrm{C}_{\mathrm{HC}} \times 10^{-6}$$

where:

M_{HC} is the diurnal hydrocarbon mass emissions (grams)

16.88 is the density of pure vapor at @ 68^{o} F (grams/ft^3)

$\mathrm{V}_{\mathrm{BAG}}$ is the total volume of sample gas in the sample bag (std. ft^3)

C_{HC} is the sample bag hydrocarbon concentration (ppm C)

12.9.2. If using Method B (section III.D.12.8.2.) for the hydrocarbon capture method, the FID hydrocarbon analyzer shall be zeroed and spanned coinciding with each sample per 40 CFR §86.140. The hydrocarbon emissions will be monitored by taking a minimum of 5 measurements, at hours 0, 12, 24, 36, and 48 of the two-day diurnal cycles. The mass of hydrocarbon emissions for each 24-hour period shall be determined and is equal to the maximum hydrocarbon mass value for each 24-hour period. This maximum hydrocarbon mass value is obtained by calculating and comparing the hydrocarbon mass values at each of the measurement time-points for each 24-hour period. The hydrocarbon mass value is defined as:

$$M_{HC} = [2.97 \times 10^{-4} \times \{(P_x \times V_x \times C_{HC_x}) / T_x - (P_i \times V_i \times C_{HC_i}) / T_i\}]$$

$$+ M_{HC_{OUT}} - M_{HC_{IN}}$$

where, for fixed volume enclosures:

M_{HC} is the diurnal hydrocarbon mass emissions (grams)

P_i is the initial barometric pressure (inches Hg)

P_x is the barometric pressure during the diurnal at time of hydrocarbon measurement (inches Hg)

V_i is the initial enclosure volume (ft^3)

V_x is the enclosure volume during the diurnal at time of hydrocarbon measurement (ft^3)

C_{HC_i} is the initial enclosure hydrocarbon concentration (ppm C)

C_{HC_x} is the enclosure hydrocarbon concentration during the diurnal at time of hydrocarbon measurement (ppm C)

T_i is the initial enclosure temperature (°R)

T_x is the enclosure temperature during the diurnal at time of hydrocarbon measurement (°R)

$M_{HC_{OUT}}$ is the mass of hydrocarbon exiting enclosure from cycle start to time of hydrocarbon measurement (grams)

$M_{HC_{IN}}$ is the mass of hydrocarbon entering enclosure from cycle start to time of hydrocarbon measurement (grams)

The measurements at the end of the first 24 hour period become the initial conditions of the next 24 hour period. For variable volume enclosures, calculate the hydrocarbon mass (M_{HC}) according to the equation used above except that $M_{HC, out}$ and $M_{HC, in}$ shall equal zero.

12.10. The final reported result shall be the highest 24-hour diurnal hydrocarbon mass emissions value out of the two 24-hour cycles.

E. Liquefied Petroleum Gas-fueled Vehicles

1. 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.

2. Calculation of LPG Emissions. The evaporative emissions for LPG systems shall be calculated in accordance with 40 CFR §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.

F. Fuel Specifications

1. For 2001 through 2014 model motor vehicles (except for 2014 model year vehicles certifying to the evaporative emission standards set forth in section I.E.1.(e)), the ~~Evaporative~~ evaporative emission test fuel shall be the fuel specified for exhaust emission testing ~~as specified~~ in part II. section A.100.3. of the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and ~~for 2001 and Subsequent~~ 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," except as provided in section III.G. of these test procedures.

2. All 2014 through 2019 model gasoline-fueled motor vehicles certifying to evaporative emission standards set forth in the section I.E.1.(e) (except those vehicles produced by a small volume manufacturer, as noted below, and those vehicles belonging to carry-over families allowed per section I.E.1.(e)(iii)) shall be tested for evaporative emissions on the gasoline set forth in part II., section A.100.3.1.2. of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles." All 2014 through 2019 gasoline-fueled model motor vehicles not certifying to evaporative emission standards set forth in the section I.E.1.(e) that are not tested using this gasoline shall conduct evaporative emission testing with the test fuel specified in section III.F.1.

All 2020 and subsequent model gasoline-fueled motor vehicles (except those vehicles produced by a small volume manufacturer) shall be tested for evaporative emissions on the gasoline set forth in part II., section A.100.3.1.2. of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles"; evaporative emission testing by the Executive Officer will be performed using said test fuel.

A small volume manufacturer shall certify all 2022 and subsequent model motor vehicles to the evaporative emission requirements using the gasoline set forth in part II., section A.100.3.1.2. of the "California 2015 and Subsequent Model Criteria Pollutant

Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles"; evaporative emission testing by the Executive Officer will be performed using said test fuel. All 2015 to 2021 model motor vehicles produced by a small volume manufacturer that are not tested using this gasoline shall conduct evaporative emission testing with the test fuel in section III.F.1.

3. For 2015 and subsequent model motor vehicles other than gasoline-fueled vehicles (except for flexible fuel vehicles certifying to evaporative emission standards set forth in the section I.E.1.(d), as noted below), the evaporative emission test fuel shall be the applicable fuel specified for evaporative emission testing in part II. section A.100.3.3 – A.100.3.6 of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles."

For 2015 and subsequent model flexible fuel vehicles certifying to the evaporative emission standards set forth in the section I.E.1.(d), the evaporative emission test fuel shall be either the fuel specified for exhaust emission testing in part II. section A.100.3. of the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," or the applicable fuel specified for evaporative emission testing in part II. section A.100.3.4 of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles."

G. Alternative Test Procedures

1. For vehicles that are required to be certified using the test fuel in section III.F.1., ~~If~~ a manufacturer may alternatively demonstrate compliance with the applicable evaporative emission standards using ~~uses for evaporative and exhaust emission testing~~ a gasoline test fuel meeting the specifications set forth in 40 CFR §86.113-94(a)(1)~~,~~ if the manufacturer also ~~may~~ uses the evaporative emission test procedures set forth in 40 CFR §§86.107-96 through 86.143-96 in place of the test procedures set forth in these test procedures.

2. Manufacturers may use an alternative set of test procedures to demonstrate compliance with the standards set forth in section I.E. of these test procedures with advance Executive Officer approval if the alternative procedure is demonstrated to yield test results equivalent to, or more stringent than, those resulting from the use of the test procedures set forth in section III.D. of these test procedures.

3. If the manufacturer uses for certification a test procedure other than section III.D., the Executive Officer has the option to conduct confirmatory and in-use compliance testing with the test procedures set forth in section III.D. of this California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles.

H. Use of Comparable Federal Requirements for Carry-across Specifications and Road Profile Correction Factors

1. Upon prior written approval of the Executive Officer, a manufacturer may use the comparable federal requirements in Title 40, CFR, Part 86 in lieu of the carry-across specifications of section II.A. of these test procedures and the running loss road profile correction factors of section III.C. The Executive Officer shall approve a manufacturer's request if the manufacturer demonstrates to the Executive Officer that the alternative methodology will not adversely affect in-use evaporative emissions.

PART IV. EVAPORATIVE EMISSION TEST PROCEDURES FOR MOTORCYCLES

1. For the purposes of these procedures, the following references in 40 CFR, Part 86, Subpart B to light-duty vehicle evaporative testing shall also apply to motorcycles: 40 CFR §§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.

2. Preconditioning shall be performed in accordance with 40 CFR §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 (40 CFR §86.132-82(a)(3) and §86.132-90(a)(3)) may be allowed by the Executive Officer under unusual circumstances.

3. 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 subparagraph (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 subparagraph (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.

4. Test Procedure

(i) The motorcycle exhaust emission test sequence is described in 40 CFR §86.530-78 through §86.540-78. The SHED test shall be accomplished by performing the diurnal portion of the SHED test (40 CFR §86.133-78 except subparagraphs a(1), k, and p; §86.133-90 except subparagraphs 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 4- CFR §86.130-78. The specified time limits shall be followed with the exception of soak times which are specified in 40 CFR §86.532-78 for motorcycles.

Running loss tests, when necessary, will be performed in accordance with 40 CFR §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) A manufacturer of Class III motorcycles with annual California sales of less than 500 units using an assigned evaporative emission control system DF pursuant to section II.B.2.1.1.(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 DF determined during previous federal or California certification testing shall not exceed the standards set forth in section 1958, title 13, CCR.

(iii) The fuel and vapor temperatures for the diurnal portion of the evaporative emission test shall conform to the following functions within ± 1.7°C with the tank filled to 50 percent ±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 ± 2 minutes, giving a fuel and vapor temperature rise of 20°C. The final fuel temperature shall be 35.5°C ± 0.5 °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 40 CFR §§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 a minimum throttle from the dynamometer to the SHED.

(vi) Calculations shall be performed in accordance with 40 CFR §86.143-78 or 86.143-90, except the standard volume for a motorcycle shall be $5ft^3$ instead of 50 ft^3.

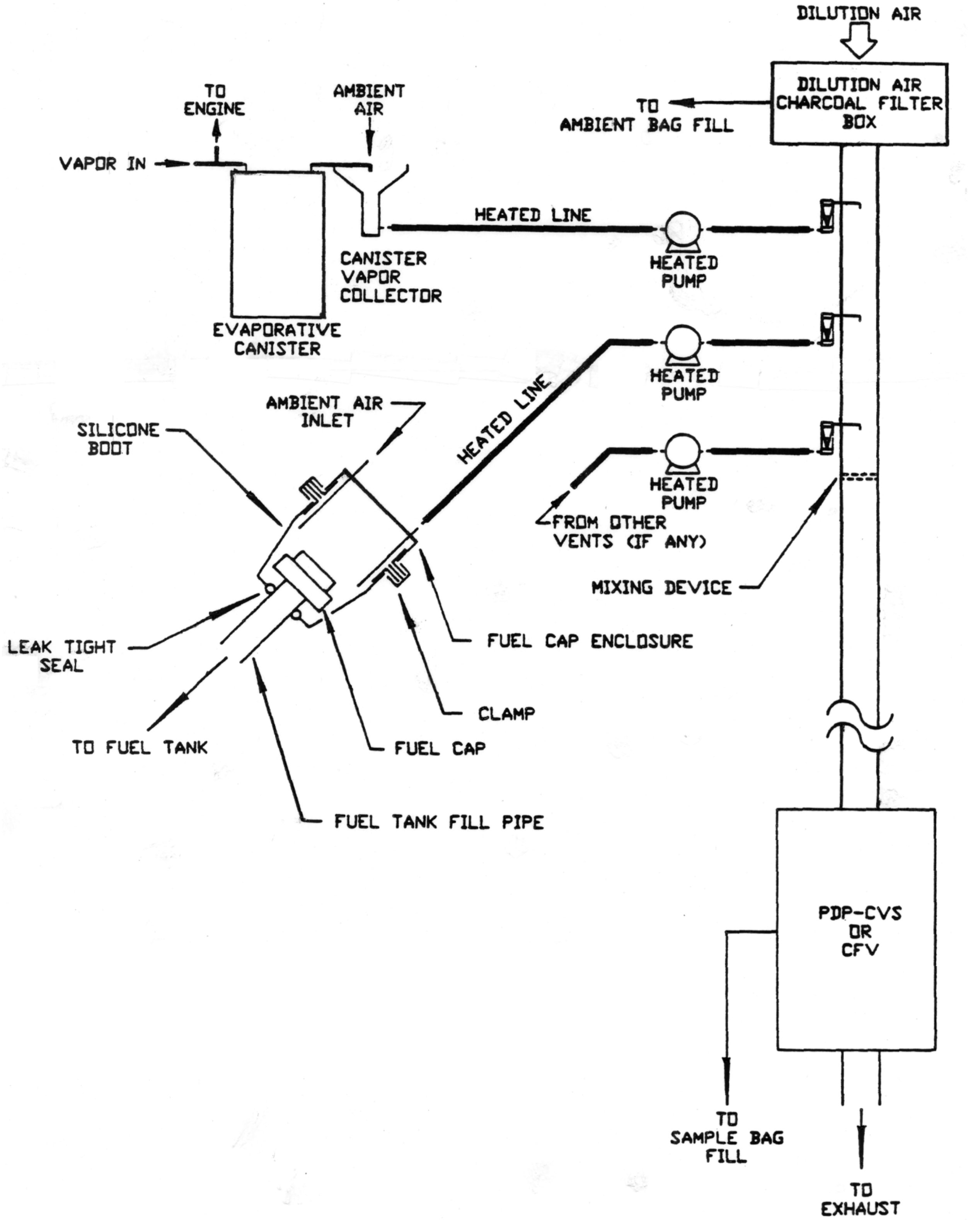


Figure 1: Running Loss Vapor Vent Collection System

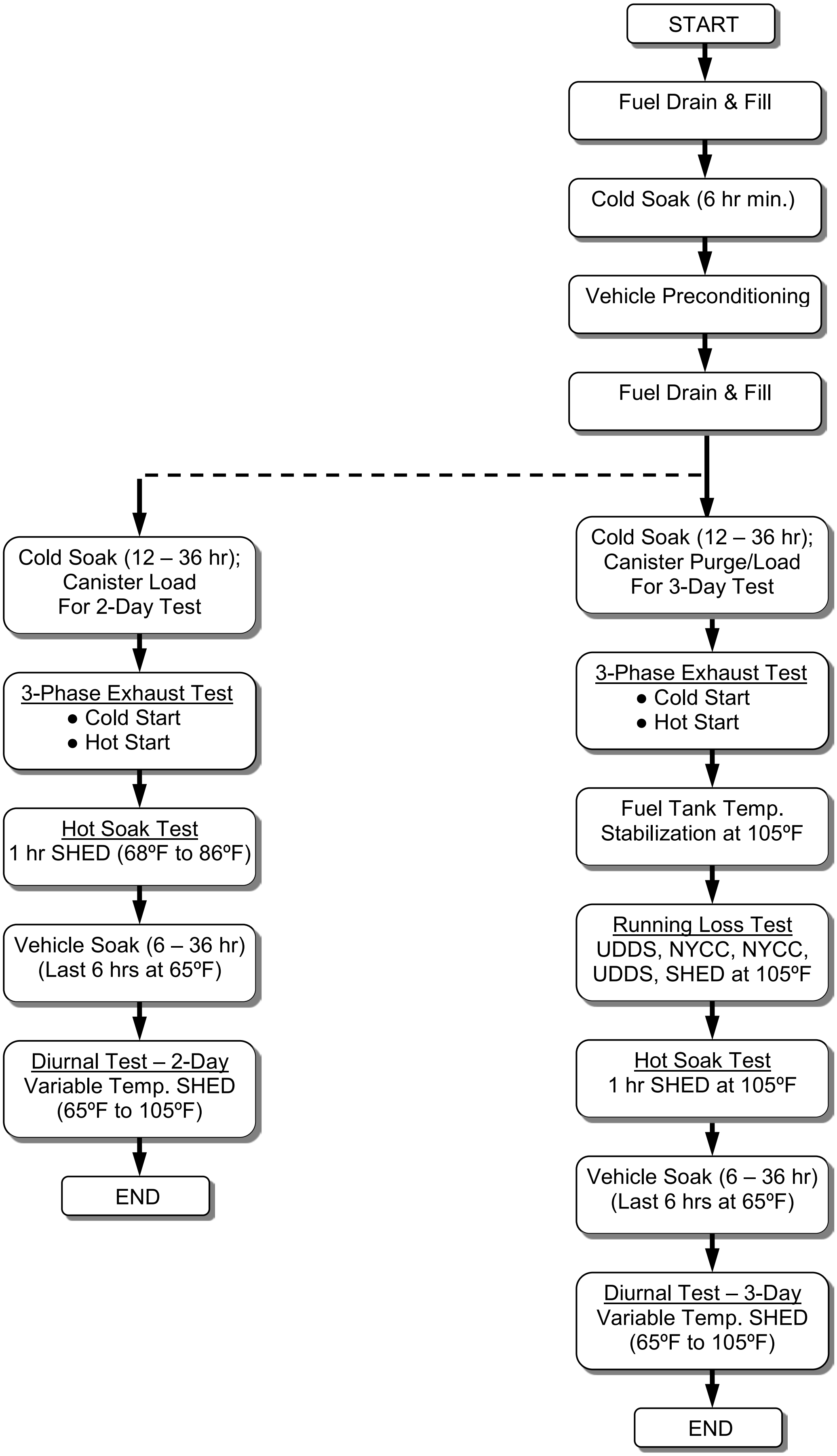


Figure 2: Test Procedure for 2001 and Subsequent Model Motor Vehicles

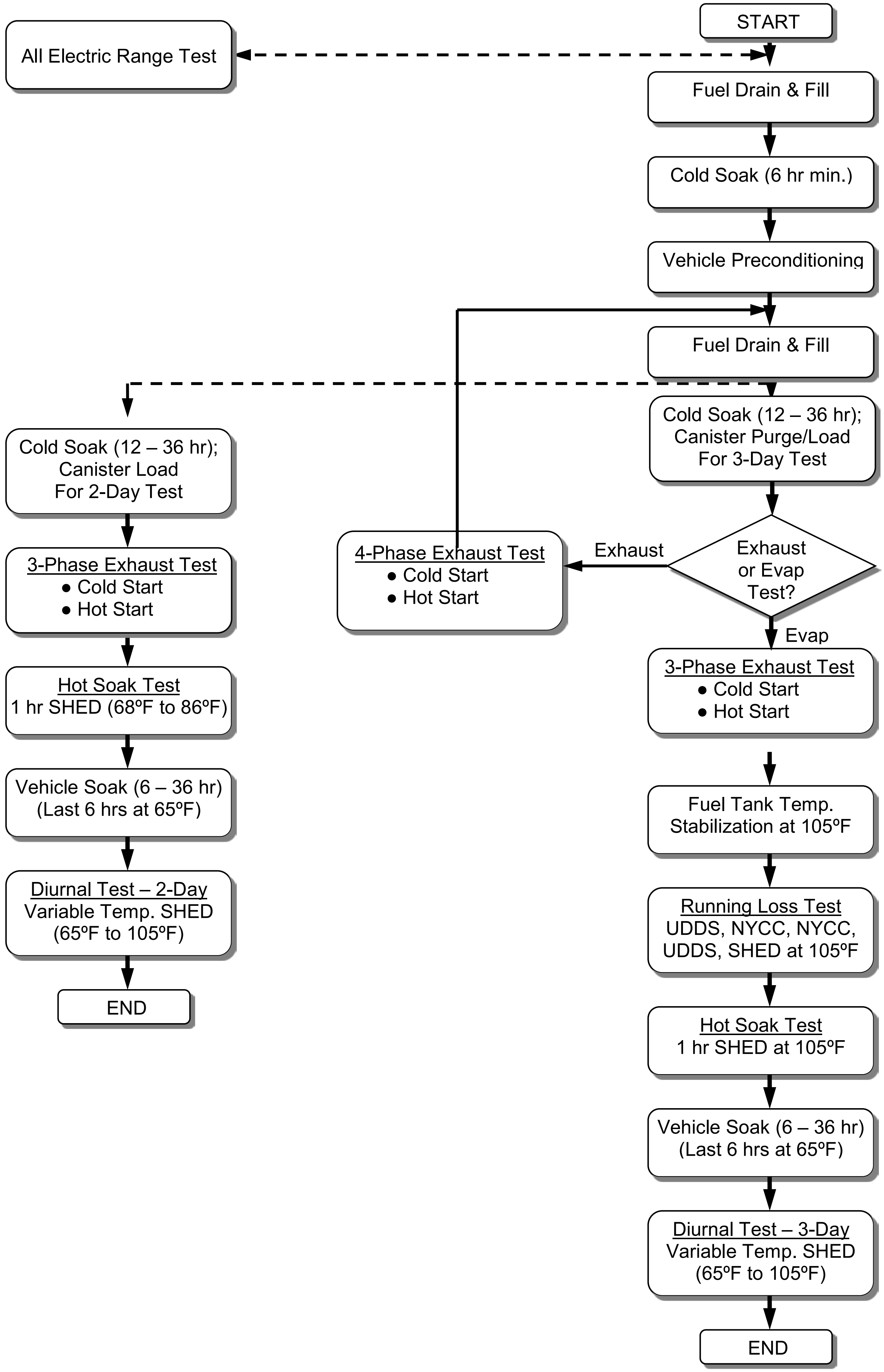


Figure 3A: Test Procedure for 2001 and Subsequent Model Hybrid Electric Vehicles

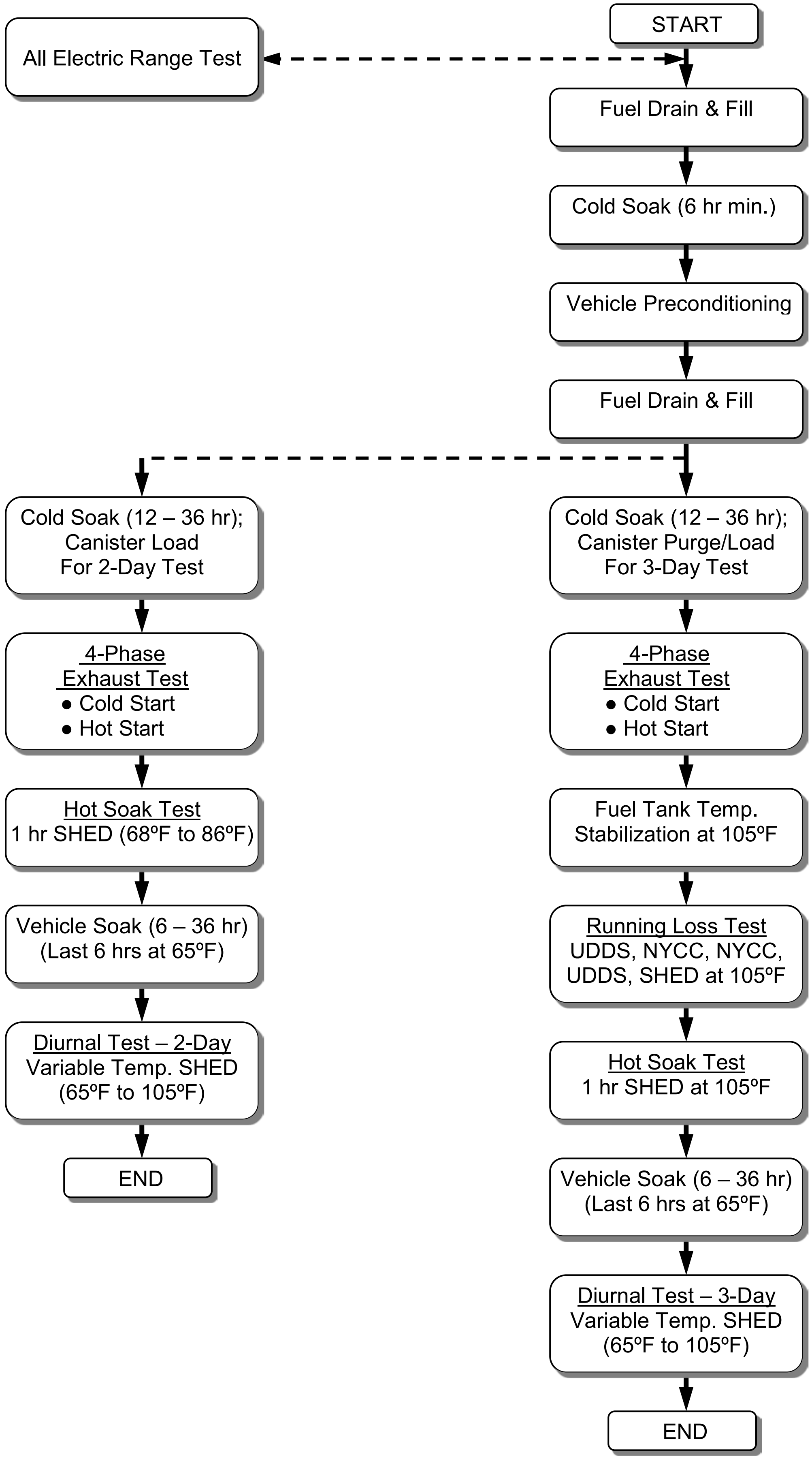


Figure 3B: Test Procedure for 2001 and Subsequent Model Hybrid Electric Vehicles

State of California
AIR RESOURCES BOARD

CALIFORNIA REFUELING EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

Adopted: August 5, 1999
Amended: September 5, 2003
Amended: June 22, 2006
Amended: October 17, 2007
Amended: December 2, 2009
Amended: September 27, 2010
Amended: March 22, 2012

Note: Proposed amendments to this document are shown in underline to indicate additions and ~~strikeouts~~ to indicate deletions compared to the test procedures as last amended September 27, 2010.

NOTE: This document is incorporated by reference in section 1978(b), title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certification of motor vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. “California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001 and Subsequent~~ and 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles” (incorporated by reference in section 1961(d), title 13, CCR).

2. “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles” (incorporated by reference in section 1961.2 (d), title 13, CCR).

3~~2~~. “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes” (incorporated by reference in section 1962.1(h), title 13, CCR).

4~~3~~. “California Evaporative Emission Standards and Test Procedures ~~For~~for 2001 and Subsequent Model Motor Vehicles” (incorporated by reference in section 1976(c), title 13, CCR).

5~~4~~. “Malfunction and Diagnostic System Requirements – 1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines” (incorporated by reference in section 1968.1, title 13, CCR).

6~~5~~. “Malfunction and Diagnostic System Requirements – 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines” (incorporated by reference in section 1968.2, title 13, CCR).

7~~6~~. “Specifications for Fill Pipes and Openings of Motor Vehicle Fuel Tanks” (incorporated by reference in section 2235, title 13, CCR).

CALIFORNIA REFUELING EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

The provisions of Title 40, Code of Federal Regulations (CFR), Part 86, Subparts B (as adopted or amended by the U.S. Environmental Protection Agency (U.S. EPA) on the date listed) and S (as adopted on May 4, 1999, or as last amended on such other date set forth next to the 40 CFR Part 86 section title listed below) to the extent they pertain to the testing and compliance of vehicle refueling emissions for passenger cars, light-duty trucks and medium-duty vehicles, are hereby adopted as the “California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles,” with the following exceptions and additions.

Subpart S Requirements

I. General Certification Requirements for Refueling Emissions

A. Applicability

1. These refueling standards and test procedures are applicable to all new 2001 and subsequent model gasoline-fueled, alcohol-fueled, diesel-fueled, liquefied petroleum gas-fueled, natural gas-fueled, and hybrid electric passenger cars (including 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles), light-duty trucks and medium-duty vehicles with a gross vehicle weight rating of less than 8,501 lbs., and to all new complete 2015 and subsequent model gasoline-fueled, alcohol-fueled, diesel-fueled, liquefied petroleum gas-fueled, natural gas-fueled, and hybrid electric (including 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles) medium-duty vehicles with a gross vehicle weight rating of 8,501 through 14,000 lbs. A manufacturer may elect to certify 2009 through 2011 model-year off-vehicle charge capable hybrid electric vehicles using these provisions. In cases where a provision applies only to a certain vehicle group based on its model year, vehicle class, motor fuel, engine type, or other distinguishing characteristics, the limited applicability is cited in the appropriate section or paragraph.

2. For general certification purposes, the requirements set forth in the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001 and Subsequent~~ and 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;” the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;” the “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes;” and the “California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles,” shall apply, except as otherwise noted in these test procedures.

3. Reference to vehicle sales throughout the United States shall mean vehicle sales in California, except when certifying to the refueling standards, in which case, vehicle sales shall mean throughout the United States.

4. A small volume manufacturer is defined as any vehicle manufacturer with California actual sales less than or equal to 4,500 new vehicles per model year based on the average number of vehicles sold by the manufacturer in the previous three consecutive years.

5. Regulations concerning U.S. EPA hearings, inspections, specific language on the Certificate of Conformity, alternative useful life, and selective enforcement audit shall not be applicable to these procedures, except where specifically noted.

6. In those instances where testing conditions or parameters are not practical or feasible for vehicles certified to the refueling standards, the manufacturer shall provide a test plan that provides equal or greater confidence in comparison to these test refueling procedures. The test plan must be approved in advance by the Executive Officer.

7. The term “[no change]” means that these test procedures do not modify the applicable federal requirement.

8. The specifications for the fuel used in testing are set forth in 40 CFR §86.113-94 [February 18, 2000]. Alternatively, California certification fuel specified in Part II, A.100.3.1.2 (test fuel with 10 percent ethanol) of the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles” may be used for 2015 and subsequent model vehicles ~~is not allowed~~ for certification or in-use testing as long as California temperatures are applied as described in Subpart B, section II.B.5.2.

B. Definitions, Acronyms, Terminology

1. These test procedures incorporate by reference the definitions set forth in the Code of Federal Regulations; and, the definitions as set forth in the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001 and Subsequent~~ and 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,” the “California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,” in the “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty

Truck, and Medium-Duty Vehicle Classes," and in the "California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles."

C. Useful Life

1. Delete §86.1805-01; §86.1805-04 and replace with:

"Useful life" shall have the same meaning as provided in title 13, CCR, §2112.

D. On-Board Diagnostics

1. Delete §86.1806 and replace with:

The applicable sections of the "Malfunction and Diagnostic System Requirements – 1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines," as set forth in title 13, CCR, section 1968.1; and, the "Malfunction and Diagnostic System Requirements – 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines," as set forth in title 13, CCR, section 1968.2, are hereby incorporated by reference into this test procedure. For purposes of this test procedure, all references to evaporative system monitoring, malfunction criteria, and MIL illumination and fault code storage shall also apply to refueling systems.

E. General Standards, increase in emissions; unsafe conditions; waivers

1. Amend §86.1810-01 [July 12, 2001] as follows:

1.1. (a) through (j). [See the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001 and Subsequent~~ and 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;" the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;" or the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."]

1.2. (k) [No change.]

1.3. (l) Substitute certification to the applicable refueling emission standards set forth in section I.I.F. of these test procedures instead of with the standards set forth in §86.1811-04(e); §86.1812-01(e); §86.1813-01(e); and, §86.1816-05(e).

1.4. (m) Substitute compliance with applicable refueling emission standards set forth in section I.I.F. of these test procedures instead of with the standards set forth in §86.1811-04(e); §86.1812-01(e); §86.1813-01(e); and, §86.1816-05(e).

1.5. (n) [No change.]

1.6. (o) and (p) [See the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001 and Subsequent~~ and 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," and the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles."]

1.7. A manufacturer must demonstrate compliance with the fuel spillage test requirements in the "Specifications for Fill Pipes and Openings of Motor Vehicle Fuel Tanks," which is hereby incorporated by reference herein.

2. In addition to the provisions set forth in these test procedures, the ARB reserves the authority to require testing to enforce compliance and to prevent noncompliance with the refueling emission standard.

3. Vehicles certified to the refueling emission standards set forth in Section I.F.2.2. below, shall not be counted in the phase-in sales percentage compliance determinations.

F. Emission Standards

1. Delete 40 CFR §§86.1811 through 86.1816 (all years).

2. The maximum refueling emissions for 2001 and subsequent model passenger cars, light-duty trucks and medium-duty vehicles with a gross vehicle weight rating less than 8,501 lbs., and 2015 and subsequent model complete medium-duty vehicles with a gross vehicle weight rating 8,501 through 14,000 lbs. for the full useful life are:

2.1. For gasoline-fueled, alcohol-fueled, diesel-fueled, fuel-flexible, and hybrid electric vehicles: 0.20 grams hydrocarbons per gallon of fuel dispensed. [For purposes of these test procedures, hydrocarbons shall mean organic material hydrocarbon equivalent for alcohol-fueled vehicles.] For liquefied petroleum gas-fueled vehicles: 0.15 grams hydrocarbons per gallon of fuel dispensed.

2.2. Vehicles powered by diesel fuel are not required to conduct testing to demonstrate compliance with the refueling emission standards set forth above, provided that all of the following provisions are met:

(A) The manufacturer can attest to the following evaluation: "Due to the low vapor pressure of diesel fuel and the vehicle tank temperatures, hydrocarbon vapor concentrations are low and the vehicle meets the 0.20 grams/gallon refueling emission standard without a control system."

(B) The certification requirement described in section I.F.2.2.(A) is provided in writing and applies for the full useful life of the vehicle.

2.3. Incomplete vehicles of 14,000 pounds gross vehicle weight rating or less that are certified as incomplete vehicles for the purposes of evaporative emissions testing as set forth in the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles,” are not required to demonstrate compliance with the refueling emission standards set forth in 2.1.

G. Durability Demonstration procedures for refueling emissions.

~~1.~~ §86.1825-01 Durability Demonstration procedures for refueling emissions [October 6, 2000] [No change.] ~~Amend as follows: Add the following sentences to the first paragraph:~~

~~2.~~

Subpart B - Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles and New Light-Duty Trucks; Test Procedures

40 CFR §§ 86.101 through 86.145 and Appendix I (UDDS Schedule) of this Subpart B, as incorporated by reference and amended in the "California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001 and Subsequent~~ and 2009 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;" the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;" the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes;" and~~,~~ the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," are hereby incorporated by reference herein.

II. Refueling Emissions Test Procedures

A. Fuel Spitback Emissions

1. §86.146-96 Fuel dispensing spitback procedure [August 23, 1995] [No change.]

B. Refueling Emissions

1. §86.150-98 Refueling test procedure; overview [September 21, 1994]

1.1. Revise subparagraph (a), first sentence, as follows: The refueling emissions test procedure described in this and subsequent sections is used to determine the conformity of vehicles with the refueling emissions standards set forth in section I.F. of these test procedures for all of the vehicle types specified in section I.A.

2. §86.151-98 General requirements; refueling test [April 6, 1994]

2.1. Revise subparagraph (a), first sentence, as follows: The refueling emissions procedure, shown in Figure B98-12, starts with the stabilizing of the vehicle and the loading of the refueling emissions canister(s) and continues with the vehicle drive for purging of the canister, followed by the refueling emissions measurement.

3. §86.152-98 Vehicle preparation; refueling test [December 8, 2005]

3.1. Amend subparagraph (a) to include: For 2012 and subsequent off-vehicle charge capable hybrid electric vehicles equipped with nonintegrated refueling canister-only systems, the refueling canister shall not be removed from the vehicle.

3.2. Subparagraph (b) [No change.]

3.3. Subparagraph (c) [No change.]

4. §86.153-98 Vehicle and canister preconditioning; refueling test [December 8, 2005]

4.1. Amend subparagraph (a) to include: The vehicle preconditioning drive for 2012 and later model-year off-vehicle charge capable hybrid electric vehicles shall include at least one complete UDDS performed entirely under a charge-sustaining mode of operation, The battery state-of-charge net change tolerance provisions specified in section F.10., of the “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes” shall not apply.

4.1.1. Add subparagraph (a)(1): 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles equipped with non-integrated refueling canister-only systems. Such vehicles and vapor storage canisters shall be preconditioned in accordance with the preconditioning procedures for the two-diurnal evaporative emissions test specified in 40 CFR 86.132-96(a) through (j), with the following exceptions.

4.1.2. Prior to conducting the applicable test sequence, the nonintegrated refueling canister shall have already achieved a stabilized state, such as is accomplished using the stabilization method described in section III.D.3.3.4, of the “California Evaporative Emission Standards and Test Procedures ~~For~~for 2001 and Subsequent Model Motor Vehicles.” Within 60 minutes of completing the vehicle preconditioning drive, a second fuel drain and fill step shall be performed, The fuel tank shall be filled to the prescribed tank fuel volume of 95 percent of the manufacturer’s nominal fuel tank capacity, determined to the nearest one-tenth of a U.S. gallon (0.38 liter) with the specified fuel.

4.1.3. After the second fuel drain and tank refill step is completed, the initial testing state of the canister shall be established by purging while performing vehicle driving, using either the chassis dynamometer procedure or the test track procedure, as described in subparagraphs (d)(1) and (d)(2) of 40 CFR 86.153-98. For vehicles equipped with dual fuel tanks that can be individually selected or isolated, the required volume of fuel shall be driven out of one tank, the second tank shall be selected as the fuel source, and the required volume of fuel shall be driven out of the second tank. A manufacturer shall plan for interruptions in the vehicle drivedowns due to factors such as work schedules, driver relief, and test equipment considerations, using good engineering practice.

4.1.3.1. The vehicle drivedown will consume 85%, or less as determined by the manufacturer, of the manufacturers’ nominal fuel tank capacity,

4.1.3.2. In order to reduce the amount of time required to consume 85 percent of the fuel tank capacity, as required by either subparagraph (d)(1) or (d)(2) in 40 CFR 86.153-98, as applicable, a manufacturer may elect to set the battery state-of- charge at a level that maximizes the amount of engine operation, prior to conducting either the chassis dynamometer or the test track driving procedure, as applicable.

4.1.3.3. With advance Executive Officer approval, a manufacturer may optionally elect to bench purge the canister either during the initial soak period, specified in 40 CFR §86.132-96(c)(1), or after the vehicle preconditioning drive step specified in section II.B.4.1., in lieu of performing the second fuel drain/fill and vehicle drivedown steps specified in sections II.B.4.1.2. and II.B.4.1.3. Approval by the Executive Officer shall be based upon assurance that the canister will be bench purged by an equivalent volume of air corresponding to a consumption of 85%, or less as determined by the manufacturer, of the manufacturers' nominal fuel tank capacity, and that the characteristics of the purge flow through the canister, such as flow rates, shall be representative of flow that occurs under the specified vehicle drivedown UDDS cycles. Within 60 minutes of completing the bench purging, the fuel drain and fill step specified in section II.B.4.1.4., shall be performed.

4.1.4. Within 60 minutes of completing the vehicle drivedown, a third fuel drain and fill step shall be performed in which the fuel tank shall be filled to a prescribed tank fuel volume of 10 percent of the manufacturer's nominal fuel tank capacity, determined to the nearest one-tenth of a U.S. gallon (0.38 liter) with the specified fuel. The manufacturer may isolate the canister using any method that does not compromise the integrity of the system. A description of the canister isolation method shall be included in the manufacturer's certification application. When the refueling canister is isolated from its system, fuel vapors shall be allowed to be vented from the fuel tank, as appropriate, during this fill step.

4.1.5. In lieu of performing the third fuel drain and fill step specified in section II.B.4.1.4., the required fuel tank volume of 10 percent may be established by using a measured drain of the fuel tank, within 60 minutes of completing the vehicle drivedown.

4.1.6. Fuel-tank-refill canister loading. Good engineering practice and safety considerations, such as, but not limited to, adequate ventilation and appropriate electrical groundings, shall apply.

4.1.7. The test vehicle shall be allowed to soak for a minimum of 6 hours and a maximum of 24 hours, at 80ºF ±3ºF (27ºC ±1.7ºC), prior to starting the fuel-tank-fill canister-loading step.

4.1.7.1. Off-vehicle charging to increase the battery state-of-charge to the highest level allowed by the manufacturer, prior to either the chassis dynamometer or the test track driving procedures specified in section II.B.4.4., shall occur during the soak period specified in section II.B.4.1.7.

4.1.8. The refueling canister shall not be isolated from its system during the fuel-tank-refill canister-loading step.

4.1.9. The test vehicle's fuel fill pipe cap shall be removed

4.1.10. The dispensed fuel temperature recording system shall be started.

4.1.11. The fuel nozzle shall be inserted into the fill pipe neck of the test vehicle, to its maximum penetration, and the tank refueling operation shall start. The plane of the nozzle's handle shall be approximately perpendicular to the floor. The fuel shall be dispensed at a temperature of 67ºF ±3.0ºF (19.4ºC ±1.7ºC), and at a dispensing rate of 9.8 gal/min ±0.3 gal/min (37.1 liter/min ±1.1 liter/min). If using California certification fuel, the fuel shall be dispensed at a temperature of 79±1.5 ºF (26.1±0.8 ºC) and at a dispensing rate of 9.8±0.3 gal/min (37.1±1.1 liter/min). When this refueling operation is conducted by the Executive Officer, a dispensing rate that is not less than 4.0 gal/min (15.1 liter/min) may be used.

4.1.12. The fuel flow shall continue until the refueling nozzle automatic shut-off is activated. The amount of fuel dispensed must be at least 85 percent of the nominal fuel tank volume, determined to the nearest one-tenth of a U.S. gallon (0.38 liter). If an automatic nozzle shut-off occurs prior to this point, the dispensing shall be reactivated within 15 seconds, and fuel dispensing continued as needed. A minimum of 3 seconds shall elapse between any automatic nozzle shutoff and the subsequent resumption of fuel dispensing.

4.1.13. As soon as possible after completing the refilling step, remove the fuel nozzle from the fill pipe neck, and replace the test vehicle's fuel fill pipe cap.

4.1.14. The refueling canister shall be isolated from its system as soon as possible after completing the refilling step.

4.1.15. For vehicles equipped with more than one fuel tank, the steps described in this section shall be performed for each fuel tank.

4.1.16. When the fuel-tank-refill canister-loading operation is completed, the test vehicle shall proceed to the non-integrated system canister purging procedures specified in section II.B.4.4. The canister shall not be isolated from its system during these canister-purging procedures.

4.1.17. The Executive Officer may approve minor modifications to this canister~~-~~-loading method when such modifications are supported by good engineering judgment, and do not reduce the stringency of the method.

4.2. Subparagraph (b) [No change.]

4.3. Subparagraph (c), amend subparagraph (c)(1) to include: A 2012 and later model-year off-vehicle charge capable hybrid electric vehicle that is tested either for exhaust emissions only or for refueling emissions, shall be processed in accordance with the provisions of section F, of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," with the following exceptions.

4.3.1. For such vehicles, the battery state-of-charge setting prior to the cold start exhaust test shall be at the highest level allowed by the manufacturer. This requirement shall be applicable regardless of a vehicle's ability to allow, or not to allow, manual activation of the auxiliary power unit. If off-vehicle charging is required to increase the battery state-of-charge for the proper setting, then this charging shall occur during the canister preconditioning process.

4.3.2. The battery state-of-charge net change tolerance provisions specified in section F.10., of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, ~~In The~~in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" shall not apply.

4.4. Amend subparagraph (d) as follows: Canister purging: nonintegrated systems. For all vehicles, except for 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles equipped with non-integrated refueling canister-only systems, within one hour of completion of canister loading to breakthrough, the fuel tank(s) shall be further filled to 95 percent of nominal tank capacity determined to the nearest one-tenth of a U.S. gallon (0.38 liter) with the fuel specified in Sec. 86.113-94. During this fueling operation, the refueling emissions canister(s) shall be disconnected, unless the manufacturer specifies that the canister(s) should not be disconnected. Following completion of refueling, the refueling emissions canister(s) shall be reconnected, if the canister was disconnected during refueling. Special care shall be taken during this step to avoid damage to the components and the integrity of the fuel system. For all vehicles, including 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles equipped with non-integrated refueling canister-only systems, vehicle driving to purge the refueling canister(s) shall be performed using either the chassis dynamometer procedure or the test track procedure, as described in subparagraphs (d)(1) and (d)(2) of 40 CFR 86.153-9. The Executive Officer may choose to shorten the vehicle driving for a partial refueling test as described in subparagraph (d)(3) of 40 CFR 86.153-98. For vehicles equipped with dual fuel tanks that can be individually selected or isolated, the required volume of fuel shall be driven out of one tank, the second tank shall be selected as the fuel source, and the required volume of fuel shall be driven out of the second tank. A manufacturer shall plan for interruptions in the vehicle drivedowns due to factors such as work schedules, driver relief, and test equipment considerations, using good engineering practice.

4.4.1. A 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicle shall be processed in accordance with the provisions of section F of the “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes,” with the following exception.

4.4.2. For such vehicles, the battery state-of-charge setting prior to either the chassis dynamometer or the test track driving procedures, as applicable, shall be at the highest level allowed by the manufacturer. This requirement shall be applicable regardless of a vehicle’s ability to allow, or not to allow, manual activation of the auxiliary power unit. If off-vehicle charging is required to increase the battery state-of-charge for the proper setting, then this charging shall occur during the soak period specified in section II.B.4.1.7., for 2012 and subsequent model-year off-vehicle charge capable hybrid electric vehicles equipped with non-integrated refueling canister-only systems, and during the canister preconditioning process for all other hybrid electric vehicles.

4.4.2.1. In order to reduce the amount of time required to consume 85 percent of the fuel tank capacity, as required by either subparagraph (d)(1) or (d)(2) in 40 CFR 86.153-98, as applicable, a manufacturer may elect to set the battery state-of--charge at a level that is less than specified in section II.B.4.4.2., prior to conducting either the chassis dynamometer or the test track driving procedure, as applicable. Such an election shall be allowed by the Executive Officer unless information, such as in-use test results, or other applicable information that may become available, indicates that such an election compromises the stringency of the test procedures.

4.4.3. The battery state-of-charge net change tolerance provisions specified in section F.10., of the “California Exhaust Emission Standards and Test

Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, ~~In~~in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" shall not apply.

4.4.4. The Executive Officer may use any of the following battery state-of-charge levels for purposes of either certification confirmatory or in-use compliance testing of such vehicles,

4.4.5. As specified in section II.B.4.4.2.

4.4.6. If applicable, at the level approved under section II.B.4.4.2.1.

4.4.7. If applicable, at any level in-between the levels indicated by sections II.B.4.4.2. and II.B.4.4.2.1.

4.4.8. In lieu of performing the vehicle drivedown step specified in section II.B.4.4., a manufacturer may, with advance Executive Officer approval, optionally elect to bench purge the canister. Approval by the Executive Officer shall be based upon assurance that the canister will be bench purged by an equivalent volume of air corresponding to a consumption of 85%, or less as determined by the manufacturer, of the manufacturers' nominal fuel tank capacity, and that the characteristics of the purge flow through the canister, such as flow rates, shall be representative of flow that occurs under the specified vehicle drivedown UDDS cycles.

4.4.9. The canister shall be isolated from its system after completing the canister-purging procedures.

4.4.10. When the optional canister bench purge specified in section II.B.4.4.8. is elected, the 10-percent fuel tank volume specified in 40 CFR 86.153-98(e), may be established by using a measured drain of the fuel tank, within 60 minutes of completing the canister bench purge.

4.5. Subparagraph (e) [No change.]

5. §86.154-98 Measurement procedure; refueling test [August 23, 1995] ~~[No change].~~

5.1. Subparagraphs (a) through (d) [No change.]

5.2. Amend subparagraph (e) (6) to include: If using California certification fuel, the fuel shall be dispensed at a temperature of 79±1.5 °F (26.1±0.8 °C) and at a dispensing rate of 9.8±0.3 gal/min (37.1±1.1 liter/min).

6. §86.155-98 Records required; refueling test [April 6, 1994] [No change].

7. §86.156-98 Calculations [April 6, 1994] [No change.]

State of California
AIR RESOURCES BOARD

SPECIFICATIONS FOR FILL PIPES AND OPENINGS OF 1977 THROUGH 2014 MODEL MOTOR VEHICLE FUEL TANKS

Adopted:	March 19, 1976
Amended:	August 5, 1976
Amended:	June 8, 1977
Amended:	December 7, 1990
Amended:	January 22, 1990
Amended:	March 22, 2012

Note: Proposed amendments to this document are shown in underline to indicate additions and ~~strikeouts~~ to indicate deletions compared to the test procedures as last amended in January 22, 1990.

As Amended: March 22, 2012
Date of Hearing: January 26-27, 2012

NOTE: This document is incorporated by reference in section 2235, title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certification of motor vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. “California 2001 through 2014 Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2001 through 2016 Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles” (incorporated by reference in section 1961(d), title 13, CCR);

2. “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes” (incorporated by reference in section 1962.1(h), title 13, CCR);

3. “California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles” (incorporated by reference in section 1976(c), title 13, CCR);

4. “Malfunction and Diagnostic System Requirements – 1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines” (incorporated by reference in section 1968.1, title 13, CCR);

5. “Malfunction and Diagnostic System Requirements – 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines” (incorporated by reference in section 1968.2, title 13, CCR);

6. “California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles” (incorporated by reference in section 1978, title 13, CCR).

SPECIFICATIONS FOR FILL PIPES AND OPENINGS OF 1977 THROUGH 2014 MODEL MOTOR VEHICLE FUEL TANKS

I. General

A. No new 1977 ~~or later~~ through 2014 model year gasoline-powered motor vehicle may be sold, offered for sale, or registered in California unless such vehicle complies with the following specifications for fill pipes and openings of motor vehicles fuel tanks. In addition, these specifications shall apply to each new 1993 ~~and subsequent~~ through 2014 model methanol-fueled passenger car, light-duty truck, medium-duty vehicle, and heavy-duty vehicle. Any references made in these specifications to gasoline or gasoline-fueled vehicles shall be applicable also to methanol or methanol-fueled vehicles. The Executive Officer may exempt vehicles for which compliance with the specifications is found to be technologically infeasible, in accordance with Paragraph 9.

B. Evidence to show compliance with these specifications shall be submitted to the Executive Officer of the Air Resources Board with the application of certification of new vehicles required by Chapter 3, Subchapter 1, Article 2, of Title 13 of the California Code of Regulations.

C. Sections 4 through 8 shall apply to new 1984 ~~and later~~ through 2014 model year otto-cycle motor vehicles, except motorcycles.

II. Definitions

A. “Fill pipe face” means the surface of the open end of the fill pipe that seals against the fuel tank cap when the cap is in place.

B. “Test nozzle spout” means a rod with dimensions shown in Figure 4 (bottom left corner), used to establish the reference lines around which the fill pipe access zone is defined.

C. “Fill pipe access zone” means the spatial zone in the vicinity of the fill pipe, as described by Figures 3 and 4, which is used for nozzle insertion, and which must be free of obstructions.

D. “Reference plane” means the plane, chosen by the vehicle manufacturer, in which the vapor recovery nozzle should remain during vapor recovery nozzle insertion, and which contains the axial centerline of the fill pipe face.

E. “Normal resting position of the test nozzle spout” means the position of the test nozzle spout is in when all of the following conditions are met:

1. the test nozzle spout is inserted into the fill pipe such that the axial centerline of the test nozzle spout lies in the reference plane;

2. the locking ring of the test nozzle spout is located immediately on the inside (i.e., the vehicle tank side) of the locking lip;

3. either the locking ring of the test nozzle spout rests upon the fill pipe wall, or the test nozzle pout shaft rests upon the locking lip as shown in Figures 1 and 2 respectively; and

4. the fuel dispensing end of the test nozzle spout (which is indicated in Figures 1 and 2) is in contact with a restraining point.

The normal resting position of the test nozzle spout is illustrated in Figures 1 and 2.

F. “Unlatched position of the test nozzle spout” means the position of the test nozzle spout is in when all of the following conditions are met:

1. the test nozzle spout is inserted into the fill pipe with the axial centerline of the test nozzle spout contained in the reference plane;

2. the locking ring of the test nozzle spout is resting on the upper surface of the locking lip so as to raise the nozzle handle though the minimum angle required (from the normal resting position) to effect insertion of the test nozzle spout into the fill pipe; and

3. the fuel dispensing end of the test nozzle spout (which is indicated in Figures 1 and 2) is in contact with a restraining point.

The unlatched position of the test nozzle spout is illustrated in Figures 1a and 2a.

G. “Angle Alpha” means the angle between the axial centerline of the test nozzle spout when in its normal resting position, and the axial centerline of the fill pipe face. Alpha is considered a positive angle when the fuel dispensing end of the test nozzle spout (which is indicated in Figures 1 and 2) is pointing down relative to the axial centerline of the fill pipe face, as illustrated in Figures 1 and 2.

H. “Angle Beta” means the angle between the axial centerline of the test nozzle spout when in its unlatched position, and the axial centerline of the fill pipe face. Beta is considered a positive angle when the fuel dispensing end of the test nozzle spout (which is indicated in Figures 1a and 2a) is pointing down relative to the axial centerline of the fill pipe face, as illustrated in Figures 1a and 2a.

I. “Restriction device” means a fill pipe device installed by the vehicle manufacturer to prevent insertion by a leaded nozzle spout and to prevent fueling with leaded gasoline, pursuant to regulations of the United States Environmental Protection Agency.

J. “Vapor recovery nozzle”, for the purpose of these specifications, means a nozzle, unleaded or leaded as appropriate for fueling vehicles, certified by the state board, pursuant to the board’s “Certification procedures for Gasoline Vapor Recovery Systems at Service Stations” established in Section 94001 of Title 17, California Code of Regulations, at any time between January 1, 1981 and September 14, 1982, together with an appropriate vapor hose. An alternative vapor recovery nozzle means any nozzle certified subsequent to September 14, 1982.

K. “Premature nozzle shut-off” means any automatic shut-off of the vapor recovery nozzle before the vehicle fuel tank is filled to either 90 percent of the nominal fuel tank capacity or to within two gallons less than the nominal tank capacity, whichever corresponds to the smaller quantity of gasoline in the fuel tank.

L. “Liquid gasoline loss” means any liquid gasoline that leaves the fill pipe/nozzle interface during dispersing or after nozzle shut-off and includes any liquid gasoline on the ground, on the vehicle, or that enters the nozzle bellows, nozzle body vapor passage, or vapor hose, but does not include liquid gasoline in the nozzle spout.

III. General Design Specifications

A. The fill pipe face shall have a smooth surface which is flat within 0.025 centimeter TIR (total indicated reading) against which any vapor recovery nozzle as defined in Section 2.J can effect a vapor-tight seal. The fill pipe face shall be round in cross-section, and shall have an outside diameter of less than 5.75 centimeters.

An internal locking lip shall be provided around at least 100 degrees of the inside circumference of the fill pipe, with at least 35 degrees extending to either side of the reference plane.

The height of the lip, as measured from the inside wall of the fill pipe, shall not be less than 0.25 centimeters, or shall not be less than 0.85 centimeters as measured from the outside wall of the fill pipe if the outside diameter of the fill pipe is between 5.2 and 5.75 centimeters. The depth of the lip shall not be less than 0.4, nor more than 1.3 centimeters into the fill pipe as measured in the reference plane from the fill pipe face. If any portion of the locking lip has depth less than 0.4 centimeters, the depth transition shall not be greater than 0.006 centimeters per degree of arc throughout that portion of the locking lip.

B. The fill pipe and all surrounding bumpers, body parts, and factory installed accessories shall be designed and fabricated so that the fill pipe access zone as delineated by Figure 4 is not obstructed. Allowance must be made for production tolerances, as these are not included in this access zone. The access zone shall allow for insertion of any vapor recovery nozzle as defined in section 2.J in at least one orientation within ±90 degrees of the upright or vertical position.

The fill pipe access zone shall be determined by first locating reference lines A and B, and Point D, E, and P. Point P, as shown in Figures 3 and 4, is located by finding the intersection point of 30.6 centimeters radius arcs struck from points D and E. Point P shall be the point from which the 19, 24, and 30.6 centimeter radii of the handle access zone (as indicated in Figures 3 and 4) as constructed. The fill pipe access zone if defined relative to reference lines A and B, as shown in Figures 3 and 4. Reference line A is the axial centerline of the test nozzle spout when it is in its normal resting position. Reference line B is the axial centerline of the test nozzle spout when it is in its unlatched position.

The sealing zone as shown in Figure 4 shall be retained normal to the axial centerline of the fill pipe face. In between the handle access zone and the sealing zone, a smooth blend shall be provided as shown in Figure 4.

C. The internal portions of the fill pipe shall be configured such that test nozzle spout can be inserted far enough into the fill pipe to allow entrance of its locking ring beyond the fill pipe locking lip, and to allow deflection of the spout to the normal resting position and back to the unlatched position without binding. If the fill pipe contains a restriction device or other valve, it must be positioned so that the test nozzle spout in the normal resting position penetrates the restriction device or other valve by a minimum of 2.25 centimeters and allows free delivery of gasoline to the vehicle tank. The internal portions of the fill pipe shall also be configured to hold the test spout in its normal resting position such that the angle Alpha (α) falls within the range $20 \text{ degrees} \geq \alpha \geq -10$ degrees as shown in Figures 1 and 2.

D. The fill pipe shall be oriented such that the axial centerline of the test nozzle spout in the normal resting position forms an angle of not less than 15 degrees with the horizontal plane, with the fuel dispensing end (which is indicated in Figures 1 and 2) pointing down. For 1980 and later model year vehicles, this angle shall not be less than 30 degrees.

IV. Fill Rate Specifications

A. Except as provided in Section 4.B below, the fill pipe shall accept a fill rate of 8 gallons per minute using the test procedures described in Section 6.

B. The fill pipe on 1987 and subsequent model year vehicles, except for those vehicles with fuel system designs carried over from the 1986 model year without change, shall accept a fill rate of 10 gallons per minute using the test procedure described in Section 6.

C. There shall be no premature nozzle shut-off in 90 percent of the test repetitions for any test nozzle using the test procedures described in Section 6.

V. Spillage and Spitback Specifications

A. There shall be no more than 1 millimeter of liquid gasoline loss per test in 90 percent of the tests using the test procedures described in Section 6.

B. There shall be no unlatching of the vapor recovery nozzle during dispensing or upon nozzle shut-off using the test procedure described in Section 6.

VI. Test Procedures

The following test procedures and test conditions shall be used for determining compliance with the specifications in Section 4 and 5.

A. Each different fill pipe/tank configuration, as appropriate to represent adequately the manufacturer’s product line, shall be tested with two vapor recovery nozzles. Each nozzle must be from a different manufacturer. At least one of the two nozzles shall be a balance-type. Each nozzle shall include a hold-open clip for hands-off dispensing. Upon the request of a vehicle manufacturer, the Executive Officer or his designate may approve alternate vapor recovery nozzles and hoses for use with the test procedures.

B. The fill pipe shall be tested as installed in the vehicle. Fuel system mock-ups sufficiently complete to demonstrate production vehicle compliance with these specifications may be used.

C. The vehicle shall be parked in a level attitude and oriented such that normal vapor and liquid hose loads are applied to the nozzle. Normal vapor and liquid hose loads may be represented by applying a retractor cable tension of approximately ten pounds to a hose clamp attached to the liquid hose approximately three feet from the nozzle as measured along the hose.

D. Gasoline used as fuel during the tests shall have a Reid vapor pressure of at least 8.5 pounds per square inch (psi) and be at a temperature of 21º plus or minus 5º Centigrade.

E. The pressure drop from the nozzle/fill pipe interface through the vapor passage shall be nominally 0.5 inch of water (gauge) as measured with a nitrogen gas flow of 60 cubic feet per hour though the vapor passage.

F. Each test shall be conducted as follows:

At the start of the test the fuel tank shall be approximately 10 percent of the nominal tank capacity. The nozzle to be sued for dispensing gasoline shall be in the normal hands-off-latched position. The fill rate shall be the minimum rate necessary to demonstrate compliance with the applicable fill rate specification set forth in Section 4. The nozzle shall be allowed to dispense gasoline until automatic nozzle shut-off.

If a premature nozzle shut-off occurs, the nozzle shall be left in the fill pipe in the same position. Dispensing shall be resumed within 10 seconds at the fill rate specified in Section 4 and dispensing shall continue until the fuel tank is filled to within 90 percent of the nominal fuel tank capacity or to within two gallons of the nominal fuel tank capacity, whichever corresponds to the smaller quantity of gasoline in the vehicle fuel tank.

G. A minimum of five tests with each chose nozzle shall be completed to demonstrate compliance with the fill rate and spillage/spitback specifications. If there is any premature nozzle shut-off or instance of liquid gasoline loss greater than 1 millimeter during the first five test with any chosen nozzle, a minimum of ten tests with that nozzle shall be completed to demonstrate compliance with the fill rate and spillage/ spitback specifications.

H. At the request of a manufacturer, the Executive Officer may approve the use of an alternative test procedure by the manufacturer upon a determination that the alternative test procedure is equivalent to the adopted test procedure. The manufacturer shall be responsible for demonstrating the equivalency of the alternative test procedure.

I. For fill pipe/tank configurations with fuel system designs unchanged from a prior model year, and which have been tested using the adopted test procedure or by an equivalent test procedure acceptable to the Executive Officer as specified in Section 6.H, the test results from the prior model year may be used for determining compliance to these specifications.

VII. Specifications to Reduce Damage to Vapor Recovery Nozzles

To avoid damage to the bellows and faceplates of vapor recovery nozzles, there shall be no sharp projections or edges within the fill pipe access zone, along the surface of the fill pipe access zone, or along the surface of adjacent zones outside of the fill pipe access zone, which could foreseeably damage the bellows or faceplate of nozzles during nozzle insertion, latching, dispensing or removal. Fill pipe access doors, including license plate holders and license plates when used as access doors, and all associated door and license plate mounting brackets, screws, and other hardware shall stand free of the fill pipe access zone during nozzle insertion, latching, dispensing, and removal. This Section shall also apply to all factory installed accessories in the vicinity of the fill pipe and opening.

VIII. Fill Pipe Assembly and Restriction Device Durability and Other Specifications

A. The manufacturer of each motor vehicle shall warrant to the ultimate purchaser and each subsequent purchaser that he vehicle is: (1) designed, built, and equipped so as to conform, at the time of sale, with the specifications in Sections 4, 5, 7, 8.B, and 8.C herein, and (2) free from defects in materials and workmanship which cause the fill pipe assembly, including restriction device, to fail to conform to the specifications in Sections 4, 5, 7, 8.B, and 8.C herein for the useful life of the vehicle as defined in Section 2035 of Title 13, California Code of Regulations. The provision of Sections 2037 (d) – (k), 2038, 2039, 2040, and 2041 of Title 13, California Code of Regulations, shall be applicable to the warranty. The fill pipe assembly, including restriction device, shall be subject to vehicle emissions related defects report and vehicle or engine recall procedures in Title 13, Chapter 3, Subchapter 2, Article 2, California Code of Regulations.

B. Any restriction device in a motor vehicle shall be sufficiently durable to withstand simple tampering and to prevent expansion of the restriction device diameter to 2.4 centimeters or removal of the restriction device without extraordinary effort.

C. The fill pipe assembly including fuel tank cap shall not expel liquid gasoline during normal driving maneuvers or parking attitudes for which the vehicle is designed irrespective of ambient temperature or tank level up to nominal capacity.

D. The fill pipe assembly of all methanol-fueled vehicles shall be designed to resist the insertion of flexible tubing of a diameter that is feasible for use in siphoning fuel. Manufacturers of methanol-fueled heavy-duty vehicles in excess of 14,000 pounds gross vehicle weight may request an exemption from this requirement. The request shall be submitted to the Executive Officer and shall be granted if the manufacturer demonstrates that compliance with this requirement is technically infeasible.

IX. Exemption of Vehicles

A. A manufacturer may apply for an exemption from the fill pipe and fuel tank opening specifications in paragraphs 3 through 8 for any of its vehicles by applying in writing to the Executive Officer. Application should be submitted at lest 60 days prior to the manufacturer’s date for final design commitment. The application shall set forth:

1. the specific models for which the exemption is sought;

2. for each such model all facts which demonstrate that compliance with the specifications is technologically infeasible; and

3. evidence showing what efforts have been and will be made by the manufacturer to overcome technological infeasibility, and what the state-of-art technology and problems consist of.

B. Upon receipt of an exemption application, together with sufficient supporting evidence, the Executive Officer may make a finding of technological infeasibility and grant an exemption. The exemption may be limited to specific models, specified body styles of any vehicle model, and/or specified model years. In determining whether to grant an exemption, the Executive Officer shall consider technologies available to the motor vehicle industry as a while. The Executive Officer may condition an exemption upon a commitment by the manufacturer to develop new technologies in accordance with a responsible compliance schedule approved by the Executive Officer. No exemption shall be granted unless the manufacturer has demonstrated a good faith effort to overcome technological infeasibility.

C. The manufacturer shall bear the responsibility for submitting evidence to the Executive Officer sufficient to justify the granting of an exemption.

Figure 1.

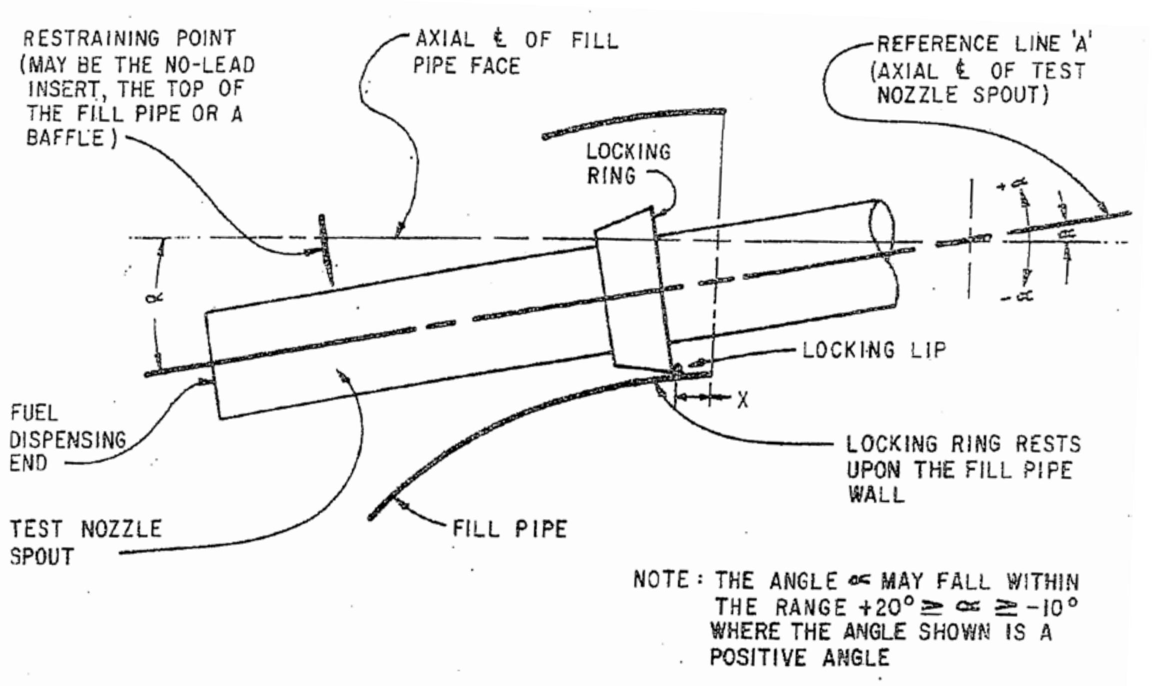


FIGURE 1 : SAE J1114 TYPE FILL PIPE (NORMAL RESTING POSITION)

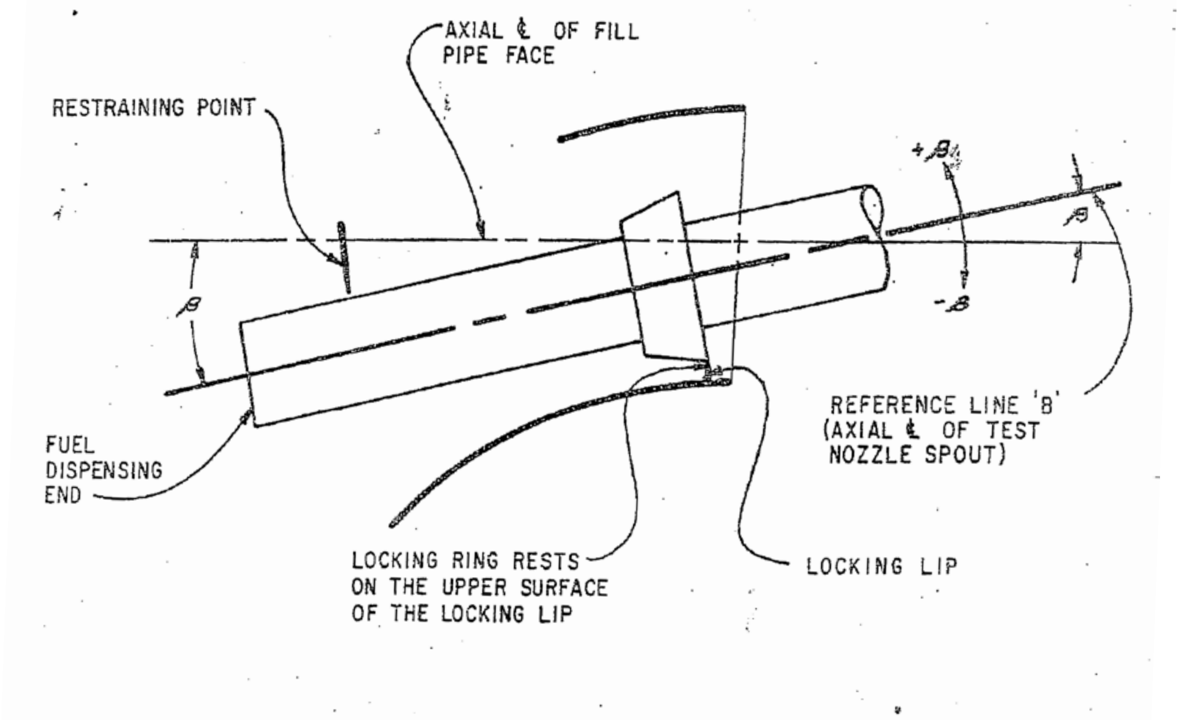
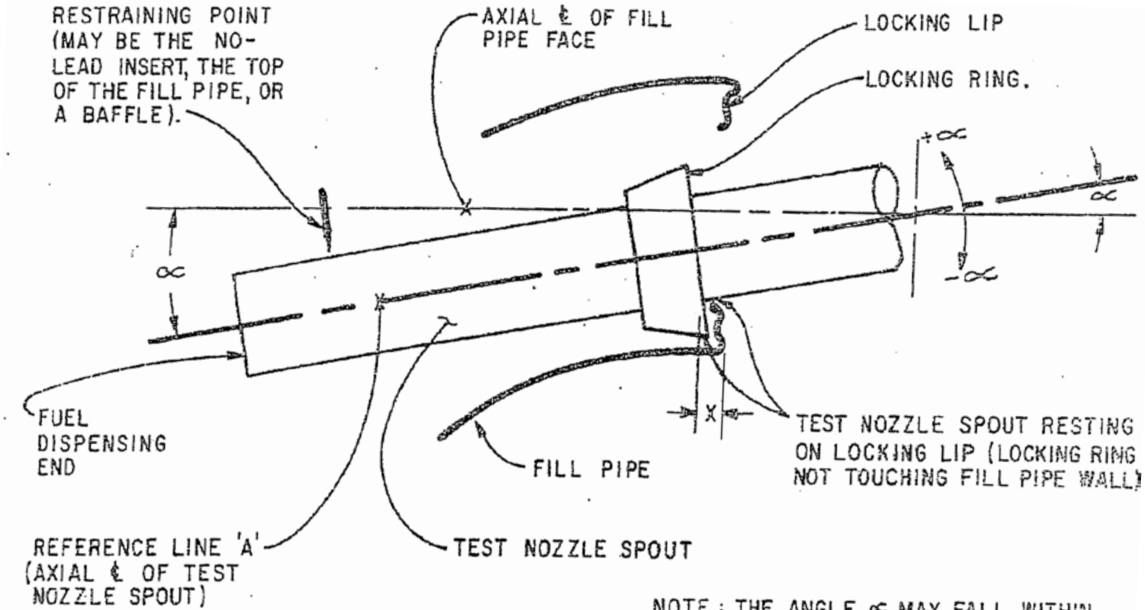


FIGURE 1a : SAE J1114 TYPE FILL PIPE (UNLATCHED POSITION)

Figure 2.



NOTE : THE ANGLE ∝ MAY FALL WITHIN THE RANGE $+20^\circ \geq \alpha \geq -10^\circ$ WHERE THE ANGLE SHOWN IS A POSITIVE ANGLE

FIGURE 2 : SAE J829B TYPE FILL PIPE (NORMAL RESTING POSITION)

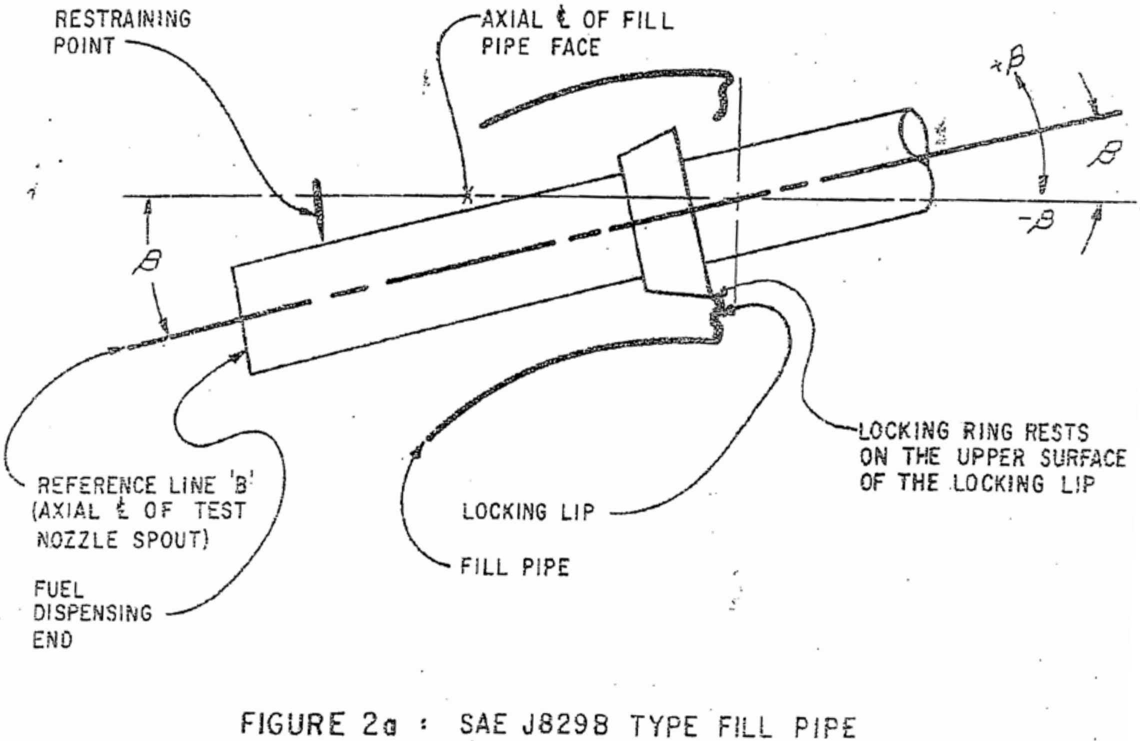


FIGURE 2a : SAE J829B TYPE FILL PIPE (UNLATCHED POSITION)

Figure 3.

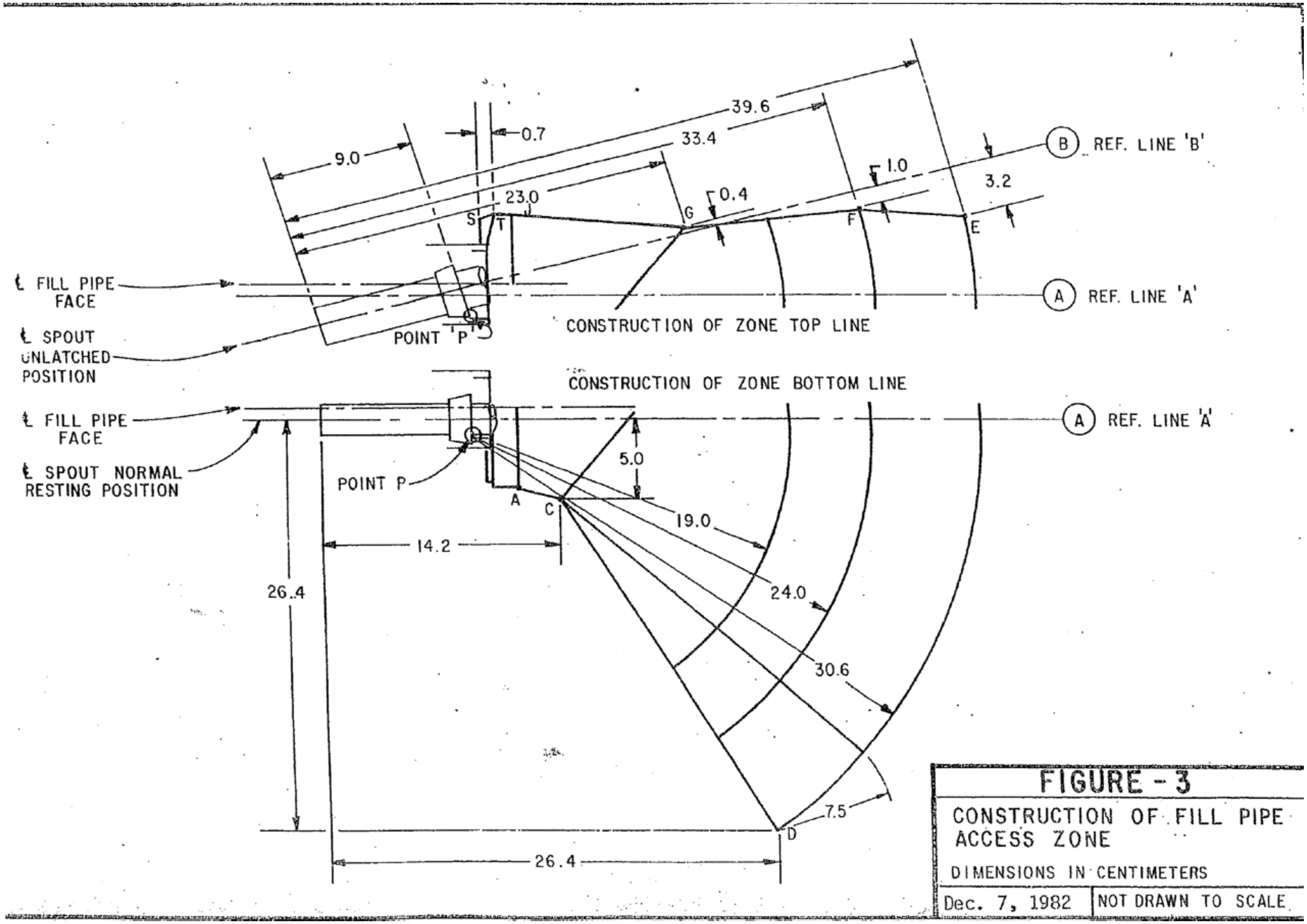


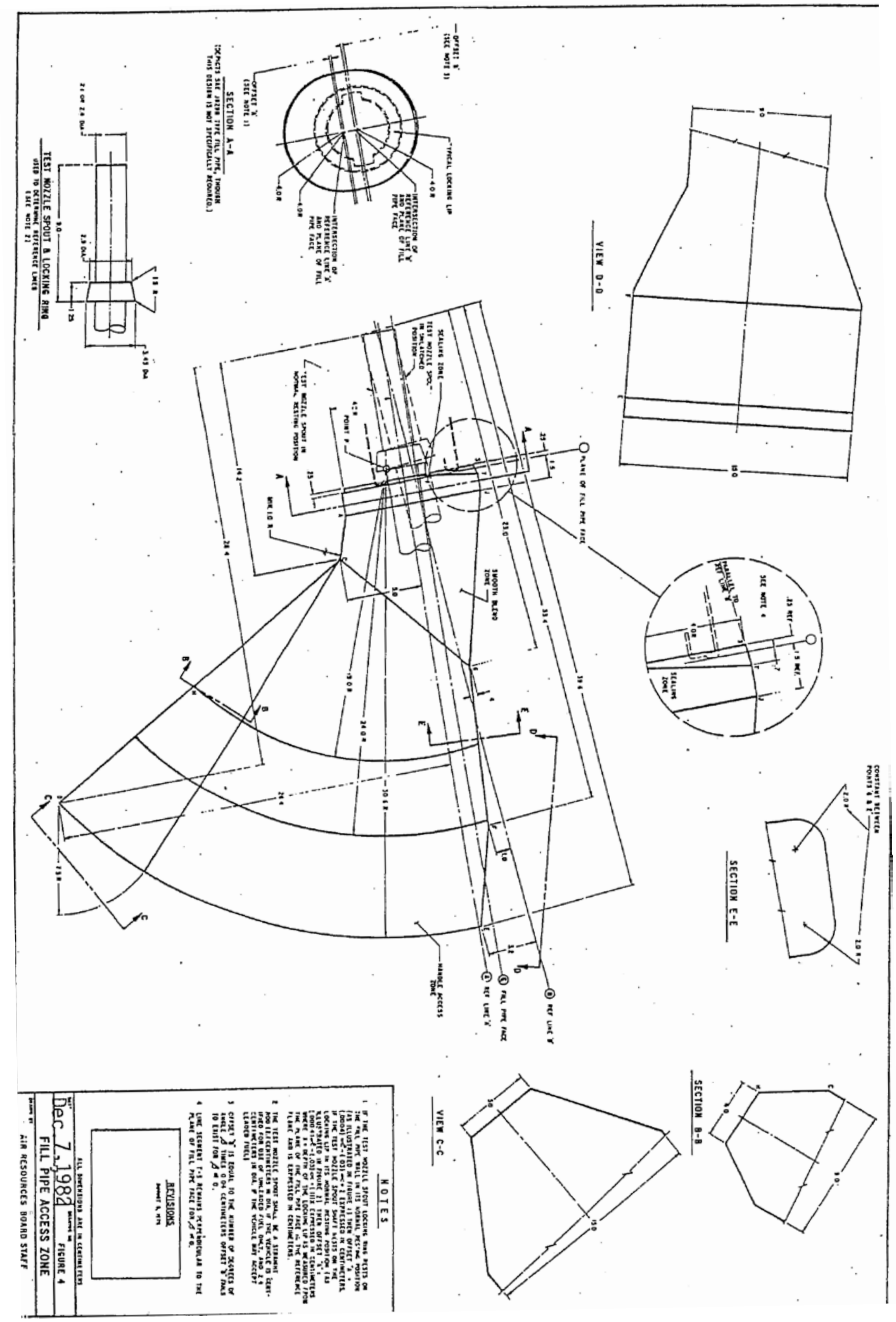
FIGURE - 3

CONSTRUCTION OF FILL PIPE ACCESS ZONE

DIMENSIONS IN CENTIMETERS

Dec. 7, 1982 NOT DRAWN TO SCALE

Figure 3 continued.



State of California
AIR RESOURCES BOARD

SPECIFICATIONS FOR FILL PIPES AND OPENINGS OF 2015 AND SUBSEQUENT MODEL MOTOR VEHICLE FUEL TANKS

Adopted: March 22, 2012

As Adopted: March 22, 2012
Date of Hearing: January 26-27, 2012

NOTE: This document is incorporated by reference in section 2235, title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certification of motor vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles" (incorporated by reference in section 1961.2 (d), title 13, CCR);

2. "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962.1(h), title 13, CCR);

3. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1976(c), title 13, CCR);

4. "Malfunction and Diagnostic System Requirements – 1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines" (incorporated by reference in section 1968.1, title 13, CCR);

5. "Malfunction and Diagnostic System Requirements – 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines" (incorporated by reference in section 1968.2, title 13, CCR);

6. "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1978, title 13, CCR).

SPECIFICATIONS FOR FILL PIPES AND OPENINGS OF MOTOR VEHICLE FUEL TANKS

I. General

A. No new 2015 or later model year gasoline or alcohol fueled passenger car, light-duty truck, medium-duty vehicle, or heavy-duty vehicle may be sold, offered for sale, or registered in California unless such vehicle complies with the following specifications for fill pipes and openings of motor vehicles fuel tanks. The Executive Officer may exempt vehicles for which compliance with the specifications is found to be technologically infeasible, in accordance with Paragraph 9.

B. Evidence to show compliance with these specifications shall be submitted to the Executive Officer of the Air Resources Board with the application of certification of new vehicles required by Chapter 3, Subchapter 1, Article 2, of Title 13 of the California Code of Regulations.

C. Sections 4 through 8 shall apply to new 2015 and later model year otto-cycle motor vehicles, except motorcycles.

II. Definitions

These test procedures incorporate by reference the definitions set forth in the International Organization for Standardization standard (ISO) “Road vehicles – Filler pipes and openings of motor vehicle fuel tanks – Vapour recovery system” (ISO-13331-1995(E)), as adopted June 1, 1995; the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;" and the “California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes,” including the incorporated definitions from the Code of Federal Regulations. In addition, the following definitions apply:

1. “Restriction device” means a fill pipe device installed by the vehicle manufacturer to prevent insertion by a leaded nozzle spout and to prevent fueling with leaded gasoline, pursuant to regulations of the United States Environmental Protection Agency.

2. “Vapor recovery nozzle”, for the purpose of these specifications, means a nozzle, unleaded or leaded as appropriate for fueling vehicles, certified by the state board, pursuant to the board’s “Certification procedures for Gasoline Vapor Recovery Systems at Service Stations” established in Section 94001 of Title 17, California Code of Regulations, at any time between January 1, 1981 and September 14, 1982, together

with an appropriate vapor hose. An alternative vapor recovery nozzle means any nozzle certified subsequent to September 14, 1982.

3. “Premature nozzle shut-off” means any automatic shut-off of the vapor recovery nozzle before the vehicle fuel tank is filled to either 90 percent of the nominal fuel tank capacity or to within two gallons less than the nominal tank capacity, whichever corresponds to the smaller quantity of gasoline in the fuel tank.

4. “Liquid gasoline loss” means any liquid gasoline that leaves the fill pipe/nozzle interface during dispersing or after nozzle shut-off and includes any liquid gasoline on the ground, on the vehicle, or that enters the nozzle bellows, nozzle body vapor passage, or vapor hose, but does not include liquid gasoline in the nozzle spout.

III. General Design Specifications

The fill pipe and opening of the vehicle fuel tank shall conform to all specifications in the ISO standard “Road vehicles – Filler pipes and openings of motor vehicle fuel tanks – Vapour recovery system” (ISO-13331-1995(E)), as adopted June 1, 1995 and incorporated by reference herein. For filler pipes with threaded-type caps, manufacturers may elect to use the alternate filler pipe sealing surface shape specified in the Society for Automotive Engineers (SAE) standard “Fuel Tank Filler Cap and Cap Retainer Threaded” (J1114), as amended August 4, 2005 and incorporated by reference herein. The alternate shape allowance would be used in lieu of section 3.1 of ISO-13331-1995(E); all other provisions of ISO-13331-1995(E) would need to be met by a manufacturer utilizing the SAE J1114 provision.

IV. Fill Rate Specifications

A. The fill pipe on 2015 and subsequent model year vehicles shall accept a fill rate of 10 gallons per minute using the test procedure described in Section 6.

B. There shall be no premature nozzle shut-off in 90 percent of the test repetitions for any test nozzle using the test procedures described in Section 6.

V. Spillage and Spitback Specifications

A. There shall be no more than 1 millimeter of liquid gasoline loss per test in 90 percent of the tests using the test procedures described in Section 6.

B. There shall be no unlatching of the vapor recovery nozzle during dispensing or upon nozzle shut-off using the test procedure described in Section 6.

VI. Test Procedures

The following test procedures and test conditions shall be used for determining compliance with the specifications in Section 4 and 5.

A. Each different fill pipe/tank configuration, as appropriate to represent adequately the manufacturer’s product line, shall be tested with two vapor recovery nozzles. Each nozzle must be from a different manufacturer. At least one of the two nozzles shall be a balance-type. Each nozzle shall include a hold-open clip for hands-off dispensing. Upon the request of a vehicle manufacturer, the Executive Officer or his designate may approve alternate vapor recovery nozzles and hoses for use with the test procedures.

B. The fill pipe shall be tested as installed in the vehicle. Fuel system mock-ups sufficiently complete to demonstrate production vehicle compliance with these specifications may be used.

C. The vehicle shall be parked in a level attitude and oriented such that normal vapor and liquid hose loads are applied to the nozzle. Normal vapor and liquid hose loads may be represented by applying a retractor cable tension of approximately ten pounds to a hose clamp attached to the liquid hose approximately three feet from the nozzle as measured along the hose.

D. Gasoline used as fuel during the tests shall have a Reid vapor pressure of at least 8.5 pounds per square inch (psi) and be at a temperature of 21º plus or minus 5º Centigrade.

E. The pressure drop from the nozzle/fill pipe interface through the vapor passage shall be nominally 0.5 inch of water (gauge) as measured with a nitrogen gas flow of 60 cubic feet per hour though the vapor passage.

F. Each test shall be conducted as follows:

At the start of the test the fuel tank shall be approximately 10 percent of the nominal tank capacity. The nozzle to be sued for dispensing gasoline shall be in the normal hands-off-latched position. The fill rate shall be the minimum rate necessary to demonstrate compliance with the applicable fill rate specification set forth in Section 4. The nozzle shall be allowed to dispense gasoline until automatic nozzle shut-off.

If a premature nozzle shut-off occurs, the nozzle shall be left in the fill pipe in the same position. Dispensing shall be resumed within 10 seconds at the fill rate specified in Section 4 and dispensing shall continue until the fuel tank is filled to within 90 percent of the nominal fuel tank capacity or to within two gallons of the nominal fuel tank capacity, whichever corresponds to the smaller quantity of gasoline in the vehicle fuel tank.

G. A minimum of five tests with each chose nozzle shall be completed to demonstrate compliance with the fill rate and spillage/spitback specifications. If there is any premature nozzle shut-off or instance of liquid gasoline loss greater than 1 millimeter during the first five test with any chosen nozzle, a minimum of ten tests with that nozzle shall be completed to demonstrate compliance with the fill rate and spillage/spitback specifications.

H. At the request of a manufacturer, the Executive Officer may approve the use of an alternative test procedure by the manufacturer upon a determination that the alternative test procedure is equivalent to the adopted test procedure. The manufacturer shall be responsible for demonstrating the equivalency of the alternative test procedure.

I. For fill pipe/tank configurations with fuel system designs unchanged from a prior model year, and which have been tested using the adopted test procedure or by an equivalent test procedure acceptable to the Executive Officer as specified in Section 6.H, the test results from the prior model year may be used for determining compliance to these specifications.

VII. Specifications to Reduce Damage to Vapor Recovery Nozzles

To avoid damage to the bellows and faceplates of vapor recovery nozzles, there shall be no sharp projections or edges within the fill pipe access zone, along the surface of the fill pipe access zone, or along the surface of adjacent zones outside of the fill pipe access zone, which could foreseeably damage the bellows or faceplate of nozzles during nozzle insertion, latching, dispensing or removal. Fill pipe access doors, including license plate holders and license plates when used as access doors, and all associated door and license plate mounting brackets, screws, and other hardware shall stand free of the fill pipe access zone during nozzle insertion, latching, dispensing, and removal. This Section shall also apply to all factory installed accessories in the vicinity of the fill pipe and opening.

VIII. Fill Pipe Assembly and Restriction Device Durability and Other Specifications

A. The manufacturer of each motor vehicle shall warrant to the ultimate purchaser and each subsequent purchaser that he vehicle is: (1) designed, built, and equipped so as to conform, at the time of sale, with the specifications in Sections 4, 5, 7, 8.B, and 8.C herein, and (2) free from defects in materials and workmanship which cause the fill pipe assembly, including restriction device, to fail to conform to the specifications in Sections 4, 5, 7, 8.B, and 8.C herein for the useful life of the vehicle as defined in Section 2035 of Title 13, California Code of Regulations. The provision of

Sections 2037 (d) – (k), 2038, 2039, 2040, and 2041 of Title 13, California Code of Regulations, shall be applicable to the warranty. The fill pipe assembly, including restriction device, shall be subject to vehicle emissions related defects report and vehicle or engine recall procedures in Title 13, Chapter 3, Subchapter 2, Article 2, California Code of Regulations.

B. Any restriction device in a motor vehicle shall be sufficiently durable to withstand simple tampering and to prevent expansion of the restriction device diameter to 2.4 centimeters or removal of the restriction device without extraordinary effort.

C. The fill pipe assembly including fuel tank cap shall not expel liquid gasoline during normal driving maneuvers or parking attitudes for which the vehicle is designed irrespective of ambient temperature or tank level up to nominal capacity.

D. The fill pipe assembly of all methanol-fueled vehicles shall be designed to resist the insertion of flexible tubing of a diameter that is feasible for use in siphoning fuel. Manufacturers of methanol-fueled heavy-duty vehicles in excess of 14,000 pounds gross vehicle weight may request an exemption from this requirement. The request shall be submitted to the Executive Officer and shall be granted if the manufacturer demonstrates that compliance with this requirement is technically infeasible.

IX. Exemption of Vehicles

A. A manufacturer may apply for an exemption from the fill pipe and fuel tank opening specifications in paragraphs 3 through 8 for any of its vehicles by applying in writing to the Executive Officer. Application should be submitted at lest 60 days prior to the manufacturer’s date for final design commitment. The application shall set forth:

1. the specific models for which the exemption is sought;

2. for each such model all facts which demonstrate that compliance with the specifications is technologically infeasible; and

3. evidence showing what efforts have been and will be made by the manufacturer to overcome technological infeasibility, and what the state-of-art technology and problems consist of.

B. Upon receipt of an exemption application, together with sufficient supporting evidence, the Executive Officer may make a finding of technological infeasibility and grant an exemption. The exemption may be limited to specific models, specified body styles of any vehicle model, and/or specified model years. In determining whether to grant an exemption, the Executive Officer shall consider technologies available to the motor vehicle industry as a while. The Executive Officer may condition an exemption upon a commitment by the manufacturer to develop new technologies in accordance with a responsible compliance schedule approved by the

Executive Officer. No exemption shall be granted unless the manufacturer has demonstrated a good faith effort to overcome technological infeasibility.

C. The manufacturer shall bear the responsibility for submitting evidence to the Executive Officer sufficient to justify the granting of an exemption.