# APPENDIX A
# PROPOSED CARFG3 REGULATIONS, INCLUDING PREDICTIVE MODEL PROCEDURE AND CARBOB PROCEDURE DOCUMENTS

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# PROPOSED REGULATION ORDER

## PROPOSED 2007 AMENDMENTS TO THE CALIFORNIA PHASE 3 REFORMULATED GASOLINE REGULATIONS

**California Code of Regulations, Title 13, Division 3**
**Chapter 5. Standards for Motor Vehicle Fuels**
**Article 1. Standards for Gasoline**

Subarticle 2. Standards for Gasoline Sold Beginning March 1, 1996

### Section 2260. Definitions.

(a) For the purposes of this subarticle, the following definitions apply:

(0.5) "Air basin" has the same meaning as defined in section 39012 of the Health and Safety Code.

(0.7) "Alternative emission reduction plan" means with respect to a specific gasoline property, the compliance option set forth in section 2265.5.

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(7.5) "Designated emissions offsetting limit" means an alternative gasoline specification limit, expressed in the nearest hundredth pound per square inch for RVP, nearest tenth percent by weight for oxygen, nearest part per million by weight for sulfur content, nearest hundredth percent by volume for benzene content, nearest tenth percent by volume for aromatic hydrocarbon content, nearest tenth percent for olefin content, and nearest degree Fahrenheit for T90 and T50, which is assigned by a producer or importer that produces gasoline to a final blend of California gasoline pursuant to section 2265.1.

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(8.5) "Emissions associated with permeation" means the incremental increase in emissions because of permeation which is calculated as the difference between the emissions from the producer's or importer's final blend formulation and the flat limits without ethanol. The Phase 3 reformulated gasoline Predictive Model, as described in the "California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model," as corrected November 18, 2004 and last amended [**insert Board**

**adoption date**], which is incorporated herein by reference, shall be used to calculate emissions associated with permeation.

Emissions are calculated as follows:

Ozone Forming Potential (tons per day) = 18.4 (tons per day) * (PCE(OFP)/2.39) * 2.80 * percent share of California gasoline sales covered by the AERP, and

NOx (tons per day) = 427.8 (tons per day) * PCE(NOx) * percent share of California gasoline sales covered by the AERP, where

PCE(OFP) and PCE(NOx) = Percent change in emissions, as predicted by the CaRFG3 Predictive Model for Ozone Forming Potential (OFP) and Oxides of Nitrogen (NOx), respectively, as described in the "California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model," as corrected November 18, 2004 and last amended [**insert Board adoption date**], which is incorporated herein by reference.

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(10.5) "Final blend credit" means the credit from a final blend of gasoline that may be used to offset a producer's or importer's final blend deficit. The amount of final blend credit shall be calculated as follows:

Final Blend Credit = $(PCE - PCE_t) * V_c$, where

PCE = Percent change in emissions values as reported by the producer or importer pursuant to section 2265(a)(2)(C).

$PCE_t$ = Percent change in emissions values, as they pertain to the PM emissions offsetting compliance option, for the PM alternative specifications that the producer or importer was intending to produce and which would have met the criteria for approval in the applicable Predictive Model Procedures but for the elevated sulfur content.

$V_c$ = volume, in barrels, of the final blend that has a final blend credit.

(10.7) "Final blend deficit" means the deficit from a final blend of gasoline that a producer or importer must offset. The amount of final blend deficit shall be calculated as follows:

Final Blend Deficit = $(PCE - 0.04) * V_d$, where

PCE = Percent change in emissions values, as they pertain to the PM emissions offsetting compliance option, which are greater than 0.04%. If the percent change in emissions values, as they pertain to the PM emissions offsetting compliance option, are all less than 0.04%, there is no final blend deficit.

$V_d$ = volume, in barrels, of the final blend that has a final blend deficit.

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(19.7) "Percent change in emissions values, as they pertain to the PM emissions offsetting compliance option" means values calculated, each for oxides of nitrogen, total ozone forming potential, and potency-weighted toxics, from the Phase 3 Predictive Model using the designated emissions offsetting limits for the candidate fuel and the flat limits in section 2262 for the reference fuel, as described in the "California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model," as corrected November 18, 2004 and last amended [**insert Board adoption date**], which is incorporated herein by reference.

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(23.5) "PM emissions offsetting compliance option" means, with respect to a specific gasoline property, the compliance option set forth in section 2265.1(a).

(23.7) "PM emissions offsetting formulation" means a final blend of gasoline that is subject to a set of designated emissions offsetting limits assigned pursuant to section 2265.1(a).

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**Section 2261. Applicability of Standards; Additional Standards.**

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(b) ***Applicability of the CaRFG Phase 3 Standards.***

(1) (A) Unless otherwise specifically provided, the CaRFG Phase 3 cap limit standards set forth in section 2262, and the CaRFG Phase 3 cap limit compliance requirements in 2262.3(a), 2262.4(a), and 2262.5(a) and (b), shall apply starting December 31, 2003. The CaRFG Phase 3 benzene and sulfur content cap limit standards in section 2262, and the CaRFG Phase 3 benzene and sulfur content cap limit compliance requirements in 2262.3(a), shall apply:

1. starting December 31, 2003 (for the benzene content cap limit and the 60 parts per million sulfur content cap limit), ~~and~~ December 31, 2005 (for the 30 parts per million sulfur content cap limit), and December 31, 2009 (for the 20 parts per million sulfur content cap limit) to all sales, supplies or offers of California gasoline from the production facility or import facility at which it was produced or imported.

2. starting February 14, 2004 (for the benzene content cap limit and the 60 parts per million sulfur content cap limit), ~~and~~ February 14, 2006 (for the 30 parts per million sulfur content cap limit), and February 14, 2009 (for the 20 parts per million sulfur content cap limit) to all sales, supplies, offers or movements of California gasoline except for transactions directly involving:

   a. the fueling of motor vehicles at a retail outlet or bulk purchaser-consumer facility, or

   b. the delivery of gasoline from a bulk plant to a retail outlet or bulk purchaser-consumer facility, and

3. starting March 31, 2004 (for the benzene content cap limit and the 60 parts per million sulfur content cap limit), ~~and~~ March 31, 2006 (for the 30 parts per million sulfur content cap limit), and March 31, 2009 (for the 20 parts per million sulfur content cap limit) to all sales, supplies, offers or movements of California gasoline, including transactions directly involving the fueling of motor vehicles at a retail outlet or bulk purchaser-consumer facility.

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(2) The CaRFG Phase 3 benzene and sulfur content cap limit standards in section 2262 shall not apply to transactions directly involving the fueling of motor vehicles at a retail outlet or bulk purchaser-consumer facility, where the person selling, offering, or supplying the gasoline demonstrates as an affirmative defense that the exceedance of the pertinent standard was caused by gasoline delivered to the retail outlet or bulk purchaser-consumer facility prior to February 14, 2004 (for the benzene content limit and the 60 parts per million sulfur content limit), ~~or~~ February 14, 2006 (for the 30 parts per million sulfur content limit), or February 14, 2009 (for the 20 parts per million sulfur content limit) or delivered to the retail outlet or bulk purchaser-consumer facility directly from a bulk plant prior to March 31, 2004 (for the benzene content limit and the 60 parts per million sulfur content limit), ~~or~~ March 31, 2006 (for the 30 parts per million sulfur content limit), or March 31, 2009 (for the 20 parts per million sulfur content limit).

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(3) ***Early Compliance with the CaRFG Phase 3 Standards Before December 31, 2003.***

(A) Any producer or importer wishing to supply from its production or import facility, before December 31, 2003, any final blends of gasoline subject to the CaRFG Phase 3 standards instead of the CaRFG Phase 2 standards may notify the executive officer of its wish to do so. The notification shall include all of the following:

1. The approximate date by which it intends to begin supplying from its production or import facility gasoline complying with the CaRFG Phase 3 standards if permitted to do so;

2. A reasonably detailed demonstration of the producer's or importer's ability and plans to begin supplying from its production or import facility substantial quantities of one or more grades of gasoline meeting the CaRFG Phase 3 standards on or after the date specified;

(B)1. Within 15 days of receipt of a request under section 2261(b)(3)(A), the executive officer shall notify the producer or importer making the request either that the request is complete, or specifying what additional information is necessary to make the request complete.

2. Within 15 days of notifying the producer or importer that the request is complete, the executive officer shall either grant or deny the request. If the request is granted the executive officer shall specify the date on which producers and importers may start to supply from their production or import facilities final blends that comply with the CaRFG Phase 3 standards. The executive officer shall grant the request if he or she determines it is reasonably likely that the producer or importer making the request will start supplying substantial quantities of one or more grades of gasoline complying with the CaRFG Phase 3 standards reasonably soon after the date specified. If the executive officer denies the request, he or she shall provide the producer or importer with a written statement explaining the reason for denial.

3. Upon granting a request made under section 2261(b)(3)(A), the executive officer shall notify interested parties of the date on which (i) producers and importers will be permitted to start supplying final blends of gasoline complying with the CaRFG Phase 3 standards, and (ii) the CaRFG Phase 2 cap limits for RVP and aromatics will become 7.20 psi and 35.0 volume percent respectively for gasoline downstream of the production or import facility. This notification shall be made by posting the pertinent information on the state board's Internet site, providing electronic mail notification to all persons subscribing to the state board's Fuels-General Internet electronic mail list, and mailing notice to all persons registered as motor vehicle fuel distributors under Health and Safety Code section 43026.

4. With respect to all final blends supplied from a production or import facility from the day specified by the executive officer in granting a request made under section 2261(b)(3)(A) through December 30, 2003, any producer or importer may comply with the CaRFG Phase 3 standards that apply starting December 31, 2003 as an alternative to the CaRFG Phase 2 standards. Whenever a producer or importer is supplying a final blend subject to the CaRFG Phase 3 standards pursuant to this section 2261(b)(3)(B)4., any notification required by sections 2264.2 or 2265(a) shall indicate that the final blend is subject to the CaRFG Phase 3 standards. When it is sold or supplied from the production or import facility, no such final blend may contain MTBE in concentrations greater than 0.60 volume percent, or contain a total of more than 0.10 weight percent oxygen collectively from all of the oxygenates identified in section 2262.6(c)(4) that have not received a determination by the California Environmental Council as described in section 2262.6(c)(1).

(4) ***Early compliance with the CaRFG Phase 3 Amendments (Emissions Associated with Permeation) Before December 31, 2009.***

(A) Any producer or importer that produces gasoline wishing to supply from its production or import facility, before December 31, 2009, any final blends of gasoline subject to the "California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model," as corrected November 18, 2004 and last amended [**insert Board adoption date**], shall notify the executive officer of its wish to do so. The notification shall include all of the information listed in section 2261(b)(4)(C).

(B) Any producer or importer that produces gasoline wishing to supply from its production or import facility, before December 31, 2009, any final blends of CARBOB subject to the "Procedures for Using the California Model for California Reformulated Gasoline Blendstocks for Oxygenate Blending (CARBOB)," as adopted April 25, 2001, last amended [**insert Board adoption date**], shall notify the executive officer of its wish to do so. The notification shall include all of the information listed in section 2261(b)(4)(C).

(C) Notification.

1. The approximate date by which it intends to begin supplying from its production or import facility gasoline complying with the "California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model," as corrected November 18, 2004 and last amended [**insert Board adoption date**] or the "Procedures for Using the California Model for California Reformulated Gasoline Blendstocks for Oxygenate Blending (CARBOB),"

as adopted April 25, 2001, last amended [**insert Board adoption date**], referred to as the amended Procedures Guides, if permitted to do so;

2. A reasonably detailed demonstration of the producer's or importer's ability and plans to begin supplying from its production or import facility substantial quantities of one or more grades of gasoline or CARBOB meeting the amended Procedures Guides on or after the date specified;

3. All of the information required pursuant to section 2265.5(b)(2).

(D)1. Within 15 days of receipt of a request under section 2261(b)(4)(A) or (B), the executive officer shall notify the producer or importer making the request either that the request is complete, or specifying what additional information is necessary to make the request complete.

2. Within 15 days of notifying the producer or importer that the request is complete, the executive officer shall either grant or deny the request. If the request is granted the executive officer shall specify the date on which producers and importers that produce gasoline may start to supply from their production or import facilities final blends that comply with the amended Procedures Guides. The executive officer shall grant the request if he or she determines it is reasonably likely that the producer or importer making the request will start supplying substantial quantities of one or more grades of gasoline or CARBOB complying with the amended Procedures Guides reasonably soon after the date specified. If the executive officer denies the request, he or she shall provide the producer or importer with a written statement explaining the reason for denial.

3. Upon granting a request made under section 2261(b)(4)(A) or (B), the executive officer shall notify interested parties of the date on which producers and importers that produce gasoline will be permitted to start supplying final blends of gasoline complying with the amended Procedures Guides. This notification shall be made by posting the pertinent information on ARB's Internet site, providing electronic mail notification to all persons subscribing to ARB's Fuels-General Internet electronic mail list, and mailing notice to all persons registered as motor vehicle fuel distributors under Health and Safety Code section 43026.

4. With respect to all final blends supplied from a production or import facility from the day specified by the executive officer in granting a request made under section 2261(b)(4)(A) or (B) through December 30, 2009, any producer or importer that produces gasoline may comply with the amended Procedures Guides that apply starting December 31, 2009. Whenever a producer or importer that produces gasoline is supplying a final blend subject to the amended Procedures Guides pursuant to this section 2261(b)(4)(B)4., any notification required by sections 2264.2 or 2265(a) shall indicate that the final blend is subject to the amended

Procedures Guides. When it is sold or supplied from the production or import facility, no such final blend may result in emissions associated with permeation unless those emissions are offset through the Predictive Model or a valid AERP.

(E) AERPs approved under this section are subject to sections 2265.5(d) – (i).

(5) ***Early compliance with the CaRFG Phase 3 Amendments (PM Emissions Offsetting) Before December 31, 2009.***

(A) Any producer or importer that produces gasoline wishing to supply from its production or import facility, before December 31, 2009, any final blends of gasoline subject to section 2264.2(d), shall notify the executive officer of its wish to do so. The notification shall include all of the following:

1. The approximate date by which it intends to begin supplying from its production or import facility gasoline complying with section 2264.2(d), if permitted to do so;

2. A reasonably detailed demonstration of the producer's or importer's ability and plans to begin supplying from its production or import facility substantial quantities of one or more grades of gasoline meeting section 2264.2(d) on or after the date specified;

3. All of the information required pursuant to section 2265.1(a)(2)(A).

(B)1. Within 15 days of receipt of a request under section 2261(b)(5)(A), the executive officer shall notify the producer or importer making the request either that the request is complete, or specifying what additional information is necessary to make the request complete.

2. Within 15 days of notifying the producer or importer that the request is complete, the executive officer shall either grant or deny the request. If the request is granted the executive officer shall specify the date on which producers and importers that produce gasoline may start to supply from their production or import facilities final blends that comply with section 2264.2(d). The executive officer shall grant the request if he or she determines it is reasonably likely that the producer or importer making the request will start supplying substantial quantities of one or more grades of gasoline complying with section 2264.2(d) reasonably soon after the date specified. If the executive officer denies the request, he or she shall provide the producer or importer with a written statement explaining the reason for denial.

3. Upon granting a request made under section 2261(b)(5)(A), the executive officer shall notify interested parties of the date on which producers and importers that produce gasoline will be permitted to start supplying final

blends of gasoline complying with section 2264.2(d). This notification shall be made by posting the pertinent information on ARB's Internet site, providing electronic mail notification to all persons subscribing to ARB's Fuels-General Internet electronic mail list, and mailing notice to all persons registered as motor vehicle fuel distributors under Health and Safety Code section 43026.

4. With respect to all final blends supplied from a production or import facility from the day specified by the executive officer in granting a request made under section 2261(b)(5)(A) through December 30, 2009, any producer or importer that produces gasoline may comply with section 2264.2(d) that applies starting December 31, 2009. Whenever a producer or importer that produces gasoline is supplying a final blend subject to section 2264.2(d) pursuant to this section 2261(b)(5)(B)4., any notification required by sections 2264.2 or 2265(a) shall indicate that the final blend is subject to the PM emissions offsetting provisions. When it is sold or supplied from the production or import facility, no such final blend may result in sulfur levels above the applicable standards unless those sulfur emissions are fully offset as provided in section 2265.1.

(E) Any producer or importer that produces gasoline that supplies from its production or import facility, before December 31, 2009, any final blends of gasoline subject to section 2264.2(d), shall comply with section 2265.1.

(c) California gasoline sold or supplied on or after March 1, 1996, is also subject to section 2253.4 (Lead/Phosphorus in Gasoline), section 2254 (Manganese Additive Content), and section 2257 (Required Additives in Gasoline). California gasoline that is supplied from a small refiner's California refinery prior to March 1, 1998, and that qualifies for treatment under section 2272(a), shall also be subject to section 2250 (Degree of Unsaturation of Gasoline) and section 2252 (Sulfur Content of Gasoline).

(d) The standards contained in this subarticle shall not apply to a sale, offer for sale, or supply of California gasoline to a refiner if: (1) the refiner further processes the gasoline at the refiner's refinery prior to any subsequent sale, offer for sale, or supply of the gasoline, and (2) in the case of standards applicable only to producers or importers, the refiner to whom the gasoline is sold or supplied is the producer of the gasoline pursuant to section 2260(a)(26)(B).

(e) The prohibitions in sections 2262.3(b) and (c), 2262.4(b), and 2262.5(c) shall not apply to gasoline which a producer or importer demonstrates was neither produced nor imported by the producer or importer.

(f) This subarticle 2, section 2253.4 (Lead/Phosphorus in Gasoline), section 2254 (Manganese Additive Content), and section 2257 (Required Additives in Gasoline) shall not apply to gasoline where the person selling, offering or supplying the gasoline demonstrates as an affirmative defense that the person has taken

reasonably prudent precautions to assure that the gasoline is used only in racing vehicles.

**Section 2262. The California Reformulated Gasoline Phase 2 and Phase 3 Standards.**

The CaRFG Phase 2 and CaRFG Phase 3 standards are set forth in the following table. For all properties but Reid vapor pressure (cap limit only) and oxygen content, the value of the regulated property must be less than or equal to the specified limit. With respect to the Reid vapor pressure cap limit and the oxygen content flat and cap limit, the limits are expressed as a range, and the Reid vapor pressure and oxygen content must be less than or equal to the upper limit, and more than or equal to the lower limit. A qualifying small refiner may comply with the small refiner CaRFG Phase 3 standards, in place of the CaRFG Phase 3 standards in this section, in accordance with section 2272.

**The California Reformulated Gasoline Phase 2 and Phase 3 Standards**

| ***Property*** | ***Flat Limits*** | | ***Averaging Limits*** | | ***Cap Limits*** | |
|---|---|---|---|---|---|---|
| | ***CaRFG Phase 2*** | ***CaRFG Phase 3*** | ***CaRFG Phase 2*** | ***CaRFG Phase 3*** | ***CaRFG Phase 2*** | ***CaRFG Phase 3*** |
| Reid Vapor Pressure[1] (pounds per square inch) | 7.00 | 7.00 or 6.90[2] | Not Applicable | Not Applicable | 7.00[3] | 6.40 - 7.20 |
| Sulfur Content (parts per million by weight) | 40 | 20 | 30 | 15 | 80 | 60[4] |
| | | | | | | 30[4] |
| | | | | | | 20[4] |
| Benzene Content (percent by volume) | 1.00 | 0.80 | 0.80 | 0.70 | 1.20 | 1.10 |
| Aromatics Content (percent by volume) | 25.0 | 25.0 | 22.0 | 22.0 | 30.0[3] | 35.0 |
| Olefins Content (percent by volume) | 6.0 | 6.0 | 4.0 | 4.0 | 10.0 | 10.0 |
| T50 (degrees Fahrenheit) | 210 | 213 | 200 | 203 | 220 | 220 |
| T90 (degrees Fahrenheit) | 300 | 305 | 290[5] | 295 | 330 | 330 |
| Oxygen Content (percent by weight) | 1.8 - 2.2 | 1.8 - 2.2 | Not Applicable | Not Applicable | 1.8[6] - 3.5 | 1.8[6]-3.5[7] |
| | | | | | 0[6] - 3.5 | 0[6] - 3.5[7] |
| Methyl tertiary-butyl ether (MTBE) and oxygenates other than ethanol | Not Applicable | Prohibited as provided in § 2262.6 | Not Applicable | Not Applicable | Not Applicable | Prohibited as provided in § 2262.6 |

1 The Reid vapor pressure (RVP) standards apply only during the warmer weather months identified in section 2262.4.

2 The 6.90 pounds per square inch (psi) flat limit applies ~~only~~ when a producer or importer is using the ~~evaporative emissions model element of the~~ CaRFG Phase 3 Predictive Model~~, in which case all predictions for evaporative emissions increases or decreases made using the evaporative emissions model are made relative to 6.90 psi and the gasoline may not exceed the maximum RVP cap limit of 7.20 psi~~ to certify a final blend not containing ethanol. Otherwise, the 7.00 psi limit applies.~~Where the~~

~~evaporative emissions model element of the CaRFG Phase 3 Predictive Model is not used, the RVP of gasoline sold or supplied from the production or import facility may not exceed 7.00 psi.~~

[3] For sales, supplies, or offers of California gasoline downstream of the production or import facility starting on the date on which early compliance with the CaRFG Phase 3 standards is permitted by the executive officer under section 2261(b)(3), the CaRFG Phase 2 cap limits for Reid vapor pressure and aromatics content shall be 7.20 psi and 35.0 percent by volume respectively.

[4] The CaRFG Phase 3 sulfur content cap limits of 60, ~~and~~ 30, and 20 parts per million are phased in starting December 31, 2003, ~~and~~ December 31, 2005, and December 31, 2009, respectively, in accordance with section 2261(b)(1)(A).

[5] Designated alternative limit may not exceed 310.

[6] The 1.8 percent by weight minimum oxygen content cap only applies during specified winter months in the areas identified in section 2262.5(a).

[7] If the gasoline contains more than 3.5 percent by weight oxygen from ethanol but no more than 10.0 volume percent ethanol, the maximum oxygen content cap is 3.7 percent by weight.

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**Section 2262.3 Compliance With the CaRFG Phase 2 and CaRFG Phase 3 Standards for Sulfur, Benzene, Aromatic Hydrocarbons, Olefins, T50 and T90.**

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(b) ***Compliance by producers and importers with the flat limits.*** No producer or importer shall sell, offer for sale, supply, or offer for supply from its production facility or import facility California gasoline which exceeds an applicable flat limit for the properties of sulfur, benzene, aromatic hydrocarbons, olefins, T50, or T90 set forth in section 2262, unless the gasoline (1) is subject to the averaging compliance option for the property in accordance with section 2264.2(a), (2) has been reported as a PM alternative gasoline formulation pursuant to section 2265(a), ~~or~~ (3) has been reported as a test-certified alternative gasoline formulation pursuant to section 2266(c), (4) has been reported as a PM emissions offsetting formulation pursuant to section 2265.1 (applicable only to producers and importers that produce gasoline), or (5) is subject to an alternative emission reduction plan pursuant to section 2265.5 (applicable only to producers and importers that produce gasoline). Notwithstanding section 2265.5(a), a producer or an importer that produces gasoline and that has elected to be subject to the flat limits specified in section 2262 shall offset its emissions associated with permeation by complying with sections 2265.5(b) – (i). An importer that does not produce gasoline shall not sell, offer for sale, supply, or offer for supply California gasoline if the gasoline creates emissions associated with permeation.

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(c) ***Optional compliance by producers and importers with the averaging limits.*** No producer or importer shall sell, offer for sale, supply, or offer for supply from its production facility or import facility California gasoline which is subject to the

averaging compliance option for the properties of sulfur, benzene, aromatic hydrocarbons, olefins, T50 or T90 in accordance with section 2264.2(a) if any of the following occurs~~:~~. Notwithstanding section 2265.5(a), a producer or an importer that produces gasoline and that has elected to be subject to an averaging limit specified in section 2262 shall offset its emissions associated with permeation by complying with sections 2265.5(b) – (i). An importer that does not produce gasoline shall not sell, offer for sale, supply, or offer for supply California gasoline if the gasoline creates emissions associated with permeation.

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(d) ***Optional compliance by producers or importers that produce gasoline with the PM emissions offsetting compliance option.*** No producer or importer that produces gasoline shall sell, offer for sale, supply, or offer for supply from its production facility or import facility a final blend of California gasoline as a PM emissions offsetting formulation subject to the designated emissions offsetting limits if any of the following occurs:

(1) The gasoline exceeds any of the designated emissions offsetting limits for sulfur, benzene, aromatic hydrocarbons, olefins, oxygen, T50, or T90 for the final blend; or

(2) The gasoline exceeds the designated emissions offsetting limit for the final blend for RVP during any of the regulatory control periods in section 2262.4(b)(2).

(3) The excess emissions of oxides of nitrogen, total ozone forming potential, or the potency-weighted toxics associated with excess sulfur in a final blend of gasoline is not fully and timely offset in accordance with section 2265.1(c).

(4) The gasoline required to be offset and the offsetting gasoline are sold, offered, or supplied in different regions where the gasoline is normally offered for sale.

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**Section 2262.4. Compliance With the CaRFG Phase 2 and CaRFG Phase 3 Standards for Reid Vapor Pressure.**

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(b) ***Compliance by producers and importers with the flat limit for Reid vapor pressure.***

(1) ***Reid vapor pressure standard for producers and importers.***

(A) In an air basin during the regulatory control periods specified in section (b)(2), no producer or importer shall sell, offer for sale, supply, or offer for supply from its production facility or import facility California gasoline which has a

Reid vapor pressure exceeding the applicable flat limit set forth in section 2262 unless the gasoline has been reported as either a PM alternative gasoline formulation pursuant to section 2265(a) or a PM emissions offsetting formulation pursuant to section 2265.1 (applicable only to producers and importers that produce gasoline) using the evaporative emissions model element of the CaRFG Phase 3 Predictive Model.

(B)In an air basin during the regulatory control periods specified in section (b)(2), no producer or importer shall sell, offer for sale, supply, or offer for supply from its production facility or import facility California gasoline which has been reported either as a PM alternative gasoline formulation pursuant to section 2265(a) or a PM emissions offsetting formulation pursuant to section 2265.1 (applicable only to producers and importers that produce gasoline) using the evaporative emissions model element of the CaRFG Phase 3 Predictive Model if the gasoline has a Reid vapor pressure exceeding the PM flat limit for Reid vapor pressure in the identified PM alternative specifications or the designated emissions offsetting limits, as applicable.

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Section 2262.5. Compliance With the Standards for Oxygen Content.

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(c) ***Compliance by producers and importers with the flat limits for oxygen content.*** No producer or importer shall sell, offer for sale, supply, or offer for supply from its production or import facility California gasoline which has an oxygen content less than flat limit for minimum oxygen content, or more than flat limit for maximum oxygen content, unless the gasoline has been (1) reported as a PM alternative gasoline formulation pursuant to section 2265(a), or as a PM emissions offsetting formulation pursuant to section 2265.1 (applicable only to producers and importers that produce gasoline), or as an alternative gasoline formulation pursuant to section 2266(c), and (2) complies with the standards contained in sections (a) and (b).

(d) ***Restrictions on adding oxygenates to California gasoline after it has been supplied from the production or import facility.***

(1) *Basic Restriction.* No person may add oxygenates to California gasoline after it has been supplied from the production or import facility at which it was produced or imported, except where the person adding the oxygenates demonstrates that: ~~[i]~~(A) the gasoline to which the oxygenates are added has been reported as a PM alternative gasoline formulation pursuant to section 2265(a), or as a PM emissions offsetting formulation pursuant to section 2265.1 (applicable only to producers and importers that produce gasoline), or as an alternative gasoline formulation pursuant to section 2266(c), and has not been commingled with other gasoline, and ~~[ii]~~(B) both before and after the person adds the oxygenate to the

gasoline, the gasoline has an oxygen content within the oxygen content specifications of the applicable PM alternative gasoline formulation, PM emissions offsetting formulation, or alternative gasoline formulation. Nothing in this section (d) prohibits adding oxygenates to CARBOB.

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**Section 2262.9. Requirements Regarding Denatured Ethanol Intended For Use as a Blend Component in California Gasoline.**

(a) ***Standards.***

(1) ***Standards for denatured ethanol.*** Starting December 31, 2003, no person shall sell, offer for sale, supply or offer for supply denatured ethanol intended for blending with CARBOB or California gasoline that fails to comply with any of the following standards:

* * * * *

(B) ***Standards based on ASTM D 4806-99***. All test methods and standards identified in the title and the table below are incorporated herein by reference.

| *Specification* | *Value* | *Test method* |
|---|---|---|
| Ethanol, vol.%, min. | 92.1 | ASTM D 5501-94(1998)ε1 |
| Methanol, vol.%, max. | 0.5 | |
| Solvent-washed gum, mg/100 ml, max. | 5.0 | ASTM D 381-00, air jet apparatus |
| Water content, vol.%, max. | 1 | ASTM E 203-96 or E 1064-00 |
| Denaturant content, vol.%, min.<br>vol.% max.<br>*The only denaturants shall be natural gasoline, gasoline components, or unleaded gasoline.* | 1.96<br>~~4.76~~<br>5.00[a] | |
| Inorganic Chloride content, mass ppm (mg/l), max. | 40 (32) | Modification of ASTM D512-89(1999), Procedure C[~~1~~b] |
| Copper content, mg/kg, max. | 0.1 | Modification of ASTM D1688-95, Test Method A[~~2~~c] |
| Acidity (as acetic acid), mass % (mg/l), max. | 0.007 (56) | ASTM D 1613-96 (1999) |
| pHe | 6.5 - 9.0 | ASTM D 6423-99 |
| Appearance | Visibly free of suspended or precipitated contaminants (clean and bright) | Determined at indoor ambient temperature unless otherwise agreed upon between the supplier and purchaser |

Note a: The maximum denaturant content limit is changed from 4.76 v% to 5.00 v% to be consistent with ASTM 4806-06c

Note ~~1~~b: The modification of ASTM D 512-89(1999), Procedure C consists of using 5 ml of sample diluted with 20 ml of water in place of the 25 ml sample specified in the standard procedure. The water shall meet ASTM D 1193-99, Type II. The volume of the sample prepared by this modification will be slightly larger than 25 ml. To allow for the dilution factor, report the chloride ion present in the fuel ethanol sample as the chloride ion present in the diluted sample multiplied by five.

Note ~~2~~c: The modification of ASTM D 1688-95, Test Method A (atomic absorption) consists of mixing reagent grade ethanol (which may be denatured according to the U.S. Bureau of Alcohol, Tobacco, and Firearms (BATF) of the U.S. Treasury Department Formula 3A or 30, as set forth in 27 CFR sections 21.35 and 21.57, as in effect April 1, 2001) in place of water as the solvent or diluent for the preparation of reagents and standard solutions. However, this must not be done to prepare the stock copper solution described in 11.1 of ASTM D 1688-95. Because a violent reaction may occur between the acid and the ethanol, use water, as specified, in the acid solution part of the procedure to prepare the stock copper solution. Use ethanol for the rinse and dilution only.

* * * * *

(3) ***Standards for products represented as appropriate for use as a denaturant in ethanol.***

* * * * *

(B) A person may sell, offer for sale, supply or offer for supply a product that is represented as only suitable for use as an ethanol denaturant in ethanol intended for blending with CARBOB or California gasoline if the denatured ethanol contains no more than a specified percentage of the denaturant that is less than ~~4.76~~ 5.00 percent. In this case, the product must be prominently labeled as only lawful for use as a denaturant where the denatured ethanol contains no more than the specified percentage of the denaturant, and the seller, supplier or offeror must take reasonably prudent precautions to assure that the denaturant will not be used in concentrations greater than the specified percentage in ethanol intended for blending with CARBOB or California gasoline. If these conditions are met, the standards in section (a)(3)(A) for the denaturant will be adjusted by multiplying the stated values by (~~4.76~~5.00 ÷ max.%), where "max.%" is the maximum percentage by volume of denaturant specified for the denatured ethanol.

(b) ***Test Methods.***

(1) In determining compliance with the denatured ethanol standards in section (a)(1)(A):

* * * * *

(B) The aromatic hydrocarbon, benzene and olefins content of denatured ethanol shall be determined by sampling the denaturant and using the methods specified in section 2263 to determine the content of those compounds in the denaturant. The result will then be multiplied by ~~0.0476~~ 0.0500, except that where it is demonstrated that the denatured ethanol contains less than ~~4.76~~ 5.00 percent denaturant, the result will be multiplied by the decimal fraction representing the percent denaturant.

* * * * *

**Section 2263. Sampling Procedures and Test Methods.**

* * * * *

(b) ***Test Methods***.

(1) In determining compliance with the gasoline standards set forth in this subarticle 2, including those in the sections identified in Table 1, the test methods presented in Table 1 shall be used. All identified test methods are incorporated herein by reference.

**Table 1**

| *Section* | *Gasoline Specification* | *Test Method* [a] |
|---|---|---|
| 2262 | Reid Vapor Pressure | ASTM D 323-58 [b] or 13 C.C.R. Section 2297 |
| 2262 | Sulfur Content | ASTM D 2622-94 [c, d] or ASTM D 5453-93 |
| 2262 | Benzene Content | ASTM D 5580-00 [e] |
| 2262 | Olefin Content | ASTM D 1319-95a [f] (Through December 31, 2001) ASTM D 6550-00[g,h,i] (Starting January 1, 2002) |
| 2262 | Oxygen Content | ASTM D 4815-~~99~~04 |
| 2262 | T90 and T50 | ASTM D 86-99aε1 |
| 2262 | Aromatic Hydrocarbon Content | ASTM D 5580-00 [j] |
| 2262.5(b) | Ethanol Content | ASTM D 4815-~~99~~04 |
| 2262.6 | MTBE Content | ASTM D 4815-~~99~~04 |
| 2262.6(c) | Oxygen from oxygenates identified in section 2262.6(c)(4) | *ASTM D 4815-~~99~~04* |

* * * * *

**Section 2263.7. Multiple Notification Requirements.**

Where a producer or importer is subject to multiple notification requirements pursuant to sections 2264(a)(2)(A), 2265.1 (applicable only to producers and importers that produce gasoline), 2265.5 (applicable only to producers and importers that produce gasoline), 2264.2(a)(2), 2264.2(b)(2), 2265(a)(2), 2266(c) or 2266.5(b), the producer or importer shall combine the notifications to the extent practicable.

* * * * *

**Section 2264.2. Election of Applicable Limit for Gasoline Supplied From a Production or Import Facility.**

(a) ***Election of the averaging compliance option*.**

* * * * *

(3) A producer or importer may not elect to sell, offer, or supply from its production facility or import facility a final blend of California gasoline subject to the averaging compliance option in section 2264 if the producer or importer is subject to any outstanding requirements to provide PM emissions offsets pursuant to section 2265.1(c) or emission reductions pursuant to section 2265.5 at the same production facility or import facility.

(b) ***Election of flat limit compliance option.***

* * * * *

(3) Once a producer or importer has made an election under this section 2264.2(b) with respect to a gasoline property, all final blends subsequently sold or supplied from the production or import facility shall be subject to the flat limit compliance option for that property until the producer or importer either (A) elects in accordance with section 2264.2(a) to have a final blend at the facility subject to the averaging compliance option for that property, or (B) elects in accordance with section 2265(a) to sell or supply a final blend at the facility as a PM alternative gasoline formulation, or (C) elects in accordance with section 2264.2(d) to sell or supply a final blend at the facility as a PM emissions offsetting formulation (applicable only to producers and importers that produce gasoline), or (D) elects in accordance with section 2265.5 to have a final blend at the facility subject to a PM alternate emissions reduction plan (applicable only to producers and importers that produce gasoline), or (E) elects in accordance with section 2266(c) to sell or supply a final blend at the facility as an alternative gasoline formulation.

* * * * *

(5) A producer or importer may not elect to sell, offer, or supply from its production facility or import facility a final blend of California gasoline subject to the flat limit compliance option if the producer or importer is subject to any outstanding requirements to provide PM emissions offsets pursuant to section 2265.1(c) or emission reductions pursuant to section 2265.5 at the same production facility or import facility.

* * * * *

(d) ***Election of the PM emissions offsetting compliance option.***

(1) Applicability. This subsection shall apply to a producer or importer that produces gasoline when all of the following conditions are satisfied:

(A) With regard to a batch of gasoline that does not meet the criteria for approval in the applicable Predictive Model Procedures, immediately prior to producing that batch, the producer or importer has reported its gasoline as a PM alternative gasoline formulation pursuant to section 2265(a),

(B) The actual sulfur content in the PM alternative gasoline formulation exceeds the PM alternative specification,

(C) But for the elevated sulfur content, the PM alternative specifications would have met the criteria for approval in the applicable Predictive Model Procedures,

(D) The gasoline reported as a PM alternative gasoline formulation has a percent change in emissions value either for oxides of nitrogen, total ozone forming potential, or potency-weighted toxics that results in a final blend deficit, and

(E) The producer or importer is not subject to any outstanding requirements to provide offsets at the same production facility or import facility pursuant to section 2264(c).

(2) A producer or importer that produces gasoline selling, offering, or supplying a final blend of gasoline from its production facility or import facility may elect pursuant to this section 2264.2(d) to have the final blend subject to the PM emissions offsetting compliance option.

(3) Once a producer or importer has made such an election for a final blend of gasoline, all final blends subsequently sold or supplied from the production facility or import facility, whether associated with a final blend deficit or a final blend credit, shall be subject to the PM emissions offsetting compliance option until the producer or importer either (A) elects in accordance with section 2264.2(a) to have a final blend at the facility subject to the averaging compliance option, or (B) elects in accordance with section 2264.2(b) to have a final blend at the facility subject to the flat limit compliance option for all fuel properties, or (C) elects in accordance with section 2265(a) to sell or supply a final blend at the facility as a PM alternative gasoline formulation, or (D) elects in accordance with section 2266(c) to sell or supply a final blend at the facility as an alternative gasoline formulation.

(4) In order to elect to have a final blend subject to the PM emissions offsetting compliance option for a final blend, the producer or importer shall notify the executive officer of such election and of the information identified in section 2265.1(a)(2)(A), within the time limits set forth in section 2265.1(a)(2)(A) and subject to section 2265.1(a)(3) and (4).

(5) Once a producer or importer has made an election under this section 2264.2(d) with respect to the PM emissions offsetting compliance option, the producer or importer may not use any previously assigned designated alternative limit for any fuel property to provide offsets pursuant to section 2264(c) for any final blend sold or supplied from the production facility or import facility subsequent to the election.

* * * * *

**Section 2265. Gasoline Subject to PM Alternative Specifications Based on the California Predictive Model.**

(a) ***Election to sell or supply a final blend as a PM alternative gasoline formulation.***

* * * * *

(2) The producer or importer shall evaluate the candidate PM alternative specifications for gasoline subject to the CaRFG Phase 2 standards in accordance with the Air Resources Board's "California Procedures for Evaluating Alternative Specifications for Phase 2 Reformulated Gasoline Using the California Predictive Model," as adopted April 20, 1995 and last amended December 11, 1998, which is incorporated herein by reference. The producer or importer shall evaluate the candidate PM alternative specifications for gasoline subject to the CaRFG Phase 3 standards in accordance with the Air Resources Board's "California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model," as

corrected November 18, 2004, which is incorporated herein by reference. Starting December 31, 2009, the producer or importer shall evaluate the candidate PM alternative specifications for gasoline subject to the CaRFG Phase 3 standards in accordance with the Air Resources Board's "California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model," as corrected November 18, 2004 and last amended [**insert Board adoption date**], which is incorporated herein by reference. (theThe twothree documents incorporated by reference in this section 2265(a)(2) are collectively referred to as the "Predictive Model Procedures.")). If the PM alternative specifications meet the criteria for approval in the applicable Predictive Model Procedures, the producer shall notify the executive officer of: (A) The identity and location of the final blend; (B) the PM alternative specifications that will apply to the final blend, including for each specification whether it applies as a PM flat limit or a PM averaging limit; and (C) the numerical values for percent change in emissions for oxides of nitrogen, hydrocarbonstotal ozone forming potential, and potency-weighted toxic air contaminants as determined in accordance with the applicable Predictive Model Procedures. The notification shall be received by the executive officer before the start of physical transfer of the gasoline from the production or import facility, and in no case less than 12 hours before the producer or importer either completes physical transfer or commingles the final blend.

(3) Once a producer or importer has notified the executive officer pursuant to this section 2265(a) that a final blend of California gasoline is being sold or supplied from a production or import facility as a PM alternative gasoline formulation, all final blends of California gasoline subsequently sold or supplied from that production or import facility shall be subject to the same PM alternative specifications until the producer or importer either (A) designates a final blend at that facility as a PM alternative gasoline formulation subject to different PM alternative specifications, (B) elects in accordance with section 2264.2 to have a final blend at that facility subject to flat limit compliance options and/or averaging compliance options, or (C) elects in accordance with section 2266(c) to sell a final blend at that facility as an alternative gasoline formulation, or (D) elects in accordance with section 2264.2(d) to sell or supply a final blend at that facility as a PM emissions offsetting formulation (applicable only to producers and importers that produce gasoline), or (E) elects in accordance with section 2265.5 to have a final blend at that facility subject to a PM alternative emissions reduction plan (applicable only to producers and importers that produce gasoline).

* * * * *

(c) ***Restrictions associated with elections to sell or supply final blends as PM alternative gasoline formulations.***

* * * * *

(4) A producer or importer may not elect to sell or supply from its production facility or import facility a final blend of California gasoline as a PM alternative gasoline formulation if the producer or importer is subject to any outstanding requirements to provide offsets pursuant to section 2265.1(c) or emission reductions pursuant to section 2265.5 at the same production facility or import facility.

* * * * *

**Section 2265.1. Offsetting Emissions Associated with Higher Sulfur Levels.**

**(a) *Assignment of designated emissions offsetting limits and percent change in emissions values for batches of gasoline for which the emissions associated with higher sulfur levels are being offset*.**

(1) A producer or an importer that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option must assign a designated emissions offsetting limit for the sulfur, benzene, olefin, aromatic hydrocarbon, and oxygen (maximum and minimum) contents, and for the T90, T50, and RVP (during the RVP regulatory control period in section 2262.4(b)(2)) for each final blend of California gasoline produced by the producer or the importer and satisfying the notification requirements in this section (a). In no case shall a designated emissions offsetting limit be less than the sulfur, benzene, olefin, or aromatic hydrocarbon contents, T90, T50, or RVP, or less than the maximum oxygen content or greater than the minimum oxygen content of the final blend shown by the sample and test conducted pursuant to section 2270. For each final blend, the producer or the importer that produces gasoline shall also assign the percent change in emissions values, as they pertain to the PM emissions offsetting compliance option, for oxides of nitrogen, total ozone forming potential, and potency-weighted toxics.

(2) ***Notification of final blends associated with a final blend deficit***

(A) Except as otherwise provided, for each final blend that has a percent change in emissions value greater than 0.04 percent for oxides of nitrogen, total ozone forming potential, or potency-weighted toxics (referred to as the deficit final blend), the producer or the importer that produces gasoline shall notify the executive officer in writing, for receipt by the executive officer before the start of physical transfer of the gasoline from the production facility or the import facility, and in no case less than 12 hours before the producer or the importer that produces gasoline either completes physical transfer or commingles the final blend, with the following information:

1. Justification for using the PM emissions offsetting compliance option, including but not limited to, an explanation for the elevated sulfur level in the final blend and why the batch will not be re-blended or a different predictive model formulation will not be developed.

2. The targeted PM alternative specifications that the producer or the importer that produces gasoline was intending to produce and which would have resulted in a passing PM formulation but for the actual sulfur content of the blend.

3. The percent change in emissions values, as they pertain to the PM emissions offsetting compliance option, for oxides of nitrogen, total ozone forming potential, and potency-weighted toxics for the targeted PM alternative specifications,

4. The company name, address, phone number, and contact information,

5. The production facility or import facility name, batch name, number, or other identification, the blend identity, grade of California gasoline, the location (with sufficient specificity to allow ARB inspectors to locate and sample the gasoline; this shall include, but is not limited to, the name of the facility, address, and identification of the tank), and other information that uniquely identifies the California gasoline subject to the PM emissions offsetting compliance option,

6. The estimated volume (in barrels),

7. The designated emissions offsetting limit for RVP, sulfur content, benzene content, aromatics content, olefins content, T50, T90, and oxygen content for the final blend,

8. The percent change in emissions values, as they pertain to the PM emissions offsetting compliance option, for oxides of nitrogen, total ozone forming potential, and potency-weighted toxics for the final blend,

9. A statement, signed by a legal representative for the producer or the importer that produces gasoline that all information submitted with the notification is true and correct, and

10. Within 24 hours after the start of the physical transfer, the date and time of the start of physical transfer from the production facility or import facility.

(B) A producer or importer that produces gasoline may report an actual volume that is less than the estimated volume, as long as notification of the actual volume is received by the executive officer no later than 48 hours after completion of the physical transfer of the final blend from the production facility or import facility. If notification of the actual volume is not timely received by the executive officer, the reported estimated volume shall be deemed the reported actual volume. If the actual volume is larger than initially estimated, the producer or the importer that produces gasoline shall revise the reported estimated volume by notifying the executive officer no

later than 24 hours after completion of the physical transfer of the final blend from the production facility or import facility.

(3) ***Notification of final blends associated with a final blend credit***.

(A) For each final blend associated with a final blend credit, the producer or the importer that produces gasoline shall notify the executive officer in writing for receipt by the executive officer before the start of physical transfer of the gasoline from the production facility or the import facility, and in no case less than 12 hours before the producer or the importer that produces gasoline either completes physical transfer or commingles the final blend, with the following information:

(1) The company name, address, phone number, and contact information,

(2) The production facility or the import facility name, batch name, number, or other identification, the blend identity, grade of California gasoline, the location (with sufficient specificity to allow ARB inspectors to locate and sample the gasoline; this shall include, but is not limited to, the name of the facility, address, and identification of the tank), and other information that uniquely identifies the California gasoline associated with a final blend credit,

(3) The estimated volume (in barrels),

(4) The designated emissions offsetting limits for RVP, sulfur content, benzene content, aromatics content, olefins content, T50, T90, and oxygen content for the final blend,

(5) The percent change in emissions values, as they pertain to the PM emissions offsetting compliance option, for oxides of nitrogen, total ozone forming potential, and potency-weighted toxics for the final blend,

(6) A statement, signed by a legal representative for the producer or the importer that produces gasoline that all information submitted with the notification is true and correct, and

(7) Within 24 hours after the completion of the physical transfer, the date and time of the completion of physical transfer from the production facility or the import facility.

(B) A producer or importer that produces gasoline may report an actual volume that is more than the estimated volume, as long as notification of the actual volume is received by the executive officer no later than 48 hours after completion of the physical transfer of the final blend from the production facility or the import facility. If notification of the actual volume is not timely received by the executive officer, the reported estimated volume shall be

deemed the reported actual volume. If the actual volume is less than initially estimated, the producer or the importer that produces gasoline shall revise the reported estimated volume by notifying the executive officer no later than 24 hours after completion of the physical transfer of the final blend from the production facility or import facility.

(4) If, through no intentional or negligent conduct, a producer or importer that produces gasoline cannot report within the time period specified in (a)(2) or (a)(3) above, the producer or importer that produces gasoline may notify the executive officer of the required data as soon as reasonably possible and may provide a written explanation of the cause of the delay in reporting. If, based on the written explanation and the surrounding circumstances, the executive officer determines that the conditions of this section (a)(4) have been met, timely notification shall be deemed to have occurred.

(5) The executive officer may enter into a written protocol with any individual producer or importer that produces gasoline for the purposes of specifying how the requirements in sections (a)(2) and (c) shall be applied to the producer's or importer's particular operations, as long as the executive officer reasonably determines that application of the regulatory requirements under the protocol is not less stringent or enforceable than application of the express terms of sections (a)(2) and (c). Any such protocol shall include the producer's or importer's agreement to be bound by the terms of the protocol.

**(b) *Additional prohibitions regarding gasoline with designated emissions offsetting limits and final blend credits or deficits.***

(1) No producer or importer that produces gasoline shall sell, offer for sale, or supply California gasoline with a final blend deficit, where the total volume of the final blend sold, offered for sale, or supplied exceeds the volume reported to the executive officer pursuant to section (a).

(2) No producer or importer that produces gasoline shall sell, offer for sale or supply California gasoline with a final blend credit, where the total volume of the final blend sold, offered for sale, or supplied is less than the volume reported to the executive officer pursuant to section (a).

(3) Final blend credits shall not include offsets or other reductions that are otherwise required by any local, State, or federal rule, regulation, or statute, or that are achieved or estimated from California gasoline not produced or imported in the same air basin as the gasoline with a final blend deficit, or that are claimed under any alternative emission reduction plan.

(c) ***Offsetting a final blend deficit.*** With respect to each final blend for which a producer or importer that produces gasoline has elected to be subject to the PM emissions offsetting compliance option, within 90 days after the start of physical transfer from a production facility or import facility of any final blend of California

gasoline with a final blend deficit, the producer or importer shall complete physical transfer from the same production facility or import facility of California gasoline with a final blend credit in sufficient quantity and for the same emissions parameter (oxides of nitrogen, total ozone forming potential, or potency-weighted toxics) to fully offset the final blend deficit.

For example, within 90 days after the start of physical transfer from a production facility or import facility of 100 barrels of any final blend of California gasoline to which a producer or importer that produces gasoline has assigned a designated emissions offsetting limit which results in a 0.10 percent increase in oxides of nitrogen, the producer or importer that produces gasoline shall complete physical transfer from the same production facility or import facility of California gasoline in sufficient quantity and quality to offset the 6 deficit points for oxides of nitrogen. The final blend deficit is calculated as:

Final Blend Deficit = (0.10 – 0.04) x 100 = 6

(d) ***Automatic termination of the producer's or importer's use of the PM emissions offsetting compliance option.***

When a producer or importer that produces gasoline has fully offset the final blend deficit, the producer's or importer's use of the PM emissions offsetting compliance option automatically terminates. Prior to selling, supplying, or offering California gasoline after the termination, the producer or importer that produces gasoline must elect to use the flat limits, designated alternative limits, PM alternative specifications, or TC limits for its next final blend. The producer or importer that produces gasoline may not use any remaining final blend credits to provide offsets pursuant to section 2265.1(c) for any final blend sold, offered, or supplied from the production facility or import facility subsequent to the election.

NOTE: Authority cited: sections 39600, 39601, 43013, 43013.1, 43018, and 43101, Health and Safety Code; and *Western Oil and Gas Ass'n*. v. *Orange County Air Pollution Control District*, 14 Cal.3d 411, 121 Cal.Rptr. 249 (1975). Reference: sections 39000, 39001, 39002, 39003, 39010, 39500, 39515, 39516, 41511, 43000, 43013, 43013.1, 43016, 43018, and 43101, Health and Safety Code; and *Western Oil and Gas Ass'n.* v. *Orange County Air Pollution Control District*, 14 Cal.3d 411, 121 Cal.Rptr. 249 (1975).

## Section 2265.5 Alternative Emission Reduction Plan (AERP)

(a) *Applicability*. This section shall apply to a producer or importer that produces gasoline when all of the following conditions are satisfied:

(1) With regard to a batch of gasoline that does not meet the criteria for approval in the applicable Predictive Model Procedures, immediately prior to producing or importing that batch, the producer or importer has reported its gasoline as a PM alternative gasoline formulation pursuant to section 2265(a),

(2) But for the elevated emissions associated with permeation, the PM alternative specifications would have met the criteria for approval in the applicable Predictive Model Procedures,

(3) All measures to correct the emissions associated with permeation would result in an economic hardship to the producer or importer and the benefit in allowing the producer or importer to use an alternative emission reduction plan is not outweighed by the public interest in enforcing the applicable Predictive Model Procedures,

(4) The producer or importer is not subject to any outstanding requirements to provide offsets at the same production facility or import facility pursuant to section 2264(c), and

(5) All AERPs sunset on December 31, 2011, unless the producer or importer requests in writing, and the Executive Officer approves in advance, an extension of the AERP for up to one additional year.

(b) *Requirements*.

(1) Where the producer or importer that produces gasoline has reported its final blend of gasoline as a flat limit formulation pursuant to section 2264.2(b), averaging limit formulation pursuant to section 2264.2(a), PM alternative gasoline formulation pursuant to section 2265(a), or test-certified alternative gasoline formulation pursuant to section 2266(c), compliance with a valid AERP shall constitute compliance with the requirements of section 2262.3(b), 2262.3(c), 2265, or 2266, respectively.

(2) An AERP application demonstrating compliance with this subsection shall contain at a minimum all of the following information:

(A) The company name, address, phone number, and contact information,

(B) The producer's or importer's name, batch name, number or other identification, grade of California gasoline, and other information that uniquely identify the California gasoline subject to the AERP,

(C) An explanation describing why the producer or importer cannot eliminate the emissions associated with permeation by reformulation or reprocessing its gasoline,

(D) The total emissions of oxides of nitrogen (NOx), total ozone forming potential, and potency-weighted toxics that would be associated with the use of California gasoline were the producer or importer to eliminate the emissions associated with permeation from its gasoline,

(E) Documentation, calculations, emissions test data, or other information that establishes the amount of NOx and associated with the producer's or importer's gasoline,

(F) The emission reduction strategy(ies) for the AERP and the date(s) that the offsets will accrue and expire for each strategy,

(G) The applicant's market share for the fuel produced under the AERP,

(H) Demonstration that the emission reduction strategy(ies) in the AERP will result in equivalent or better emission benefits for NOx, total ozone forming potential, and potency-weighted toxics than would be achieved through elimination of emissions associated with permeation from the gasoline for the same affected region and for the period the AERP will be in effect, during and outside the RVP regulatory control periods in section 2262.4(b)(2),

(I) Demonstration that the emission reductions are achieved in the general region where the fuel is sold,

(J) The proposed recordkeeping, reporting, monitoring, and testing procedures that the applicant plans to use to demonstrate continued compliance with the AERP and achievement of each increment of progress toward compliance,

(K) Adequate enforcement provisions,

(L) For each final blend of California gasoline to which the AERP applies, the NOx, total ozone forming potential, and potency-weighted toxics emission limits during the period the AERP will be in effect,

(M) The projected volume of each final blend of California gasoline subject to the AERP during the period the AERP will be in effect,

(N) The period that the AERP will be in effect,

(O) A compliance plan that includes increments of progress (specific events and dates) that describe periodic, measurable steps toward compliance during the proposed period of the AERP,

(P) The date by which the producer or importer plans to discontinue using the AERP,

(Q) A statement, signed by a legal representative for the producer or importer that all information submitted with the AERP application is true and correct, and

(R) The producer's or importer's agreement to be bound by the terms of the AERP.

(3) Emission reduction calculations demonstrating equivalence between the AERP and elimination of the emissions associated with permeation from the gasoline shall only include NOx, total ozone forming potential, and potency-weighted toxics emissions from California gasoline sold or supplied in California.

(4) An applicant wishing to participate in an AERP may include one or more production facilities or import facilities, but the applicant shall only include such facilities that the applicant owns or operates under their direct control.

(5) The emission reduction associated with the AERP must be from combustion related sources or gasoline related sources.

(6) AERPs may include, but are not limited to:

(A) Vehicle scrappage,

(B) Offsetting emissions with lower emitting diesel fuel batches,

(C) Incentive grants for cleaner-than-required engines, equipment and other sources of pollution providing early or extra emission reductions.

(7) Emission reductions included in an AERP shall not include reductions that are otherwise required by any local, State, or federal rule, regulation, or statute, or that are achieved or estimated from equipment not located within the region associated with the AERP, or that are claimed under section 2265.1, or that are claimed under another program, such as the Voluntary Accelerated Vehicle Retirement or Carl Moyer program, or the result of standard business practices that the producer or importer would have done without the AERP.

(8) The producer or importer subject to an approved AERP shall maintain all records required to verify compliance with the provisions of the AERP in a manner and form specified by the Executive Officer in the approved AERP. Required records may include, but are not limited to, volume of California gasoline sold, offered, or supplied to which the AERP applies, and/or emissions test results. Such records shall be retained for a period of not less than five (5) years and shall be submitted to the Executive Officer within 20 days in the manner specified in the approved AERP and upon request by the Executive Officer.

(9) Prior to selling, offering, or supplying a batch of California gasoline with emissions associated with permeation, the producer or importer shall first have established sufficient offsets for the applicable emissions associated with permeation. With the exception of offsets from vehicle scrappage and

incentive grants for cleaner-than-required engines, equipment and other sources of pollution, offsets shall expire at midnight on the day they accrued.

(c) *Application Process*.

(1) Applications for an AERP shall be submitted in writing to the Executive Officer for evaluation.

(2) The application shall be accompanied by a fee of $6,700.00 to cover the costs of processing the AERP application. If the applicant withdraws the application before the 30-day first comment period, $4,100.00 of the fee shall be refunded.

(3) The Executive Officer shall make available for public review all documents pertaining to an AERP application.

(4) The Executive Officer will send a notice to subscribers of the Fuels listserv that a person has requested the Executive Officer consider a request for an AERP. The Executive Officer shall also provide a copy of all such documents to each person who has requested copies of the documents. Collectively, those persons on the Fuels listserv and those persons who have requested copies of the documents shall be treated as interested parties.

(5) After an AERP application has been received and deemed complete, the Executive Officer shall provide a 30-day public comment period to receive comments on any element of the AERP application. Any public comment addressing whether the Executive Officer should approve or disapprove the AERP application shall be based on the contents and merits of the application. No comment received by the Executive Officer after the 30-day period will be considered. The Executive Officer shall send to subscribers of the Fuels listserv, and mail to those interested parties who have requested copies by mail, of the following:

(A) The identity of the applicant producer(s) or importer(s);
(B) The start and end dates for the 30-day comment period;
(C) The address of the AERP internet site where the application is posted; and.
(D) Where and how to submit comments.

The Executive Officer shall post on the AERP internet site, send to subscribers of the Fuels listserv, and mail to those interested parties who have requested copies by mail, notification of public comments received during the 30-day comment period.

(6) The Executive Officer may hold a public hearing to accept public comments or decide the merits of the application.

(7) *Final Action.*

After the public comment period ends, the Executive Officer may take final action to either approve or deny the AERP application. The Executive Officer shall notify the applicant, post on the ARB internet site, send to subscribers of the Fuels listserv, and mail to those interested parties who have requested copies by mail, of the final action.

(8) *Notification to the Executive Officer of Changes to information in the AERP application.* The applicant shall notify the Executive Officer in writing within 30 days upon learning of any information that would alter any information provided in the AERP application.

(d) *Revocation or Modification of an Approved AERP.*

(1) With 30-days written notice to the AERP holder, the Executive Officer may revoke or modify, as needed, an approved AERP in any of the following situations:

(A) There have been more than one violations of the approved AERP,

(B) The Executive Officer has reason to believe that an approved AERP has been granted that no longer meets the criteria or requirements for an AERP,

(C) The applicant demonstrates that it can no longer comply with the requirements of the approved AERP in its current form,

(D) The applicant demonstrates to the satisfaction of the Executive Officer that the continuation of the AERP will result in economic hardship to the applicant, the applicant submits a substitute plan in accordance with section 2265.5(c) to offset any emissions not otherwise offset by the AERP, and the Executive Officer approves the substitute plan, or

(E) The applicant's facility modifications and/or other means of eliminating emissions associated with permeation from its gasoline have been completed.

(2) The Executive Officer shall notify the applicant, post on the AERP internet site, send to subscribers of the Fuels listserv, and mail to those interested parties who have requested copies by mail, of a revocation or modification of an approved AERP.

(3) Any violations incurred pursuant to subsection (e) shall not be cancelled or in any way affected by the subsequent cancellation or modification of an AERP.

(e) *Additional prohibitions*.

(1) No person may sell, offer, or supply California gasoline that creates emissions associated with permeation unless the applicant has first been notified in

writing by the Executive Officer that the AERP application has been approved.

(2) Failure to meet any requirement of this section or any condition of an approved AERP shall constitute a single, separate violation of this article for each day until such requirement or condition is satisfied.

(3) False reporting of any information contained in an AERP application, or any supporting documentation or amendments thereto, shall constitute a single, separate violation of the requirements of this article for each day that the approved AERP is in effect.

(4) Any net exceedance at any given time, taking into consideration the amount of offsets and the gasoline produced under the AERP, of NOx, total ozone forming potential, or potency-weighted toxics during the period the AERP is in effect shall constitute a single, separate violation of the requirements of this article for each day the California gasoline subject to the AERP is sold, supplied, or offered in California.

(5) Any of the following actions shall each constitute a single, separate violation of the requirements of this article for each day after the applicable deadline until the requirement or condition is satisfied:

(A) Failure to report data or failure to report data accurately in writing to the Executive Officer when required by this section or the approved AERP;

(B) False reporting of any information submitted to the Executive Officer for determining compliance with the AERP;

(C) Failure to completely offset emissions, pursuant to any offset reconciliation requirements in the AERP, during the period the AERP is in effect;

(D) Sale, supply, or offer of volumes of California gasoline which purportedly complies with the AERP in excess of the approved AERP.

(6) Offsets shall not include offsets or other reductions that are otherwise required by any local, State, or federal rule, regulation, or statute, or that are achieved or estimated from California gasoline not produced in the same air basin as the gasoline associated with the AERP, or that are claimed under section 2265.1.

(f) A cause of action against the AERP holder under this section shall be deemed to accrue on the date(s) when the records establishing a violation of the AERP are received by the Executive Officer.

(g) *Transferability*. Rights to use, or protection under, the AERP are non-transferable, unless such transfer is approved in writing by the Executive Officer.

(h) *Notification of final blends associated with an AERP*

(1) Except as otherwise provided, for each final blend, the producer or importer shall notify the executive officer in writing, for receipt by the executive officer before the start of physical transfer of the gasoline from the production facility or import facility, and in no case less than 12 hours before the producer or importer either completes physical transfer or commingles the final blend, with the following information:

(A) The company name, address, phone number, and contact information,

(B) The production facility or import facility name, batch name, number, or other identification, the blend identity, grade of California gasoline, the location (with sufficient specificity to allow ARB inspectors to locate and sample the gasoline; this shall include, but is not limited to, the name of the facility, address, and identification of the tank), and other information that uniquely identifies the California gasoline subject to the AERP,

(C) The estimated volume (in barrels),

(D) The identity of the alternative emission reduction plan, which was approved by the executive officer and the NOx, total ozone forming potential, and potency-weighted toxics emission limits stated in that plan,

(E) The PM alternative specifications for RVP, sulfur content, benzene content, aromatics content, olefins content, T50, T90, and oxygen content,

(F) Documentation, calculations, emissions test data, and other information that establishes the amount of NOx, total ozone forming potential, and potency-weighted toxics associated with the final blend of California gasoline to which the AERP applies,

(G) A statement, signed by a legal representative for the producer or importer that all information submitted with the notification is true and correct, and

(H) Within 24 hours after the start of the physical transfer, the date and time of the start of physical transfer from the production facility or import facility.

(2) A producer or importer may report an actual volume that is less than the estimated volume, as long as notification of the actual volume is received by the executive officer no later than 48 hours after completion of the physical transfer of the final blend from the production facility or import facility. If notification of the actual volume is not timely received by the executive officer, the reported estimated volume shall be deemed the reported actual volume. If the actual volume is larger than initially estimated, the producer or importer shall revise the reported estimated volume by notifying the executive officer no later than 24 hours after completion of the physical transfer of the final blend from the

production facility or import facility.

(i) ***Notification of permeation offsets***

(1) *Vehicle scrappage*. The producer or importer shall notify the Executive Officer in writing as provided in the AERP with all documentation, calculations, emissions test data, and other information that establishes the amount of NOx, total ozone forming potential, and potency-weighted toxics associated with the vehicle scrappage and the date(s) the offsets accrued.

(2) *Fuels*. Except as otherwise provided, the producer or importer shall notify the executive officer in writing as provided in the AERP, for receipt by the executive officer before the start of physical transfer of the gasoline from the production facility or import facility, and in no case less than 12 hours before the producer or importer either completes physical transfer or commingles the final blend, with the information in subsection (h)(1) as they relate to other batches of California gasoline or diesel fuel used to offset the emissions associated with permeation.

(3) *Incentive grants*. The producer or importer shall notify the Executive Officer in writing as provided in the AERP with all documentation, calculations, emissions test data, and other information that establishes the amount of NOx, total ozone forming potential, and potency-weighted toxics associated with the incentive grants for cleaner-than-required engines, equipment and other sources of pollution providing early or extra emission reductions and the date(s) the offsets accrued.

(4) *Other reduction strategies*. The producer or importer shall notify the Executive Officer in writing as provided in the AERP with all documentation, calculations, emissions test data, and other information that establishes the amount of NOx, total ozone forming potential, and potency-weighted toxics associated with the reduction strategy and the date(s) the offsets accrued.

NOTE: Authority cited: sections 39600, 39601, 43013, 43013.1, 43018, and 43101, Health and Safety Code; and *Western Oil and Gas Ass'n*. v. *Orange County Air Pollution Control District*, 14 Cal.3d 411, 121 Cal.Rptr. 249 (1975). Reference: sections 39000, 39001, 39002, 39003, 39010, 39500, 39515, 39516, 41511, 43000, 43013, 43013.1, 43016, 43018, and 43101, Health and Safety Code; and *Western Oil and Gas Ass'n.* v. *Orange County Air Pollution Control District*, 14 Cal.3d 411, 121 Cal.Rptr. 249 (1975).

## Section 2266. Certified Gasoline Formulations Resulting in Equivalent Emission Reductions Based on Motor Vehicle Emissions Testing.

(a) ***Certification of test-certified alternative gasoline formulations*.** Following application by a producer or importer, the executive officer may certify, and identify alternative specifications for, test-certified alternative gasoline formulation pursuant to the Air Resources Board's "California Procedures for Evaluating Alternative

Specifications for Gasoline Using Vehicle Emissions Testing," as last amended April 25, 2001, which is incorporated herein by reference. Notwithstanding section 2265.5(a), a producer or an importer that produces gasoline that has elected to be subject to a test-certified alternative gasoline formulation pursuant to section 2266 shall offset its emissions associated with permeation by complying with sections 2265.5(b) – (i).

(b) ***Prohibited activities regarding test-certified alternative gasoline formulations*.**

* * * * *

(3) A producer or importer may not elect to sell or supply from its production or import facility a final blend of California gasoline as a test-certified alternative gasoline formulation if the producer or importer is subject to any outstanding requirements to provide offsets at the same production or import facility pursuant to section 2264(c).

(4) A producer or importer that produces gasoline may not elect to sell or supply from its production facility or import facility a final blend of California gasoline as a test-certified alternative gasoline formulation if the producer or importer is subject to any outstanding requirements to provide offsets at the same production facility or import facility pursuant to section 2265.1(c) or 2265.5.

(5) An importer that does not produce gasoline shall not sell, offer for sale, supply, or offer for supply California gasoline if the gasoline creates emissions associated with permeation.

* * * * *

Section 2266.5. Requirements Pertaining to California Reformulated Gasoline Blendstock for Oxygen Blending (CARBOB) and Downstream Blending.

(a) ***Application of the California gasoline standards to CARBOB.***

* * * * *

(2) ***Determining whether a final blend of CARBOB complies with the standards for California gasoline.***

* * * * *

(B) ***Determining whether a final blend of CARBOB complies with the standards for California gasoline by use of the CARBOB Model.***

1. A producer or importer may elect to have the CARBOB model used in determining whether a final blend designated as CARBOB complies with

the standards applicable to California gasoline, by providing the notice in section (b)(1)(C). In this case, the CARBOB limits for the final blend shall be determined in accordance with the "Procedures for Using the California Model for California Reformulated Gasoline Blendstocks for Oxygenate Blending (CARBOB)," as adopted April 25, 2001, last amended [**insert Board adoption date**], which is incorporated by reference herein. The CARBOB's compliance with the assigned CARBOB limit for a property shall constitute compliance with the corresponding finished gasoline limit – be it a section 2262 flat limit, PM flat limit, TC limit, or (if no designated alternative limit has been established) section 2262 or PM averaging limit. In addition, where the producer or importer has elected to use the CARBOB model for a given final blend that is not being transferred from its production or import facility during the Reid vapor pressure control period for that facility set forth in section 2262.4(a), the final blend must have a Reid vapor pressure no lower than the value used in the T50 CARBOB model.

* * * * *

(C) ***Determining whether a final blend of CARBOB complies with the standards for California gasoline by oxygenate blending and testing.*** Except as otherwise provided in section (a)(2)(B), the properties of a final blend of CARBOB shall be determined for purposes of compliance with sections 2262, 2262.3, 2262.4, 2262.5, 2262.6, 2265, and 2266 by adding the specified type and amount of oxygenate to a representative sample of the CARBOB and determining the properties and characteristics of the resulting gasoline in accordance with an applicable test method identified in section 2263(b) or permitted under section 2263(c).

* * * * *

(5) ***Assignment of designated alternative limits for CARBOB and for the oxygenated California gasoline where the producer or importer has elected to use the CARBOB model.***

* * * * *

(C) ***Determining the designated alternative limit for the final blend after the CARBOB is oxygenated.*** Whenever a producer or importer has assigned a designated alternative limit for a final blend of CARBOB, the designated alternative limit for the final blend after the CARBOB is oxygenated shall be determined in accordance with the "Procedures for Using the California Model for California Reformulated Gasoline Blendstocks for Oxygenate Blending (CARBOB)," as adopted April 25, 2001, last amended [**insert Board adoption date**], which is incorporated by reference herein. This will be the final blend's designated alternative limit for purposes of compliance with sections 2262.3(c)(3) and 2264(b) and (c).

* * * * *

(6) ***Determining whether downstream CARBOB complies with the cap limits for California gasoline.***

(A) ***Determining whether downstream CARBOB complies with the cap limits for California gasoline through the use of CARBOB cap limits derived from the CARBOB Model.*** Whenever downstream CARBOB designated for ethanol blending has already been supplied from its production or import facility, the CARBOB's compliance with the cap limits for California gasoline may be determined by applying the CARBOB cap limits in the following table:

| ***Property*** | ***a) CARBOB Cap Limits*** | |
|---|---|---|
| | ***b)*** | |
| | ***CaRFG2*** | ***CaRFG3*** |
| Reid Vapor Pressure[1] (pounds per square inch) | 5.78 | 5.99 |
| Sulfur Content (parts per million by weight) | 89 | 66[2] |
| | | 32[2] |
| | | 21[2] |
| Benzene Content (percent by volume) | 1.33 | 1.22 |
| Aromatics Content (percent by volume) | 33.1 | 38.7 |
| Olefins Content (percent by volume) | 11.1 | 11.1 |
| T50 (degrees Fahrenheit) | 232[3] | 232[3] |
| | 237[3] | 237[3] |
| T90 (degrees Fahrenheit) | 335 | 335 |

[1] The Reid vapor pressure standards apply only during the warmer weather months identified in section 2262.4.

[2] The CaRFG Phase 3 CARBOB cap limits for sulfur are phased in starting December 31, 2003, ~~and~~ December 31, 2005, and December 31, 2009, in accordance with section 2261(b)(1)(A).

[3] The first number applies to CARBOB that is subject to the Reid vapor pressure standard pursuant to section 2262.4, and the second number applies to CARBOB that is not subject to the Reid vapor pressure standard.

* * * * *

(b) ***Notification to ARB regarding the supply of CARBOB from the facility at which it was produced or imported.***

(1) A producer or importer supplying a final blend of CARBOB from the facility at which the producer or importer produced or imported the CARBOB must notify the executive officer of the information set forth below, along with any information required under section 2265(a)(2) (for a PM alternative gasoline formulation), section 2265.1 (for a PM emissions offsetting formulation, applicable only to producers and importers that produce gasoline), section 2265.5 (for an alternative emission reduction plan, applicable only to producers and importers that produce gasoline), or 2266(c) (for a test-certified alternative gasoline formulation). The notification must be received by the executive officer before the start of physical transfer of the final blend of CARBOB from the production or import facility, and in no case less than 12 hours before the producer or importer either completes physical transfer or commingles the final blend.

* * * * *

(E) The designation of each oxygenate type or types and amount or range of amounts to be added to the CARBOB, and the applicable flat limit, PM alternative specification, designated emissions offsetting limit, or TC alternative specification for oxygen. The amount or range of amounts of oxygenate to be added shall be expressed as a volume percent of the gasoline after the oxygenate is added, in the nearest tenth of a percent. For any final blend of CARBOB except one that is subject to PM alternative specifications, designated emissions offsetting limits, alternative emission reduction plan, or TC alternative specifications, the amount of oxygenate to be added must be such that the resulting California gasoline will have a minimum oxygen content no lower than 1.8 percent by weight and a maximum oxygen content no greater than 2.2 percent by weight. For a final blend of CARBOB that is subject to PM alternative specifications or designated emissions offsetting limits, the amount or range of amounts of oxygenate to be added must be such that the resulting California gasoline has an oxygen content that meets the oxygen content PM alternative specification or designated emissions offsetting limits for the final blend. For a final blend of CARBOB that is subject to TC alternative specifications, the amount or range of amounts of oxygenate to be added must be such that the resulting California gasoline has an oxygen content that meets the oxygen content alternative specification for the final blend.

* * * * *

(d) ***Documentation required when CARBOB is transferred.***

(1) ***Required Documentation.*** On each occasion when any person transfers custody or title of CARBOB, the transferor shall provide the transferee a document that prominently:

* * * * *

(B) Identifies the applicable flat limit, PM alternative specification, designated emissions offsetting limit, or TC alternative specification for oxygen, and

* * * * *

**Section 2270. Testing and Recordkeeping.**

(a) (1) The requirements of this section (a) shall apply to each producer and importer that has elected to be subject to an averaging limit in section 2262, or to a PM averaging limit, or to a producer or importer that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option pursuant to section 2264.2(d). The references to sulfur content shall apply to each producer or importer that has elected to be subject to the section 2262 averaging limit for sulfur, or to a PM averaging limit for sulfur, or to a producer or importer that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option pursuant to section 2264.2(d). The references to benzene content shall apply to each producer or importer that has elected to be subject to the section 2262 averaging limit for benzene, or to a PM averaging limit for benzene, or to a producer or importer that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option pursuant to section 2264.2(d). The references to olefin content shall apply to each producer or importer that has elected to be subject to the section 2262 averaging limit for olefin content, or to a PM averaging limit for olefin content, or to a producer or importer that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option pursuant to section 2264.2(d). The references to T90 shall apply to each producer or importer that has elected to be subject to the section 2262 averaging limit for T90, or to a PM averaging limit for T90, or to a producer or importer that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option pursuant to section 2264.2(d). The references to T50 shall apply to each producer or importer that has elected to be subject to the section 2262 averaging limit for T50, or to a PM averaging limit for T50, or to a producer or importer that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option pursuant to section 2264.2(d). The references to aromatic hydrocarbon content shall apply to each producer or importer that has elected to be subject to the section 2262 averaging limit for aromatic hydrocarbon content, or to a PM averaging limit for aromatic hydrocarbon content, or to a producer or importer

that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option pursuant to section 2264.2(d). The references to oxygen content and RVP shall apply to each producer or importer that produces gasoline that has elected to be subject to the PM emissions offsetting compliance option pursuant to section 2264.2(d).

(2) Each producer shall sample and test for the sulfur, aromatic hydrocarbon, olefin, oxygen, and benzene content, RVP (during the RVP regulatory control periods in section 2262.4(b)(2)), T50 and T90 in each final blend of California gasoline which the producer has produced, by collecting and analyzing a representative sample of gasoline taken from the final blend, using the methodologies specified in section 2263. If a producer blends gasoline components directly to pipelines, tankships, railway tankcars or trucks and trailers, the loading(s) shall be sampled and tested for the sulfur, aromatic hydrocarbon, olefin, oxygen, and benzene content, RVP (during the RVP regulatory control periods in section 2262.4(b)(2)), T50 and T90 by the producer or authorized contractor. The producer shall maintain, for two years from the date of each sampling, records showing the sample date, identity of blend sampled, container or other vessel sampled, final blend volume, sulfur, aromatic hydrocarbon olefin, oxygen, and benzene content, RVP, T50 and T90. All gasoline produced by the producer and not tested as California gasoline by the producer as required by this section shall be deemed to have a sulfur, aromatic hydrocarbon, olefin, oxygen, and benzene content, RVP (during the RVP regulatory control periods in section 2262.4(b)(2)), T50 and T90 exceeding the applicable averaging limit standards specified in section 2262, exceeding the comparable PM averaging limits if applicable, or exceeding the designated emissions offsetting limits, unless the producer demonstrates that the gasoline meets those standards and limits.

(3) Each importer shall sample and test for the sulfur, aromatic hydrocarbon, olefin and benzene content, T50 and T90 in each final blend of California gasoline which the importer has imported by tankship, pipeline, railway tankcars, trucks and trailers, or other means, by collecting and analyzing a representative sample of the gasoline, using the methodologies specified in section 2263. The importer shall maintain, for two years from the date of each sampling, records showing the sample date, product sampled, container or other vessel sampled, the volume of the final blend, sulfur content, aromatic hydrocarbon, olefin and benzene content, T50 and T90. All gasoline imported by the importer and not tested as California gasoline by the importer as required by this section shall be deemed to have a sulfur, aromatic hydrocarbon, olefin and benzene content, T50 and T90 exceeding the applicable averaging limit standards specified in section 2262, or exceeding the comparable PM averaging limit(s) if applicable, or exceeding the designated emissions offsetting limits, unless the importer demonstrates that the gasoline meets those standards and limit(s).

(4) A producer or importer shall provide to the executive officer any records required to be maintained by the producer or importer pursuant to this section within 20 days of a written request from the executive officer if the request is received

before expiration of the period during which the records are required to be maintained. Whenever a producer or importer fails to provide records regarding a final blend of California gasoline in accordance with the requirements of this section, the final blend of gasoline shall be presumed to have been sold by the producer or importer in violation of the applicable averaging limit standards in section 2262, or the PM averaging limit(s), or the designated emissions offsetting limits, to which the producer or importer has elected to be subject.

(5) The executive officer may enter into a protocol with any producer or importer for the purpose of specifying alternative sampling, testing, recordkeeping, or reporting requirements which shall satisfy the provisions of sections (a)(2) or (a)(3). The executive officer may only enter into such a protocol if s/he reasonably determines that application of the regulatory requirements under the protocol will be consistent with the state board's ability effectively to enforce the averaging limit standards in section 2262, the averaging limit compliance requirements in section 2262.3(c), ~~and~~ the PM averaging limit(s), the PM emissions offsetting compliance option requirements in section 2265.1, and the alternative emission reduction plan requirements in section 2265.5. Any such protocol shall include the producer's or importer's agreement to be bound by the terms of the protocol.

* * * * *

**Section 2271. Variances.**

(a) ***Applications for variances.*** Any person who cannot comply with the standards or compliance requirements set forth in sections 2262, 2262.3, 2262.4, 2262.5, ~~or~~ 2262.6, 2265.1, or 2265.5 because of reasons beyond the person's reasonable control may apply to the executive officer for a variance. Except for emergency variances as provided in section (h), the application shall be accompanied by a fee of $6700.00 to cover the costs of processing the variance. If the applicant withdraws the application before the variance hearing is held, $4100.00 of the fee shall be refunded. The application shall set forth:

* * * * *

(e) ***Factors to be considered in making the necessary findings for granting variances.***

In making the findings specified in section (d), the factors set forth below shall be considered. It is the responsibility of the applicant to provide the information necessary to adequately evaluate these factors.

(1) Regarding the finding specified in section (d)(1):

* * * * *

(B) To demonstrate that requiring compliance would result in an "extraordinary economic hardship," the applicant must make a substantial showing that no alternative to a variance would eliminate or mitigate the need for a variance. Potential alternatives that the applicant shall address include the following: 1. obtaining complying gasoline from outside sources, or obtaining blending materials that would allow production of complying gasoline, ~~and~~ 2. using the applicable California Predictive Model (as specified in Title 13, CCR, section 2265) to maximize the production of complying gasoline, or to minimize the degree of noncompliance, through the use of a PM alternative gasoline formulation, 3. electing to use the PM emissions offsetting compliance option, and 4. applying for an alternative emission reduction plan. The applicant shall compare the economics of operations without a variance, for the period over which the variance is proposed, with the economics of operations after the variance compliance plan has been implemented (e.g., the economic hardship during the term of the variance shall be measured against the eventual cost of long-term compliance.) The operations may include facets of the applicant's business other than gasoline operations, if those facets are directly affected by the ability to conduct the gasoline business. An applicant may also address any supply shortages that could result from the failure to grant a variance and the economic affects of such shortages on the persons who do, or could, receive gasoline from the applicant.

* * * * *

**Section 2273. Labeling of Equipment Dispensing Gasoline Containing MTBE.**

* * * * *

(b) ***Residual levels of MTBE.***

(1) The labeling requirements in section 2273(a) do not apply to equipment dispensing gasoline from a storage tank containing gasoline having an MTBE content of less than 0.6 percent by volume, as determined by American Society of Testing and Materials (ASTM) Test Method D 4815-~~99~~04, which is incorporated herein by reference, or any other test method determined by the executive officer to give equivalent results.

* * * * *

(d) ***Deliveries of gasoline to retail outlets.***

(1) Any person delivering gasoline to a retail gasoline outlet from December 16, 1999 through December 30, 2003 shall provide to the outlet operator or responsible employee, at the time of delivery of the fuel, an invoice, bill of lading, shipping paper, or other documentation which states whether the gasoline does or does not contain 0.6 percent by volume or more MTBE, and which may

identify the volumetric amount of MTBE in the gasoline. For purposes of determining compliance with this section 2273(d), the volumetric MTBE content of gasoline shall be determined by ASTM Test Method D 4815-~~99~~04, which is incorporated herein by reference, or any other test method determined by the executive officer to give equivalent results.

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**State of California**
**California Environmental Protection Agency**
**AIR RESOURCES BOARD**

# California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model

c) Adopted: June 16, 2000

**B. Amended: April 25, 2001**

***C. Last Amended: [insert Board adoption date]***

**Note:** ~~**This is a wholly new document adopted by the Air Resources Board.**~~ The preexisting text is set forth below in normal type. The amendments are shown in *underline italic* to indicate additions and ~~strikeout~~ to indicate deletions.

## Table of Contents

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*List of Tables*

# I. INTRODUCTION

## A. Purpose and Applicability

1. The predictive model prescribed in this document may be used to evaluate gasoline specifications as alternatives to the Phase 3 California Reformulated Gasoline (RFG) flat and averaging limits in the gasoline specifications set forth in Title 13, California Code of Regulations (13 CCR), section 2262.

   This procedure:

   - ♦ prescribes the range of specifications that may be utilized to select a set of candidate Phase 3 RFG alternative gasoline specifications for evaluation,
   - ♦ defines the Phase 3 RFG reference specifications,
   - ♦ prescribes the calculations to be used to predict the emissions from the candidate fuel specifications and the reference Phase 3 RFG specifications,
   - ♦ prescribes the calculations to be used to compare the emissions resulting from the candidate fuel specifications to the reference Phase 3- RFG specifications,
   - ♦ establishes the requirements for the demonstration and approval of the candidate fuel specifications as an alternative Phase 3 RFG formulation, and
   - ♦ establishes the notification requirements.

2. Gasoline properties for which alternative gasoline specifications may be set by this procedure include all eight Phase 3 RFG properties.

3. The Phase 3 RFG specifications, established in 13 CCR, section 2262, are shown in Table 1.

*4. The pollutant emissions addressed by these procedures and the units of model predictions are shown in Table 2.*

**Table 1**
**Properties and Specifications for Phase 3 Reformulated Gasoline**

| Fuel Property | Units | Flat Limit | Averaging Limit | Cap Limit |
|---|---|---|---|---|
| Reid vapor pressure (RVP) | psi, max. | 6.90[1]/7.00 | none | 7.20 |
| Sulfur (SUL) | ppmw, max. | 20 | 15 | 60/30[3]/*20*[3] |
| Benzene (BENZ) | vol.%, max. | 0.80/1.00[2] | 0.70 | 1.10 |
| Aromatic HC (AROM) | vol.%, max. | 25.0/35.0[2] | 22.0 | 35.0 |
| Olefin (OLEF) | vol.%, max. | 6.0 | 4.0 | 10.0 |
| Oxygen (OXY) | wt. % | 1.8 (min)<br>2.2 (max) | none | 1.8(min)[4]<br>3.5(max)[5] |
| Temperature at 50 % distilled (T50) | deg. F, max. | 213/220[2] | 203 | 220 |
| Temperature at 90% distilled (T90) | deg. F, max. | 305/312[2] | 295 | 330 |

~~1 Applicable during the summer months identified in 13 CCR, sections 2262.4(b). If the applicant elects to comply with the regulatory option which provides for the use of the evaporative HC emissions model, the flat RVP limit is 6.90. That is, all predictions for evaporative emissions increases or decreases made using the evaporative HC emissions models are made relative to 6.90 psi. If the applicant elects to comply with the regulatory option which provides for the use of only the exhaust HC emissions model, the flat RVP limit and the candidate fuel RVP specification is 7.00. Also, under the federal Reformulated Gasoline Regulations, the U.S. EPA enforces a minimum RVP limit of 6.4 psi.~~

~~The exhaust models contain an RVP term, but this has been made constant by fixing the RVP for both the reference and candidate fuels at 7.00 psi in the calculation of the standardized RVP values used in the exhaust emission equations. This fixing of the RVP takes RVP out of the exhaust models as a fuel property which effects exhaust emissions. Thus, RVP effects only evaporative HC emissions.~~

*1 The flat limit for RVP is 7.00 psi. The flat limit for RVP is 6.90 when the fuel being certified is blended without ethanol.*

2 The higher value is the small refiner CaRFG flat limit for qualifying small refiners only, as specified in section 2272.

3 The *CaRFG* Phase 3 ~~RFG~~ sulfur content cap limits of 60*,* ~~and~~ 30*, and 20* parts per million are phased in starting December 31, ~~2002~~*2003*, *December 31, 2005*, and December 31, ~~2004~~*2009*, respectively, in accordance with section 2261(b)(1)(A).

4 Applicable only during specified winter months in the areas identified in 13 CCR, section 2262.5(a).

5 If the gasoline contains more than 3.5 percent by weight oxygen but not more than 10 volume percent ethanol, the maximum oxygen content cap is 3.7 percent by weight.

~~4. The pollutant emissions addressed by these procedures and the units of model predictions are shown in Table 2.~~

~~**Table 2**~~
~~**Predictive Model Pollutants and Their Units of Prediction**~~

***Table 2***
***Predictive Model Pollutants and Their Units of Measurement***

| **Pollutant Predictions** | **Units** |
|---|---|
| Oxides of Nitrogen (NOx) | gm/mile |
| Exhaust Hydrocarbons (HC) | gm/mile |
| Evaporative Hydrocarbons (HC) | Percent Change (Candidate Fuel Relative to Reference Fuel) |
| Exhaust Potency-Weighted Toxics (PWT) | mg/mile |
| Evaporative Benzene | mg/mile |
| Exhaust CO (Adjustment Factor for Oxygen) | ~~Percent Change (Relative to 2.0 Percent Oxygen)~~*gm/mile* |

**B. Synopsis of Procedure**

The predictive model is used to predict the emissions for gasoline meeting the Phase 3 RFG specifications (reference fuel specifications) and the emissions for a candidate gasoline meeting alternative specifications (candidate fuel specifications). The predicted emissions are functions of the regulated fuel properties shown in Table 1. The candidate gasoline is accepted as equivalent to Phase 3 RFG if its predicted emissions for each pollutant is less than or equal (within roundoff) to the predicted emissions for a fuel meeting the Phase 3 RFG specifications.

**1. What is the Predictive Model?**

The predictive model consists of a number of sub-models. The sub-models are equations which relate gasoline properties to the exhaust emissions and evaporative emissions changes which result when the gasoline is used to fuel a motor vehicle. The emissions predictions are expressed in the units shown in Table 2.

~~Eighteen~~*Twenty-one* separate exhaust sub-models have been developed for ~~six~~*seven* pollutants (NOx, HC, *CO,* benzene, 1,3-butadiene, formaldehyde, and acetaldehyde). Three exhaust sub-models have been developed for each of the ~~six~~*seven* pollutants: one sub-model for each of three vehicle emissions control technology "Tech" classes (Tech 3, Tech 4, and *Tech 5).* ~~Tech 5).~~

In addition, six sub-models have been developed for evaporative emissions. Three sub-models have been developed for evaporative hydrocarbon emissions and three sub-models have been developed for evaporative benzene emissions. For both evaporative hydrocarbon emissions and evaporative benzene emissions, one sub-model has been developed for each of the following evaporative emission processes:
1) Diurnal/Resting Losses, 2) Hot Soak Emissions, and 3) Running Losses. Finally, an adjustment factor has been developed to predict the effect of ~~gasoline oxygen content~~*changing fuel properties* on exhaust CO emissions.

### 2. Combination of Sub-Model Predictions for Exhaust Emissions Across Tech Classes

The exhaust emissions of the reference fuel specifications and the candidate fuel specifications for each Tech class of vehicles are predicted by the sub-models of the predictive model. The differences between the predicted exhaust emissions for the reference fuel specifications and the candidate fuel specifications are combined to yield Tech class-weighted predicted emissions differences. These predicted differences represent the predicted differences in exhaust emissions between the reference fuel specifications and the candidate fuel specifications for the entire California vehicle fleet. For NOx and exhaust HC emissions, the differences in predictions for each Tech class are combined using Tech class weighting factors which represent the fraction of the total emissions originating from each Tech class.

For the exhaust toxics emissions, the predicted emissions for Tech classes are weighted both by fractions and by potencies. The potency weights represent the relative carcinogenicity of the toxic pollutants. For each toxic pollutant, the predicted exhaust emissions for each Tech class is weighted by ~~a VMT (vehicle miles traveled)~~*the HC exhaust Tech group* weighting factor which represents the fraction of the total vehicle miles traveled by each Tech class. Then, the Tech class-weighted emissions prediction for each toxic pollutant is multiplied by the relative potency for that pollutant. The Tech class-weighted, potency-weighted predictions for each toxic pollutant are then summed to yield the predicted total potency-weighted exhaust toxics emissions. Finally, an emissions prediction for evaporative benzene emissions is added to the prediction for total potency-weighted exhaust toxics emissions to yield a prediction for total potency-weighted toxics emissions. This calculation is performed for both the reference fuel specifications and the candidate fuel specifications.

### 3. Combination of Evaporative HC Emissions Predictions with Exhaust HC Emissions Predictions (Optional)

Two compliance options are available to applicants. The first compliance option includes predictions for differences in evaporative HC emissions between the candidate fuel specifications and the Phase 3 RFG reference fuel in the evaluation of the HC emissions equivalency of the candidate fuel. The second option does not, and the HC emissions equivalency of the candidate fuel specifications is based only on the predictions of the exhaust HC emissions models, as is the case in the Phase 2 RFG regulations. In the first compliance option, the Tech class-weighted difference in the predicted exhaust HC emissions between the reference fuel specifications and the candidate fuel specifications is combined with the predicted difference in evaporative HC emissions between the

two fuels when evaluating the HC emissions equivalency of the candidate fuel specifications. This combination estimates the difference in total HC emissions (exhaust plus evaporative) between the reference fuel specifications and the candidate fuel specifications. In the second compliance option, the predicted evaporative HC emissions changes are not included and the HC emissions equivalency of the candidate fuel specifications is based only on the Tech class-weighted difference in the predicted exhaust HC emissions. This was the only compliance option available in the Phase 2 RFG regulations. The second option is being offered for applicants who are not interested in using the evaporative HC emissions model in the evaluation of the HC emissions equivalency of the alternative fuel specifications.

Under the first compliance option, when combining the Tech class-weighted difference in the predicted exhaust HC emissions with the predicted difference in evaporative HC emissions, the greater ozone-forming potential of the exhaust emissions is recognized by the inclusion of a "reactivity adjustment" factor for the evaporative HC emissions. Also, the ozone-forming potential of CO emissions is recognized in this compliance option by the inclusion of a CO adjustment factor in the sum of exhaust and evaporative HC emissions. Thus, under this compliance option, the combination of the model predictions for exhaust HC emissions, evaporative HC emissions changes, and the CO adjustment factor yields a number which represents a prediction for the change in ozone-forming potential (OFP) between the reference fuel specifications and the candidate fuel specifications. The flat and cap RVP limits for this compliance option are ~~6.90~~*7.00* psi, and 7.20 psi, respectively *for fuels containing ethanol, and flat and cap RVP limits of 6.90 and 7.20 psi, respectively for fuels not containing ethanol*.

Under the second compliance option, only the Tech class-weighted difference in the predicted exhaust HC emissions is used in comparing the HC emissions of the reference fuel specifications to the HC emissions of the candidate fuel specifications. Under this option, evaporative HC emissions of the candidate fuel are limited by the imposition of a flat (and cap) RVP limit of 7.0. The CO adjustment factor also is not used under the second compliance option.

**4. Determination of Emissions Equivalency**

The candidate fuel specifications are deemed equivalent to the reference fuel specifications if, for each pollutant (NOx, total OFP or exhaust HC, and potency-weighted toxics (PWT)), the predicted percent change in emissions between the candidate fuel specifications and the reference Phase 3 RFG specifications is equal to or less than 0.04%. If the applicant has elected to use the evaporative HC emissions model in the evaluation of the emissions equivalency, the 0.04% criteria must be met for NOx, OFP, and PWT. If the applicant has elected not to use the evaporative HC emissions model, the 0.04% criteria must be met for NOx, exhaust HC, and PWT. If, for any of the three pollutants in the criteria, the predicted percent change in emissions between the candidate fuel specifications and the reference Phase 3 RFG specifications is equal to or greater than 0.05%, the candidate specifications are deemed unacceptable and may not be a substitute for Phase 3 RFG. [Note: All final values of the percent change in emissions shall be reported to the nearest hundredth using conventional rounding.] ~~In addition to satisfying the 0.04% emissions difference criteria, the candidate fuel specifications are required to meet the Phase 3 RFG specification for driveability index (DI) of 1225.~~

## C. Definitions

1. **Alternative gasoline formulation** means a final blend of gasoline that is subject to a set of alternative specifications deemed acceptable pursuant to the California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model.

2. **Alternative fuel specifications** means the specifications for the following gasoline properties, as determined in accordance with 13 CCR, section 2263:
   - ♦ maximum Reid vapor pressure, expressed in the nearest hundredth of a pound per square inch;
   - ♦ maximum sulfur content, expressed in the nearest parts per million by weight;
   - ♦ maximum benzene content, expressed in the nearest hundredth of a percent by volume;
   - ♦ maximum olefin content, expressed in the nearest tenth of a percent by volume;
   - ♦ minimum and maximum oxygen content, expressed in the nearest tenth of a percent by weight;
   - ♦ maximum T50, expressed in the nearest degree Fahrenheit;
   - ♦ maximum T90, expressed in the nearest degree Fahrenheit; and
   - ♦ maximum aromatic hydrocarbon content, expressed in the nearest tenth of a percent by volume.

3. **Applicant** means the party seeking approval of alternative gasoline specifications and responsible for the demonstration described herein.

4. **Aromatic hydrocarbon content (Aromatic HC, AROM)** means the amount of aromatic hydrocarbons in the fuel expressed to the nearest tenth of a percent by volume in accordance with 13 CCR, section 2263.

5. **ASTM** means the American Society of Testing and Materials.

6. **Averaging Limit** means a limit for a fuel property that must be achieved in accordance with 13 CCR, section 2264.

7. **Benzene content (BENZ or Benz)** means the amount of benzene contained in the fuel expressed to the nearest hundredth of a percent by volume in accordance with 13 CCR, section 2263.

8. **Candidate fuel or candidate fuel specifications** means the fuel or set of specifications which are being evaluated for its emission performance using these procedures.

9. **Cap limit** means a limit that applies to all California gasoline throughout the gasoline distribution system, in accordance with 13 CCR, sections 2262.3 (a), 2262.4 (a), and 2262.5 (a) and (b).

10. **EMFAC/~~BURDEN 7G~~ *2007*** means the EMFAC/~~BURDEN 7G~~ *2007* motor vehicle emission inventory and emissions calculation system maintained by the ARB.

*11. **Ethanol content** means the amount of ethanol in the fuel expressed to the nearest tenth of a percent by volume.*

~~11~~*12*. **Executive Officer** means the executive officer of the Air Resources Board, or his or her designee.

~~12~~*13*. **Exhaust-only option** means the compliance option available to applicants which uses only the exhaust HC emissions models in the evaluation of the HC emissions equivalency of the candidate fuel specifications.

~~13~~*14*. **Evap option** means the compliance option available to applicants which uses the evaporative HC emissions models and the CO adjustment factor in the evaluation of the HC emissions equivalency of the candidate fuel specifications.

~~14~~*15*. **Flat limit** means a single limit for a fuel property that applies to all California gasoline sold or supplied from a California production facility or import facility.

~~15~~*16*. **Intercept** means the average vehicle effect for a particular Tech class and a particular pollutant. The intercept represents the average emissions across vehicles in the Tech class, for a fuel with properties equal to the average values of all fuels in the data base for that Tech class.

~~16~~*17*. **MTBE content (MTBE)** means the amount of methyl tertiary-butyl ether in the fuel expressed in the nearest tenth of a percent by volume.

~~17~~*18*. **Olefin content (OLEF)** means the amount of olefins in the fuel expressed in the nearest tenth of a percent by volume in accordance with 13 CCR, section 2263.

~~18~~*19*. **Oxygen content (OXY)** means the amount of oxygen contained in the fuel expressed in the nearest tenth of a percent by weight in accordance with 13 CCR, section 2263.

~~19~~*20*. **Phase 3 reformulated gasoline (Phase 3 RFG)** means gasoline meeting the flat or averaging limits of the Phase 3 RFG regulations.

~~20~~*21*. **Potency-weighted exhaust toxics (PWT)** means the mass exhaust emissions of benzene, 1,3-butadiene, formaldehyde, and acetaldehyde multiplied by the relative potency with respect to 1,3-butadiene.

~~21~~*22*. **Predictive model** means a set of equations that relate the properties of a particular gasoline formulation to the predicted exhaust and evaporative emissions that result when that gasoline is combusted in a motor vehicle engine.

~~22~~*23*. **Reference fuel or reference fuel specifications** means a gasoline meeting the flat or average specifications for Phase 3 RFG.

~~23~~*24*. **Reid vapor pressure (RVP)** means the vapor pressure of the fuel expressed in the nearest hundredth of a pound per square inch in accordance with 13 CCR, section 2263.

~~24~~*25*. **Sulfur content (SUL)** means the amount of sulfur contained in the fuel expressed in the nearest part per million in accordance with 13 CCR, section 2263.

~~25~~*26*. **Technology class (Tech 3, Tech 4, and Tech 5)** means a classification of vehicles by model year based on the type of technology used to control gasoline exhaust emissions.

~~26~~*27*. **50% distillation temperature (T50)** means the temperature at which 50% of the fuel evaporates expressed in the nearest degree Fahrenheit in accordance with 13 CCR, section 2263.

~~27~~*28*. **90% distillation temperature (T90)** means the temperature at which 90% of the fuel evaporates expressed in the nearest degree Fahrenheit in accordance with 13 CCR, section 2263.

~~28~~*29*. **Total potency-weighted toxics (PWT)** means the sum of the mass exhaust emissions of benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, and the evaporative benzene emissions, multiplied by the relative potency with respect to 1,3-butadiene.

~~29~~*30*. **Toxic air contaminants** means exhaust emissions of benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, and evaporative benzene emissions.

## II. VEHICLE TECHNOLOGY CLASS AND WEIGHTING FACTORS

### A. Vehicle Technology Groups

For the purpose of these procedures, exhaust sub-models been developed for three categories of light-duty vehicles (passenger cars and light-duty trucks) using the vehicle model year as an indicator of the type of emission controls used. Table 3 shows the three vehicle categories.

**Table 3**
**Vehicle Categories**

| Technology Class | Model Year | Emission Controls |
|---|---|---|
| Tech 3 | 1981-1985 | older closed-loop three-way catalyst |
| Tech 4 | 1986-1995 | closed-loop three-way catalyst |
| Tech 5 | 1996~~+~~-*2015* | three-way catalyst, adaptive learning, LEVs |

### B. Emission-Weighting Factors ~~for NOx and Exhaust HC~~

Emission-weighting factors are used, for ~~both~~ NOx*,* ~~and~~ exhaust HC*, and CO* emissions, to weight the model predictions for each technology class. These weightings represent, for each of the ~~two~~*three* pollutants, the fractional contribution of exhaust emissions from on-road gasoline-fueled vehicles in a particular Tech class to the total emissions from these vehicles from all three Tech classes in the year ~~2005~~*2015*. The year ~~2005~~*2015* was selected because it approximately represents the midpoint year over which the Phase 3 reformulated gasoline regulations will be most effective. The factors were calculated using the information in EMFAC~~/BURDEN 7G~~ *2007*. The emission-weighting factors (EWF) are shown in Table 4 and are used in the combination of the sub-models for NOx*,* ~~and~~ exhaust HC*, and CO* emissions.

**Table 4**
**Emissions Weighting Factors**

| Pollutant | Tech 3 | Tech 4 | Tech 5 |
|---|---|---|---|
| NOx | ~~0.122~~*0.052* | ~~0.348~~*0.325* | ~~0.530~~*0.622* |
| HC | ~~0.166~~*0.075* | ~~0.540~~*0.380* | ~~0.294~~*0.546* |
| *CO* | *0.063* | *0.288* | *0.649* |

## C. ~~VMT~~*Toxics* Weighting Factors ~~for Exhaust Toxics~~

~~For exhaust~~*Since* toxics emissions~~, vehicle miles traveled (VMT)~~ *are also exhaust HC, the hydrocarbon* weighting factors are used to weight the model predictions for each technology class. ~~The VMT weightings represent the fractional VMT contribution from vehicles in each of the three Tech classs.~~ The values were calculated for the year ~~2005~~*2015* using the ARB's EMFAC~~/BURDEN 7G~~ *2007* motor vehicle emissions inventory. The ~~VMT~~*toxics* weighting factors (~~VM~~TWFs) are shown in Table 5 and are used in the combination of the exhaust toxics emissions sub-models.

**Table 5**
**~~Vehicle Miles Traveled~~*Toxics* Weighting Factors (~~VM~~TWFs)**

| Pollutant | Tech 3 | Tech 4 | Tech 5 |
|---|---|---|---|
| **Benzene** | ~~0.021~~*0.075* | ~~0.180~~*0.380* | ~~0.799~~*0.546* |
| **1,3-Butadiene** | ~~0.021~~*0.075* | ~~0.180~~*0.380* | ~~0.799~~*0.546* |
| **Formaldehyde** | ~~0.021~~*0.075* | ~~0.180~~*0.380* | ~~0.799~~*0.546* |
| **Acetaldehyde** | ~~0.021~~*0.075* | ~~0.180~~*0.380* | ~~0.799~~*0.546* |

## III. GENERAL EQUATIONS FOR CALCULATING PERCENT CHANGES IN EMISSIONS

### A. Summary and Explanation

- The applicant will first select ~~which~~*one* of two compliance options ~~he/she wishes to be subject to~~. The first compliance option, referred to as the exhaust and evap model option, uses the exhaust HC emissions models, the evaporative HC emissions changes models, and the CO adjustment ~~factor~~ in determining the HC emissions equivalency of the candidate fuel specifications *based on ozone forming potential*. The second option, referred to as the exhaust-only option, uses only the exhaust HC emissions model in the determination of the HC emissions equivalency of the candidate fuel specifications. (See III.B)

  The exhaust and evap model option may only be used for final blends of California gasoline or CARBOB where some part of the final blend is physically transferred from its production or import facility during the Reid vapor pressure control period for the production or import facility set forth in section 2262.4, title 13, California Code of Regulations, or within 15 days before the start of such period.

- The applicant will select a candidate specification for each property, and will identify whether the specification represents a flat limit or an averaging limit. The Phase 3 RFG reference specification is identified for each property using the flat/average limit compliance option selected for the corresponding candidate specification. (See III.B.)

- The selected candidate specifications and the comparable Phase 3 RFG reference specifications are inserted into the predictive model equations to determine the predicted candidate and reference emissions by Tech class. (See III.C.)

- Because oxygen is specified in the form of a range, emissions predictions are, in a majority of the cases, made for two oxygen levels, the upper level of the specified range for the candidate fuel specifications and the lower level. The emissions of the candidate fuel are compared to the emissions of the reference fuel at both of these oxygen levels. ~~The only two cases where two emissions predictions are not~~ *When the range between the upper and lower oxygen levels is less than or equal to 0.04% then the prediction is only* made for the ~~candidate fuel specifications is if the oxygen range~~*average* of the ~~candidate fuel specifications is within the range of 1.8 to 2.2 percent (inclusive) or within the range of 2.5 to 2.9 percent (inclusive). In either of these cases, the predicted emissions for the candidate fuel specifications are compared to the predicted emissions for the reference fuel specifications at only one~~*two* oxygen level*s*. *If the range is greater than 0.04%, then the prediction is based on the individual upper and lower levels.*

- For NOx and exhaust HC, the ratio of the predicted emissions for the candidate fuel specifications to the predicted emissions for the reference fuel specifications is emissions weighted according to the relative contribution of each technology class.

These emissions-weighted ratios are summed, reduced by 1, and multiplied by 100 to represent the Tech class-weighted percent change in emissions. The resulting values represent the predicted percent change in NOx or exhaust HC emissions between the candidate fuel specifications and reference fuel specifications. (See III.D.)

- If the exhaust and evap model option has been selected, the predicted percent change in evaporative HC emissions between the candidate fuel specifications and the reference fuel specifications is computed using the equations given in Section VII*I*.A. The predicted change is computed for each evaporative emissions process. (See VII*I*.A)

- If the exhaust and evap model option has been selected, the ~~credit resulting from the reduction of~~ CO emissions is calculated in accordance with the ~~equation~~*equations* given in Section ~~IX~~*VI*.A. (See ~~IX~~*VI*.A)

- If the exhaust and evap model option has been selected, the predicted percent changes in exhaust HC emissions, evaporative HC emissions, and the CO credit are combined in accordance with the equation given in Section X to yield the predicted percent change in ozone-forming potential (OFP) between the reference fuel specifications and the candidate fuel specifications. (See X)

- For exhaust toxics emissions, the predicted emissions for the candidate fuel specifications and the reference fuel specifications (for each pollutant and each Tech class) are ~~VMT~~ weighted *using the toxics weighting factors* and potency-weighted, in accordance with the equations given in VI*I*.B. (See VI*I*.B)

- The evaporative benzene emissions predictions for the reference fuel specifications and the candidate fuel specifications are calculated in accordance with the equations given in Section ~~VIII~~*IX*.A. Note that emissions predictions for evaporative benzene emissions are made even if the applicant is not using the compliance option which provides for the use of the evaporative HC emissions models. (See ~~VIII~~*IX*.A)

- For both the reference fuel specifications and the candidate fuel specifications, the VMT and potency-weighted exhaust toxics emissions predictions are combined with the potency-weighted evaporative benzene emissions predictions, in accordance with the equations given in Sections XI.A and XI.B. This yields the total potency-weighted toxics emissions prediction for the reference fuel specifications and for the candidate fuel specifications. (See XI.A and XI.B)

- The percent change in the predicted total potency-weighted toxics emissions between the reference fuel specifications and the candidate fuel specifications is calculated in accordance with the equation given in Section XI.C. (See XI.C)

## B. Selection by Applicant of Candidate and Reference Specifications

The applicant shall first select ~~which~~*one* of two compliance options ~~he/she wishes to be subject to~~. The first compliance option uses the exhaust HC emissions models, the evaporative HC emissions models, and the CO adjustment factor in determining the HC emissions equivalency of the candidate fuel specifications. The second option uses only the exhaust HC emissions model in the determination of the HC emissions equivalency of the candidate fuel specifications.

If the applicant selects the first compliance option, the applicable Phase 3 RVP limits are a flat limit of ~~6.90~~*7.00* and a cap limit of 7.20. That is, if the applicant elects to use the evaporative HC emissions predictive model, all evaporative HC emissions changes predicted by the model for the candidate fuel will be based on the use of ~~6.90~~*7.00* psi as the RVP of the Phase 3 reference fuel. If the applicant selects the second compliance option, the applicable Phase 3 RVP limit is a flat (and cap) limit of 7.00. *If the applicant selects to certify an alternative formulation produced without ethanol, then the applicable flat limit for either compliance option is 6.90 psi RVP.*

Next, the applicant shall, for each fuel property, select a candidate specification and indicate whether this specification represents a flat limit or an averaging limit. The appropriate corresponding Phase 3 RFG reference specifications (flat or average) are then identified. Table ~~7~~*6* provides an optional worksheet to assist the applicant in selecting the candidate and reference specifications. These steps are summarized below.

1. Identify the value of the candidate specification for each fuel property and insert the values into Table ~~7~~*6*. The candidate specifications may have any value for RVP, sulfur, benzene, aromatic hydrocarbons, olefins, T50, and T90 as long as each specification is less than or equal to the cap limits shown in Table 1. Note that, if the applicant is not using the compliance option which provides for the use of the evaporative HC emissions models, no value is entered for RVP into the "Candidate Fuel Specifications" column of Table ~~7~~*6* (In this case the RVP is 7.00). The candidate specification may have any value for oxygen as long as the specification is within the range of the cap limits shown in Table 1.

2. ~~The oxygen contents of the candidate fuel specifications can be found from Table 6. Note that, because~~*Since* oxygen is specified in the form of a range, there are usually two candidate fuel specifications for oxygen, the upper end of the range (maximum) and the lower end of the range (minimum). ~~There are two exceptions to this, in which cases it is assumed that the candidate fuel specifications have a single oxygen content. If the oxygen range of the candidate fuel specifications is within the range of 1.8 to 2.2 percent (inclusive), the oxygen content of the candidate fuel specifications is assumed to be 2.0 percent. If the oxygen range of the candidate fuel specifications is within the range of 2.5 to 2.9 percent, the oxygen content of the candidate fuel specifications is assumed to be 2.7 percent. Also, the predictive model equations assume that only one oxygenate is being blended into the gasoline. Thus, it is~~

~~assumed that the total oxygen content is equal to either the total oxygen content as MTBE or the total oxygen content as ethanol. If the refiner is blending both MTBE and ethanol into a gasoline, a small error will be introduced in the predictive model predictions for formaldehyde and acetaldehyde.~~*When the range between the upper and lower oxygen levels is less than or equal to 0.4 percent, then the prediction is only made for the average of the two oxygen levels. If the range is greater than 0.4 percent, then the prediction is based on the individual upper and lower levels.*

3. The hot soak benzene emissions model contains ~~an~~*a* MTBE content term. ~~Thus, for hot soak benzene emissions predictions, it is necessary to specify the oxygen content as MTBE for the candidate and reference fuel. Table 6 is used as in 2. above, using the oxygen content as MTBE of the candidate fuel, to specify the oxygen content as MTBE for the candidate and reference fuel specifications. That is, the~~*The* relevant oxygen content value is the oxygen content as MTBE, not the total oxygen content as in the case of the exhaust emissions predictions. The result is that, if the candidate fuel does not contain MTBE, the oxygen content as MTBE for the reference fuel is 2.0 percent, and the oxygen content as MTBE for the candidate fuel is zero percent. The reason it is assumed that the reference fuel contains MTBE is that MTBE was the oxygenate used while the Phase 2 regulations were in effect, and this assumption helps ensure that potency-weighted toxics emissions from Phase 3 gasoline will not be greater than those from Phase 2 gasoline.

4. For each property other than oxygen and RVP, indicate whether the candidate specification will represent a flat limit or an averaging limit.

5. For each candidate specification identified in 1., identify the appropriate corresponding Phase 3 RFG reference specifications (flat or average). Circle the appropriate flat or average limit for the reference fuel in Table ~~7~~*6*. The circled values are the reference specifications which will be used in the predictive model.

~~6. Table 6 gives the oxygen contents of the reference fuel specifications. Because oxygen is specified in the form of a range, there are two reference fuel oxygen specifications. In most cases they are the same, but in two cases they are not. These two cases are: 1) If the minimum oxygen content of the candidate fuel specifications is within 1.8 to 2.2 percent (inclusive) and the maximum oxygen content of the candidate is greater than 2.2 percent, and 2) If the minimum oxygen content of the candidate fuel specifications is less than 1.8 percent and the maximum oxygen content of the candidate is between 1.8 and 2.2 percent (inclusive). In case 1), the oxygen contents of the reference fuel specifications are 1.8 and 2.0 percent. In case 2), the oxygen contents of the reference fuel specifications are 2.0 and 2.2 percent. (See Table 6)~~

~~Examples:~~

~~If you elect to meet a sulfur limit of 10 for the candidate fuel and elect to comply with a flat limit, the reference fuel sulfur limit would be 20. However, if you elect to meet a sulfur limit of 10 on average, the reference fuel sulfur limit would be 15.~~

~~If the oxygen range of the candidate fuel specifications is 2.0 percent to 2.5 percent, the maximum oxygen content of the candidate fuel is 2.5 percent and the minimum oxygen content of the candidate fuel is 2.0 percent. The maximum oxygen content of the reference fuel is 2.0 percent and the minimum oxygen content of the reference fuel is 1.8 percent. The predicted emissions from the candidate fuel specifications with 2.5 percent oxygen are compared to the predicted emissions from the reference fuel specifications with 2.0 percent oxygen, and the predicted emissions from the candidate fuel specifications with 2.0 percent oxygen are compared to the predicted emissions from the reference fuel specifications with 1.8 percent oxygen. These comparisons are described by row 2 of Table 6.~~

**A. Table 6**

**Candidate and Reference Specifications for Oxygen**

| Oxygen Content for Candidate Fuel Specified by Applicant | | Number of Reference vs Candidate Comparisons Required | Values to be Used in Comparison in Equations | |
|---|---|---|---|---|
| Minimum | maximum | | Candidate | Reference |
| ≥ 1.8, ≤ 2.2 | ≥ 1.8, ≤ 2.2 | 1 | 2.0 | 2.0 |
| ≥ 1.8, ≤ 2.2 | > 2.2 | 2 | minimum | 1.8 |
| | | | maximum | 2.0 |
| < 1.8 | ≥ 1.8, ≤ 2.2 | 2 | minimum | 2.0 |
| | | | maximum | 2.2 |
| < 1.8 | > 2.2 | 2 | minimum | 2.0 |
| | | | maximum | 2.0 |
| < 1.8 | < 1.8 | 2 | minimum | 2.0 |
| | | | maximum | 2.0 |
| ≥ 2.5, ≤ 2.9 | ≥ 2.5, ≤ 2.9 | 1 | 2.7 | 2.0 |
| > 2.2, < 2.5 | > 2.2 | 2 | maximum | 2.0 |
| | | | minimum | 2.0 |
| ≥ 2.5 | > 2.9 | 2 | minimum | 2.0 |
| | | | maximum | 2.0 |

**Table ~~7~~*6***
**Optional Worksheet for Candidate and Reference Fuel Specifications**

**Does the applicant which to use the evaporative HC emissions model and the CO adjustment factor in the evaluation of the equivalency of the candidate fuel specifications? YES ___ NO ___**

**If the above question is answered yes, the flat RVP limit is 6.90 psi and the RVP cap is 7.20 psi. If the above question is answered no, 7.00 psi is the flat RVP limit and the candidate fuel RVP specification.**

| **Fuel Property** | **Candidate Fuel[1]: Specifications** | **Compliance Option: Flat or Average** | **Reference Fuel: Phase 3 RFG Specifications** (Circle Option Chosen) | |
|---|---|---|---|---|
| | | | **Flat** | **Average** |
| **RVP** | | Flat | *7.00*[5] / 6.90[5] / ~~7.00~~ | None |
| **Sulfur** | | | 20 | 15 |
| **Benzene** | | | 0.80/1.00[6] | 0.70 |
| **Aromatic** | | | 25.0/35.0[6] | 22.0 |
| **Olefin** | | | 6.0 | 4.0 |
| **Oxygen[2] (Total)** | (min)<br>(max) | Flat-Range | (min)<br>(max) | None |
| **Oxygen[3] (as MTBE)** | (min)<br>(max) | Not Applicable | Not Applicable | None |
| **Oxygen[4] (as EtOH)** | (min)<br>(max) | Not Applicable | Not Applicable | None |
| **T50** | | | 213/220[6] | 203 |
| **T90** | | | 305/312[6] | 295 |

Note: Footnotes are on the next page

Footnotes for Table ~~7~~6

1 The fuel property value must be within or equal to the cap limit.

2 ~~If the oxygen content range for the candidate fuel is ≥ 1.8 and ≤ 2.2, the candidate fuel and reference fuel oxygen value used in the predictive model equation is 2.0. For all other cases, see Table 6, Candidate and Reference Specifications for Oxygen.~~*When the range between the upper and lower oxygen levels is less than or equal to 0.4 percent, then the prediction is only made for the average of the two oxygen levels. If the range is greater than 0.4 percent, then the prediction is based on the individual upper and lower levels.*

3 The oxygen content (as MTBE) is reported because the hot soak evaporative benzene emissions model includes an MTBE content term (See VIII.A.2).

4 The oxygen content (as EtOH) is reported because the exhaust formaldehyde and the exhaust acetaldehyde models include EtOH content terms for the predictions for the candidate fuel specifications (See VI.A.1.c & d., VI.A.2.c & d., VI.A.3.c & d.). The EtOH content term is not included in the exhaust formaldehyde and acetaldehyde predictions for the reference fuel specifications because it is assumed that, for the reference fuel specifications, MTBE is the oxygenate used to meet the oxygen requirement.

5 ~~If the applicant elects to use the evaporative HC emissions models, the flat RVP limit is 6.90. That is, all predictions for evaporative emissions increases or decreases are made relative to 6.90 psi. If the applicant has elected not to use the evaporative HC emissions models, the flat RVP limit is 7.00. The exhaust models contain an RVP term, but this term has been made constant by fixing the RVP for both the reference and candidate fuels at 7.00 psi in the calculation of the standardized RVP values used in the exhaust emissions equations. This fixing of the RVP takes RVP out of the exhaust models as a fuel property which effects exhaust emissions.~~*If the applicant elects to certify an alternative formulation without theuse of ethanol, then the appropriate flat limit will be 6.90 psi; otherwise, the flat limit for RVP is 7.00 psi.*

6 The higher value is the small refiner CaRFG flat limit for qualifying small refiners only, as specified in section 2272.

## C. General Equations for Calculating Exhaust Emissions by Pollutant and by Technology Class

The selected candidate specifications and set reference specifications are inserted into the predictive model equations to determine the predicted pollutant emissions generated from each fuel formulation by Tech Class. The following is the general form of the equations used to calculate exhaust emissions of the candidate and reference fuel specifications for each pollutant and for each technology class.

$ln\ y_{Tech}$ = intercept + Σ [(fuel effects coefficient) x (standardized fuel property)]

or

$y_{Tech}$ = Exp {intercept + Σ [(fuel effects coefficient) x (standardized fuel property)]}

where

***ln*** is the natural logarithm.

**Exp** is the exponential.

$\mathbf{y_{Tech}}$ is the exhaust emission prediction in grams per mile (for NOx~~, and~~ HC*, and CO*), and milligrams per mile (for benzene, 1,3-butadiene, formaldehyde, and acetaldehyde) for a particular technology class. (Note: $\mathbf{y_{Tech\text{-}REF}}$ is the emissions prediction for the reference fuel specifications and $\mathbf{y_{Tech\text{-}CAND}}$ is the emissions prediction for the candidate fuel specifications.)

**intercept** represents the average vehicle effect for a particular Tech class and a particular pollutant. The intercepts are provided in Table ~~13~~*12*, Coefficients for NOx, ~~and~~*Exhaust* HC, *and CO* Equations, and Table ~~14~~*13*, Coefficients for Toxics Equations.

**fuel effects coefficient** represents the average fuel effects across all vehicles in the database for a particular Tech class and a particular pollutant. The fuel effect coefficients are provided in Table ~~13~~*12*, Coefficients for NOx, ~~and~~ Exhaust HC, *and CO* Equations, and Table ~~14~~*13*, Coefficients for Exhaust Toxics Equations.

**standardized fuel property** is defined as:

standardized fuel property =

$$\frac{\text{[(actual fuel property) - (mean fuel value)]}}{\text{standard deviation of the value for the fuel property}}$$

**actual fuel property** represents the candidate or reference fuel property selected by the applicant in Table ~~7~~*6*, Worksheet for Candidate and Reference Specifications.

Note that the actual fuel property may represent the minimum value of selected candidate fuel properties and is established by the linearization equations defined in sections IV. A. 2 & 3 and V. A. 2 & 3.

**mean fuel value** represents the average fuel values from all data that are used in developing the California Predictive Model. The mean and standard deviation are provided in Table ~~12~~*11*, Standardization of Fuel Properties-Mean and Standard Deviation.

**standard deviation** of the value for the fuel property is the standard deviation from all data that are used in developing the California Predictive Model.

The equations include a term for the RVP effect, however, this term has been made a constant. This was done by computing the standardized RVP value at an actual RVP value of 7.0, and then multiplying this standardized RVP value by the RVP effect coefficient, thereby yielding an additional constant in the equations. Thus, the RVP term is shown as an additional constant (in addition to the intercept) in the exhaust emissions equations. This effectively removes from the exhaust models RVP as fuel property which effects exhaust emissions.

## D. General Equations for Calculating Percent Change of Exhaust Emissions Between Candidate and Reference Specifications

To calculate the percent change of NOx, ~~and~~ exhaust HC, *and CO* emissions, the ratio of the predicted emissions for the candidate specifications to the predicted emissions from reference specifications is multiplied by the technology class emission-weighting factors for NOx, ~~and~~ HC, *and CO*. These weighted ratios are summed. The sum is reduced by 1 and multiplied by 100 to give the percent change in NOx, ~~or~~ HC, *or CO* emissions.

The following is the general form of the equations used to calculate percent change in exhaust emissions between the candidate fuel specifications and the reference fuel specifications for each pollutant.

% Change in NOx, ~~and~~ Exhaust HC, *and CO* Emissions:

%CE = change in emissions =

$$\{[(y_{\text{Tech 3-CAND}} / y_{\text{Tech 3-REF}}) \times EWF_{3q}] + [(y_{\text{Tech 4-CAND}} / y_{\text{Tech 4-REF}}) \times EWF_{4q}] + [(y_{\text{Tech 5-CAND}} / y_{\text{Tech 5-REF}}) \times EWF_{5q}]\} - 1\} \times 100$$

where

$y_{\text{Tech 3}}$, $y_{\text{Tech 4}}$, and $y_{\text{Tech 5}}$ are the pollutant emissions in grams per mile of a particular pollutant and particular Tech class,

$y_{\text{Tech-CAND}}$ is the emissions for the candidate specifications, and
$y_{\text{Tech-REF}}$ is the emissions for the reference specifications.

$EWF_{3q}$, $EWF_{4q}$, and $EWF_{5q}$ are the technology class 3, technology class 4, and technology class 5 weighting factors for the particular pollutant q. The Vehicle Technology Class Weighting Factors are provided in Table 4.

## E. General Equations for Calculating Percent Change of Exhaust Emissions Between Candidate and Reference Specifications

The total Tech class-weighted, potency-weighted exhaust toxics emissions is calculated as shown below.

$E_{PWT\text{-}CAND}$ = Exhaust PWT emissions for candidate specifications =

$$\sum\{[((y_{\text{Tech 3q-CAND}}) \times (VMTWF_3)) + ((y_{\text{Tech 4q-CAND}}) \times (VMTWF_4)) + ((y_{\text{Tech 5q-CAND}}) \times (VMTWF_5))] \times (PWF_q)\}$$

$E_{PWT\text{-}REF}$ = Exhaust PWT emissions for reference specifications =

$$\sum\{[((y_{\text{Tech 3q-REF}}) \times (VMTWF_3)) + ((y_{\text{Tech 4q-REF}}) \times (VMTWF_4)) + ((y_{\text{Tech 5q-REF}}) \times (VMTWF_5))] \times (PWF_q)\}$$

where

The summations are performed across the q number of toxics pollutants, that is:
**($y_{Tech\ 3q}$), ($y_{Tech\ 4q}$), ($y_{Tech\ 5q}$)** are the predicted emissions in milligrams per mile for each toxic air contaminant for Tech classes 3, 4, and 5.

**$y_{Tech\text{-}CAND}$** is the emissions for the candidate fuel specifications, and
**$y_{Tech\text{-}REF}$** is the emissions for the reference fuel specifications

**$VMTWF_3$**, **$VMTWF_4$, $VMTWF_5$** are the VMT weighting factors for Tech classes 3, 4 and 5, respectively. These values are shown in Table 5.

**$PWF_q$** is the potency-weighting factor for each toxic air contaminant q provided in Table ~~8~~*7*.

These equations are shown again in more detail in Section VI*I*.B.1 for the candidate fuel specifications and Section VI*I*.B.2 for the reference fuel specifications.

**Table ~~8~~*7***
**Toxic Air Contaminant Potency-Weighting Factors**

| Pollutant | Potency-Weighting Factor |
|---|---|
| Benzene | 0.170 |
| 1,3-Butadiene | 1.000 |
| Formaldehyde | 0.035 |
| Acetaldehyde | 0.016 |

## IV. OXIDES OF NITROGEN (NOx) EXHAUST EMISSIONS CALCULATIONS

### A. NOx Emissions by Technology Class

The property values from the Table ~~7~~*6* worksheet are used to calculate NOx emissions for the candidate and reference specifications.

#### 1. NOx Emissions for Tech 3

The NOx emissions for the candidate ($y_{\text{Tech 3-CAND}}$) and reference ($y_{\text{Tech 3-REF}}$) specifications for Tech 3 are calculated as follows:

NOx emissions Tech 3 = $y_{\text{Tech 3}}$ =

| Description | Equation |
|---|---|
| | ~~Exp~~ |
| ~~intercept~~ | ~~{ 0.0794329063~~ ~~+~~ |
| ~~RVP (constant)~~ | ~~( 0.037472865)~~ ~~+~~ |
| ~~Sulfur~~ | ~~(0.0159437432) (SULFUR - 195.344776)~~ ~~+~~ ~~131.660328~~ |
| ~~Aromatic HC~~ | ~~(0.0532102243) (AROM - 30.908412)~~ ~~+~~ ~~9.487116~~ |
| ~~Olefin~~ | ~~(0.0230182271) (OLEF - 8.433311)~~ ~~+~~ ~~5.873226~~ |
| ~~Oxygen~~ | ~~(0.0172437318) (OXY - 0.877509)~~ ~~+~~ ~~1.233789~~ |
| ~~T50~~ | ~~( 0.0098269256) (T50 - 211.692062)~~ ~~+~~ ~~16.882813~~ |
| ~~T90~~ | ~~( 0.0005174949) (T90 - 315.301357)~~ ~~+~~ ~~25.72665~~ |
| ~~RVPT50~~ | ~~( 0.0080077184) (7 - 8.626364) (T50 - 211.692062)~~ ~~+~~ ~~0.588437 16.882813~~ |

~~T50T90 (0.0075452045) (T50 - 211.692062) (T90 - 315.301357) +~~
~~16.882813 25.72665~~

~~AROT90 (-0.0096828310) (ARO - 30.908412) (T90 - 315.301357) }~~
~~9.487116 25.72665~~

*Exp*

*intercept {-0.159800 +*

*RVP (0.424915) +*

*Sulfur (0.028040) (SULFUR - 139.691080) +*
*126.741459*

*Aromatic HC (0.047060) (AROM - 30.212969) +*
*8.682044*

*Olefin (0.021110) (OLEF - 7.359624) +*
*5.383804*

*Oxygen (0.014910) (OXY - 0.892363) +*
*1.235405*

*T50 (-0.007360) (T50 - 212.245188) +*
*15.880385*

*T90 (0.000654) (T90 - 312.121596) }*
*23.264684*

where

SULFUR, AROM, OLEF, OXYGEN, T50, and T90 are the value limits for the candidate and reference specifications identified in the Table ~~7~~*6* worksheet.

**2. NOx Emissions for Tech 4**

The NOx emissions for the candidate ($y_{\text{Tech 4-CAND}}$) and reference ($y_{\text{Tech 4-REF}}$) specifications for Tech 4 are calculated as follows:

NOx emissions Tech 4 = $y_{\text{Tech 4}}$ =

Description Equation

~~Exp~~

~~intercept { -0.6016053913 +~~

~~RVP (constant) ( 0.009882551) +~~

~~Sulfur (0.0432360679) (SULFUR - 180.770373) + 147.006156~~

~~Aromatic HC (0.0090548129) (AROM - 27.849881) + 7.004743~~

~~Olefin (0.0184655971) (OLEF - 6.806801) + 4.665131~~

~~Oxygen (0.0137833705) (OXY - 1.355654) + 1.224639~~

~~T50 ( 0.0001960893) (T50 - 207.019049) + 17.195294~~

~~T90 ( 0.0005521256) (T90 - 311.785331) + 21.595186~~

~~AROOXY ( 0.0058732618) (AROM - 27.849881) (OXY - 1.355654) + 7.004743 1.224639~~

~~OXYOXY (0.0102435186) (OXY - 1.355654) (OXY - 1.355654) }~~ ~~1.224639 1.224639~~

*Exp*

*intercept {-0.634694 +*

*RVP (-0.007046) +*

*Sulfur (0.051043) (SULFUR - 154.120828) + 136.790450*

*Aromatic HC (0.011366) (AROM - 27.317137) + 6.880833*

*Olefin (0.017193) (OLEF - 6.549450) + 4.715345*

*Oxygen* *(0.028711) (OXY - 1.536017)* + *1.248887*

*T50* *(-0.002431) (T50 - 205.261051)* + *17.324472*

*T90* *(0.002087) (T90 - 310.931422)* + *20.847425*

*T50T50* *(0.006268) (T50 - 205.261051) (T50 - 205.261051)* + *17.324472* *17.324472*

*T90ARO* *(-0.002892) (T90 - 310.931422) (AROM - 27.317137)* + *20.847425* *6.880833*

*OXYOXY* *(0.010737) (OXY - 1.536017) (OXY - 1.536017)* } *1.248887* *1.248887*

where

For calculating the reference fuel NOx emissions, SULFUR, AROM, OLEF, OXY, T50, and T90 are equal to the corresponding values for the reference specifications in the Table ~~7~~6 worksheet.

For calculating candidate fuel NOx emissions, SULFUR, AROM, OLEF, T50, and T90 are equal to the corresponding values for the candidate specifications in the Table ~~7~~6 worksheet. The value for OXY is determined as follows:

If the value of the candidate fuel Oxygen specification in the Table ~~7~~6 worksheet is less than the $OXYGEN_{(LIN)}$ value, then the $OXYGEN_{(LIN)}$ value is the value for OXY, where $OXYGEN_{(LIN)}$ is calculated as follows:

$$OXYGEN_{(LIN)} = -0.895 + (0.0512 \times AROM)$$

If the value for the candidate Oxygen specification in the Table ~~7~~6 worksheet is greater than or equal to the $OXYGEN_{(LIN)}$ value, then the Oxygen specification in the Table ~~7~~6 worksheet is the value for OXY.

### 3. NOx Emissions for Tech 5

The NOx emissions for the candidate ($y_{Tech\ 5\text{-}CAND}$) and reference ($y_{Tech\ 5\text{-}REF}$) specifications for Tech 5 are calculated as follows:

NOx emissions Tech 5 = $y_{Tech\ 5}$ =

| Description | Equation |
|---|---|
| ~~Exp~~ | |
| ~~intercept~~ | ~~{-1.728220052~~ ~~+~~ |
| ~~RVP (constant)~~ | ~~(-0.010505860)~~ ~~+~~ |
| ~~Sulfur~~ | ~~(0.432840567) (SULFUR - 180.770373) / 147.006156~~ ~~+~~ |
| ~~Aromatic HC~~ | ~~(0.010121940) (AROM - 27.849881) / 7.004743~~ ~~+~~ |
| ~~Olefin~~ | ~~(0.018827975) (OLEF - 6.806801) / 4.665131~~ ~~+~~ |
| ~~Oxygen~~ | ~~(0.013712404) (OXY - 1.355654) / 1.224639~~ ~~+~~ |
| ~~T50~~ | ~~(-0.001476484) (T50 - 207.019049) / 17.195294~~ ~~+~~ |
| ~~T90~~ | ~~(-0.004765110) (T90 - 311.785331) / 21.595186~~ ~~+~~ |
| ~~AROOXY~~ | ~~(-0.005918359) (AROM - 27.849881) / 7.004743 (OXY - 1.355654) / 1.224639~~ ~~+~~ |
| ~~OXYOXY~~ | ~~(0.010133923) (OXY - 1.355654) / 1.224639 (OXY - 1.355654) / 1.224639~~ ~~}~~ |
| *Exp* | |
| *intercept* | *{-1.599255* + |
| *RVP* | *(-0.000533)* + |
| *Sulfur* | *(0.947915) (SULFUR - 144.628900) / 140.912200* + |
| *Aromatic HC* | *(0.013671) (AROM - 26.875940) / 6.600312* + |

*Olefin (0.017335) (OLEF - 6.251891) + 4.431845*

*Oxygen (0.016036) (OXY - 1.551772) + 1.262823*

*T50 (0.012397) (T50 - 206.020900) + 16.582090*

*T90 (0.000762) (T90 - 310.570200) + 22.967590*

*T50T50 (-0.022211) (T50 - 206.020900) (T50 - 206.020900) + 16.582090 16.582090*

*T50OXY (-0.015564) (T50 - 206.020900) (OXY - 1.551772) + 16.582090 1.262823*

*OXYOXY (0.015199) (OXY - 1.551772) (OXY - 1.551772) } 1.262823 1.262823*

where

For calculating the reference fuel NOx emissions, SULFUR, AROM, OLEF, OXY, T50, and T90 are equal to the corresponding values for the reference specifications in the Table ~~7~~*6* worksheet.

For calculating candidate fuel NOx emissions, SULFUR, AROM, OLEF, T50, and T90 are equal to the corresponding values for the candidate specifications in the Table ~~7~~*6* worksheet. The value for OXY is determined as follows:

If the value of the candidate fuel Oxygen specification in the Table ~~7~~*6* worksheet is less than the $OXYGEN_{(LIN)}$ value, then the $OXYGEN_{(LIN)}$ value is the value for OXY, where $OXYGEN_{(LIN)}$ is calculated as follows:

$$OXYGEN_{(LIN)} = -0.895 + (0.0512 \times AROM)$$

If the value for the candidate Oxygen specification in the Table ~~7~~*6* worksheet is greater than or equal to the $OXYGEN_{(LIN)}$ value, then the Oxygen specification in the Table ~~7~~*6* worksheet is the value for OXY.

## B. Percent Change in NOx Emissions

The percent change in NOx emissions between the candidate specifications and the reference specifications is calculated as follows:

$$\%CE_{NOx} = \{\{[(y_{\text{Tech 3-CAND}} / y_{\text{Tech 3-REF}}) \times EWF_{3\text{-NOx}}] + [(y_{\text{Tech 4-CAND}} / y_{\text{Tech 4-REF}}) \times EWF_{4\text{-NOx}}] + [(y_{\text{Tech 5-CAND}} / y_{\text{Tech 5-REF}}) \times EWF_{5\text{-NOx}})]\} - 1\} \times 100$$

where

$y_{\text{Tech 3-CAND}}$, $y_{\text{Tech 4-CAND}}$, and $y_{\text{Tech 5-CAND}}$ are the NOx emissions for the candidate specifications in grams per mile for Tech 3, Tech 4, and Tech 5 respectively.

$y_{\text{Tech 3-REF}}$, $y_{\text{Tech 4-REF}}$, and $y_{\text{Tech 5-REF}}$ are the NOx emissions for the reference specifications in grams per mile for Tech 3, Tech 4, and Tech 5 respectively.

The NOx emissions for Tech 3 are calculated in accordance with the equations in section IV. A. 1.

The NOx emissions for Tech 4 are calculated in accordance with the equations in section IV. A. 2.

The NOx emissions for Tech 5 are calculated in accordance with the equations in section IV. A. 3.

$EWF_{3\text{-NOx}}$, $EWF_{4\text{-NOx}}$, and $EWF_{5\text{-NOx}}$ are the emission-weighting factors for NOx as shown in Table 4.

## V. EXHAUST HYDROCARBONS (HC) EMISSIONS CALCULATIONS

### A. Exhaust HC Emissions by Technology Class

The property values from the Table ~~7~~6 worksheet are used to calculate HC emissions for the candidate and reference specifications.

#### 1. Exhaust HC Emissions for Tech 3

The HC emissions for the candidate ($y_{\text{Tech 3-CAND}}$) and reference ($y_{\text{Tech 3-REF}}$) specifications for Tech 3 are calculated as follows:

HC emissions Tech 3 = $y_{\text{Tech 3}}$ =

| Description | Equation |
|---|---|
| | ~~Exp~~ |
| ~~intercept~~ | ~~( 0.79146931 +~~ |
| ~~RVP (constant)~~ | ~~(-0.001311794) +~~ |
| ~~Sulfur~~ | ~~(0.0055023672) (SULFUR - 195.344776) + 131.660328~~ |
| ~~Aromatic HC~~ | ~~(-0.0437495823) (AROM - 30.908412) + 9.487116~~ |
| ~~Olefin~~ | ~~(-0.0306356465) (OLEF - 8.433311) + 5.873226~~ |
| ~~Oxygen~~ | ~~( 0.0268848312) (OXY - 0.877509) + 1.233789~~ |
| ~~T50~~ | ~~(0.0108590213) (T50 - 211.692062) + 16.882813~~ |
| ~~T90~~ | ~~(0.0021787792) (T90 - 315.301357) + 25.72665~~ |
| ~~SULARO~~ | ~~( 0.0456568399) (SULFUR - 195.344776) (AROM - 30.908412) + 131.660328 9.487116~~ |

~~RVPT50 (-0.0174815748) (7 - 8.626364) (T50 - 211.692062)~~ }

~~0.588437 16.882813~~

*Exp*

*intercept {-0.752270 +*

*RVP (0.000013) +*

*Sulfur (0.038207) (SULFUR - 139.691080) +*
*126.741459*

*Aromatic HC (0.014103) (AROM - 30.212969) +*
*8.682044*

*Olefin (-0.016533) (OLEF - 7.359624) +*
*5.383804*

*Oxygen (-0.026365) (OXY - 0.892363) +*
*1.235405*

*T50 (0.015847) (T50 - 212.245188) +*
*15.880385*

*T90 (0.011768) (T90 - 312.121596) +*
*23.264684*

*T90ARO (0.016606) (T90 - 312.121596) (AROM - 30.212969) +*
*23.264684 8.682044*

*T90OLE (-0.007995) (T90 - 312.121596) (OLEF - 7.359624)* }

*23.264684 5.383804*

where

SULFUR, AROM, OLEF, OXYGEN, T50, and T90 are the value limits for the candidate and reference specifications identified in the Table ~~7~~*6* worksheet.

**2. Exhaust HC Emissions for Tech 4**

The HC emissions for the candidate ($y_{\text{Tech 4-CAND}}$) and reference ($y_{\text{Tech 4-REF}}$) specifications for Tech 4 are calculated as follows:

HC emissions Tech 4 = $y_{\text{Tech 4}}$ =

| Description | Equation |
|---|---|
| ~~Exp~~ | |
| ~~intercept~~ | ~~{ 1.131422309 +~~ |
| ~~RVP (constant)~~ | ~~(0.022383518) +~~ |
| ~~Sulfur~~ | ~~(0.092788380) (SULFUR - 180.770373) + 147.006156~~ |
| ~~Aromatic HC~~ | ~~(0.000103714) (AROM - 27.849881) + 7.004743~~ |
| ~~Olefin~~ | ~~( 0.009384652) (OLEF - 6.806801) + 4.665131~~ |
| ~~Oxygen~~ | ~~( 0.013881563) (OXY - 1.355654) + 1.224639~~ |
| ~~T50~~ | ~~(0.060684722) (T50 - 207.019049) + 17.195294~~ |
| ~~T90~~ | ~~(0.040077769) (T90 - 311.785331) + 21.595186~~ |
| ~~AROARO~~ | ~~( 0.008602222) (AROM - 27.849881) (AROM - 27.849881) + 7.004743 7.004743~~ |
| ~~AROT90~~ | ~~(0.008466012) (AROM - 27.849881) (T90 - 311.785331) + 7.004743 21.595186~~ |
| ~~OXYT90~~ | ~~(0.010447976) (OXY - 1.355654) (T90 - 311.785331) + 1.224639 21.595186~~ |
| ~~T50T50~~ | ~~(0.020099767) (T50 - 207.019049) (T50 - 207.019049) + 17.195294 17.195294~~ |
| ~~T90T90~~ | ~~(0.016985255) (T90 - 311.785331) (T90 - 311.785331) } 21.595186 21.595186~~ |
| ~~*Exp*~~ | |

*intercept* *{-1.142182* +

*RVP* *(-0.019335)* +

*Sulfur* *(0.079373) (SULFUR - 154.120828)* +
*136.790450*

*Aromatic HC* *(0.002047) (AROM - 27.317137)* +
*6.880833*

*Olefin* *(-0.010716) (OLEF - 6.549450)* +
*4.715345*

*Oxygen* *(-0.019880) (OXY - 1.536017)* +
*1.248887*

*T50* *(0.052939) (T50 - 205.261051)* +
*17.324472*

*T90* *(0.037684) (T90 - 310.931422)* +
*20.847425*

*T50ARO* *(0.019031) (T50 - 205.261051) (AROM - 27.317137)* +
*17.324472* *6.880833*

*T50T50* *(0.017086) (T50 - 205.261051) (T50 - 205.261051)* +
*17.324472* *17.324472*

*T50OXY* *(0.013724) (T50 - 205.261051) (OXY - 1.536017)* +
*17.324472* *1.248887*

*T90T90* *(0.013914) (T90 - 310.931422) (T90 - 310.931422)* +
*20.847425* *20.847425*

*AROARO* *(-0.010999) (AROM - 27.317137) (AROM - 27.317137)* +
*6.880833* *6.880833*

*AROOXY* *(0.007221) (AROM - 27.317137) (OXY - 1.536017)* *}*
*6.880833* *1.248887*

where

For calculating the reference fuel HC emissions, SULFUR, AROM, OLEF, OXY, T50, and T90 are equal to the corresponding values for the reference specifications in the Table ~~7~~6 worksheet.

For calculating the candidate fuel HC emissions, SULFUR, AROM, OLEF, and OXY are equal to the corresponding values for the candidate specifications in the Table ~~7~~6 worksheet. The values for T50 and T90 are determined as follows:

If the value for the candidate T50 specification in the Table ~~7~~6 worksheet is less than 181.1 then 181.1 is the value for T50.

If the value for the candidate T50 specification in the Table ~~7~~6 worksheet is greater than or equal to 181.1, the T50 specification in the Table ~~7~~6 worksheet is the value for T50.

If the value for the candidate fuel T90 specification in the Table ~~7~~6 worksheet is less than the $T90_{(LIN)}$ value, then the $T90_{(LIN)}$ value is the value for T90 where $T90_{(LIN)}$ is calculated as follows:

$$T90_{(LIN)} = 316.9 - (0.8235 \times AROM) - (5.41 \times OXY)$$

If the value for the candidate T90 specification in the Table ~~7~~6 worksheet is greater than or equal to the $T90_{(LIN)}$ value, then the T90 specification in the Table ~~7~~6 worksheet is the value for T90.

### 3. Exhaust HC Emissions for Tech 5

The HC emissions for the candidate ($y_{\text{Tech 5-CAND}}$) and reference ($y_{\text{Tech 5-REF}}$) specifications for Tech 5 are calculated as follows:

HC emissions Tech 5 = $y_{\text{Tech 5}}$ =

| Description | Equation |
|---|---|
| ~~Exp~~ | |
| ~~intercept~~ | ~~{ 2.506947412 +~~ |
| ~~RVP (constant)~~ | ~~(0.023617461) +~~ |
| ~~Sulfur~~ | ~~(0.255035043) (SULFUR - 180.770373) + 147.006156~~ |
| ~~Aromatic HC~~ | ~~(0.000975711) (AROM - 27.849881) + 7.004743~~ |

~~Olefin ( 0.009675903) (OLEF - 6.806801) + 4.665131~~

~~Oxygen (-0.014748918) (OXY - 1.355654) + 1.224639~~

~~T50 (0.057474407) (T50 - 207.019049) + 17.195294~~

~~T90 (0.038464284) (T90 - 311.785331) + 21.595186~~

~~AROARO (-0.008618124) (AROM - 27.849881) (AROM - 27.849881) + 7.004743 7.004743~~

~~AROT90 (0.008824753) (AROM - 27.849881) (T90 - 311.785331) + 7.004743 21.595186~~

~~OXYT90 (0.010141739) (OXY - 1.355654) (T90 - 311.785331) + 1.224639 21.595186~~

~~T50T50 (0.019045885) (T50 - 207.019049) (T50 - 207.019049) + 17.195294 17.195294~~

~~T90T90 (0.016517838) (T90 - 311.785331) (T90 - 311.785331) } 21.595186 21.595186~~

*Exp*

*intercept {-2.671187 +*

*RVP (-0.012824) +*

*Sulfur (0.242238) (SULFUR - 144.628900) + 140.912200*

*Aromatic HC (0.003039) (AROM - 26.875940) + 6.600312*

*Olefin (-0.010908) (OLEF - 6.251891) + 4.431845*

*Oxygen (-0.007528) (OXY - 1.551772) + 1.262823*

$$T50 \quad (0.056796)\ (T50 - 206.020900) + 16.582090$$

$$T90 \quad (0.010803)\ (T90 - 310.570200) + 22.967590$$

$$T50ARO \quad (0.016761)\ (T50 - 206.020900)\ (AROM - 26.875940) + 16.582090 \quad 6.600312$$

$$T50T50 \quad (0.019563)\ (T50 - 206.020900)\ (T50 - 206.020900) + 16.582090 \quad 16.582090$$

$$T50OXY \quad (0.014082)\ (T50 - 206.020900)\ (OXY - 1.551772) + 16.582090 \quad 1.262823$$

$$T90T90 \quad (0.015216)\ (T90 - 310.570200)\ (T90 - 310.570200) + 22.967590 \quad 22.967590$$

$$T90OXY \quad (0.013372)\ (T90 - 310.570200)\ (OXY - 1.551772) + 22.967590 \quad 1.262823$$

$$AROARO \quad (-0.009740)\ (AROM - 26.875940)\ (AROM - 26.875940) + 6.600312 \quad 6.600312$$

$$AROOXY \quad (0.006902)\ (AROM - 26.875940)\ (OXY - 1.551772) \Big\} \quad 6.600312 \quad 1.262823$$

where

For calculating the reference fuel HC emissions, SULFUR, AROM, OLEF, OXY, T50, and T90 are equal to the corresponding values for the reference specifications in the Table ~~7~~6 worksheet.

For calculating the candidate fuel HC emissions, SULFUR, AROM, OLEF, and OXY are equal to the corresponding values for the candidate specifications in the Table ~~7~~6 worksheet. The values for T50 and T90 are determined as follows:

If the value for the candidate T50 specification in the Table ~~7~~6 worksheet is less than 181.1, then 181.1 is the value for T50.

If the value for the candidate T50 specification in the Table ~~7~~6 worksheet is greater than or equal to 181.1, the T50 specification in the Table ~~7~~6 worksheet is the value for T50.

If the value for the candidate fuel T90 specification in the Table ~~7~~*6* worksheet is less than the $T90_{(LIN)}$ value, then the $T90_{(LIN)}$ value is the value for T90 where $T90_{(LIN)}$ is calculated as follows:

$$T90_{(LIN)} = 316.9 - (0.8235 \times AROM) - (5.41 \times OXY)$$

If the value for the candidate T90 specification in the Table ~~7~~*6* worksheet is greater than or equal to the $T90_{(LIN)}$ value, then the T90 specification in the Table ~~7~~*6* worksheet is the value for T90.

## B. Percent Change in Exhaust HC Emissions

The percent change in exhaust HC emissions between the candidate fuel specifications and the reference fuel specifications is calculated as follows:

$$\%CE_{EXHC} = \{\{[(y_{\text{Tech 3-CAND}} / y_{\text{Tech 3-REF}}) \times EWF_{3\text{-HC}}] + [(y_{\text{Tech 4-CAND}} / y_{\text{Tech 4-REF}}) \times EWF_{4\text{-HC}}] + [(y_{\text{Tech 5-CAND}} / y_{\text{Tech 5-REF}}) \times EWF_{5\text{-HC}}]\} - 1\} \times 100$$

where

$y_{\text{Tech 3-CAND}}$, $y_{\text{Tech 4-CAND}}$, and $y_{\text{Tech 5-CAND}}$ are the exhaust HC emissions for the candidate specifications in grams per mile for Tech 3, Tech 4, and Tech 5 respectively.

$y_{\text{Tech 3-REF}}$, $y_{\text{Tech 4-REF}}$, and $y_{\text{Tech 5-REF}}$ are the exhaust HC emissions for the reference specifications in grams per mile for Tech 3, Tech 4, and Tech 5 respectively.

The exhaust HC emissions for Tech 3 are calculated according to the equations in section V. A. 1.

The exhaust HC emissions for Tech 4 are calculated according to the equations in section V. A. 2.

The exhaust HC emissions for Tech 5 are calculated according to the equations in section V. A. 3.

$EWF_{3\text{-HC}}$, $EWF_{4\text{-HC}}$, and $EWF_{5\text{-HC}}$ are the emission-weighting factors for HC as shown in Table 4.

## *VI. CARBON MONOXIDE (CO) EMISSIONS CALCULATIONS*

### *A. CO Emissions by Technology Class*

*The property values from the Table 6 worksheet are used to calculate CO emissions for the candidate and reference specifications.*

#### *1. CO Emissions for Tech 3*

*The CO emissions for the candidate ($y_{Tech\ 3\text{-}CAND}$) and reference ($y_{Tech\ 3\text{-}REF}$) specifications for Tech 3 are calculated as follows:*

*CO emissions Tech 3 = $y_{Tech\ 3}$ =*

| *Description* | *Equation* | |
|---|---|---|
| | *Exp* | |
| *intercept* | *{1.615613* | *+* |
| *RVP* | *(0.012087)* | *+* |
| *Sulfur* | *(0.031849) (SULFUR - 139.691080) 126.741459* | *+* |
| *Aromatic HC* | *(0.085541) (AROM - 30.212969) 8.682044* | *+* |
| *Olefin* | *(0.002416) (OLEF - 7.359624) 5.383804* | *+* |
| *Oxygen* | *(-0.068986) (OXY - 0.892363) 1.235405* | *+* |
| *T50* | *(0.009897) (T50 - 212.245188) 15.880385* | *+* |
| *T90* | *(-0.025449) (T90 - 312.121596) 23.264684* | *+* |
| *T50T90* | *(0.017463) (T50 - 212.245188) (T90 - 312.121596) 15.880385 23.264684* | *}* |

*where*

*SULFUR, AROM, OLEF, OXYGEN, T50, and T90 are the value limits for the candidate and reference specifications identified in the Table 6 worksheet.*

***2. CO Emissions for Tech 4***

*The CO emissions for the candidate ($y_{Tech\ 4\text{-}CAND}$) and reference ($y_{Tech\ 4\text{-}REF}$) specifications for Tech 4 are calculated as follows:*

*CO emissions Tech 4 = $y_{Tech\ 4}$ =*

| *Description* | *Equation* |
|---|---|
| | *Exp* |
| *intercept* | *{1.195246 +* |
| *RVP* | *(-0.025878) +* |
| *Sulfur* | *(0.073616) (SULFUR - 154.120828) + 136.790450* |
| *Aromatic HC* | *(0.025960) (AROM - 27.317137) + 6.880833* |
| *Olefin* | *(0.001263) (OLEF - 6.549450) + 4.715345* |
| *Oxygen* | *(-0.052530) (OXY - 1.536017) + 1.248887* |
| *T50* | *(0.022750) (T50 - 205.261051) + 17.324472* |
| *T90* | *(-0.008820) (T90 - 310.931422) + 20.847425* |
| *OXYOXY* | *(-0.016510) (OXY - 1.536017) (OXY - 1.536017) + 1.248887 1.248887* |
| *T50ARO* | *(0.009884) (T50 - 205.261051) (AROM - 27.317137) + 17.324472 6.880833* |
| *T90OLE* | *(-0.007360) (T90 - 310.931422) (OLEF - 6.549450) + 20.847425 4.715345* |

*T90T90 (0.007767) (T90 - 310.931422) (T90 - 310.931422) }*

*20.847425 20.847450*

*where*

*For calculating the reference fuel CO emissions, SULFUR, AROM, OLEF, OXY, T50, and T90 are equal to the corresponding values for the reference specifications in the Table 6 worksheet.*

*For calculating the candidate fuel CO emissions, SULFUR, AROM, OLEF, and OXY are equal to the corresponding values for the candidate specifications in the Table 6 worksheet. The values for T50 and T90 are determined as follows:*

*If the value for the candidate T50 specification in the Table 6 worksheet is less than 181.1 then 181.1 is the value for T50.*

*If the value for the candidate T50 specification in the Table 6 worksheet is greater than or equal to 181.1, the T50 specification in the Table 6 worksheet is the value for T50.*

*If the value for the candidate fuel T90 specification in the Table 6 worksheet is less than the $T90_{(LIN)}$ value, then the $T90_{(LIN)}$ value is the value for T90 where $T90_{(LIN)}$ is calculated as follows:*

$$T90_{(LIN)} = 316.9 - (0.8235 \times AROM) - (5.41 \times OXY)$$

*If the value for the candidate T90 specification in the Table 6 worksheet is greater than or equal to the $T90_{(LIN)}$ value, then the T90 specification in the Table 6 worksheet is the value for T90.*

***3. CO Emissions for Tech 5***

*The CO emissions for the candidate ($y_{Tech\ 5\text{-}CAND}$) and reference ($y_{Tech\ 5\text{-}REF}$) specifications for Tech 5 are calculated as follows:*

*CO emissions Tech 5 = $y_{Tech\ 5}$ =*

*Description Equation*

*Exp*

*intercept {-0.240521 +*

*RVP* *(-0.014137)* +

*Sulfur* *(0.123649) (SULFUR - 144.628900)* + *140.912200*

*Aromatic HC* *(0.025775) (AROM - 26.875940)* + *6.600312*

*Olefin* *(0.005001) (OLEF - 6.251891)* + *4.431845*

*Oxygen* *(-0.087967) (OXY - 1.551772)* + *1.262823*

*T50* *(0.018195) (T50 - 206.020900)* + *16.582090*

*T90* *(-0.128296) (T90 - 310.570200)* + *22.967590*

*OXYOXY* *(0.026310) (OXY - 1.551772) (OXY - 1.551772)* + *1.262823* *1.262823*

*T50ARO* *(0.009797) (T50 - 206.020900) (AROM - 26.875940)* + *16.582090* *6.600312*

*T50OXY* *(0.021763) (T50 - 206.020900) (OXY – 1.551772)* } *16.582090* *1.262823*

*where*

*For calculating the reference fuel CO emissions, SULFUR, AROM, OLEF, OXY, T50, and T90 are equal to the corresponding values for the reference specifications in the Table 6 worksheet.*

*For calculating the candidate fuel CO emissions, SULFUR, AROM, OLEF, and OXY are equal to the corresponding values for the candidate specifications in the Table 6 worksheet. The values for T50 and T90 are determined as follows:*

*If the value for the candidate T50 specification in the Table 6 worksheet is less than 181.1, then 181.1 is the value for T50.*

*If the value for the candidate T50 specification in the Table 6 worksheet is greater than or equal to 181.1, the T50 specification in the Table 6 worksheet is the value for T50.*

*If the value for the candidate fuel T90 specification in the Table 6 worksheet is less than the $T90_{(LIN)}$ value, then the $T90_{(LIN)}$ value is the value for T90 where $T90_{(LIN)}$ is calculated as follows:*

$$T90_{(LIN)} = 316.9 - (0.8235 \times AROM) - (5.41 \times OXY)$$

*If the value for the candidate T90 specification in the Table 6 worksheet is greater than or equal to the $T90_{(LIN)}$ value, then the T90 specification in the Table 6 worksheet is the value for T90.*

***B. Percent Change in CO Emissions***

*The percent change in CO emissions between the candidate fuel specifications and the reference fuel specifications is calculated as follows:*

$$\%CE_{CO} = \{\{[(y_{Tech\ 3\text{-}CAND} / y_{Tech\ 3\text{-}REF}) \times EWF_{3\text{-}CO}] + [(y_{Tech\ 4\text{-}CAND} / y_{Tech\ 4\text{-}REF}) \times EWF_{4\text{-}CO}] + [(y_{Tech\ 5\text{-}CAND} / y_{Tech\ 5\text{-}REF}) \times EWF_{5\text{-}CO}]\} - 1\} \times 100$$

*where*

$y_{Tech\ 3\text{-}CAND}$, $y_{Tech\ 4\text{-}CAND}$, *and* $y_{Tech\ 5\text{-}CAND}$ *are the CO emissions for the candidate specifications in grams per mile for Tech 3, Tech 4, and Tech 5 respectively.*

$y_{Tech\ 3\text{-}REF}$, $y_{Tech\ 4\text{-}REF}$, *and* $y_{Tech\ 5\text{-}REF}$ *are the CO emissions for the reference specifications in grams per mile for Tech 3, Tech 4, and Tech 5 respectively.*

*The CO emissions for Tech 3 are calculated according to the equations in section VI. A. 1.*

*The CO emissions for Tech 4 are calculated according to the equations in section VI. A. 2.*

*The CO emissions for Tech 5 are calculated according to the equations in section VI. A. 3.*

$EWF_{3\text{-}CO}$, $EWF_{4\text{-}CO}$, *and* $EWF_{5\text{-}CO}$ *are the emission-weighting factors for CO as shown in Table 4.*

## VI*I*. POTENCY-WEIGHTED TOXICS (PWT) EXHAUST EMISSIONS CALCULATIONS

### A. Mass Emissions of Toxics by Technology Class

The property values from the Table ~~7~~*6* worksheet are used to calculate mass toxic emissions for the candidate and reference specifications.

#### 1. Mass Emissions for Tech 3

The mass emissions for each toxic for Tech 3 are calculated as follows:

a. Benzene mass emissions Tech 3 = $y_{\text{Tech 3}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {2.95676525 + |
| ~~Sulfur~~ | ~~(0.0683768) (SULFUR - 195.344776) / 131.660328 +~~ |
| ~~Aromatic HC~~ | ~~(0.15191575) (AROM - 30.908412) / 9.487116 +~~ |
| ~~Oxygen~~ | ~~(-0.03295985) (OXY - 0.877509) / 1.233789 +~~ |
| ~~BENZ~~ | ~~(0.12025037) (BENZ - 1.389446) / 0.436822 }~~ |
| *Sulfur* | *(0.0683768) (SULFUR – 139.691080) / 126.741459 +* |
| *Aromatic HC* | *(0.15191575) (AROM - 30.212969) / 8.682044 +* |
| *Oxygen* | *(-0.03295985) (OXY - 0.892363) / 1.235405 +* |
| *BENZ* | *(-0.12025037) (BENZ - 1.389446) / 0.436822 }* |

b. 1,3-Butadiene mass emissions Tech 3 = $y_{\text{Tech 3}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {0.67173886 + |
| ~~Olefin~~ | ~~(0.18408319) (OLEF - 8.433311) / 5.873226 +~~ |
| ~~T50~~ | ~~(0.11391774) (T50 - 211.692062) / 16.882813~~ } |
| *Olefin* | *(0.18408319) (OLEF - 7.350624) / 5.383804* + |
| *T50* | *(0.11391774) (T50 - 212.245188) / 15.880385* } |

c. Formaldehyde mass emissions Tech 3 = $y_{\text{Tech 3}}$ =

| Description | Equation |
|---|---|
| | ~~Exp~~ |
| ~~intercept~~ | ~~{2.16836424~~ ~~+~~ |
| ~~BENZ~~ | ~~( 0.1423482) (BENZ - 1.389446) / 0.436822~~ ~~+~~ |
| ~~Aromatic HC~~ | ~~( 0.07537099) (AROM - 30.908412) / 9.487116~~ ~~+~~ |
| ~~Oxygen~~ | ~~(0.12278577) (OXY - 0.877509) / 1.233789~~ ~~+~~ |
| ~~Oxygen (as EtOH)~~[1] | ~~( 0.12295089) (Type) (OXY - 0.877509) / 1.233789~~ ~~}~~ |
| *Exp* | |
| *intercept* | *{2.12836424* + |
| *Aromatic HC* | *(-0.07537099) (AROM - 30.212969) / 8.682044* + |
| *Oxygen* | *(0.12278577) (OXY - 0.892363) / 1.235405* + |
| *Oxygen (as EtOH)*[1] | *(-0.12295089) (Type) (OXY - 0.8892363) / 1.235405* + |
| *BENZ* | *(-0.1423482) (BENZ - 1.389446) / 0.436822* } |

1 — The Oxygen (as EtOH) term is an indicator variable term which is included only in the model prediction for the candidate fuel specifications, and only if the oxygen originates from the use of ethanol. This term is not included in the calculation for the reference fuel specifications because it is assumed that the oxygen from the reference fuel originates from the use of MTBE. Mathematically, this means that the value of Type in the above equation is 1.0 for the prediction for the candidate fuel specifications if ethanol is used, 0 for the prediction for the candidate fuel specifications if ethanol is not used, and 0 for all predictions for reference fuel specifications.

d. Acetaldehyde mass emissions Tech 3 = $y_{\text{Tech 3}}$ =

| Description | Equation |
|---|---|
| ~~Exp~~ | |
| ~~intercept~~ | ~~{1.10122139 +~~ |
| ~~Oxygen~~ | ~~(0.00122983) (OXY - 0.877509) / 1.233789 +~~ |
| ~~Oxygen (as EtOH)~~[1] | ~~(0.54678495) (Type) (OXY - 0.877509) / 1.233789 +~~ |
| ~~Aromatic HC~~ | ~~(-0.09219416) (AROM - 30.908412) / 9.487116 }~~ |
| *Exp* | |
| *intercept* | *{1.10122139 +* |
| *Aromatic HC* | *(-0.09219416) (AROM - 30.212969) / 8.682044 +* |
| *Oxygen* | *(0.00122983) (OXY - 0.892363) / 1.235405 +* |
| *Oxygen (as EtOH)*[1] | *(0.54678495) (Type) (OXY - 0.892363) / 1.235405 }* |

where

SULFUR, AROM, OLEF, OXYGEN, T50, and T90 are the value limits for the candidate and reference specifications identified in the Table ~~7~~*6* worksheet.

1 — The Oxygen (as EtOH) term is an indicator variable term which is included only in the model prediction for the candidate fuel specifications, and only if the oxygen originates from the use of ethanol. This term is not included in the calculation for the reference fuel specifications because it is assumed that the oxygen from the reference fuel originates from the use of MTBE. Mathematically, this means that the value of Type in the above equation is 1.0 for the prediction for the candidate fuel specifications if ethanol is used, 0 for the prediction for the candidate fuel specifications if ethanol is not used, and 0 for all predictions for reference fuel specifications.

**2. Mass Emissions for Tech 4**

The mass emissions for each toxic for Tech 4 are calculated as follows:

a. Benzene mass emissions Tech 4 = $y_{\text{Tech 4}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {2.3824773 + |
| ~~RVP (constant)~~ | ~~(-0.048140014) +~~ |
| ~~Sulfur~~ | ~~(0.09652526) (SULFUR - 180.770373) + 147.006156~~ |
| ~~Aromatic HC~~ | ~~(0.15517085) (AROM - 27.849881) + 7.004743~~ |
| ~~Olefin~~ | ~~(-0.02548759) (OLEF - 6.806801) + 4.665131~~ |
| ~~T50~~ | ~~(0.04666208) (T50 - 207.019049) + 17.195294~~ |
| ~~BENZ~~ | ~~(0.11689441) (BENZ - 1.009607) } 0.530184~~ |
| | *Exp* |
| *intercept* | *{2.3824773 +* |
| *RVP* | *(0.07392876) +* |
| *Sulfur* | *(0.09652526) (SULFUR - 154.120828) + 136.790450* |
| *Aromatic HC* | *(0.15517085) (AROM - 27.317137) + 6.880833* |
| *Olefin* | *(-0.02548759) (OLEF - 6.549450) + 4.715345* |

$$\frac{T50}{17.324472} \quad \frac{(0.04666208)\,(T50 - 205.261051)}{} \quad +$$

$$\frac{BENZ}{0.530184} \quad \frac{(0.11689441)\,(BENZ - 1.009607)}{} \quad \Big\}$$

b. 1,3-Butadiene mass emissions Tech 4 = $y_{\text{Tech 4}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {0.43090426 + |
| ~~BENZ~~ | ~~(0.03644387) (BENZ - 1.009607) / 0.530184 +~~ |
| ~~Aromatic HC~~ | ~~(-0.03604344) (AROM - 27.849881) / 7.004743 +~~ |
| ~~Olefin~~ | ~~(0.10354089) (OLEF - 6.806801) / 4.665131 +~~ |
| ~~Oxygen~~ | ~~(-0.02511374) (OXY - 1.355654) / 1.224639 +~~ |
| ~~T50~~ | ~~(0.03707822) (T50 - 207.019049) / 17.195294 +~~ |
| ~~T90~~ | ~~(0.09454201) (T90 - 311.785331) / 21.595186~~ } |
| *Aromatic HC* | *(-0.03604344) (AROM - 27.317137) / 6.880833 +* |
| *Olefin* | *(0.10354089) (OLEF - 6.549450) / 4.715345 +* |
| *Oxygen* | *(-0.02511374) (OXY - 1.536017) / 1.248887 +* |
| *T50* | *(0.03707822) (T50 - 205.261051) / 17.324472 +* |
| *T90* | *(0.09454201) (T90 - 310.931422) / 20.847425* |

$$BENZ \quad \left\{ \frac{(0.03644387)\,(BENZ - 1.009607)}{0.530184} \right\}$$

c. Formaldehyde mass emissions Tech 4 = $y_{\text{Tech 4}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {1.05886661 + |
| ~~Sulfur~~ | ~~(-0.04135075) (SULFUR - 180.770373) / 147.006156 +~~ |
| ~~Aromatic HC~~ | ~~(-0.05466283) (AROM - 27.849881) / 7.004743 +~~ |
| ~~Oxygen~~ | ~~(0.06370091) (OXY - 1.355654) / 1.224639 +~~ |
| ~~Oxygen (as EtOH)~~[1] | ~~(-0.09819814) (Type) (OXY - 1.355654) / 1.224639 +~~ |
| ~~T90~~ | ~~(0.06037698) (T90 - 311.785331) / 21.595186~~ } |
| *Sulfur* | *(-0.04135075) (SULFUR - 154.120828) / 136.790450 +* |
| *Aromatic HC* | *(-0.05466283) (AROM - 27.317137) / 6.880833 +* |
| *Oxygen* | *(0.06370091) (OXY - 1.536017) / 1.248887 +* |
| *Oxygen (as EtOH)*[1] | *(-0.09819814) (Type) (OXY - 1.536017) / 1.248887 +* |
| *T90* | *(0.06037698) (T90 - 310.981422) / 20.847425* } |

1 — The Oxygen (as EtOH) term is an indicator variable term which is included only in the model prediction for the candidate fuel specifications, and only if the oxygen originates from the use of ethanol. This term is not included in the calculation for the reference fuel specifications because it is assumed that the oxygen from the

reference fuel originates from the use of MTBE. Mathematically, this means that the value of Type in the above equation is 1.0 for the prediction for the candidate fuel specifications if ethanol is used, 0 for the prediction for the candidate fuel specifications if ethanol is not used, and 0 for all predictions for reference fuel specifications.

d. Acetaldehyde mass emissions Tech 4 = $y_{\text{Tech 4}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {0.16738341 + |
| ~~Aromatic HC~~ | ~~(-0.05552641) (AROM - 27.849881) + 7.004743~~ |
| ~~Sulfur~~ | ~~(0.02788263) (SULFUR - 180.770373) + 147.006156~~ |
| ~~BENZ~~ | ~~(0.06148653) (BENZ - 1.009607) + 0.530184~~ |
| ~~Oxygen~~ | ~~(0.02382123) (OXY - 1.355654) + 1.224639~~ |
| ~~Oxygen (as EtOH)~~ ~~1~~ | ~~(0.46699012) (Type) (OXY - 1.355654) + 1.224639~~ |
| ~~T50~~ | ~~(0.04314573) (T50 - 207.019049) + 17.195294~~ |
| ~~T90~~ | ~~(0.06252964) (T90 - 311.785331)~~ ~~}~~ ~~21.595186~~ |
| *Sulfur* | *(0.02788263) (SULFUR - 154.120828) + 136.790450* |
| *Aromatic HC* | *(-0.05552641) (AROM - 27.317137) + 6.880833* |
| *Oxygen* | *(0.02382123) (OXY - 1.536017) + 1.248887* |
| *Oxygen (as EtOH)* *1* | *(0.46699012) (Type) (OXY - 1.536017) + 1.248887* |

*T50* *(0.04314573) (T50 - 205.261051)* + *17.324472*

*T90* *(0.06252964) (T90 - 310.931422)* + *20.847425*

*BENZ* *(0.06148653) (BENZ - 1.009607)* } *0.530184*

where

SULFUR, AROM, OLEF, OXYGEN, T50, and T90 are the values for the candidate and reference specifications in the Table ~~7~~*6* worksheet.

1 — The Oxygen (as EtOH) term is an indicator variable term which is included only in the model prediction for the candidate fuel specifications, and only if the oxygen originates from the use of ethanol. This term is not included in the calculation for the reference fuel specifications because it is assumed that the oxygen from the reference fuel originates from the use of MTBE. Mathematically, this means that the value of Type in the above equation is 1.0 for the prediction for the candidate fuel specifications if ethanol is used, 0 for the prediction for the candidate fuel specifications if ethanol is not used, and 0 for all predictions for reference fuel specifications.

**3. Mass Emissions for Tech 5**

The mass emissions for each toxic for Tech 5 are calculated as follows:

a. Benzene mass emissions Tech 5 = $y_{\text{Tech 5}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {2.3824773 + |
| ~~RVP (constant)~~ | ~~(-0.048140014) +~~ |
| ~~Sulfur~~ | ~~(0.09652526) (SULFUR - 180.770373) + 147.006156~~ |
| ~~Aromatic HC~~ | ~~(0.15517085) (AROM - 27.849881) + 7.004743~~ |
| ~~Olefin~~ | ~~(-0.02548759) (OLEF - 6.806801) + 4.665131~~ |
| ~~T50~~ | ~~(0.04666208) (T50 - 207.019049) + 17.195294~~ |

~~BENZ (0.11689441) (BENZ - 1.009607) }~~

~~0.530184~~

*RVP (0.06514198) +*

*Sulfur (0.09652526) (SULFUR - 144.628900) +*
*140.912200*

*Aromatic HC (0.15517085) (AROM - 26.875940) +*
*6.600312*

*Olefin (-0.02548759) (OLEF - 6.251891) +*
*4.431845*

*T50 (0.04666208) (T50 - 206.020900) +*
*16.582090*

*BENZ (0.11689441) (BENZ - 1.009607) }*

*0.530184*

b. 1,3-Butadiene mass emissions Tech 5 = $y_{\text{Tech 5}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {0.43090426 + |
| ~~BENZ~~ | ~~(0.03644387) (BENZ - 1.009607) / 0.530184 +~~ |
| ~~Aromatic HC~~ | ~~(-0.03604344) (AROM - 27.849881) / 7.004743 +~~ |
| ~~Olefin~~ | ~~(0.10354089) (OLEF - 6.806801) / 4.665131 +~~ |
| ~~Oxygen~~ | ~~(-0.02511374) (OXY - 1.355654) / 1.224639 +~~ |
| ~~T50~~ | ~~(0.03707822) (T50 - 207.019049) / 17.195294 +~~ |
| ~~T90~~ | ~~(0.09454201) (T90 - 311.785331) / 21.595186~~ } |
| *Aromatic HC* | *(-0.03604344) (AROM - 26.875940) / 6.600312 +* |
| *Olefin* | *(0.10354089) (OLEF - 6.251891) / 4.431845 +* |
| *Oxygen* | *(-0.02511374) (OXY - 1.551772) / 1.262823 +* |
| *T50* | *(0.03707822) (T50 - 206.020900) / 16.582090 +* |
| *T90* | *(0.09454201) (T90 - 310.570200) / 22.967590 +* |

$$BENZ \quad \left\{ \frac{(0.03644387)\,(BENZ - 1.009607)}{0.530184} \right\}$$

c. Formaldehyde mass emissions Tech 5 = $y_{\text{Tech 5}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {1.05886661 + |
| ~~Sulfur~~ | ~~(-0.04135075) (SULFUR - 180.770373) / 147.006156 +~~ |
| ~~Aromatic HC~~ | ~~(-0.05466283) (AROM - 27.849881) / 7.004743 +~~ |
| ~~Oxygen~~ | ~~(0.06370091) (OXY - 1.355654) / 1.224639 +~~ |
| ~~Oxygen (as EtOH)~~[1] | ~~(-0.09819814) (Type) (OXY - 1.355654) / 1.224639 +~~ |
| ~~T90~~ | ~~(0.06037698) (T90 - 311.785331) / 21.595186~~ } |
| *Sulfur* | *(-0.04135075) (SULFUR - 144.628900) / 140.912200 +* |
| *Aromatic HC* | *(-0.05466283) (AROM - 26.875940) / 6.600312 +* |
| *Oxygen* | *(0.06370091) (OXY - 1.551772) / 1.262823 +* |
| *Oxygen (as EtOH)*[1] | *(-0.09819814) (Type) (OXY - 1.551772) / 1.262823 +* |
| *T90* | *(0.000000) (T90 - 310.570200) / 22.967590* } |

1 — The Oxygen (as EtOH) term is an indicator variable term which is included only in the model prediction for the candidate fuel specifications, and only if the oxygen originates from the use of ethanol. This term is not included in the calculation for the reference fuel specifications because it is assumed that the oxygen from the

reference fuel originates from the use of MTBE. Mathematically, this means that the value of Type in the above equation is 1.0 for the prediction for the candidate fuel specifications if ethanol is used, 0 for the prediction for the candidate fuel specifications if ethanol is not used, and 0 for all predictions for reference fuel specifications.

d. Acetaldehyde mass emissions Tech 5 = $y_{\text{Tech 5}}$ =

| Description | Equation |
|---|---|
| | Exp |
| intercept | {0.16738341 + |
| ~~Aromatic HC~~ | ~~(-0.05552641) (AROM - 27.849881) + 7.004743~~ |
| ~~Sulfur~~ | ~~(0.02788263) (SULFUR - 180.770373) + 147.006156~~ |
| ~~BENZ~~ | ~~(0.06148653) (BENZ - 1.009607) + 0.530184~~ |
| ~~Oxygen~~ | ~~(0.02382123) (OXY - 1.355654) + 1.224639~~ |
| ~~Oxygen (as EtOH)~~ ~~1~~ | ~~(0.46699012) (Type) (OXY - 1.355654) + 1.224639~~ |
| ~~T50~~ | ~~(0.04314573) (T50 - 207.019049) + 17.195294~~ |
| ~~T90~~ | ~~(0.06252964) (T90 - 311.785331)~~ ~~}~~ ~~21.595186~~ |
| *Sulfur* | *(0.02788263) (SULFUR - 144.628900) + 140.912200* |
| *Aromatic HC* | *(-0.05552641) (AROM - 26.875940) + 6.600312* |
| *Oxygen* | *(0.02382123) (OXY - 1.551772) + 1.262823* |
| *Oxygen (as EtOH)*[1] | *(0.046699012) (Type) (OXY - 1.551772) + 1.262823* |
| *T50* | *(0.04314573) (T50 - 206.020900) +* |

$$\frac{}{16.582090}$$

$$T90 \quad \frac{(0.06252964)\,(T90 - 310.570200)}{22.967590} +$$

$$BENZ \quad \frac{(0.06148653)\,(BENZ - 1.009607)}{0.530184} \Bigg\}$$

where

SULFUR, AROM, OLEF, OXYGEN, T50, and T90 are the values for the candidate and reference specifications in the Table ~~7~~6 worksheet.

1 — The Oxygen (as EtOH) term is an indicator variable term which is included only in the model prediction for the candidate fuel specifications, and only if the oxygen originates from the use of ethanol. This term is not included in the calculation for the reference fuel specifications because it is assumed that the oxygen from the reference fuel originates from the use of MTBE. Mathematically, this means that the value of Type in the above equation is 1.0 for the prediction for the candidate fuel specifications if ethanol is used, 0 for the prediction for the candidate fuel specifications if ethanol is not used, and 0 for all predictions for reference fuel specifications.

## B. Computation of Total Potency-Weighted Exhaust Toxics Emissions

### 1. Calculation of VMT-Weighted and Potency-weighted Emissions for Candidate Specifications

$$EX_{PWT\text{-}CAND} =$$

$$\{((y_{BZ\text{-}TECH3} \times VMTWF_3)+(y_{BZ\text{-}TECH4} \times VMTWF_4)+(y_{BZ\text{-}TECH5} \times VMTWF_5))x(PWF_{BZ})\} +$$

$$\{((y_{BD\text{-}TECH3} \times VMTWF_3)+(y_{BD\text{-}TECH4} \times VMTWF_4)+(y_{BD\text{-}TECH5} \times VMTWF_5))x(PWF_{BD})\} +$$

$$\{((y_{FOR\text{-}TECH3} \times VMTWF_3)+(y_{FOR\text{-}TECH4} \times VMTWF_4)+(y_{FOR\text{-}TECH5} \times VMTWF_5))x(PWF_{FOR})\} +$$

$$\{((y_{ACE\text{-}TECH3} \times VMTWF_3)+(y_{ACE\text{-}TECH4} \times VMTWF_4)+(y_{ACE\text{-}TECH5} \times VMTWF_5))x(PWF_{ACE})\}$$

where

**$EX_{PWT\text{-}CAND}$** is the PWT emissions for the candidate specifications.

**$y_{BZ\text{-}TECH}$** is the benzene emissions prediction for Tech 3, Tech 4, or Tech 5,
**$y_{BD\text{-}TECH}$** is the 1,3-butadiene emissions prediction for Tech 3, Tech 4, or Tech 5,
**$y_{FOR\text{-}TECH}$** is the formaldehyde emissions prediction for Tech 3, Tech 4, or Tech 5,
**$y_{ACE\text{-}TECH}$** is the acetaldehyde emissions prediction for Tech 3, Tech 4, or Tech 5.

**$VMTWF_3$**, **$VMTWF_4$**, and **$VMTWF_5$** are the VMT weighting factors for Tech class 3, Tech class 4, and Tech class 5 vehicles, respectively. These values are shown in Table 5.

**$PWF_q$** is the potency weighting factor for toxic pollutant q provided in Table ~~8~~*7*.

**2. Calculation of Percent VMT and Potency-Weighted Emissions for Reference Specifications**

$EX_{PWT\text{-}REF}$ =

$\{((y_{BZ\text{-}TECH3} \times VMTWF_3)+(y_{BZ\text{-}TECH4} \times VMTWF_4)+(y_{BZ\text{-}TECH5} \times VMTWF_5))x(PWF_{BZ})\}$ +

$\{((y_{BD\text{-}TECH3} \times VMTWF_3)+(y_{BD\text{-}TECH4} \times VMTWF_4)+(y_{BD\text{-}TECH5} \times VMTWF_5))x(PWF_{BD})\}$ +

$\{((y_{FOR\text{-}TECH3} \times VMTWF_3)+(y_{FOR\text{-}TECH4} \times VMTWF_4)+(y_{FOR\text{-}TECH5} \times VMTWF_5))x(PWF_{FOR})\}$ +

$\{((y_{ACE\text{-}TECH3} \times VMTWF_3)+(y_{ACE\text{-}TECH4} \times VMTWF_4)+(y_{ACE\text{-}TECH5} \times VMTWF_5))x(PWF_{ACE})\}$

where

**$EX_{PWT\text{-}REF}$** is the PWT emissions for the reference specifications.

**$y_{BZ\text{-}TECH}$** is the benzene emissions prediction for Tech 3, Tech 4, or Tech 5,
**$y_{BD\text{-}TECH}$** is the 1,3-butadiene emissions prediction for Tech 3, Tech 4, or Tech 5,
**$y_{FOR\text{-}TECH}$** is the formaldehyde emissions prediction for Tech 3, Tech 4, or Tech 5,
**$y_{ACE\text{-}TECH}$** is the acetaldehyde emissions prediction for Tech 3, Tech 4, or Tech 5.

**$VMTWF_3$**, **$VMTWF_4$**, and **$VMTWF_5$** are the VMT weighting factors for Tech class 3, Tech class 4, and Tech class 5 vehicles, respectively. These values are shown in Table 5.

**$PWF_q$** is the potency-weighting factor for toxic pollutant q provided in Table ~~8~~7.

## VII*I*. CALCULATION*S* ~~OF~~*FOR* CHANGES IN EVAPORATIVE HYDROCARBON (HC) EMISSIONS

a) A. Evaporative HC Emissions by Process

*The evaporative HC models predict the percent change in evaporative HC emissions as a function of RVP* in psi*, relative to ~~an~~*a reference fuel's *RVP~~ of 6.9 psi~~. As stated in Table 1, ~~the~~ the RVP of the reference fuel is* 7.0 psi for an ethanol blended candidate fuel or *6.9* psi for a non-oxygenated candidate fuel*. Thus, the models predict the percent change in evaporative HC emissions of the candidate fuel relative to ~~the~~*a particular *reference fuel. There are three evaporative HC models~~, one~~* for each type of candidate fuel, i.e., oxygenated (ethanol) and non-oxygenated candidate fuels. The three HC models are *for each of the following three evaporative emissions processes: 1) Diurnal/Resting Loss Emissions, 2) Hot Soak Emissions, and 3) Running Loss Emissions.*

~~———~~**1. Diurnal/Resting Loss Emissions**

*a.* The predicted percent change in Diurnal/Resting Loss Emissions (% $CE_{DIRES}$) *of an oxygenated candidate fuel* is*:*

~~% $CE_{DIRES}$ = 100 x Exp[-1.6175913018 + (0.234433522 x RVP)] - 100~~

*% **CE**$_{DIRES}$ = $\dfrac{100 \times [43.589427 + (3.730921 \times RVP)]}{[34.535116 + (3.730921 \times 7.0)]} - 100$*

where RVP is the RVP of the candidate fuel.

*b. The predicted percent change in Diurnal/Resting Loss Emissions (% **CE**$_{DIRES}$) of a non-oxygenated candidate fuel is:*

*% **CE**$_{DIRES}$ = $\dfrac{100 \times [34.535116 + (3.730921 \times RVP)]}{[34.535116 + (3.730921 \times 6.9)]} - 100$*

*where RVP is the RVP of the candidate fuel.*

~~———~~**2. Hot Soak Emissions**

*a.* The predicted percent change in Hot Soak Emissions (% $CE_{HS}$) *of an oxygenated candidate fuel* is*:*

~~% $CE_{HS}$ = 100 x Exp[-5.57770591578 + (1.14227006 x RVP) - (0.048392302 x $RVP^2$)] - 100~~

*% **CE**$_{HS}$ = $\dfrac{100 \times [10.356585 + (4.369978 \times RVP)]}{[9.228675 + (4.369978 \times 7.0)]} - 100$*

where RVP is the RVP of the candidate fuel.

*b. The predicted percent change in Hot Soak Emissions (% **CE**$_{HS}$) of a non-oxygenated candidate fuel is:*

$$\%\ \mathbf{CE}_{HS} = 100 \times \frac{[9.228675 + (4.369978 \times RVP)]}{[9.228675 + (4.369978 \times 6.9)]} - 100$$

*where RVP is the RVP of the candidate fuel.*

***2. Running Loss Emissions***

*a. The predicted percent change in Running Loss (% **CE**$_{RL}$) of an oxygenated candidate fuel is:*

$$\%\ \mathbf{CE}_{RL} = 100 \times \frac{[42.517912 + (9.744935 \times RVP)]}{[40.567912 + (9.744935 \times 7.0)]} - 100$$

*where RVP is the RVP of the candidate fuel.*

*b. The predicted percent change in Running Loss (% **CE**$_{RL}$) of a non-oxygenated candidate fuel is:*

$$\%\ \mathbf{CE}_{RL} = 100 \times \frac{[40.567912 + (9.744935 \times RVP)]}{[40.567912 + (9.744935 \times 6.9)]} - 100$$

*where RVP is the RVP of the candidate fuel.*

~~**3. Running Loss Emissions**~~

~~The predicted percent change in Running Loss Emissions (% $CE_{RL}$) is~~

~~$\%\ CE_{RL} = (10.636 \times RVP^2) - (112.211 \times RVP) + 267.87594$~~

~~where RVP is the RVP of the candidate fuel.~~

## ~~VIII~~*IX*. EVAPORATIVE BENZENE EMISSIONS CALCULATIONS

A. Evaporative Benzene Emissions by Process

*The evaporative benzene models predict the evaporative benzene emissions (in units of milligrams per mile) as a function of RVP, gasoline benzene content, and gasoline MTBE content (for Hot Soak Benzene Emissions). There are three evaporative benzene models, one for each of the following three processes of evaporative benzene emissions: 1) Diurnal/Resting Loss Emissions, 2) Hot Soak Emissions, and 3) Running Loss Emissions.*

### 1. Diurnal/Resting Loss Emissions

The predicted Diurnal/Resting Loss Benzene Emissions ($EVBenz_{DIRES}$) is calculated as follows:

$$EVBenz_{DIRES} = \{572 \times [Exp(-4.304062385 + (0.234434005 \times RVP))] \times [(0.0294917804 \times Benz) - (0.0017567009 \times Benz \times RVP)]\}$$

where
$EVBenz_{DIRES}$ is the predicted evaporative Diurnal/Resting Loss benzene emissions and is calculated for both the reference and candidate fuel specifications,
Benz is the benzene content of the gasoline, in percent by volume, and
RVP is the RVP of the gasoline, in psi.

### 2. Hot Soak Loss Emissions

The predicted Hot Soak Benzene emissions ($EVBenz_{HS}$) is calculated as follows:

$$EVBenz_{HS} = \{572 \times [Exp(-8.498652909 + (1.142251184 \times RVP) - (0.048390975 \times RVP^2))] \times [(0.0463141591 \times Benz) - (0.0027179513 \times Benz \times RVP) - (0.0001435812 \times Benz \times MTBE)]\}$$

where
$EVBenz_{HS}$ is the predicted evaporative Hot Soak benzene emissions and is calculated for both the reference and candidate fuel specifications,
Benz is the benzene content of the gasoline, in percent by volume,
RVP is the RVP of the gasoline, in psi, and
MTBE is the MTBE content of the gasoline, in percent by volume.

### 3. Running Loss Emissions

The predicted Running Loss Benzene emissions ($EVBenz_{RL}$) is calculated as follows:

$$EVBenz_{RL} = \{572 \times [0.3925594957 - (0.1197399622 \times RVP) + (0.011349611 \times RVP^2)] \times [(0.0648391842 \times Benz) - (0.005622979 \times Benz \times RVP)]\}$$

where

$EVBenz_{RL}$ is the predicted evaporative Running Loss benzene emissions and is calculated for both the reference and candidate fuel specifications,

Benz is the benzene content of the gasoline, in percent by volume, and

RVP is the RVP of the gasoline, in psi.

~~If the applicant elects not to use the compliance option which provides for the use of the evaporative HC emissions models, the RVP of both the reference fuel and candidate fuel is assumed to be 7.00 for purposes of using the equations in this section to calculate evaporative benzene emissions.~~

## IX. CREDIT FOR REDUCTIONS IN CO EMISSIONS

In recognition of the ozone-forming potential of CO emissions, the Phase 3 RFG regulations and the predictive model calculations allow a HC reduction credit for the reductions in CO emissions which result from the addition of oxygen to gasoline. The amount of the credit is proportional to the oxygen content of the candidate predictive model gasoline. However, the credit is allowed only if the oxygen content of the candidate predictive model gasoline is greater than a nominal 2.0 percent. Because the Phase 3 RFG gasoline regulations and these Predictive Model Procedures regard any actual oxygen content between 1.8 percent and 2.2 percent, inclusive, as a nominal 2.0 percent, the CO credit would not be given until the actual oxygen content of the gasoline is greater than 2.2 percent (The credit would be 0 for actual oxygen contents less than or equal to 2.2 percent). There is no penalty, or debit, assessed for candidate predictive model gasolines with oxygen contents less than a nominal 2.0 percent.

### A. Equation for Computing the CO Reduction Credit

The CO emissions reduction credit is a function only of the oxygen content of the candidate predictive model gasoline and is computed using the following equation:

$$\%CE_{CO} = (OXY - 2.0) \times (-5.93333) \qquad \text{If } OXY > 2.2$$

$$\%CE_{CO} = 0 \qquad \text{If } OXY \leq 2.2$$

where

$\%CE_{CO}$ is the predicted percent reduction in CO emissions relative to the nominal 2.0 percent oxygen, and

OXY is the oxygen content of the candidate gasoline, in percent by weight.

## X. COMBINATION OF EXHAUST HC EMISSIONS PREDICTIONS, EVAPORATIVE HC EMISSIONS PREDICTIONS, AND CO ~~REDUCTION CREDIT~~*EMISSIONS PREDICTIONS*

In combining the model predictions for exhaust HC, evaporative HC, and CO emissions, the ozone-forming potential of each of the three processes is recognized. The predicted percent change in emissions for each process is multiplied by a factor which represents, for that process, the ozone-forming potential of the emissions. For purposes of this discussion, this ozone-forming potential value will be referred to as relative reactivity. The predicted percent change for each process is also multiplied by a factor which represents the relative contribution of the process to the total inventory of reactive ozone precursors (HC and CO) from gasoline vehicles. The products of the predicted changes in emissions, relative reactivities, and contribution factors are then added. This sum is then divided by the sum of the products of the individual reactivities and emissions contribution fractions for each process. This quotient represents the percent change in the ozone-forming potential of the candidate fuel specifications relative to the reference fuel specifications.

The predicted percent change in exhaust HC emissions is the Tech class-weighted predicted change computed in accordance with the equation shown in Section V.B. For evaporative HC emissions, each of the individual evaporative processes (Diurnal/Resting, Hot Soak, and Running) has a different relative reactivity. Thus, for the evaporative emissions processes, the products of the predicted change in emissions and relative reactivity are computed separately. These three products are included individually in the overall sum. The predicted percent change in the three evaporative HC emissions processes are those computed in accordance with the equations given in Sections VII*I*.A.1, ~~,~~ VII*I*.A.2, and VII*I*.A.3. The predicted percent change in CO emissions is the prediction computed in accordance with the equation given in section ~~IX.A~~*VI.B*.

The combination of the exhaust HC, ~~and~~ the evaporative HC, *and the CO* model predictions~~, and the CO reduction credit~~ can be illustrated mathematically as follows: (Note that this calculation is performed only if the applicant selects the compliance option which provides for the use of the evaporative HC emissions models and the CO adjustment factor.)

$$\%CE_{OFP} = [(\%CE_{EXHC} \times R_{EXHC} \times F_{EXHC}) + (\%CE_{DIRES} \times R_{DIRES} \times F_{DIRES}) + (\%CE_{HS} \times R_{HS} \times F_{HS}) + (\%CE_{RL} \times R_{RL} \times F_{RL}) + (\%CE_{CO} \times R_{CO} \times F_{CO})] \Big/ [(R_{EXHC} \times F_{EXHC}) + (R_{DIRES} \times F_{DIRES}) + (R_{HS} \times F_{HS}) + (R_{RL} \times F_{RL}) + (R_{CO} \times F_{CO})]$$

where~~,~~

$\%CE_{OFP}$ ~~—~~ is the net percent change in ozone-forming potential of the reference fuel specifications relative to the candidate fuel specifications,

$\%CE_{EXHC}$ ~~—~~ is the predicted percent change in Tech-class weighted exhaust HC as given by the equation in Section V.B,

$\%CE_{DIRES}$ ~~—~~ is the predicted percent change in Diurnal/Resting Loss emissions as given by the equation in Section VII*I*.A.1,

$\%CE_{HS}$ ___ is the predicted percent change in Hot Soak emissions as given by the equation in Section VII*I*.A.2,

$\%CE_{RL}$ ___ is the predicted percent change in Running Loss emissions as given by the equation in Section VII*I*.A.3,

$\%CE_{CO}$ ___ is the predicted percent change in CO emissions as given by the equation in Section ~~IX.A~~*VI.B*, and

the R's are the relative reactivities as shown below in Table ~~9~~*8*, and the F's are the fractions of emissions from gasoline vehicles for each process in the year 2005, as given by the ARB's EMFAC~~/BURDEN 7G~~ *2007* motor vehicle emissions model and shown below in Table ~~10~~*9*.

**Table ~~9~~*8***
**Relative Reactivity Values**

| Process | R Value |
|---|---|
| Exhaust HC | 1.000 |
| Diurnal/Resting HC | ~~0.65~~*0.683* |
| Hot Soak HC | ~~0.86~~*0.778* |
| Running Loss HC | ~~0.60~~*0.681* |
| CO | ~~0.021~~*0.0150* |

**Table ~~10~~*9***
**Emissions Fractions**

| Process | F Value |
|---|---|
| Exhaust HC | ~~0.070~~*0.0454* |
| Diurnal/Resting HC | ~~0.0101~~*0.0174* |
| Hot Soak HC | ~~0.0082~~*0.0113* |
| Running Loss HC | ~~0.0157~~*0.0310* |
| CO | ~~0.896~~*0.8949* |

## XI. COMBINATION OF EXHAUST TOXICS EMISSIONS PREDICTIONS WITH EVAPORATIVE BENZENE EMISSIONS PREDICTIONS

The Diurnal/Resting Loss, Hot Soak, and Running Loss evaporative benzene predictions are each multiplied by the toxic air contaminant potency-weighting factor for benzene given in Table ~~8~~*7*, and then summed to give the total potency-weighted evaporative benzene prediction. This prediction is then added to the total Tech class-weighted, potency-weighted exhaust toxics predictions computed in accordance with the equations given in Section V.B to give the total Tech class-weighted, potency-weighted toxics emissions predictions. The addition is performed for both the candidate fuel and the reference fuel. The combination is shown mathematically below:

Total Toxics for the Candidate Fuel Specifications:

~~Total Potency-Weighted Evaporative Benzene Prediction~~
*Total Potency-Weighted Evaporative Benzene Prediction*

$$\mathbf{EVBENZ_{TOT\text{-}CAND} = (EVBENZ_{DIRES\text{-}CAND} + EVBENZ_{HS\text{-}CAND} + EVBENZ_{RL\text{-}CAND}) \times PWF_{BENZ}}$$

~~**Total Potency-Weighted Toxics Prediction**~~
*Total Potency-Weighted Toxics Prediction*

$E_{PWT\text{-}CAND} = EX_{PWT\text{-}CAND} + EVBENZ_{TOT\text{-}CAND}$ ~~where~~

*where*

$EVBENZ_{TOT\text{-}CAND}$ is the total potency-weighted evaporative benzene emission prediction for the candidate fuel specifications,

$EVBENZ_{DIRES\text{-}CAND}$ is the diurnal/resting loss benzene emission prediction for the candidate fuel specifications, as given by the equation in Section ~~VIII~~*IX*.A.1,

$EVBENZ_{HS\text{-}CAND}$ is the hot soak benzene emission prediction for the candidate fuel specifications, as given by the equation in Section ~~VIII~~*IX*.A.2,

$EVBENZ_{RL\text{-}CAND}$ is the running loss benzene emission prediction for the candidate fuel specifications, as given by the equation in Section ~~VIII~~*IX*.A.3,

$PWF_{BENZ}$ is the potency-weighting factor for benzene shown in Table ~~8~~*7*,

$E_{PWT\text{-}CAND}$ is the total potency-weighted toxics prediction for the candidate fuel specifications, and

$EX_{PWT\text{-}CAND}$ is the total Tech class-weighted, potency-weighted exhaust toxics prediction for the candidate fuel specifications computed in accordance with the equation give in Section VI*I*.B.1.

Total Toxics for the Reference Fuel Specifications

~~Total Potency-Weighted Evaporative Benzene Prediction~~
*Total Potency-Weighted Evaporative Benzene Prediction*

$$EVBENZ_{TOT\text{-}REF} = (EVBENZ_{DIRES\text{-}REF} + EVBENZ_{HS\text{-}REF} + EVBENZ_{RL\text{-}REF}) \times PWF_{BENZ}$$

~~Total Potency-Weighted Toxics Prediction~~
*Total Potency-Weighted Toxics Prediction*

$E_{PWT\text{-}REF} = EX_{PWT\text{-}REF} + EVBENZ_{TOT\text{-}REF}$ ~~where~~

*where*

$EVBENZ_{TOT\text{-}REF}$ is the total potency-weighted evaporative benzene emission prediction for the reference fuel specifications,

$EVBENZ_{DIRES\text{-}REF}$ is the diurnal/resting loss benzene emission prediction for the reference fuel specifications, as given by the equation in Section ~~VIII~~*IX*.A.1,

$EVBENZ_{HS\text{-}REF}$ is the hot soak benzene emission prediction for the reference fuel specifications, as given by the equation in Section ~~VIII~~*IX*.A.2,

$EVBENZ_{RL\text{-}REF}$ is the running loss benzene emission prediction for the reference fuel specifications, as given by the equation in Section ~~VIII~~*IX*.A.3,

$PWF_{BENZ}$ is the potency-weighting factor for benzene shown in Table ~~8~~*7*

$E_{PWT\text{-}REF}$ is the total potency-weighted toxics prediction for the candidate fuel specifications, and

$EX_{PWT\text{-}REF}$ is the total Tech class-weighted, potency-weighted exhaust toxics prediction for the candidate fuel specifications computed in accordance with the equation give in Section VI*I*.B.2.

Calculation of *the* Percent Change in Total Predicted Toxics Emissions

The percent change in the total predicted toxics emissions between the candidate fuel specifications and the reference fuel specification is calculated as follows:

$$\%CE_{PWT} = \left[ \left( E_{PWT\text{-}CAND} - E_{PWT\text{-}REF} \right) / E_{PWT\text{-}REF} \right] \times 100$$

## XII. DETERMINATION OF ACCEPTABILITY

If, for each pollutant (NOx, Ozone-forming Potential (OFP) or exhaust HC (EXHC), and Potency-Weighted Toxics (PWT)), the percent difference in emissions between the candidate fuel specifications and the reference Phase 3 RFG specifications is equal to or less than 0.04%, the candidate specifications are deemed acceptable as an alternative to Phase 3 RFG. If the applicant selects the compliance option which provides for the use of the evaporative HC emissions models, the candidate fuel specifications must pass for NOx, OFP, and PWT to be acceptable as an alternative Phase 3 RFG formulation. If the applicant does not select the compliance option which provides for the use of the evaporative HC emissions models, the candidate fuel specifications must pass for NOx, EXHC, and PWT to be acceptable as an alternative Phase 3 RFG formulation.

These criteria are mathematically shown below.

Applicant Elects to Use the Evaporative HC Emissions Model Compliance Option

$$\%CE_{NOx} \leq 0.04\%, \text{ and}$$
$$\%CE_{OFP} \leq 0.04\%, \text{ and}$$
$$\%CE_{PWT} \leq 0.04\%.$$

Applicant Elects not to Use the Evaporative HC Emissions Model Compliance Option

$$\%CE_{NOx} \leq 0.04\%, \text{ and}$$
$$\%CE_{EXHC} \leq 0.04\%, \text{ and}$$
$$\%CE_{PWT} \leq 0.04\%.$$

where

$\%CE_{NOx}$ is given by the equation in Section IV.B,
$\%CE_{OFP}$ is given by the equation in Section X,
$\%CE_{EXHC}$ is given by the equation in Section V.B, and
$\%CE_{PWT}$ is given by the equation in Section XI.C.

If the percent change in emission between the candidate specifications and the reference Phase 3 RFG specifications is equal to or greater than 0.05% for any pollutant (NOx, OFP, EXHC, PWT) in the above equivalency criteria, then the candidate specifications are deemed unacceptable and may not be a substitute for Phase 3 RFG. [Note: All final values of the percent change in emissions shall be reported to the nearest hundredth using conventional rounding.]

If the candidate specifications are deemed acceptable, the property values and the compliance options of the candidate specifications become the property values and compliance options for the alternative gasoline formulation.

## XIII. NOTIFICATION OF INTENT TO OFFER AN ALTERNATIVE GASOLINE FORMULATION

A producer or importer intending to sell or supply an alternative gasoline formulation of California gasoline from its production facility or import facility shall notify the executive officer in accordance with 13 CCR, section 2265(a).

Table ~~11~~*10*, Alternative Specifications for Phase 3 RFG Using the California Predictive Model Notification, has been provided as an example of the minimum information required.

**Table ~~11~~*10***

**B. Alternative Specifications for Phase 3 RFG Using California Predictive Model Notification**

Name of Producer/Importer:_____ Facility Location:_____ Name of Person Reporting:_____ Telephone No:_____ Date/Time of This Report:_____ I.D. of 1st Batch with this Specification:

- All California gasoline transferred from this facility will meet the specifications listed below until the next Alternative Specifications report to the ARB.
- Fuel properties that will be averaged will be reported as the "Designated Alternative Limit and Volume of Gasoline Report" separately to the ARB.

Compliance Option (check one): Evap. Option_____ Exhaust-Only Option

| Fuel Property | Candidate Fuel Property | Compliance Option: | Reference Fuel: Phase 3 Property Value | |
|---|---|---|---|---|
| | | | Flat | AverageRVP |
| RVP | | Flat | 6.90/7.00 | None |
| Sulfur | | | 20 | 15 |
| Benzene | | | 0.80 | 0.70 |
| Aromatic HC | | | 25.0 | 22.0 |
| Olefin | | | 6.0 | 4.0 |
| Oxygen[1] | (min.) | | (min.) | None |
| | (max.) | | (max.) | |
| $T_{50}$ | | | 213 | 203 |
| $T_{90}$ | | | 305 | 295 |

1- See Table 6 in the Predictive Model Procedures for the specification of candidate and reference oxygen levels.

| **Pollutant**[2] | **Percent Change in Emissions**[3] |
|---|---|
| **Oxides of Nitrogen** | |
| **OFP or Exhaust HC** | |
| **Potency-Weighted Toxics** | |

2- Where Applicable, a %CE must be reported for both the candidate fuel minimum and maximum oxygen specifications. ~~See Table 6 for explanation of when both %CE's must be reported.~~

3- Percent change calculated using equations presented in sections IV.B, V.B, VI.B, and X of the Phase 3 Predictive Model Procedures Document.

Please FAX this report to the ARB Enforcement Division at (916) 445-0884

**Table ~~12~~*11***
**Standardization of Fuel Properties - Mean and Standard Deviation**

| Fuel Property | Tech 3 | | Tech 4 and Tech 5 | |
|---|---|---|---|---|
| | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** |
| **RVP** | 8.626364 | 0.588437 | 8.308910 | 0.846737 |
| **Sulfur** | 195.344776 | 131.660328 | 180.770373 | 147.006156 |
| **Aromatic HC** | 30.908412 | 9.487116 | 27.849881 | 7.004743 |
| **Olefin** | 8.433311 | 5.873226 | 6.806801 | 4.665131 |
| **Oxygen** | 0.877509 | 1.233789 | 1.355654 | 1.224639 |
| **T50** | 211.692062 | 16.882813 | 207.019049 | 17.195294 |
| **T90** | 315.301357 | 25.72665 | 311.785331 | 21.595186 |
| **Benzene** | 1.389446 | 0.436822 | 1.009607 | 0.530184 |

***Table 12***
***Coefficients for NOx, Exhaust HC, and CO Equations***

| Model Term | Tech 3 | | | Tech 4 | | | Tech 5 | | |
|---|---|---|---|---|---|---|---|---|---|
| | NOx | HC | CO | NOx | HC | CO | NOx | HC | CO |
| Intercept | -0.159800 | -0.752270 | 1.615613 | -0.634694 | -1.142182 | 1.195246 | -1.599255 | -2.671187 | -0.240521 |
| RVP | 0.424915 | 0.000013 | 0.012087 | -0.007046 | -0.019335 | -0.025878 | -0.000533 | -0.012824 | -0.014137 |
| Sulfur | 0.028040 | 0.038207 | 0.031849 | 0.051043 | 0.079373 | 0.073616 | 0.947915 | 0.242238 | 0.123649 |
| Aromatic HC | 0.047060 | 0.014103 | 0.085541 | 0.011366 | 0.002047 | 0.025960 | 0.013671 | 0.003039 | 0.025775 |
| Olefin | 0.021110 | -0.016533 | 0.002416 | 0.017193 | -0.010716 | 0.001263 | 0.017335 | -0.010908 | 0.005001 |
| Oxygen | 0.014910 | -0.026365 | -0.068986 | 0.028711 | -0.019880 | -0.052530 | 0.016036 | -0.007528 | -0.087967 |
| T50 | -0.007360 | 0.015847 | 0.009897 | -0.002431 | 0.052939 | 0.022750 | 0.012397 | 0.056796 | 0.018195 |
| T90 | 0.000654 | 0.011768 | -0.025449 | 0.002087 | 0.037684 | -0.008820 | 0.000762 | 0.010803 | -0.128296 |
| T90ARO | | 0.016606 | | -0.002892 | | | | | |
| T90OLE | | -0.007995 | | | | -0.007360 | | | |
| T50T90 | | | 0.017463 | | | | | | |
| T50T50 | | | | 0.006268 | 0.017086 | | -0.022211 | 0.019563 | |
| OXYOXY | | | | 0.010737 | | -0.016510 | 0.015199 | | 0.026310 |
| T50ARO | | | | | 0.019031 | 0.009884 | | 0.016761 | 0.009797 |
| T50OXY | | | | | 0.013724 | | -0.015564 | 0.014082 | 0.021763 |
| T90T90 | | | | | 0.013914 | 0.007767 | | 0.015216 | |
| AROARO | | | | | -0.010999 | | | -0.009740 | |
| AROOXY | | | | | 0.007221 | | | 0.006902 | |
| T90OXY | | | | | | | | 0.013372 | |

**Table 13**
**Coefficients for NOx and Exhaust HC Equations**

| Model Term | Tech 3 | | Tech 4 | | Tech 5 | |
|---|---|---|---|---|---|---|
| | NOx | HC | NOx | HC | NOx | HC |
| Intercept | -0.0794329063 | -0.79146931 | -0.6016053913 | -1.131422309 | -1.728220052 | -2.506947412 |
| RVP (constant) | -0.037472865 | -0.001311794 | -0.009882551 | 0.022383518 | -0.01050586 | 0.023617461 |
| Sulfur | 0.0159437432 | 0.0055023672 | 0.0432360679 | 0.092788380 | 0.432840567 | 0.255035043 |
| Aromatic HC | 0.0532102243 | -0.0437495823 | 0.0090548129 | 0.000103714 | 0.010121940 | 0.000975711 |
| Olefin | 0.0230182271 | -0.0306356465 | 0.0184655971 | -0.009384652 | 0.018827975 | -0.009675903 |
| Oxygen | 0.0172437318 | -0.0268848312 | 0.0137833705 | -0.013881563 | 0.013712404 | -0.014748918 |
| T50 | -0.0098269256 | 0.0108590213 | -0.0001960893 | 0.060684722 | -0.001476484 | 0.057474407 |
| T90 | -0.0005174949 | 0.0021787792 | -0.0005521256 | 0.040077769 | -0.004765110 | 0.038464284 |
| AROARO | | | | -0.008602222 | | -0.008618124 |
| AROOXY | | | -0.0058732618 | | -0.005918359 | |
| OXYT90 | | | | 0.010447976 | | 0.010141739 |
| T50T50 | | | | 0.020099767 | | 0.019045885 |
| T50T90 | 0.0075452045 | | | | | |
| T90T90 | | | | 0.016985255 | | 0.016517838 |
| SULARO | | -0.0456568399 | | | | |
| RVPT50 | -0.0080077184 | -0.0174815748 | | | | |
| AROT90 | -0.0096828310 | | | 0.008466012 | | 0.008824753 |
| OXYOXY | | | 0.0102435186 | | 0.010133923 | |

**Table ~~14~~*13***
**Coefficients for Exhaust Toxics Equations**

| Model Term | Tech 3 | | | |
|---|---|---|---|---|
| | **Benzene** | **Butadiene** | **Formaldehyde** | **Acetaldehyde** |
| **Intercept** | 2.95676525 | 0.67173886 | 2.16836424 | 1.10122139 |
| **RVP (constant)** | | | | |
| **Sulfur** | 0.0683768 | | | |
| **Aromatic HC** | 0.15191575 | | -0.07537099 | -0.09219416 |
| **Olefin** | | 0.18408319 | | |
| **Oxygen** | -0.03295985 | | 0.12278577 | 0.00122983 |
| **Oxygen (as EtOH)** | | | -0.12295089 | 0.54678495 |
| **T50** | | 0.11391774 | | |
| **T90** | | | | |
| **Benzene** | 0.12025037 | | -0.1423482 | |
| **Model Term** | **Tech 4 ~~and Tech 5~~** | | | |
| | **Benzene** | **Butadiene** | **Formaldehyde** | **Acetaldehyde** |
| **Intercept** | 2.3824773 | 0.43090426 | 1.05886661 | 0.16738341 |
| **RVP (constant)** | ~~-0.048140014~~ 0.07392876 | | | |
| **Sulfur** | 0.09652526 | | -0.04135075 | 0.02788263 |
| **Aromatic HC** | 0.15517085 | -0.03604344 | -0.05466283 | -0.05552641 |
| **Olefin** | -0.02548759 | 0.10354089 | | |
| **Oxygen** | | -0.02511374 | 0.06370091 | 0.02382123 |
| **Oxygen (as EtOH)** | | | -0.09819814 | 0.46699012 |
| **T50** | 0.04666208 | 0.03707822 | | 0.04314573 |
| **T90** | | 0.09454201 | 0.06037698 | 0.06252964 |
| **Benzene** | 0.11689441 | 0.03644387 | | 0.06148653 |

| Model Term | Tech 5 | | | |
|---|---|---|---|---|
| | Benzene | Butadiene | Formaldehyde | Acetaldehyde |
| Intercept | 2.3824773 | 0.43090426 | 1.05886661 | 0.16738341 |
| RVP (constant) | 0.06514198 | | | |
| Sulfur | 0.09652526 | | -0.04135075 | 0.02788263 |
| Aromatic HC | 0.15517085 | -0.03604344 | -0.05466283 | -0.05552641 |
| Olefin | -0.02548759 | 0.10354089 | | |
| Oxygen | | -0.02511374 | 0.06370091 | 0.02382123 |
| Oxygen (as EtOH) | | | -0.09819814 | 0.46699012 |
| T50 | 0.04666208 | 0.03707822 | | 0.04314573 |
| T90 | | 0.09454201 | 0.06037698 | 0.06252964 |
| Benzene | 0.11689441 | 0.03644387 | | 0.06148653 |

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**A-3) PROCEDURES FOR USING THE CALIFORNIA MODEL FOR CALIFORNIA REFORMULATED GASOLINE BLENDSTOCKS FOR OXYGENATE BLENDING (CARBOB)**

State of California
California Environmental Protection Agency
AIR RESOURCES BOARD

# Procedures for Using the California Model for California Reformulated Gasoline Blendstocks for Oxygenate Blending (CARBOB)

Adopted: April 25, 2001
*Last Amended: [**insert Board adoption date**]*

Note: ~~This is a newly adopted document which is shown in normal type.~~ *The preexisting text is set forth below in normal type. The amendments are shown in underline italic to indicate additions and ~~strikeout~~ to indicate deletions.*

~~As adopted April 25, 2001~~
~~Board Hearing: November 16, 2000~~J

# Procedures for Using the California Model for California Reformulated Gasoline Blendstocks for Oxygenate Blending (CARBOB)

Table of Contents

# 1 INTRODUCTION AND BACKGROUND

The procedures in this document describe how to use the ARB's model for California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB). The procedures are applicable when ethanol is being blended into California Reformulated Gasoline (RFG). The procedures can be used to comply with either the Phase 2 or Phase 3 gasoline regulations. For simplicity, the procedures described in this document will be referred to as the CARBOB procedures. CARBOB is the gasoline blendstock that, when blended with ethanol, results in a finished gasoline which meets the requirements of the Phase 2 or Phase 3 California Reformulated Gasoline (RFG) Regulations. The CARBOB procedures in this document are to be used in combination with the California Procedures for Evaluating Alternative Specifications for Phase 2 Reformulated Gasoline Using the California Predictive Model or with the California Procedures for Evaluating Alternative Specifications for Phase 3 Reformulated Gasoline Using the California Predictive Model (i.e., "The Predictive Model Procedures"). The Predictive Model Procedures implement Section 2265 of the California Code of Regulations, Gasoline Subject to PM Alternative Specifications Based on the California Predictive Model. The principal element of the Predictive Model Procedures is the Phase 2 or Phase 3 predictive model which is used to evaluate the emissions equivalency of alternative complying gasolines that producers wish to produce.

Under the predictive model provisions of the Phase 2 and Phase 3 RFG regulations, the refiner inputs into the predictive model equations the fuel properties of the gasoline he is interested in producing, referred to as the predictive model candidate gasoline. The predicted emissions associated with the candidate gasoline's properties are compared to the predicted emissions for a gasoline meeting either the Phase 2 or Phase 3 limits adopted by the Air Resources Board. If the predicted emissions for the refiner's predictive model candidate gasoline are equivalent to the predicted emissions for a gasoline meeting the appropriate reformulated gasoline limits (either Phase 2 or Phase 3), the predictive model candidate gasoline is allowed to be produced as an alternative complying gasoline.

Section 2266.5, Requirements Pertaining to California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB) and Downstream Blending contains the requirements governing the production and blending of CARBOB. These CARBOB procedures implement the use of the CARBOB model, which is the principle element of these procedures. The CARBOB model is a set of equations which predict the properties of the finished gasoline (gasoline after the addition of ethanol), given the properties of the CARBOB, the properties of the ethanol blended into the CARBOB, and the ethanol content of the finished gasoline. The CARBOB properties, the ethanol properties, and the ethanol content of the finished gasoline are inputs to the CARBOB model, and the properties of the finished gasoline are outputs. The finished gasoline outputs from the CARBOB model are then input into either the Phase 2 or Phase 3 predictive model (depending on which regulations are applicable), as the predictive model candidate gasoline, and the emissions equivalency of the predictive model candidate gasoline is evaluated in accordance with the Predictive Model Procedures.

Thus, the properties of the finished predictive model candidate gasoline can be determined without actually blending the ethanol into the CARBOB.

The purposes of CARBOB model are to facilitate the enforcement of the RFG regulations and to reduce the sampling and testing demands on the refiners in ensuring that gasolines containing ethanol meet the requirements of the RFG regulations. Enforcement is facilitated by allowing the enforcement staff to sample and test CARBOB and to compare the measured CARBOB properties to the properties reported to the ARB. The enforcement staff does not necessarily have to blend into the CARBOB ethanol in order to determine if the finished gasoline complies.

## 2. GENERAL USE OF THE CARBOB MODEL

As discussed above, the CARBOB model is a set of equations which relate the properties of finished gasoline (gasoline containing ethanol) to the properties of the CARBOB, the properties of the ethanol blended into the CARBOB, and the amount of ethanol that is blended. The CARBOB model uses these inputs to estimate the properties of the finished gasoline, which are then input into either the Phase 2 or Phase 3 Predictive Model. The Predictive Model then evaluates whether the finished gasoline meets the emissions equivalency requirements applicable to gasolines subject to the predictive model alternative specifications of the Phase 2 or Phase 3 gasoline regulations. Figure 1 illustrates schematically how the inputs and outputs to the CARBOB model are used in combination with the Predictive Model.

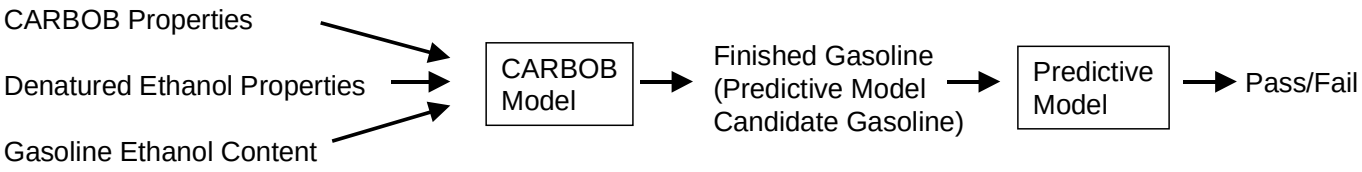
With the exception of the T50 distillation temperature and the oxygen content, the CARBOB model contains one equation for each fuel property regulated under the Phase 2 and Phase 3 RFG regulations. In the case of T50, there are two equations. There is one equation for T50 when the ethanol content of the gasoline is greater than or equal to 4.0 percent and less than 9.0 percent, and another equation when the ethanol content is from 9.0 to 10.0 percent (inclusive). If the ethanol content of the finished gasoline is less than 4.0 percent, the CARBOB model cannot be used. The CARBOB model does not contain an input for the oxygen content. The oxygen content of the predictive model candidate gasoline is input directly into either the Phase 2 or Phase 3 predictive model.

In using the CARBOB model, the user first indicates whether he intends to input into the CARBOB model proprietary values for the aromatics, olefins, sulfur, and benzene contents of the ethanol that is to blended into the CARBOB. The presence of these compounds in the ethanol generally results from the use of a denaturant. If the user does not intend to use proprietary values for the aromatics, olefins, sulfur, and benzene contents, default values are used.

The user then enters into the CARBOB model the values of the CARBOB properties, and the amount of ethanol that is to be blended into the gasoline. The CARBOB model outputs the properties of the finished (ethanol-containing gasoline). The properties of the finished gasoline are input into either the Phase 2 or Phase 3

predictive model (whichever regulatory limits are appropriate) as the properties of the predictive model candidate gasoline. The emissions equivalency of the predictive model candidate gasoline is evaluated by the predictive model in accordance with the provisions of the Predictive Model Procedures.

Figure 1
Schematic Showing the Integration of the CARBOB Model with the Predictive Model



## 3. CARBOB MODEL EQUATIONS

The equations which constitute the CARBOB model are shown below:

A. RVP Model

$RVP_{FG} = 1.446 + 0.961*RVP_{CARBOB}$ where,

$RVP_{FG}$ is the RVP of the finished gasoline, in psi.
$RVP_{CARBOB}$ is the RVP of the CARBOB, in psi.

B. T50 Models

There are two CARBOB models for T50. The first is for a finished gasoline ethanol content of greater than or equal to 4.0 percent, but less than 9.0 percent. The second is for a finished gasoline ethanol content of greater than or equal to 9.0 percent, but less than or equal to 10.0 percent.

**i. Model for 4% $\leq$ EtOH < 9%**

$T50_{FG} = 21.93 + 14.875*EtOH - 10.238*RVP_{CARBOB} + 0.672*T50_{CARBOB} + 0.02579*T90_{CARBOB} - 0.8313*EtOH^2 - 0.3103*RVP_{CARBOB}*EtOH + 0.06623*T50_{CARBOB}*EtOH - 0.05519*T90_{CARBOB}*EtOH + 0.03607*RVP_{CARBOB}*T90_{CARBOB}$
where,

$T50_{FG}$ is the T50 of the finished gasoline, in degrees F,
EtOH is the ethanol content of the finished gasoline, including the denaturant, in vol.%,
$RVP_{CARBOB}$ is the RVP of the CARBOB, in psi,
$T50_{CARBOB}$ is the T50 of the CARBOB, in degrees F,
$T90_{CARBOB}$ is the T90 of the CARBOB, in degrees F.

**ii. Model for 9% $\leq$ EtOH $\leq$ 10%**

$T50_{FG} = 559.276 - 0.5431*RVP_{CARBOB} - 4.1884*T50_{CARBOB} - 0.3957*T90_{CARBOB} + 0.01482*T50_{CARBOB}^2 - 0.05309*T50_{CARBOB}*RVP_{CARBOB} + 0.02884*T90_{CARBOB}*RVP_{CARBOB}$
where,

$T50_{FG}$ is the T50 of the finished gasoline, in degrees F,
EtOH is the ethanol content of the finished gasoline, including the denaturant, in vol.%,

$RVP_{CARBOB}$ is the RVP of the CARBOB, in psi,
$T50_{CARBOB}$ is the T50 of the CARBOB, in degrees F,
$T90_{CARBOB}$ is the T90 of the CARBOB, in degrees F.

Note that there is a T50 CARBOB model only for CARBOB ethanol contents greater than or equal to 4.0 percent. If the ethanol content of the CARBOB is less than 4.0 percent the CARBOB model can not be used.

C. T90 Model

$T90_{FG} = 1.493 + 0.964*T90_{CARBOB} + 0.0468*T50_{CARBOB} - 0.473*EtOH$
where,

$T90_{FG}$ is the T90 of the finished gasoline, in degrees F,
$T90_{CARBOB}$ is the T90 of the CARBOB, in degrees F,
$T50_{CARBOB}$ is the T50 of the CARBOB, in degrees F,
EtOH is the ethanol content of the finished gasoline, including the denaturant, in vol.%.

D. Aromatic Content Model

$AROM_{FG} = ((1 - (EtOH*0.01))*AROM_{CARBOB}) + (EtOH*0.01*AROM_{EtOH})$
where,

$AROM_{FG}$ is the aromatic content of the finished gasoline, in vol.%,
EtOH is the ethanol content of the finished gasoline, including the denaturant, in vol.%,
$AROM_{CARBOB}$ is the aromatic content of the CARBOB, in vol.%,
$AROM_{EtOH}$ is the aromatic content of the ethanol, in vol.%.

E. Olefin Content Model

$OLEF_{FG} = ((1 - (EtOH*0.01))*OLEF_{CARBOB}) + (EtOH*0.01*OLEF_{EtOH})$
where,

$OLEF_{FG}$ is the olefin content of the finished gasoline, in vol.%,
EtOH is the ethanol content of the finished gasoline, including the denaturant, in vol.%,
$OLEF_{CARBOB}$ is the olefin content of the CARBOB, in vol.%,
$OLEF_{EtOH}$ is the olefin content of the ethanol, in vol.%.

F. Benzene Content Model

$BENZ_{FG} = ((1 - (EtOH*0.01))*BENZ_{CARBOB}) + (EtOH*0.01*BENZ_{EtOH})$
where,

$BENZ_{FG}$ is the benzene content of the finished gasoline, in vol.%,
EtOH is the ethanol content of the finished gasoline, including the denaturant, in vol.%,
$BENZ_{CARBOB}$ is the benzene content of the CARBOB, in vol.%,
$BENZ_{EtOH}$ is the benzene content of the ethanol, in vol.%.

G. Sulfur Model

$SULF_{FG} = \{((1- (EtOH*0.01))*SULF_{CARBOB}*0.718) + (EtOH*0.01*SULF_{EtOH}*0.788)\} / \{((1-(EtOH*0.01))*0.718) + (EtOH*0.01*0.788)\}$ where,

$SULF_{FG}$ is the sulfur content of the finished gasoline, in ppm,
EtOH is the ethanol content of the finished gasoline, including the denaturant, in vol.%,
$SULF_{CARBOB}$ is the sulfur content of the CARBOB, in ppm by wt.,
$SULF_{EtOH}$ is the sulfur content of the ethanol, in ppm by wt.

## 4. DETAILED APPLICATION OF THE CARBOB MODEL EQUATIONS

This section will provide a step-by-step explanation of the how the CARBOB model equations are used and how the outputs from the CARBOB model are input into the Predictive Model equations.

The first step in the ~~process is for the user to decide if he is interested in using the evaporative emissions model element of the Phase 3 predictive model (If he is compying with the Phase 3 regulations). If the Phase 2 regulations are applicable, this step is not applicable because there is no evaporative emissions element associated with the Phase 2 predictive model. The user generally will not be interested in using the evaporative emissions model element of the Phase 3 predictive model if he is interested in complying with a flat 7.0 psi RVP limit instead of a limit less than 6.9 psi, or greater than 7.0 psi.~~

~~The next step in the~~ use of the CARBOB model is for the user to specify the properties of the ethanol that is to blended into the CARBOB. The ethanol properties to be specified are: 1) the aromatic content (vol.%), 2) the olefin content (vol.%), 3) the sulfur content (wt. ppm), and 4) the benzene content (vol.%). If the user does not specify values for the ethanol properties, the CARBOB model uses default property values. The default property values are shown in Table 1 below. If the user specifies

values for the ethanol properties, they are to be specified to the same number of decimal places as is shown for the default properties.

**Table 1**
**Default Ethanol Properties Values Used in the CARBOB Model**

| Property | Default Property |
|---|---|
| Aromatic content | 1.7 vol.% |
| Olefin content | 0.5 vol.% |
| Sulfur content | 10 ppmw |
| Benzene content | 0.06 vol.% |

After the user specifies the ethanol properties (or elects to use the default ethanol property values), he specifies the values of the properties of the CARBOB and the ethanol content (including the denaturant) of the finished gasoline. The values of the CARBOB properties and ethanol content are specified to the number of decimal places shown in Table 2.

**Table 2**
**Fuel Properties Specified in CARBOB Model**

| Fuel Property | Units | Decimal Places |
|---|---|---|
| Reid vapor pressure (RVP) | psi, max. | 0.01 |
| T50 Distilation Temperature (T50) | deg. F, max. | 1.0 |
| T90 Distillation Temperature (T90) | deg. F, max. | 1.0 |
| Aromatics Content | vol.%, max. | 0.1 |
| Olefin Content | vol.%, max. | 0.1 |
| Ethanol Content | vol.%, max. | 0.1 |
| Sulfur Content | ppmw, max. | 1.0 |
| Benzene Content | vol.%, max. | 0.01 |

The user then uses the CARBOB model equations shown in Section 3 above and the values for each CARBOB property, ethanol property, and the ethanol content of the finished gasoline, to compute, for each property for which there is a CARBOB model, the corresponding property for the finished gasoline. The value for each property of the finished gasoline is then input into either the Phase 2 or Phase 3 predictive model as the predictive model candidate gasoline. The use of the Phase 2 or Phase 3 predictive model is dictated by which regulations are in effect or applicable to the user at the time. The applicable Predictive Model then evaluates the emissions equivalency of the predictive model candidate gasoline in accordance with the process described in the Phase 2 and Phase 3 Predictive Model Procedures.

If the user intends to produce gasoline in which at least one property will comply with the predictive model averaging compliance option, and the user is establishing a DAL for the CARBOB in accordance with section 2266.5(a)(5)(B), the CARBOB model

must be used to calculate the designated alternative limit (DAL) for the final blend of oxygenated gasoline.

For the gasoline aromatic content, olefin content, benzene content, and sulfur content, the DAL for the final blend of oxygenated gasoline is calculated directly from the CARBOB models for these properties by inputting into the CARBOB models for these properties the DAL for the CARBOB. The CARBOB model prediction is the DAL for the final blend of oxygenated gasoline.

The methodology described above is also used in calculating the T50 and T90 DALs for final blends of oxygenated gasoline, with one exception. This exception occurs if a producer is producing gasoline in which the T50 will comply with a predictive model flat limit and the T90 will comply with a predictive model averaging limit, or the T50 will comply with a predictive model averaging limit and the T90 will comply with a predictive -model flat limit. In these cases, the DAL for the final blend of oxygenated gasoline is calculated by inputting into the CARBOB model the value of the CARBOB DAL for the property (either T50 or T90) which is being produced to the predictive model averaging limit, and inputting into the CARBOB model the flat limit of the CARBOB property (T50 or T90) that is being produced to the predictive model flat limit. The CARBOB model prediction is the DAL for the final blend of oxygenated gasoline for the property being produced under the predictive model averaging compliance option.

A minimum RVP requirement for CARBOB would be in effect during the non-RVP control period (i.e., the time in which the RVP limits specified in Section 2262 are not in effect). The purpose of this "wintertime" RVP specification is different from the purpose of the summertime RVP requirement for CARBOB or final blend of oxygenated gasoline. The purpose of the non-RVP control period minimum RVP requirement is to ensure that the T50 of a final blend of oxygenated gasoline is not greater than the value predicted by the CARBOB model. The minimum RVP requirement for the non-RVP control period arises as a consequence of the RVP term in the T50 CARBOB model. The T50 CARBOB model predicts that the T50 of a final blend of oxygenated gasoline decreases as the RVP of the CARBOB increases. Thus, while there are no basic flat or average RVP limits for CARBOB or gasoline that is not subject to the maximum RVP standards in section 2262, it is still necessary to specify the RVP of the CARBOB during the non-RVP control period in order to make a prediction for the T50 of the final blend of oxygenated gasoline. The RVP value that is used in making this prediction becomes a minimum allowable RVP for the particular blend of CARBOB during the non-RVP control period. That is, during the non-RVP control period, the CARBOB produced by the refiner is required to have an RVP greater than or equal to the value used in the T50 CARBOB model. This ensures that the final blend of oxygenated gasoline has a T50 less than or equal to that predicted by the T50 CARBOB model.

Shown in Table 3 on the next page is a worksheet which includes a step-by-step process to illustrate the use of the CARBOB procedures and to assist the user in using the CARBOB model. The worksheet in Table 3 assumes that the user is complying with

the Phase 3 regulations, but the same process would be used if the user were complying with the Phase 2 regulations. Only Step 5 in the process shown in Table 3 would be different if the user were complying with the Phase 2 gasoline regulations. In that case, the user would compare his predictive model candidate gasoline to the applicable Phase 2 limits instead of the Phase 3 limits.

**Table 3**
**Worksheet for Computing Finished Gasoline Properties from CARBOB Properties**

Step 1: Do you elect to use the evaporative emissions model element of the Phase 3 Predictive Model? Yes (Y) or No (N)

Step 2: Specify the properties of the ethanol, or use the default values in the table below.

| Property | Specified Value | Default Value |
|---|---|---|
| Aromatic content (vol.%) | | 1.7 |
| Olefin content (vol.%) | | 0.5 |
| Sulfur content (ppmw) | | 10 |
| Benzene content (vol.%) | | 0.06 |

Step 3: Specify the ethanol content, including the denaturant, in volume percent, of the finished gasoline. Ethanol content = _____ vol. percent.

Step 4: Enter in the table below the values of the CARBOB properties. For these CARBOB property values, and the ethanol properties specified in Step 2, and the ethanol content specified in Step 3, use the CARBOB model equations shown in Section 3 to compute the properties of the finished gasoline. Enter both the CARBOB values and the predicted finished gasoline values in the table below.

| Property | CARBOB Value | Predicted Finished Gasoline Value[1] |
|---|---|---|
| RVP (psi) | | |
| T50 (deg. F) | | |
| T90 (deg. F) | | |
| Aromatics (vol.%) | | |
| Oxygen as Ethanol (max.) (vol.%) | Not Specified by User | |
| Oxygen as Ethanol (min.) (vol.%) | Not Specified by User | |
| Sulfur (ppmw) | | |
| Benzene (vol.%) | | |

1 – The maximum and minimum oxygen values are specified by the user and are not predicted by the CARBOB model.

Step 5: Complete Table 7 of the Phase 3 Predictive Model Procedures by entering into column 2 (Candidate Fuel Specifications) of Table 7 of the Phase 3 Predictive Model Procedures the predicted finished gasoline property values from Step 4. For convenience,

Table 7 of the Phase 3 Predictive Model Procedures is shown on the next page. Proceed with the evaluation of the candidate fuel in accordance with the requirements specified in the Phase 3 predictive model Procedures.

**Table 4**
**(Table 7 of Predictive Model Procedures)**
**Optional Worksheet for Candidate and Reference Fuel Specifications**

~~Does the applicant which to use the evaporative HC emissions model and the CO adjustment factor in the evaluation of the equivalency of the candidate fuel specifications? YES ___ NO ___~~

~~If the above question is answered yes, the flat RVP limit is 6.90 psi and the RVP cap is 7.20 psi. If the above question is answered no, 7.00 psi is the flat RVP limit and the candidate fuel RVP specification.~~

*Does the applicant wish to certify a fuel containing ethanol? YES ___ NO ___*

*If the above question is answered yes, then the flat RVP limit is 7.00 psi and the RVP cap is 7.20 psi. If the above question is answered no, then 6.90 psi is the flat RVP limit for the candidate fuel RVP specification.*

| Fuel Property | Candidate Fuel[1]: Specifications | Compliance Option: Flat or Average | **Reference Fuel: Phase 3 RFG Specifications** (Circle Option Chosen) | |
|---|---|---|---|---|
| | | | Flat | Average |
| RVP | | Flat | 6.90[5] / 7.00 | None |
| Sulfur | | | 20 | 15 |
| Benzene | | | 0.80/1.00[6] | 0.70 |
| Aromatic | | | 25.0/35.0[6] | 22.0 |
| Olefin | | | 6.0 | 4.0 |
| Oxygen[2] (Total) | (min) | Flat-Range | (min) | None |
| | (max) | | (max) | |
| Oxygen[3] (as MTBE) | (min) | Not Applicable | Not Applicable | None |
| | (max) | | | |
| Oxygen[4] (as EtOH) | (min) | Not Applicable | Not Applicable | None |
| | (max) | | | |
| T50 | | | 213/220[6] | 203 |
| T90 | | | 305/312[6] | 295 |

note: Footnotes are on the next page

Footnotes for Table 4

[1] The fuel property value must be within or equal to the cap limit.

[2] If the oxygen content range for the candidate fuel is 1.8 and 2.2, the candidate fuel and reference fuel oxygen value used in the predictive model equation is 2.0. For all other cases, see Table 6, Candidate and Reference Specifications for Oxygen.

[3] The oxygen content (as MTBE) is reported because the hot soak evaporative benzene emissions model includes an MTBE content term (See VIII.A.2).

[4] The oxygen content (as EtOH) is reported because the exhaust formaldehyde and the exhaust acetaldehyde models include EtOH content terms for the predictions for the candidate fuel specifications -(See VI.A.1.c & d., VI.A.2.c & d., VI.A.3.c & d.). The EtOH content term is not included in the exhaust formaldehyde and acetaldehyde predictions for the reference fuel specifications because it is assumed that, for the reference fuel specifications, MTBE is the oxygenate used to meet the oxygen requirement.

[5] ~~If the applicant elects to use the evaporative HC emissions models, the flat RVP limit is 6.90. That is, all predictions for evaporative emissions increases or decreases are made relative to 6.90 psi. If the applicant has elected not to use the evaporative HC emissions models, the flat RVP limit is 7.00. The exhaust models contain an RVP term, but this term has been made constant by fixing the RVP for both the reference and candidate fuels at 7.00 psi in the calculation of the standardized RVP values used in the exhaust emissions equations. This fixing of the RVP takes RVP out of the exhaust models as a fuel property which effects exhaust emissions.~~

*If the applicant wishes to certify a fuel containing ethanol, then the flat RVP limit is 7.00. If the applicant wishes to certify a fuel that does not contain ethanol, then the flat limit for RVP is 6.90 psi. In either circumstance, the cap limit for RVP is 7.20 psi. The exhaust models contain an RVP term, but this term has been made constant by fixing the RVP for both the reference and candidate fuels at 7.00 psi in the calculation of the standardized RVP values used in the exhaust emissions equations. This fixing of the RVP takes RVP out of the exhaust models as a fuel property which effects exhaust emissions.*

[6] The higher value is the small refiner CaRFG flat limit for qualifying small refiners only, as specified in section 2272.

Table 3 shows that the oxygen content is not specified in the CARBOB model by the user. The user specifies only the ethanol content of the finished gasoline, which is used in the CARBOB model equations to calculate the properties of the finished gasoline. As shown by the CARBOB model equations shown in Section 3, the ethanol content of the finished gasoline is used in all the CARBOB model equations except RVP.

The oxygen content of the finished gasoline is specified by the user when using either the Phase 2 or the Phase 3 predictive model. The user specifies in the predictive model an oxygen content range. The oxygen content range is specified when all other properties of the predictive model candidate fuel are specified, as shown in Table 4 above. For a more detailed discussion of the specification of the oxygen content range for predictive model candidate fuels, see the Predictive Model Procedures document.

After the CARBOB model predictions have been made and entered into the predictive model, all evaluations of the finished gasoline predictive model candidate fuel are made in accordance with the provisions of the Predictive Model Procedures.