

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**

Adopted: June 16, 2000
Amended: April 25, 2001
Amended: [Insert date of amendment]

Note: The proposed amendments are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions compared to the Procedures as amended April 25, 2001. Preexisting underlined text has generally been changed to italics to avoid having that text confused with text that is underlined because it is being added.

Only those portions affected by the proposed amendments are shown. The symbol "* * * * *" means that intervening text not proposed to be amended is not shown.

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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.

**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
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)	none	1.8(min) ⁴
		2.2 (max)		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 affects only evaporative HC emissions.

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

³ The Phase 3 RFG sulfur content cap limits of 60 and 30 parts per million are phased in starting December 31, ~~2002~~ 2003, and December 31, ~~2004~~ 2005, 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 from ethanol but not more than 10.0 volume percent ethanol, the maximum oxygen content cap is 3.7 percent by weight.

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B. Synopsis of Procedure

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4. Determination of Emissions Equivalency

The candidate fuel specifications are deemed equivalent to the reference fuel specifications if, for each pollutant (NO_x, 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 NO_x, OFP, and PWT. If the applicant has elected not to use the evaporative HC emissions model, the 0.04% criteria must be met for NO_x, 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.~~

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III. GENERAL EQUATIONS FOR CALCULATING PERCENT CHANGES IN EMISSIONS

A. Summary and Explanation

- ◆ The applicant will first select which 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. 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~~ three cases where two emissions predictions are not made for the candidate fuel specifications is if the oxygen range 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), or within the range of 3.3 to 3.7 percent (inclusive). In these cases, the predicted emissions for the candidate fuel specifications are compared to the predicted emissions for the reference fuel specifications at only one oxygen level.
- ◆ For NO_x 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 NO_x 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.A. The predicted change is computed for each evaporative emissions process. (See VII.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 given in Section IX.A. (See IX.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 and potency-weighted, in accordance with the equations given in VI.B. (See VI.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.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.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 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 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 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.

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 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. 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 (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 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~~ three exceptions to this, in which case 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 (inclusive), the oxygen content of the candidate fuel specifications is assumed to be 2.7 percent. If the oxygen range of the candidate fuel specifications is within the range of 3.3 to 3.7 percent (inclusive), the oxygen content of the candidate fuel specifications is assumed to be 3.5 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.
3. The hot soak benzene emissions model contains an 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 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. 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.

**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
$\geq 1.8,$ ≤ 2.2	$\geq 1.8,$ ≤ 2.2	1	2.0	2.0
$\geq 1.8,$ ≤ 2.2	> 2.2	2	minimum	1.8
			maximum	2.0
< 1.8	$\geq 1.8,$ ≤ 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
$\geq 2.5,$ ≤ 2.9	$\geq 2.5,$ ≤ 2.9	1	2.7	2.0
$> 2.2,$ < 2.5	> 2.2	2	minimum	2.0
			maximum	2.0
$\geq 2.5,$ < 3.3	> 2.9	2	minimum	2.0
			maximum	2.0
≥ 3.3 ≤ 3.7	≥ 3.3 ≤ 3.7	<u>1</u>	<u>3.5</u>	<u>2.0</u>

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