Rulemaking file

State of California
AIR RESOURCES BOARD

Resolution 94-38

June 9, 1994

Agenda Item No.: 94-6-2

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

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

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

WHEREAS, section 43018(c) of the Health and Safety Code provides that in carrying out section 43018, the Board shall adopt standards and regulations which will result in the most cost-effective combination of control measures on all classes of motor vehicles and motor vehicle fuel, including but not limited to specification of vehicular fuel composition;

WHEREAS, Health and Safety Code section 43013 authorizes the Board to adopt and implement motor vehicle fuel specifications for the control of air contaminants and sources of air pollution which the Board has found to be necessary, cost-effective, and technologically feasible to carry out the purposes of Division 26 of the Health and Safety Code;

WHEREAS, following a public hearing on November 21-22, 1991, the Board approved regulations for Phase 2 reformulated gasoline (Phase 2 RFG), applicable to gasoline sold in California for use in motor vehicles beginning March 1, 1996; these regulations include a comprehensive set of specifications affecting eight different gasoline properties and are designed to ensure that in-use gasoline is a significantly cleaner-burning fuel;

WHEREAS, the Phase 2 RFG regulations require that, for each of the eight regulated properties, producers and importers meet either "flat" or, if available, "averaging" limits when their gasoline is supplied from the production or import facility, and require that gasoline at any point in the distribution system not exceed "cap" limits for the properties;

WHEREAS, in Resolution 91-54 approving the Phase 2 RFG regulations, the Board directed the Executive Officer to continue work on the development of a predictive model that could be used to certify a set of alternative specifications that could be met to satisfy compliance with the Phase 2 RFG requirements, and to schedule a future rulemaking hearing for the Board to consider adoption of the predictive model;

WHEREAS, the staff has proposed amendments to the Phase 2 RFG regulations which would provide producers and importers of California gasoline the option of using the "California Predictive Model" to establish alternative Phase 2 RFG specifications that could be met in lieu of the specifications set forth in the Phase 2 RFG regulations, and which would identify the procedures and requirements for such use;

WHEREAS, the amendments proposed by the staff would also make a number of other changes to the Phase 2 RFG regulations, including extending the dates for compliance with the cap limits so that they apply starting April 15, 1996, to sales of gasoline from all facilities except for bulk plants, retail outlets, or bulk purchaser-consumer facilities, and apply throughout the distribution system starting June 1, 1996; allowing more frequent switching between the flat and averaging limits; allowing producers and importers initially to report the estimated volume of gasoline in a batch subject to designated alternative limits; requiring California refiners to comply with the Phase 2 RFG producer limits when producing gasoline that will be offered for sale at an out-of-state terminal where the fuel is identified as gasoline suitable for sale in California; and inserting an additional significant digit (to a tenth of a percent) for all references to the aromatic hydrocarbon content values;

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

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

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

WHEREAS, the Board finds that:

The California Predictive Model approved herein provides a technically sound means for determining the emissions impacts of alternative gasoline formulations in comparison to gasoline meeting the Phase 2 RFG specifications;

The regulatory amendments approved herein allowing the use of the California Predictive Model will provide producers and importers of California gasoline with additional flexibility and the opportunity to maximize production capabilities, better address conditions that may affect fuel supply, and reduce the operating costs of complying with the Phase 2 RFG regulations;

The amendments approved herein pertaining to the compliance dates for the "cap" limits will help provide for a smoother transition to Phase 2 RFG and help ensure that there is a continued adequate supply of gasoline in the state;

The other amendments approved herein will help gasoline producers effectively manage refinery operations and reduce burdens on small importers of gasoline;

The modifications to the California Predictive Model described in Attachment C hereto are necessary and appropriate to improve and simplify the Model;

The modifications described in Attachment C pertaining to limited extensions of the averaging period under the averaging compliance option are necessary and appropriate to afford additional flexibility in meeting the Phase 2 RFG requirements during the initial period of implementation;

No alternative has been identified to the Board which would be less costly than the amendments approved herein while being equally or more effective in achieving increments of air quality improvement in a manner that ensures full compliance with the statutory mandates in sections 43013 and 43018 of the Health and Safety Code;

While the Phase 2 RFG regulations approved herein are different from the reformulated gasoline regulations contained in the Federal Code of Regulations, the regulations approved herein are authorized by state law;

The ARB has worked with the United States Environmental Protection Agency and gasoline producers to effectively streamline the enforcement requirements of the federal reformulated gasoline regulations as they apply in California, and, as a result, the federal regulations exempt California producers from many of the federal enforcement

requirements from March 1, 1996 to January 1, 2000, as long as certain criteria are met; and

The amendments approved herein will not have any adverse impact on the economy of the state;

WHEREAS, the Board further finds that:

The amendments approved herein may result in a very small increase in emissions during March 1 to June 1, 1996 due to the extension of the cap limit compliance date for terminals, bulk plants, and service stations; however, any such emission increases would be insignificant because no changes are being made to the requirement that gasoline leaving production and import facilities must meet the Phase 2 RFG limits beginning March 1, 1996;

There is a possibility that the amendments approved herein may sometimes result in an increase in summertime CO emissions in 1996 and subsequent years when the predictive model is used because gasoline producers will not be required to demonstrate that there will be no increases in CO;

The requirement in the Phase 2 RFG regulations that all gasoline sold in the State contain a minimum of 1.8 percent oxygen by weight during the wintertime months will minimize CO emissions during the times when carbon monoxide concentrations are highest;

All areas of California are projected to be in attainment for the federal and state ambient air quality standards for CO by 1996 except Los Angeles County; the requirement in the federal reformulated gasoline regulations that all gasoline sold in Los Angeles County and most of the rest of Southern California contain a minimum of 2.0 percent oxygen by weight throughout the year will help minimize CO emissions and will fully mitigate any increase in CO emissions that could otherwise be associated with use of the California Predictive Model approved herein; and

In all other respects the amendments approved herein will not result in any significant adverse environmental impacts.

NOW, THEREFORE, BE IT RESOLVED that the Board hereby approves the amendments to sections 2260, 2261, 2262.2, 2262.3, 2262.4, 2262.5, 2262.6, 2262.7, 2264, and 2270, and the adoption of sections 2264.2 and 2265, in Title 13, California Code of Regulations, as set forth in Attachment A hereto, and approves the adoption of the "California Procedures for Evaluating Alternative Specifications for Phase 2 Reformulated Gasoline Using the

California Predictive Model," as set forth in Attachment B hereto, with the modifications described in Attachment C hereto.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to incorporate into the approved regulations and incorporated document the modifications described in Attachment C hereto with such other conforming modifications as may be appropriate, and either to adopt the modified regulations, amendments, and new document after making them available to the public for a supplemental written comment period of 15 days, with such additional modifications as may be appropriate in light of supplemental comments received, or to present the regulations, amendments, and document to the Board for further consideration if he determines that this is warranted in light of supplemental written comments received.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to continue to work with the United States Environmental Protection Agency and with gasoline producers and marketers to ensure that the federal and California reformulated gasoline regulations continue to be implemented in an integrated manner that avoids unnecessary burdens on the regulated public.

I hereby certify that the above is a true and correct copy of Resolution 94-38, as adopted by the Air Resources Board.

Pat Hutchens

Pat Hutchens, Board Secretary

Resolution 94-38

June 9, 1994

Identification of Attachments to the Resolution

Attachment A: Proposed amendments to sections 2260, 2261, 2262.2, 2262.3, 2262.4, 2262.5, 2262.6, 2262.7, 2264, and 2270, and adoption of sections 2264.2 and 2265, in Title 13, California Code of Regulations, as set forth in Appendix A to the Staff Report.

Attachment B: The proposed "California Procedures for Evaluating Alternative Specifications for Phase 2 Reformulated Gasoline Using the California Predictive Model," as set forth in Appendix B to the Staff Report.

Attachment C: Staff's Suggested Changes to the Proposed Amendments to the California Reformulated Gasoline Regulations (distributed at the hearing on June 9, 1994).

State of California
AIR RESOURCES BOARD

Staff's Suggested Changes to the Proposed Amendments to the California Reformulated Gasoline Regulations

June 9, 1994

I. Phase 2 Reformulated Gasoline Regulations

1. Limited Extensions of the 90-Day Offset Period Under the Averaging Compliance Option

Existing Requirements. In the case of six of the eight Phase 2 reformulated gasoline (Phase 2 RFG) specifications, the regulations allow producers or importers to use an averaging compliance option instead of complying with the specified flat limits. The averaging limits for each of the six properties are more stringent than the comparable flat limits. Under the averaging option, a producer or importer may assign differing "designated alternative limits" (DALs) to different batches of gasoline being supplied from the production or import facility. Each batch of gasoline must meet the DAL for the batch. In addition, a producer or importer supplying a batch of gasoline with a DAL less stringent than the averaging limit must within 90 days before or after supply from the same facility sufficient quantities of gasoline subject to more stringent DALs to fully offset the exceedances of the averaging limit.

Proposed Modification. The staff proposes a modification which would allow producers to extend the 90-day offset period in limited circumstances. The producers would be allowed up to three extensions in 1996, and up to three extensions in 1997. The maximum duration of each extension would be 10 days, and the extensions could be taken consecutively. The extension provision would sunset December 31, 1997, and thus no extensions could start on or after January 1, 1998.

Each extension would apply to the required time in which a batch or batches of gasoline with DALs generating "debits" for a particular parameter would have to be fully offset by a subsequent batch or batches of gasoline with a more stringent DAL generating "credits" for that parameter. Each extension would allow debits for a parameter to be offset up to 100 days after shipment of the debit batch, rather than in no more than 90 days. The extension would also apply to other debit batches for that parameter whose 90-day offset period expires during the extension period, although the extension length for these batches would diminish as the fixed ending date is approached. For example, a refiner may on January 1 produce a batch of gasoline with a sulfur deficit, and on January 6 produce another batch with a sulfur deficit. The 90-day period for offsetting the January 1 batch ends March 31. If a refiner extends the March 31 offset deadline 10 days to April 10, April 10 would also become the new offset deadline for the January 6 batch.

In order to extend an offset period beyond 90 days, a producer would have to notify the ARB before 5:00 p.m. on the 90th day. The producer would be required to identify an unforeseen event necessitating the extension. In the notification, the producer would have to specify the DAL parameter(s) and the date the extension would go into effect.

A single extension could apply to more than one DAL parameter if (a) the additional fuel parameters are identified in the original notification, (b) the need for an extension for the additional parameters is shown to be attributable to the unforeseen event identified in the notification, and (c) the additional parameters have a "debit" balance at the time of the extension notification and would reach 90-day offset deadlines during the requested extension period.

This modification would also apply to importers operating under the averaging compliance option.

Rationale. The extension provisions are designed to provide additional flexibility in meeting the Phase 2 RFG regulations during the early years of implementation as producers gain more experience in blending gasoline to simultaneously meet all of the Phase 2 RFG specifications. While they will allow an extension of the offset period, they will not change the requirement for full offsets for all DAL "debit" batches.

Section Affected: new section 2264.4.

2. Use of an Enforcement Protocol with the California Predictive Model Option

Add a provision that allows the use of enforcement protocols to vary the notification requirements pertaining to gasoline batches to be sold subject to alternative specifications based on application of the California Predictive Model. The regulatory language would be identical to a current provision allowing protocols regarding designated alternative limit notifications.

Sections Affected: adopt new 2265(a)(4) to read:

> [Section 2265] (a)(4) The executive officer may enter into a written protocol with any individual producer or importer for the purposes of specifying how the requirements in section (a)(2) 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 section (a)(2). Any such protocol shall include the producer's or importer's agreement to be bound by the terms of the protocol.

3. Miscellaneous

Make the following nonsubstantive editorial revision in the first sentence of section 2264.2(a)(1):

(1) A producer of importer selling or supplying a final blend of gasoline from its production or import facility may elect pursuant to this section 2264.2 to have the final blend subject to the averaging compliance option for one or more of the following properties: sulfur, benzene, olefins, ~~or~~ aromatic hydrocarbons, ~~content~~, T90, or T50.

II. California Procedures for Evaluating Alternative Specifications for Phase 2 Reformulated Gasoline Using the California Predictive Model

1. Eliminate Insignificant Terms in the Toxics Equations

To simplify the equations for the individual toxics, the statistical analysis was redone to include only the statistically significant terms (at a p-value = 0.05). The analysis was redone for both Tech class 3 and 4 and all four toxics (benzene, 1,3-butadiene, acetaldehyde, and formaldehyde). As a result, a number of insignificant terms in the individual equations were eliminated and the coefficients for the remaining terms were changed.

Sections Affected: VI.A., Table 12 (See Exhibit 1)

2. Adjust the T50 and T90 Responses in the Hydrocarbon Equation for Tech Class 4

There are limited emissions data at low values of the 50 percent and 90 percent distillation temperatures. Consequently, the responses predicted by the Tech class 4 hydrocarbon equation relative to low T50 and T90 values indicate that there will be an increase in hydrocarbon emissions at low values of the two distillation temperatures. These responses do not appear to be supported by the data. Therefore, a linearization technique has been employed to "flatten-out" the responses of T50 and T90.

Sections Affected: III.C., V.A.2. (See Exhibit 1)

3. Adjust the RVP*Oxygen Response in the Oxides of Nitrogen Equation for Tech Class 4.

There are limited emissions data at low values of the Reid vapor pressure as a function of the oxygen content of the fuel. Consequently, the responses predicted by the Tech class 4 oxides of nitrogen equation relative to low RVP and oxygen values indicate that there will be an increase in oxides of nitrogen emissions at low values of RVP and oxygen. These responses do not appear to be supported by the data. Therefore, a linearization technique has been employed to "flatten-out" the responses of RVP and oxygen.

Sections Affected: III.C., IV.A.2. (See Exhibit 1)

Exhibit 1

Staff's Proposed Modifications to the California Procedures for Alternative Specifications for Phase 2 Reformulated Gasoline Using the California Predictive Model

Note: This Exhibit contains only those sections that include changes to the originally proposed text. The modifications to the originally proposed text are shown shaded to indicate additions and ~~strikeout~~ to indicate deletions.

C. General Equations for Calculating 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 emissions of the candidate and reference specifications for each pollutant and for each technology class.

$$ln\ y_{Tech} = \text{intercept} + \sum [(\text{fuel effects coefficient}) \times (\text{standardized fuel property})]$$

or

$$y_{Tech} = Exp\ \{\text{intercept} + \sum [(\text{fuel effects coefficient}) \times (\text{standardized fuel property})]\}$$

where

ln is the natural logarithm.

Exp is the inverse of the natural logarithm.

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

intercept represents the average vehicle effect for a particular Tech class and a particular pollutant. The intercepts are provided in Table 11, Coefficients for NOx and HC Equations, and Table 12, 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 is provided in Table 11, Coefficients for NOx and HC Equations, and Table 12, Coefficients for Toxics.

standardized fuel property is defined as:

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

actual fuel property represents the candidate or reference fuel property selected by the applicant in Table 7, 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 and V. A. 2.

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 10, 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.

IV. OXIDES NITROGEN (NOx) EXHAUST EMISSIONS CALCULATIONS

A. NOx Emissions by Technology Class

The property values from the Table 7 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	{-0.15597638 +
RVP	(-0.01671797) $\frac{(\text{RVP} - 8.651419)}{0.580438}$ +
Sulfur	(0.01785987) $\frac{(\text{SULFUR} - 193.574245)}{130.374657}$ +
Aromatic HC	(0.05428291) $\frac{(\text{AROM} - 30.967805)}{9.491877}$ +
Olefin	(0.02292342) $\frac{(\text{OLEF} - 8.34672)}{5.873768}$ +
Oxygen	(0.01439508) $\frac{(\text{OXY} - 0.912512)}{1.249609}$ +
T50	(-0.01161378) $\frac{(\text{T50} - 211.338086)}{17.374327}$ +
T90	(0.00341764) $\frac{(\text{T90} - 315.839826)}{25.694736}$ +
T50T90	(0.00857682) $\frac{(\text{T50} - 211.338086)}{17.374327}$ $\frac{(\text{T90} - 315.839826)}{25.694736}$ +

AROT90	(-0.0097818) $\frac{(ARO - 30.967805)}{9.491877}$ $\frac{(T90 - 315.839826)}{25.694736}$	}

where

RVP, SULFUR, AROM, OLEF, OXYGEN, T50, and T90 are the value limits for the candidate and reference specifications identified in the Table 7 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	{-0.58546115	+
RVP	(0.03005909) $\frac{(RVP - 8.707348)}{0.52813}$	+
Sulfur	(0.050086115) $\frac{(SULFUR - 174.036113)}{137.356549}$	+
Aromatic HC	(0.004154304) $\frac{(AROM - 28.604566)}{7.848674}$	+
Olefin	(0.025949698) $\frac{(OLEF - 7.001772)}{4.988003}$	+
Oxygen	(0.011321599) $\frac{(OXY - 1.266843)}{1.310604}$	+
T50	(0.00195233) $\frac{(T50 - 208.186678)}{18.149553}$	+
T90	(-0.00820391) $\frac{(T90 - 311.36879)}{22.988439}$	+

$$AROOXY = (-0.00579379)\left(\frac{AROM - 28.604566}{7.848674}\right)\left(\frac{OXY - 1.266843}{1.310604}\right) +$$

$$RVPOXY = (0.006283521)\left(\frac{RVP - 8.707348}{0.52813}\right)\left(\frac{OXY - 1.266843}{1.310604}\right) +$$

$$OXYOXY = (0.013486985)\left(\frac{OXY - 1.266843}{1.310604}\right)\left(\frac{OXY - 1.266843}{1.310604}\right) \}$$

~~where~~

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

where

For calculating the reference fuel NOx emissions, RVP, SULFUR, AROM, OLEF, OXYGEN, T50, AND T90 are the values for the reference specifications in the Table 7 worksheet.

For calculating candidate fuel NOx emissions, RVP, SULFUR, AROM, OLEF, T50, AND T90 are the values for the candidate specifications in the Table 7 worksheet. The value for oxygen is determined as follows:

If the value for the candidate OXYGEN specification in the Table 7 worksheet is less than the $OXYGEN_{(LIN)}$ value , the $OXYGEN_{(LIN)}$ value is the value for OXYGEN, where $OXYGEN_{(LIN)}$ is calculated as follows:

$$OXYGEN_{(LIN)} = 4.724 + 0358669\ AROM - 578083\ RVP$$

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

V. HYDROCARBONS (HC) EXHAUST EMISSIONS CALCULATIONS

A. HC Emissions by Technology Class

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

1. 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	{-0.79454695	+
RVP	(0.004470126) $\frac{(RVP - 8.651419)}{0.580438}$	+
Sulfur	(0.001933575) $\frac{(SULFUR - 193.574245)}{130.374657}$	+
Aromatic HC	(-0.03844685) $\frac{(AROM - 30.967805)}{9.491877}$	+
Olefin	(-0.02100516) $\frac{(OLEF - 8.34672)}{5.873768}$	+
Oxygen	(-0.02735656) $\frac{(OXY - 0.912512)}{1.249609}$	+
T50	(0.010253527) $\frac{(T50 - 211.338086)}{17.374327}$	+
T90	(0.017858355) $\frac{(T90 - 315.839826)}{25.694736}$	+

RVPT50	$(-0.01626671)\ \frac{(RVP - 8.651419)}{0.580438}\ \frac{(T50 - 211.338086)}{17.374327}$	+
SULARO	$(-0.04053717)\ \frac{(SULFUR - 193.574245)}{130.374657}\ \frac{(AROM - 30.967805)}{9.491877}$	+
AROT90	$(0.018225949)\ \frac{(AROM - 30.967805)}{9.491877}\ \frac{(T90 - 315.839826)}{25.694736}$	}

where

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

2. 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	{-1.18303868	+
RVP	$(-0.00850444)\ \frac{(RVP - 8.707348)}{0.52813}$	+
Sulfur	$(0.116903682)\ \frac{(SULFUR - 174.036113)}{137.356549}$	+
Aromatic HC	$(0.001368326)\ \frac{(AROM - 28.604566)}{7.848674}$	+

Olefin (-0.0068737) $\frac{(OLEF - 7.001772)}{4.988003}$ +

Oxygen (-0.01035001) $\frac{(OXY - 1.266843)}{1.310604}$ +

T50 (0.076436841) $\frac{(T50 - 208.186678)}{18.149553}$ +

T90 (0.038947849) $\frac{(T90 - 311.36879)}{22.988439}$ +

AROARO (-0.01197286) $\frac{(AROM - 28.604566)}{7.848674}$ $\frac{(AROM - 28.604566)}{7.848674}$ +

AROT90 (0.012076013) $\frac{(AROM - 28.604566)}{7.848674}$ $\frac{(T90 - 311.36879)}{22.988439}$ +

OXYT90 (0.015107193) $\frac{(OXY - 1.266843)}{1.310604}$ $\frac{(T90 - 311.36879)}{22.988439}$ +

T50T50 (0.025807977) $\frac{(T50 - 208.186678)}{18.149553}$ $\frac{(T50 - 208.186678)}{18.149553}$ +

T90T90 (0.018209586) $\frac{(T90 - 311.36879)}{22.988439}$ $\frac{(T90 - 311.36879)}{22.988439}$ }

~~where~~

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

where

For calculating the reference fuel HC emissions, RVP, SULFUR, AROM, OLEF, OXYGEN, T50, AND T90 are the values for the reference specifications in the Table 7 worksheet.

For calculating the candidate fuel HC emissions, RVP, SULFUR, AROM, OLEF, and OXYGEN are the values for the candidate specifications in the Table 7 worksheet. The values for T50 and T90 are determined as follows:

If the value for the candidate T50 specification in the Table 7 worksheet is less than 181, 181 is the value for T50.

If the value for the candidate T50 specification in the Table 7 worksheet is greater than or equal to 181, the T50 specification in the Table 7 worksheet is the value for T50.

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

$$T90_{(LIN)} = 323.8 - 9.712\ AROM - 7.27598\ OXYGEN$$

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

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

A. Mass Emissions of Toxics by Technology Classa

The property values from the Table 7 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 = $y_{Tech\ 3}$ =

Description	Equation	
	Exp	
intercept	{2.98444988 {2.9937382	+
~~RVP~~	~~(0.00012084)(RVP - 8.651419) / 0.580438~~	~~+~~
Sulfur	~~(0.06702145)~~(0.0723141)(SULFUR - 193.574245) / 130.374657	+
Aromatic HC	~~(0.11271704)~~(0.1524752)(AROM - 30.967805) / 9.491877	+
~~Olefin~~	~~(0.0262828)(OLEF - 8.34672) / 5.873768~~	~~+~~
Oxygen	~~(0.00010461)~~(-0.034762)(OXY - 0.912512) / 1.249609	+
~~T50~~	~~(0.07400871)(T50 - 211.338086) / 17.374327~~	~~+~~
~~T90~~	~~(0.03666419)(T90 - 315.839826) / 25.694736~~	~~+~~

BENZ	~~(0.13158634)~~(0.1235949)(BENZ - 1.365963) / 0.444768	}

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

Description	Equation	
	Exp	
intercept	~~{0.55265837~~ {0.668257	+
~~RVP~~	~~(-0.11048744)(RVP - 8.651419) / 0.580438~~	~~+~~
~~Sulfur~~	~~(0.12662294)(SULFUR - 193.574245) / 130.374657~~	~~+~~
~~Aromatic HC~~	~~(0.04922477)(AROM - 30.967805) / 9.491877~~	~~+~~
Olefin	~~(0.12457297)~~(0.150707)(OLEF - 8.34672) / 5.873768	+
~~Oxygen~~	~~(-0.01861222)(OXY - 0.912512) / 1.249609~~	~~+~~
~~T50~~	~~(-0.04669652)(T50 - 211.338086) / 17.374327~~	~~+~~
T90	~~(0.1898306)~~(0.165206)(T90 - 315.839826) / 25.694736	}

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

Description	Equation	
	Exp	
intercept	~~{2.06596608~~ {2.041917	+
~~RVP~~	~~(0.02179558)(RVP - 8.651419) / 0.580438~~	~~+~~
Sulfur	~~(-0.18622636)~~(-0.18011)(SULFUR - 193.574245) / 130.374657	+
Aromatic HC	~~(-0.1265364)~~(-0.09754)(AROM - 30.967805) / 9.491877	+
~~Olefin~~	~~(0.00492199)(OLEF - 8.34672) / 5.873768~~	~~+~~
Oxygen	~~(0.17601939)~~(0.153291)(OXY - 0.912512) / 1.249609	+
~~T50~~	~~(0.06301058)(T50 - 211.338086) / 17.374327~~	~~+~~
~~T90~~	~~(-0.04218807)(T90 - 315.839826) / 25.694736~~ }	

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

Description	Equation	
	Exp	
intercept	{0.99348033 [1.041177	+
RVP	(0.00386954)(RVP − 8.651419) / 0.580438	+
Sulfur	(0.04468183)(SULFUR − 193.574245) / 130.374657	+
Aromatic HC	(−0.14176068)(−0.10224)(AROM − 30.967805) / 9.491877	+
Olefin	(0.03247264)(OLEF − 8.34672) / 5.873768	+
Oxygen	(0.11153843)(OXY − 0.912512) / 1.249609	+
T50	(0.10500375)(T50 − 211.338086) / 17.374327	+
T90	(−0.02459286)(T90 − 315.839826) / 25.694736 }	

where

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

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	~~{2.07694733~~ {2.078612	+
RVP	~~(0.0205809)~~(0.01972)(RVP - 8.707348) / 0.52813	+
Sulfur	~~(0.14014755)~~(0.140432)(SULFUR - 174.036113) / 137.356549	+
Aromatic HC	~~(0.17375044)~~(0.169401)(AROM - 28.604566) / 7.848674	+
Olefin	~~(0.02072724)~~(0.02158)(OLEF - 7.001772) / 4.988003	+
Oxygen	~~(0.02074571)~~(0.022392)(OXY - 1.266843) / 1.310604	+
T50	~~(0.04810616)~~(0.052416)(T50 - 208.186678) / 18.149553	+
~~T90~~	~~(0.00084762)(T90 - 311.36879) / 22.988439~~	~~+~~
BENZ	~~(0.14364029)~~(0.145341)(BENZ - 1.092985) / 0.563303 }	

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

Description	Equation	
	Exp	
intercept	~~{-0.12216754~~ {-0.12765	+
~~RVP~~	~~(0.0235653)(RVP - 8.707348) / 0.52813~~	~~+~~
Sulfur	~~(0.05667595)~~(0.060078)(SULFUR - 174.036113) / 137.356549	+
Aromatic HC	~~(-0.04969117)~~(-0.04862)(AROM - 28.604566) / 7.848674	+
Olefin	~~(0.13697093)~~(0.135542)(OLEF - 7.001772) / 4.988003	+
~~Oxygen~~	~~(0.00190223)(OXY - 1.266843) / 1.310604~~	~~+~~
T50	~~(0.05848709)~~(0.058141)(T50 - 208.186678) / 18.149553	+
T90	~~(0.08820685)~~(0.089544)(T90 - 311.36879) / 22.988439 }	

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

Description	Equation	
	Exp	
intercept	{0.57054336 [0.56907	+
RVP	(0.00037903(RVP − 8.707348) / 0.52813	+
Sulfur	(−0.04718751[−0.04472](SULFUR − 174.036113) / 137.356549	+
Aromatic HC	(−0.07461695)[−0.07248](AROM − 28.604566) / 7.848674	+
Olefin	(0.01552007)(OLEF − 7.001772) / 4.988003	+
Oxygen	(0.07852942)[0.073394](OXY − 1.266843) / 1.310604	+
T50	(0.00214242)(T50 − 208.186678) / 18.149553	+
T90	(0.08066587)[0.081896](T90 − 311.36879) / 22.988439	}

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

Description	Equation	
	Exp	
intercept	~~{-0.30025158~~ {-0.30842	+
RVP	~~(0.05984811)~~(0.061495)(RVP - 8.707348) / 0.52813	+
~~Sulfur~~	~~(0.00342614)(SULFUR - 174.036113) / 137.356549~~	~~+~~
Aromatic HC	~~(-0.0799839)~~(-0.06631)(AROM - 28.604566) / 7.848674	+
~~Olefin~~	~~(0.01920116)(OLEF - 7.001772) / 4.988003~~	~~+~~
Oxygen	~~(0.12257203)~~(0.084501)(OXY - 1.266843) / 1.310604	+
T50	~~(0.11079701)~~(0.08131)(T50 - 208.186678) / 18.149553	+
T90	~~(0.06243205)~~(0.070103)(T90 - 311.36879) / 22.988439	+
~~BENZ~~	~~(0.08929885)(BENZ - 1.092985) / 0.563303~~	~~}~~

where

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

Table 12
Coefficients for Toxics Equations

Pollutant Emission	Tech 3			
	Benzene	Butadiene	Formaldehyde	Acetaldehyde
Intercept	2.98444988	0.55265837	2.06596608	0.99348033
RVP	0.00012084	-0.11048744	0.02179558	0.00386954
Sulfur	0.06702145	0.12662294	-0.18622636	0.04468183
Aromatic HC	0.11271704	0.04922477	-0.1265364	-0.14176068
Olefin	0.0262828	0.12457297	0.00492199	0.03247264
Oxygen	0.00010461	-0.01861222	0.17601939	0.11153843
T50	0.07400871	-0.04669652	0.06301058	0.10500375
T90	-0.03666419	0.1898306	-0.04218807	-0.02459286
Benzene	0.13158634			

Pollutant Emission	Tech 4			
	Benzene	Butadiene	Formaldehyde	Acetaldehyde
Intercept	2.07694733	-0.12216754	0.57054336	-0.30025158
RVP	0.0205809	0.0235653	0.00037903	0.05984811
Sulfur	0.14014755	0.05667595	-0.04718751	0.00342614
Aromatic HC	0.17375044	-0.04969117	-0.07461695	-0.0799839
Olefin	0.02072724	0.13697093	0.01552007	0.01920116
Oxygen	0.02074571	0.00190223	0.07852942	0.12257203
T50	0.04810616	0.05848709	0.00214242	0.11079701
T90	0.00084762	0.08820685	0.08066587	0.06243205
Benzene	0.14364029			0.08929885

Table 12
Coefficients for Toxics Equations

Pollutant Emission	Tech 3			
	Benzene	Butadiene	Formaldehyde	Acetaldehyde
Intercept	2.9937382	0.668257	2.041917	1.041177
RVP				
Sulfur	0.0723141		-0.18011	
Aromatic HC	0.1524752		-0.09754	-0.10224
Olefin		0.150707		
Oxygen	-0.034762		0.153291	
T50				
T90		0.165206		
Benzene	0.1235949			

Pollutant Emission	Tech 4			
	Benzene	Butadiene	Formaldehyde	Acetaldehyde
Intercept	2.078612	-0.12765	0.56907	-0.30842
RVP	0.01972			0.061495
Sulfur	0.140432	0.060078	-0.04472	
Aromatic HC	0.169401	-0.04862	-0.07248	-0.06631
Olefin	0.02158	0.135542		
Oxygen	0.022392		0.073394	0.084501
T50	0.052416	0.058141		0.08131
T90		0.089544	0.081896	0.070103
Benzene	0.145341			