§§ 80.43–80.44

being evaluated fall within the ranges shown in this paragraph (c). If the properties of the fuel being evaluated fall outside the range shown in this paragraph (c), the model may not be used to determine the VOC or toxics performance of the fuel:

<table>
<thead>
<tr>
<th>Fuel parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene content</td>
<td>0.0–4.9 vol %</td>
</tr>
<tr>
<td>RVP</td>
<td>6.6–9.0 psi</td>
</tr>
<tr>
<td>Oxygenate content</td>
<td>0–4.0 wt %</td>
</tr>
<tr>
<td>Aromatics content</td>
<td>0–55 vol %</td>
</tr>
</tbody>
</table>

1 For gasoline sold in California, the applicable RVP range shall be 6.4–9.0 psi.

(2) The model given in paragraphs (a) and (b) of this section shall be effective from January 1, 1995 through December 31, 1997, unless extended by action of the Administrator.


§§ 80.43–80.44 [Reserved]

§ 80.45 Complex emissions model.

(a) Definition of terms. For the purposes of this section, the following definitions shall apply:

Target fuel = The fuel which is being evaluated for its emissions performance using the complex model

OXY = Oxygen content of the target fuel in terms of weight percent

SUL = Sulfur content of the target fuel in terms of parts per million by weight

RVP = Reid Vapor Pressure of the target fuel in terms of pounds per square inch

E200 = 200 °F distillation fraction of the target fuel in terms of volume percent

E300 = 300 °F distillation fraction of the target fuel in terms of volume percent

ARO = Aromatics content of the target fuel in terms of volume percent

BEN = Benzene content of the target fuel in terms of volume percent

OLE = Olefins content of the target fuel in terms of volume percent

MTB = Methyl tertiary butyl ether content of the target fuel in terms of weight percent oxygen

ETB = Ethyl tertiary butyl ether content of the target fuel in terms of weight percent oxygen

TAM = Tertiary amyl methyl ether content of the target fuel in terms of weight percent oxygen

POM = Tertiary amyl methyl ether content of the target fuel in terms of weight percent oxygen

exp = The function that raises the number e (the base of the natural logarithm) to the power in its domain

Phase I = The years 1995–1999

Phase II = Year 2000 and beyond

(b) Weightings and baselines for the complex model. (1) The weightings for normal and higher emitters \((w_1 \text{ and } w_2)\), respectively) given in table 1 shall be used to calculate the exhaust emission performance of any fuel for the appropriate pollutant and Phase:

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VOC &amp; toxics</td>
</tr>
<tr>
<td>Normal Emitters ((w_1))</td>
<td>0.52</td>
</tr>
<tr>
<td>Higher Emitters ((w_2))</td>
<td>0.48</td>
</tr>
</tbody>
</table>

(2) The following properties of the baseline fuels shall be used when determining baseline mass emissions of the various pollutants:

<table>
<thead>
<tr>
<th>Fuel property</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen (wt %)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sulfur (ppm)</td>
<td>339</td>
<td>338</td>
</tr>
<tr>
<td>RVP (psi)</td>
<td>8.7</td>
<td>11.5</td>
</tr>
<tr>
<td>E200 (%)</td>
<td>41.0</td>
<td>50.0</td>
</tr>
<tr>
<td>E300 (%)</td>
<td>83.0</td>
<td>83.0</td>
</tr>
<tr>
<td>Aromatics (vol %)</td>
<td>32.0</td>
<td>26.4</td>
</tr>
<tr>
<td>Olefins (vol %)</td>
<td>9.2</td>
<td>11.9</td>
</tr>
<tr>
<td>Benzene (vol %)</td>
<td>1.53</td>
<td>1.64</td>
</tr>
</tbody>
</table>

(3) The baseline mass emissions for VOC, NO\(_x\) and toxics given in tables 3, 4 and 5 of this paragraph (b)(3) shall be used in conjunction with the complex model during the appropriate Phase and season:

<table>
<thead>
<tr>
<th>Exhaust pollutant</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>446.0</td>
<td>907.0</td>
</tr>
<tr>
<td>NO(_x)</td>
<td>660.0</td>
<td>750.0</td>
</tr>
<tr>
<td>Benzene</td>
<td>26.10</td>
<td>37.57</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>2.19</td>
<td>3.57</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>4.85</td>
<td>7.73</td>
</tr>
<tr>
<td>1,3-Butadiene</td>
<td>4.31</td>
<td>7.27</td>
</tr>
<tr>
<td>POM</td>
<td>1.50</td>
<td>2.21</td>
</tr>
</tbody>
</table>
TABLE 4—BASELINE NON-EXHAUST EMISSIONS (SUMMER ONLY)

<table>
<thead>
<tr>
<th>Non-exhaust pollutant</th>
<th>Phase I Region 1 (mg/mile)</th>
<th>Phase I Region 2 (mg/mile)</th>
<th>Phase II Region 1 (mg/mile)</th>
<th>Phase II Region 2 (mg/mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>860.48</td>
<td>769.10</td>
<td>559.31</td>
<td>492.07</td>
</tr>
</tbody>
</table>

TABLE 5—TOTAL BASELINE VOC, NOX AND TOXICS EMISSIONS

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Summer (mg/mile)</th>
<th>Winter (mg/mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phase I Region 1</td>
<td>Phase I Region 2</td>
</tr>
<tr>
<td>NOX</td>
<td>660.0</td>
<td>660.0</td>
</tr>
<tr>
<td>VOCE</td>
<td>1306.5</td>
<td>1215.1</td>
</tr>
<tr>
<td>Toxics</td>
<td>48.61</td>
<td>47.58</td>
</tr>
</tbody>
</table>

(c) VOC performance. (1) The exhaust VOC emissions performance of gasolines shall be given by the following equations:

\[
\text{VOCE} = \text{VOC(b)} + (\text{VOC(b)} \times Y_{\text{voc}}(t)/100)
\]

Where

\[
Y_{\text{voc}}(t) = [\text{W}(\text{N}) + (\text{W}(\text{H}) - 1) \times 100
\]

Where

\[
\text{VOC} = \text{Exhaust VOC emissions in milligrams/mile}
\]

(2) VOC equation for normal emitters.

\[
\text{v}_{1} = (-0.003641 \times \text{OXY}) + (0.0005219 \times \text{SUL}) + (0.0289749 \times \text{RVP}) + (-0.014470 \times \text{E200}) + (-0.006624 \times \text{E300}) + (0.0323712 \times \text{ARO}) + (-0.002858 \times \text{OLE}) + (0.0001072 \times \text{E200}) + (0.00004087 \times \text{E300}) + (-0.0000341 \times \text{ARO} \times \text{E300})
\]

(1) Consolidated VOC equation for normal emitters.

(2) VOC equation for higher emitters.

\[
\text{v}_{2} = (-0.003626 \times \text{OXY}) + (-5.40 \times 10^{-6} \times \text{SUL}) + (0.043295 \times \text{RVP}) + (-0.015004 \times \text{E200}) + (-0.062327 \times \text{E300}) + (0.0282042 \times \text{ARO}) + (-0.002858 \times \text{OLE}) + (0.000016 \times \text{E200}) + (0.00004087 \times \text{E300}) + (-0.0000287 \times \text{ARO} \times \text{E300})
\]

(ii) VOC equation for higher emitters.

\[
\text{v}_{1} = (0.03641 \times \text{OXY}) + (0.0735 \times \text{SUL}) + (0.01447 \times \text{RVP}) + (-0.003641 \times \text{E200}) + (-0.003641 \times \text{E300}) + (0.03641 \times \text{ARO}) + (-0.00735 \times \text{OLE}) + (0.00166 \times \text{E200}) + (0.00166 \times \text{E300}) + (-0.00166 \times \text{ARO} \times \text{E300})
\]

(3) Flat line extrapolations. (A) During Phase I, fuels with E200 values greater than 65.83 percent shall be evaluated with the E200 fuel parameter set equal to 65.83 percent when calculating Y_{voc}(t) and VOCE using the equations described in paragraphs (c)(1)(i) and (ii) of this section. Fuels with E300 values greater than E300* (calculated using the equation E300* = 80.32 + (0.390 \times \text{sul}) + (0.043295 \times \text{v}) + (0.0001072 \times \text{e200}) + (0.00004087 \times \text{e300}) + (-0.0000341 \times \text{aro} \times \text{e300})) shall be evaluated with the E300 parameter set equal to E300* when calculating VOCE using the equations described in paragraphs (c)(1)(i) and (ii) of this section. For E300* values greater than 94, the linearly extrapolated model presented in paragraph (c)(1)(iv) of this section shall be used.

(B) During Phase II, fuels with E200 values greater than 65.52 percent shall be evaluated with the E200 fuel parameter set equal to 65.52 percent when calculating VOCE using the equations described in paragraphs (c)(1)(i) and (ii)
of this section. Fuels with E300 values greater than E300* (calculated using the equation E300* = 79.75 + [0.385 × ARO]) shall be evaluated with the E300 parameter set equal to E300* when calculating VCE using the equations described in paragraphs (c)(1)(i) and (ii) of this section. For E300* values greater than 94, the linearly extrapolated model presented in paragraph (c)(1)(iv) of this section shall be used.

(iv) Linear extrapolations. (A) The equations in paragraphs (c)(1)(i) and (ii) of this section shall be used within the allowable range of E300, E200, and ARO for the appropriate Phase, as defined in table 6:

TABLE 6—ALLOWABLE RANGES OF E200, E300, AND ARO FOR THE EXHAUST VOC EQUATIONS IN PARAGRAPHS (C)(1)(I) AND (II) OF THIS SECTION

<table>
<thead>
<tr>
<th>Fuel parameter</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower limit</td>
<td>Higher limit</td>
</tr>
<tr>
<td>E200</td>
<td>33.00</td>
<td>65.83</td>
</tr>
<tr>
<td>E300</td>
<td>72.00</td>
<td>Variable</td>
</tr>
<tr>
<td>ARO</td>
<td>18.00</td>
<td>46.00</td>
</tr>
</tbody>
</table>

1 Higher E300 limit = lower of 94.0 or 80.32 + (0.390 × ARO).
2 Higher E300 limit = lower of 94.0 or 79.75 + (0.385 × ARO).

(B) For fuels with E200, E300 and/or ARO levels outside the ranges defined in table 6, \( Y_{VOC} \) shall be defined:

(1) For Phase I:

\[
Y_{VOC}(t) = 100\% \times 0.52 \times \left[ \frac{\exp(v_1(b))}{\exp(v_1(b))} - 1 \right] + 100\% \times 0.48 \times \left[ \frac{\exp(v_2(b))}{\exp(v_2(b))} - 1 \right] + \frac{\{[0.0002144 \times E200] - 0.014470 \times \Delta E200]}{\{[(0.0008174 \times E300)] - 0.068624 - (0.000348 \times ARO)} \times \Delta E300\} + \frac{\{[-0.000348 \times E300] + 0.032372 \times \Delta ARO\} + \{100\% \times 0.556 \times \{\exp(v_1(et))} / \exp(v_1(b))\} \times \{[0.0002122 \times E200] - 0.01350 \times \Delta E200\} + \{[(0.000816 \times E300)] - 0.06233 - (0.00029 \times ARO]} \times \Delta E300\} + \{[(0.00029 \times E300] + 0.028204 \times \Delta ARO\}]
\]

(C) During Phase I, the “edge target” fuel shall be identical to the target fuel for all fuel parameters, with the following exceptions:

(1) If the E200 level of the target fuel is less than 33 volume percent, then the E200 value for the “edge target” fuel shall be set equal to 33 volume percent.

(2) If the aromatics level of the target fuel is less than 18 volume percent, then the ARO value for the “edge target” fuel shall be set equal to 18 volume percent.

(3) If the aromatics level of the target fuel is greater than 46 volume percent, then the ARO value for the “edge target” fuel shall be set equal to 46 volume percent.

(4) If the E300 level of the target fuel is less than 72 volume percent, then the E300 value for the “edge target” fuel shall be set equal to 72 volume percent.

(5) If the E300 level of the target fuel is greater than 95 volume percent, then the E300 value of the target fuel shall be set equal to 95 volume percent for the purposes of calculating VOC emissions with the Phase I equation given in paragraph (c)(1)(iv) of this section.

(6) If \([80.32 + (0.390 \times ARO)]\) exceeds 94 for the target fuel, and the target fuel value for E200 exceeds 94, then the E300 value for the “edge target” fuel shall be set equal to 94 volume percent.

(7) If the E200 value of the target fuel is less than 33 volume percent, then \(\Delta E200\) shall be set equal to (E200 − 33 volume percent).

(8) If the E200 level of the target fuel equals or exceeds 33 volume percent, then \(\Delta E200\) shall be set equal to zero.

(9) If the aromatics level of the target fuel is less than 18 volume percent, then \(\Delta ARO\) shall be set equal to (ARO−18 volume percent). If the aromatics level of the target fuel is less than 10 volume percent, then \(\Delta ARO\) shall be set equal to −8 volume percent.
(10) If the aromatics level of the target fuel is greater than 46 volume percent, then \( \Delta \text{ARO} \) shall be set equal to \((\text{ARO} - 46 \text{ volume percent})\).

(11) If neither of the conditions established in paragraphs (c)(1)(iv)(C)(9) and (10) of this section are met, then \( \Delta \text{ARO} \) shall be set equal to zero.

(12) If the E300 level of the target fuel is less than 72 percent, then \( \Delta \text{E300} \) shall be set equal to \((\text{E300} - 72 \text{ percent})\).

(13) If the E300 level of the target fuel is greater than 94 volume percent and \((80.32 + (0.390 \times \text{ARO}))\) also is greater than 94, then \( \Delta \text{E300} \) shall be set equal to \((\text{E300} - 94 \text{ volume percent})\). If the E300 level of the target fuel is greater than 95 volume percent and \((80.32 + (0.390 \times \text{ARO}))\) also is greater than 94, then \( \Delta \text{E300} \) shall be set equal to 1 volume percent.

(14) If neither of the conditions established in paragraphs (c)(1)(iv)(C)(12) and (13) of this section are met, then \( \Delta \text{E300} \) shall be set equal to zero.

(D) During Phase II, the “edge target” fuel is identical to the target fuel for all fuel parameters, with the following exceptions:

(1) If the E200 level of the target fuel is less than 33 volume percent, then the E200 value for the “edge target” fuel shall be set equal to 33 volume percent.

(2) If the aromatics level of the target fuel is less than 18 volume percent, then the ARO value for the “edge target” fuel shall be set equal to 18 volume percent.

(3) If the aromatics level of the target fuel is greater than 46 volume percent, then the ARO value for the “edge target” fuel shall be set equal to 46 volume percent.

(4) If the E300 level of the target fuel is less than 72 volume percent, then the E300 value for the “edge target” fuel shall be set equal to 72 volume percent.

(5) If the E300 level of the target fuel is greater than 95 volume percent, then the E300 value of the target fuel shall be set equal to 95 volume percent for the purposes of calculating VOC emissions with the Phase II equation given in paragraph (c)(1)(iv)(B) of this section.

(6) If \((79.75 + (0.385 \times \text{ARO}))\) exceeds 94 for the target fuel, and the target fuel value for E300 exceeds 94, then the E300 value for the “edge target” fuel shall be set equal to 94 volume percent.

(7) If the E200 level of the target fuel is less than 33 volume percent, then \( \Delta \text{E200} \) shall be set equal to \((\text{E200} - 33 \text{ volume percent})\).

(8) If the E200 level of the target fuel equals or exceeds 33 volume percent, then \( \Delta \text{E200} \) shall be set equal to zero.

(9) If the aromatics level of the target fuel is less than 18 volume percent, then \( \Delta \text{ARO} \) shall be set equal to \(\text{ARO} \) equals or exceeds 33 volume percent.

(10) If the aromatics level of the target fuel is greater than 46 volume percent, then \( \Delta \text{ARO} \) shall be set equal to \((\text{ARO} - 46 \text{ volume percent})\).

(11) If neither of the conditions established in paragraphs (c)(1)(iv)(D)(9) and (10) of this section are met, then \( \Delta \text{ARO} \) shall be set equal to zero.

(12) If the E300 level of the target fuel is less than 72 percent, then \( \Delta \text{E300} \) shall be set equal to \((\text{E300} - 72 \text{ percent})\).

(13) If the E300 level of the target fuel is greater than 94 volume percent and \((79.75 + (0.385 \times \text{ARO}))\) also is greater than 94, then \( \Delta \text{E300} \) shall be set equal to \((\text{E300} - 94 \text{ volume percent})\). If the E300 level of the target fuel is greater than 95 volume percent and \((79.75 + (0.385 \times \text{ARO}))\) also is greater than 94, then \( \Delta \text{E300} \) shall be set equal to 1 volume percent.

(2) The winter exhaust VOC emissions performance of gasolines shall be given by the equations presented in paragraph (c)(1) of this section with the RVP value set to 8.7 psi for both the baseline and target fuels.

(3) The nonexhaust VOC emissions performance of gasolines in VOC Control Region 1 shall be given by the following equations, where:

\[ \text{VOCNe1} = \text{Total nonexhaust emissions of volatile organic compounds in VOC Control Region 1 in grams per mile} \]

\[ \text{VOCDI1} = \text{Diurnal emissions of volatile organic compounds in VOC Control Region 1 in grams per mile} \]

\[ \text{VOCHS1} = \text{Hot soak emissions of volatile organic compounds in VOC Control Region 1 in grams per mile} \]
§ 80.45

VOCR1 = Running loss emissions of volatile organic compounds in VOC Control Region 1 in grams per mile
VOCR1 = Refueling emissions of volatile organic compounds in VOC Control Region 1 in grams per mile

(i) During Phase I:

VOCNE1 = VOCDI1 + VOCHS1 + VOCRL1 + VOCRF1
VOCDI1 = \[0.00736 \times (\text{RVP})^2 \] - \[0.0790 \times \text{RVP}\] + 0.2553
VOCHS1 = \[0.01557 \times (\text{RVP})^2 \] - \[0.1671 \times \text{RVP}\] + 0.5399
VOCRL1 = \[0.00279 \times (\text{RVP})^2 \] + \[0.1096 \times \text{RVP}\] - 0.7340
VOCRF1 = \[0.006668 \times \text{RVP}\] - 0.0180

(ii) During Phase II:

VOCNE1 = VOCDI1 + VOCHS1 + VOCRL1 + VOCRF1
VOCDI1 = \[0.007385 \times (\text{RVP})^2 \] - \[0.08981 \times \text{RVP}\] + 0.3158
VOCHS1 = \[0.006654 \times (\text{RVP})^2 \] - \[0.08094 \times \text{RVP}\] + 0.2846
VOCRL1 = \[0.017768 \times (\text{RVP})^2 \] - \[0.18746 \times \text{RVP}\] + 0.6146
VOCRF1 = \[0.004767 \times \text{RVP}\] + 0.011859

(4) The nonexhaust VOC emissions performance of gasolines in VOC Control Region 2 shall be given by the following equations, where:

VOCNE2 = Total nonexhaust emissions of volatile organic compounds in VOC Control Region 2 in grams per mile
VOCDI2 = Diurnal emissions of volatile organic compounds in VOC Control Region 2 in grams per mile
VOCHS2 = Hot soak emissions of volatile organic compounds in VOC Control Region 2 in grams per mile
VOCRL2 = Running loss emissions of volatile organic compounds in VOC Control Region 2 in grams per mile
VOCR2 = Refueling emissions of volatile organic compounds in VOC Control Region 2 in grams per mile

(i) During Phase I:

VOCNE2 = VOCDI2 + VOCHS2 + VOCRL2 + VOCRF2
VOCDI2 = \[0.006818 \times (\text{RVP})^2 \] - \[0.07682 \times \text{RVP}\] + 0.2610
VOCHS2 = \[0.014421 \times (\text{RVP})^2 \] - \[0.16248 \times \text{RVP}\] + 0.5520
VOCRL2 = \[0.016255 \times (\text{RVP})^2 \] - \[0.1306 \times \text{RVP}\] + 0.2963
VOCRF2 = \[0.004767 \times \text{RVP}\] + 0.011859

(ii) During Phase II:

VOCNE2 = VOCDI2 + VOCHS2 + VOCRL2 + VOCRF2
VOCDI2 = \[0.004775 \times (\text{RVP})^2 \] - \[0.05872 \times \text{RVP}\] + 0.21306
VOCHS2 = \[0.006078 \times (\text{RVP})^2 \] - \[0.07474 \times \text{RVP}\] + 0.27117
VOCRL2 = \[0.016169 \times (\text{RVP})^2 \] - \[0.17206 \times \text{RVP}\] + 0.56724
VOCRF2 = \[0.004767 \times \text{RVP}\] + 0.011859

(5) Winter VOC emissions shall be given by VOCE, as defined in paragraph (c)(2) of this section, using the appropriate baseline emissions given in paragraph (b)(3) of this section. Total nonexhaust VOC emissions shall be set equal to zero under winter conditions.

(6) Total VOC emissions. (1) Total summer VOC emissions shall be given by the following equations:

VOC1 = (VOCE / 1000) + VOCNE1
VOC2 = (VOCE / 1000) + VOCNE2
VOC1 = Total summer VOC emissions in VOC Control Region 1 in terms of grams per mile
VOC2 = Total summer VOC emissions in VOC Control Region 2 in terms of grams per mile

(ii) Total winter VOC emissions shall be given by the following equations:

VOCW = (VOCE/1000)
VOCW = Total winter VOC emissions in terms of grams per mile

(7) Phase I total VOC emissions performance. (i) The total summer VOC emissions performance of the target fuel in percentage terms from baseline levels shall be given by the following equations during Phase I:

VOCS1% = \[100\% \times (\text{VOCS1} - 1.306 \text{ g/mi}) / 1.306 \text{ g/mi}\]
VOCS2% = \[100\% \times (\text{VOCS2} - 1.215 \text{ g/mi}) / 1.215 \text{ g/mi}\]
VOC1% = Percentage change in VOC emissions from baseline levels in VOC Control Region 1
VOC2% = Percentage change in VOC emissions from baseline levels in VOC Control Region 2

(ii) The total winter VOC emissions performance of the target fuel in percentage terms from baseline levels shall be given by the following equations during Phase I:

VOCW% = \[100\% \times (\text{VOCW} - 0.660 \text{ g/mi}) / 0.660 \text{ g/mi}\]
VOCW% = Percentage change in winter VOC emissions from baseline levels

(8) Phase II total VOC emissions performance. (i) The total summer VOC emissions performance of the target fuel in percentage terms from baseline levels...
levels shall be given by the following equations during Phase II:

\[ \text{VOCS1} = \left( 100\% \times \text{VOCS1-1.4663 g/mi} \right) / (1.4663 \text{ g/mi}) \]

\[ \text{VOCS2} = \left( 100\% \times \text{VOCS2-1.3991 g/mi} \right) / (1.3991 \text{ g/mi}) \]

(ii) The total winter VOC emissions performance of the target fuel in percentage terms from baseline levels shall be given by the following equation during Phase II:

\[ \text{VOCW} = \left( 100\% \times (\text{VOC} - 1.341 \text{ g/mi}) \right) / (1.341 \text{ g/mi}) \]

(d) \( \text{NOx} \) performance. (1) The summer \( \text{NOx} \) emissions performance of gasoline shall be given by the following equations:

\[ \text{NOx} = \text{NOx}(b) + [\text{NOx}(b) \times Y(t)/100] \]

where

\[ Y_{\text{NOx}}(t) = \left( w_1 \times N_o \times w_2 \times H_s - 1 \right) \times 100 \]

where

\[ N_o = \exp(n_o(t)) \times \exp(n_o(b)) \]

\[ H_s = \exp(n_s(t)) \times \exp(n_s(b)) \]

\[ w_1 = \text{Weighting factor for normal emitters as defined in paragraph (b)(1) of this section} \]

\[ w_2 = \text{Weighting factor for higher emitters as defined in paragraph (b)(1) of this section for the appropriate Phase} \]

\[ n_o(t) = \text{Normal emitter NOx equation as defined in paragraph (d)(1)(i) of this section, evaluated using the target fuel’s properties subject to paragraphs (d)(1)(ii) and (iv) of this section} \]

\[ n_s(t) = \text{Higher emitter NOx equation as defined in paragraph (d)(1)(ii) of this section, evaluated using the target fuel’s properties subject to paragraphs (d)(1)(ii) and (iv) of this section} \]

\[ n_o(b) = \text{Normal emitter NOx equation as defined in paragraph (d)(1)(i) of this section, evaluated using the base fuel’s properties} \]

\[ n_s(b) = \text{Higher emitter NOx equation as defined in paragraph (d)(1)(ii) of this section, evaluated using the base fuel’s properties} \]

(i) Consolidated equation for normal emitters.

\[ n_1 = \left( 0.0018571 \times \text{OXY} \right) + \left( 0.0006921 \times \text{SUL} \right) + \left( 0.0009744 \times \text{RVP} \right) + \left( 0.0009310 \times \text{E200} \right) + \left( 0.00098460 \times \text{E300} \right) + \left( 0.00093692 \times \text{ARO} \right) + \left( -0.002774 \times \text{OLE} \right) + \left( -0.63 \times 10^{-7} \times \text{SUL}^2 \right) + \left( -0.000119 \times \text{ARO}^2 \right) + \left( 0.0003665 \times \text{OLE}^2 \right) \]

(ii) Equation for higher emitters.

\[ n_2 = \left( -0.00913 \times \text{OXY} \right) + \left( 0.000252 \times \text{SUL} \right) + \left( -0.01397 \times \text{RVP} \right) + \left( 0.000931 \times \text{E200} \right) + \left( -0.00401 \times \text{E300} \right) + \left( 0.007097 \times \text{ARO} \right) + \left( -0.00276 \times \text{OLE} \right) + \left( 0.0003665 \times \text{OLE}^2 \right) + \left( -7.995 \times 10^{-5} \times \text{ARO}^2 \right) \]

(iii) Flat line extrapolations. (A) During Phase I, fuels with olefin levels less than 3.77 volume percent shall be evaluated with the OLE fuel parameter set equal to 3.77 volume percent when calculating \( \text{NOx} \) performance using the equations described in paragraphs (d)(1)(i) and (ii) of this section. Fuels with aromatics levels greater than 36.2 volume percent shall be evaluated with the ARO fuel parameter set equal to 36.8 volume percent when calculating \( \text{NOx} \) performance using the equations described in paragraphs (d)(1)(i) and (ii) of this section.

(B) During Phase II, fuels with olefin levels less than 3.77 volume percent shall be evaluated with the OLE fuel parameter set equal to 3.77 volume percent when calculating \( \text{NOx} \) performance using the equations described in paragraphs (d)(1)(i) and (ii) of this section. Fuels with aromatics levels greater than 36.8 volume percent shall be evaluated with the ARO fuel parameter set equal to 36.8 volume percent when calculating \( \text{NOx} \) performance using the equations described in paragraphs (d)(1)(i) and (ii) of this section.

(iv) Linear extrapolations. (A) The equations in paragraphs (d)(1)(i) and (ii) of this section shall be used within the allowable range of SUL, OLE, and ARO for the appropriate Phase, as defined in the following table 7:

<table>
<thead>
<tr>
<th>Fuel parameter</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low end</td>
<td>High end</td>
</tr>
<tr>
<td>SUL</td>
<td>10.0</td>
<td>450.0</td>
</tr>
<tr>
<td>OLE</td>
<td>3.77</td>
<td>19.0</td>
</tr>
<tr>
<td>ARO</td>
<td>18.0</td>
<td>36.2</td>
</tr>
</tbody>
</table>

(B) For fuels with SUL, OLE, and/or ARO levels outside the ranges defined in Table 7 of paragraph (d)(1)(iv), (A) of this section, \( Y_{\text{NOx}}(t) \) shall be defined as:

(i) For Phase I:

\[ Y_{\text{NOx}}(t) = 100\% \times 0.82 \times \frac{\exp(n_1(t))}{\exp(n_1(b))} - 1 \]
§ 80.45 40 CFR Ch. I (7–1–10 Edition)

\[
+ 100\% \times 0.18 \times \frac{[n_2(\text{et})/\exp(n_2(b)) - 1]}{\exp(n_2(b))} \]
\[
+ 100\% \times 0.82 \times \frac{[\exp(n_1(\text{et})/\exp(n_1(b))] \times [([(0.0000133 \times SUL_n) + 0.000692]) \times \Delta SUL]}{\exp(n_1(b))} \]
\[
+ [(0.000733 \times ARO_n) - 0.002774] \times \Delta ARO) \]
\[
+ [(0.000732 \times OLE_n) - 0.00276] \times \Delta OLE)]] \]
\[
+ (100\% \times 0.18 \times [\exp(n_2(\text{et})/\exp(n_2(b))]) \times [((0.0000252 \times SUL) + \Delta SUL + 
\[
+ [(0.0001599 \times ARO_n) + 0.007097] \times \Delta ARO) \]
\[
+ [(0.000732 \times OLE_n) - 0.00276] \times \Delta OLE)]] \]
\]

Where:

\( n_1, n_2 \) = The equations defined in paragraphs (d)(1)(i) and (ii) of this section.

\( \text{et} \) = Collection of fuel parameters for the “edge target” fuel. These parameters are defined in paragraphs (d)(1)(iv)(C) and (D) of this section.

\( n_1(\text{et}) \) = The function \( n_1 \) evaluated with “edge target” fuel parameters, which are defined in paragraph (d)(1)(iv)(C) of this section.

\( n_2(\text{et}) \) = The function \( n_2 \) evaluated with “edge target” fuel parameters, which are defined in paragraph (d)(1)(iv)(C) of this section.

\( n_1(b) \) = The function \( n_1 \) evaluated with the appropriate baseline fuel parameters defined in paragraph (b)(2) of this section.

\( n_2(b) \) = The function \( n_2 \) evaluated with the appropriate baseline fuel parameters defined in paragraph (b)(2) of this section.

\( SUL_n \) = The value of SUL for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( ARO_n \) = The value of ARO for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( OLE_n \) = The value of OLE for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( \Delta \text{SUL} \) = The value of SUL for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( \Delta \text{ARO} \) = The value of ARO for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( \Delta \text{OLE} \) = The value of OLE for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( SUL_0 \) = The value of SUL for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( ARO_0 \) = The value of ARO for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( OLE_0 \) = The value of OLE for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( \Delta \text{SUL}_0 \) = The value of SUL for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( \Delta \text{ARO}_0 \) = The value of ARO for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

\( \Delta \text{OLE}_0 \) = The value of OLE for the “edge target” fuel, as defined in paragraph (d)(1)(iv)(C) of this section.

For Phase II:

\( Y_{SUL}(t) = 100\% \times 0.738 \times [\exp(n_1(\text{et})/\exp(n_1(b))] - 1) \]
\[
+ 100\% \times 0.262 \times [\exp(n_2(\text{et})/\exp(n_2(b))] - 1) \]
\[
+ [(0.0000133 \times \Delta SUL) + 0.000692] \times \Delta SUL \]
\[
+ [(0.000733 \times \Delta ARO) + 0.0083632] \times \Delta ARO \]
\[
+ [(0.000732 \times \Delta OLE) - 0.00276] \times \Delta OLE)]] \]

If the sulfur level of the target fuel is less than 10 parts per million, then the value of SUL for the “edge target” fuel shall be set equal to 10 parts per million.

If the sulfur level of the target fuel is greater than 450 parts per million, then the value of SUL for the “edge target” fuel shall be set equal to 450 parts per million.

If the aromatics level of the target fuel is less than 18 volume percent, then the value of ARO for the “edge target” fuel shall be set equal to 18 volume percent.

If the olefins level of the target fuel is greater than 19 volume percent, then the value of OLE for the “edge target” fuel shall be set equal to 19 volume percent.

If the E300 level of the target fuel is greater than 95 volume percent, then the E300 value of the target fuel shall be set equal to 95 volume percent for the purposes of calculating NO\textsubscript{X} emissions with the equations given in paragraph (d)(1)(iv)(B) of this section.

If the sulfur level of the target fuel is less than 10 parts per million, then \( \Delta SUL \) shall be set equal to (SUL – 10 parts per million).

If the sulfur level of the target fuel is greater than 450 parts per million, then \( \Delta SUL \) shall be set equal to (SUL – 450 parts per million).

If the sulfur level of the target fuel is neither less than 10 parts per million nor greater than 450 parts per million, then \( \Delta SUL \) shall be set equal to zero.

If the aromatics level of the target fuel is less than 18 volume percent and greater than 10 volume percent, then \( \Delta ARO \) shall be set equal to (ARO – 18 volume percent).
than 10 volume percent, then $\Delta$ARO shall be set equal to $-8$ volume percent.

(10) If the aromatics level of the target fuel is greater than or equal to 18 volume percent, then $\Delta$ARO shall be set equal to zero.

(11) If the olefins level of the target fuel is greater than 19 volume percent, then $\Delta$OLE shall be set equal to zero.

(2) The winter NO\textsubscript{X} emissions performance of gasolines shall be given by the equations presented in paragraph (d)(1) of this section with the RVP value set to 8.7 psi.

(3) The NO\textsubscript{X} emissions performance of the target fuel in percentage terms from baseline levels shall be given by the following equations:

For Phase I:
\[ \text{Summer } NO\textsubscript{X}\% = \left[ 100\% \times \frac{\text{NO}\textsubscript{X} \text{ (g/mi)}}{0.660 \text{ g/mi}} \right] \]
\[ \text{Winter } NO\textsubscript{X}\% = \left[ 100\% \times \frac{\text{NO}\textsubscript{X} \text{ (g/mi)}}{0.750 \text{ g/mi}} \right] \]

For Phase II:
\[ \text{Summer } NO\textsubscript{X}\% = \left[ 100\% \times \frac{\text{NO}\textsubscript{X} \text{ (g/mi)}}{1.340 \text{ g/mi}} \right] \]
\[ \text{Winter } NO\textsubscript{X}\% = \left[ 100\% \times \frac{\text{NO}\textsubscript{X} \text{ (g/mi)}}{1.540 \text{ g/mi}} \right] \]

Summer NO\textsubscript{X}\% = Percentage change in NO\textsubscript{X} emissions from summer baseline levels

Winter NO\textsubscript{X}\% = Percentage change in NO\textsubscript{X} emissions from winter baseline levels

(e) Toxics performance—(1) Summer toxics performance. (i) Summer toxic emissions performance of gasolines in VOC Control Regions 1 and 2 shall be given by the following equations:

\[ \text{TOXICS1} = \text{EXHBZ} + \text{FORM} + \text{ACET} + \text{BUTA} + \text{POM} + \text{NEBZ1} \]
\[ \text{TOXICS2} = \text{EXHBZ} + \text{FORM} + \text{ACET} + \text{BUTA} + \text{POM} + \text{NEBZ2} \]

where

TOXICS1 = Summer toxics performance in VOC Control Region 1 in terms of milligrams per mile.

TOXICS2 = Summer toxics performance in VOC Control Region 2 in terms of milligrams per mile.

EXHBZ = Exhaust emissions of benzene in terms of milligrams per mile, as determined in paragraph (e)(4) of this section.

FORM = Emissions of formaldehyde in terms of milligrams per mile, as determined in paragraph (e)(5) of this section.

ACET = Emissions of acetaldehyde in terms of milligrams per mile, as determined in paragraph (e)(6) of this section.

BUTA = Emissions of 1,3-butadiene in terms of milligrams per mile, as determined in paragraph (e)(7) of this section.

POM = Polycyclic organic matter emissions in terms of milligrams per mile, as determined in paragraph (e)(8) of this section.

NEBZ1 = Nonexhaust emissions of benzene in VOC Control Region 1 in milligrams per mile, as determined in paragraph (e)(9) of this section.

NEBZ2 = Nonexhaust emissions of benzene in VOC Control Region 2 in milligrams per mile, as determined in paragraph (e)(10) of this section.

(ii) The percentage change in summer toxics performance in VOC Control Regions 1 and 2 shall be given by the following equations:

For Phase I:
\[ \text{TOXICS1}\% = \left[ 100\% \times \frac{\text{TOXICS1} - 48.61 \text{ mg/mi}}{48.61 \text{ mg/mi}} \right] \]
\[ \text{TOXICS2}\% = \left[ 100\% \times \frac{\text{TOXICS2} - 47.58 \text{ mg/mi}}{47.58 \text{ mg/mi}} \right] \]

For Phase II:
\[ \text{TOXICS1}\% = \left[ 100\% \times \frac{\text{TOXICS1} - 86.34 \text{ mg/mi}}{86.34 \text{ mg/mi}} \right] \]
\[ \text{TOXICS2}\% = \left[ 100\% \times \frac{\text{TOXICS2} - 85.61 \text{ mg/mi}}{85.61 \text{ mg/mi}} \right] \]

where

TOXICS1\% = Percentage change in summer toxics emissions in VOC Control Region 1 from baseline levels.

TOXICS2\% = Percentage change in summer toxics emissions in VOC Control Region 2 from baseline levels.

(2) Winter toxics performance. (i) Winter toxic emissions performance of gasolines in VOC Control Regions 1 and 2 shall be given by the following equation, evaluated with the RVP set at 8.7 psi:

\[ \text{TOXICW} = \left[ \text{EXHBZ} + \text{FORM} + \text{ACET} + \text{BUTA} + \text{POM} \right] \]

where

TOXICW = Winter toxics performance in VOC Control Regions 1 and 2 in terms of milligrams per mile.
FORM = Emissions of formaldehyde in terms of milligrams per mile, as determined in paragraph (e)(5) of this section.
ACET = Emissions of acetaldehyde in terms of milligrams per mile, as determined in paragraph (e)(6) of this section.
BUTA = Emissions of 1,3-butadiene in terms of milligrams per mile, as determined in paragraph (e)(7) of this section.
POM = Polycyclic organic matter emissions in terms of milligrams per mile, as determined in paragraph (e)(8) of this section.

(ii) The percentage change in winter toxics performance in VOC Control Regions 1 and 2 shall be given by the following equation:

For Phase I:

\[
\text{TOXICW}\% = 100\% \times \left( \frac{\text{TOXICW} - 58.36 \text{ mg/mi}}{58.36 \text{ mg/mi}} \right)
\]

For Phase II:

\[
\text{TOXICW}\% = 100\% \times \left( \frac{\text{TOXICW} - 120.55 \text{ mg/mi}}{120.55 \text{ mg/mi}} \right)
\]

where

TOXICW\% = Percentage change in winter toxics emissions in VOC Control Regions 1 and 2 from baseline levels.

(3) The year-round toxics performance in VOC Control Regions 1 and 2 shall be derived from volume-weighted performances of individual batches of fuel as described in §80.67(g).

(4) Exhaust benzene emissions shall be given by the following equation, subject to paragraphs (e)(4)(i) and (ii) of this section:

\[
\text{EXHBZ} = \text{BENZ(b)} + (\text{BENZ(b)} \times \frac{Y_{\text{BEN}(t)}}{100})
\]

where

EXHBZ = Exhaust benzene emissions in milligrams/mile
Y_{\text{BEN}(t)} = \left( (w_1 \times N_b) + (w_2 \times H_b) - 1 \right) \times 100

(i) Consolidated equation for normal emitters.

\[
b_1 = (0.0006197 \times \text{SUL}) + (-0.003376 \times \text{E200}) + (0.0265900 \times \text{ARO}) + (0.2223900 \times \text{BEN})
\]

(ii) Equation for higher emitters.

\[
b_2 = (-0.096047 \times \text{OXY}) + (0.0003370 \times \text{SUL}) + (0.0112510 \times \text{E300}) + (0.0118820 \times \text{ARO}) + (0.2223180 \times \text{BEN})
\]

(iii) If the aromatics value of the target fuel is less than 10 volume percent, then an aromatics value of 10 volume percent shall be used when evaluating the equations given in paragraphs (e)(4)(i) and (ii) of this section. If the E300 value of the target fuel is greater than 95 volume percent, then an E300 value of 95 volume percent shall be used when evaluating the equations in paragraphs (e)(4)(i) and (ii) of this section.

(5) Formaldehyde mass emissions shall be given by the following equation, subject to paragraphs (e)(5)(iii) and (iv) of this section:

\[
\text{FORM} = \text{FORM(b)} + (\text{FORM(b)} \times \frac{Y_{\text{FORM}(t)}}{100})
\]

where

FORM = Exhaust formaldehyde emissions in terms of milligrams/mile.
Y_{\text{FORM}(t)} = \left( (w_1 \times N_f) + (w_2 \times H_f) - 1 \right) \times 100

\[
b_1 = (0.0006197 \times \text{SUL}) + (-0.003376 \times \text{E200}) + (0.0265900 \times \text{ARO}) + (0.2223900 \times \text{BEN})
\]

\[
b_2 = (-0.096047 \times \text{OXY}) + (0.0003370 \times \text{SUL}) + (0.0112510 \times \text{E300}) + (0.0118820 \times \text{ARO}) + (0.2223180 \times \text{BEN})
\]

\[w_1 = \text{Weighting factor for normal emitters as defined in paragraph (b)(2) of this section for the appropriate Phase.}\]

\[w_2 = \text{Weighting factor for higher emitters as defined in paragraph (b)(1) of this section for the appropriate Phase.}\]

\[b_1(t), b_2(t) = \text{Normal emitter benzene equation, as defined in paragraph (e)(4)(i) of this section, evaluated using the target fuel's properties.}\]

\[b_1(t), b_2(t) = \text{Higher emitter benzene equation as defined in paragraph (e)(4)(ii) of this section, evaluated using the target fuel's properties.}\]
shall not be evaluated with the Com-
non-alcohol, non-ether oxygenates
Oxygen in the form of methanol or
evaluated as if it were in the form of ETBE.
methyl, non-ethyl ethers shall be eval-
ETBE. Oxygen in the form of non-
evaluated as if it were in the form of
ethyl ethers other than ETBE shall be
form of MTBE. Oxygen in the form of
ethanol. Oxygen in the form of methyl
are more complex or have higher mo-
emissions and emissions performance,
graphs (e)(5) (i) and (ii) of this section.
(f), evaluated using the target fuel’s prop-
properties subject to paragraphs (e)(5) (iii)
and (iv) of this section.
(f) = Higher emitter formaldehyde equa-
tion as defined in paragraph (e)(5)(i) of this
section, evaluated for the base fuel’s prop-
erties.
(f) = Higher emitter formaldehyde equa-
tion as defined in paragraph (e)(5)(ii) of this
section, evaluated for the base fuel’s prop-
erties.

(i) Consolidated equation for normal
emitters.
f1 = \( (0.0010226 \times E300) + (0.007166 \times ARO) + (0.046231 \times MTB) \)

(ii) Equation for higher emitters.
f2 = \( (0.0010226 \times E300) + (0.007166 \times ARO) + (0.0093152 \times OLE) + (0.046231 \times MTB) \)

(iii) If the aromatics value of the tar-
get fuel is less than 10 volume percent,
then an aromatics value of 10 volume
percent shall be used when evaluating
the equations given in paragraphs (e)(5)
(i) and (ii) of this section. If the E300
value of the target fuel is greater than
95 volume percent, then an E300 value
of 95 volume percent shall be used when
evaluating the equations given in para-
graphs (e)(5) (i) and (ii) of this section.
(iv) When calculating formaldehyde
emissions and emissions performance,
oxygen in the form of alcohols which
are more complex or have higher mo-
lecular weights than ethanol shall be
evaluated as if they were in the form of
ethanol. Oxygen in the form of methyl
ethers other than TAME and MTBE
shall be evaluated as if they were in the
form of MTBE. Oxygen in the form of
ethyl ethers other than ETBE shall be
evaluated as if they were in the form of
ETBE. Oxygen in the form of non-
methyl, non-ethyl ethers shall be eval-
uated as if they were in the form of ETBE.
Oxygen in the form of methanol or
non-alcohol, non-ether oxygenates
shall not be evaluated with the Com-
plex Model, but instead must be evalu-
ated through vehicle testing per §80.48.
(6) Acetaldehyde mass emissions
shall be given by the following equa-
tion, subject to paragraphs (e)(6) (iii)
and (iv) of this section:
\[
ACET = ACET(t) + (ACET(b) \times Y_{ACET(t)}/100)
\]
\[
Y_{ACET(t)} = [(w_1 \times N_a) + (w_2 \times H_a) - 1] \times 100
\]
where
ACET = Exhaust acetaldehyde emissions
in terms of milligrams/mile
Y_{ACET(t)} = Acetaldehyde performance of
target fuel in terms of percentage change
from baseline
ACET(b) = Baseline acetaldehyde emissions
as defined in paragraph (b)(2) of this
section for the appropriate phase and season
N_a = exp a_t/exp a_b
H_a = exp a_t/exp a_b

w_1 = Weighting factor for normal emitters
as defined in paragraph (b)(1) of this section
w_2 = Weighting factor for higher emitters
as defined in paragraph (b)(1) of this section
for the appropriate phase

\[
f_1 = (-0.010226 \times E300) + (-0.007166 \times ARO) + (0.046231 \times MTB)
\]

\[
f_2 = (-0.010226 \times E300) + (-0.007166 \times ARO) + (-0.0093152 \times OLE) + (0.046231 \times MTB)
\]

\[
a_t = \exp a(t)/\exp a(b)
\]

ACET = Acetaldehyde equation
as defined in paragraph (e)(6)(i) of this
section, evaluated for the target fuel’s
properties subject to paragraphs (e)(6) (iii)
and (iv) of this section

\[
a_t = \exp a(t)/\exp a(b)
\]

ACET = Acetaldehyde equation
as defined in paragraph (e)(6)(ii) of this
section, evaluated using the target fuel’s
properties subject to paragraphs (e)(6) (iii)
and (iv) of this section

\[
a_t = \exp a(t)/\exp a(b)
\]

ACET = Acetaldehyde equation
as defined in paragraph (e)(6)(i) of this
section, evaluated for the base fuel’s
properties

\[
a_t = \exp a(t)/\exp a(b)
\]

ACET = Acetaldehyde equation
as defined in paragraph (e)(6)(ii) of this
section, evaluated using the target fuel’s
properties subject to paragraphs (e)(6) (iii)
and (iv) of this section

\[
a_t = \exp a(t)/\exp a(b)
\]
value of the target fuel is greater than 95 volume percent, then an E300 value of 95 volume percent shall be used when evaluating the equations given in paragraphs (e)(6)(i) and (ii) of this section.

(iv) When calculating acetaldehyde emissions and emissions performance, oxygen and the form of alcohols which are more complex or have higher molecular weights than ethanol shall be evaluated as if it were in the form of ethanol. Oxygen in the form of methyl ethers other than TAME and MTBE shall be evaluated as if it were in the form of ETBE. Oxygen in the form of ethyl ethers other than ETBE shall be evaluated as if it were in the form of ETBE. Oxygen in the form of methanol or non-alcohol, non-ether oxygenates shall not be evaluated with the Complex Model, but instead must be evaluated through vehicle testing per §80.48.

(7) 1,3-butadiene mass emissions shall be given by the following equations, subject to paragraph (e)(7)(iii) of this section:

\[
\text{BUTA} = \text{BUTA}(b) + (\text{BUTA}(b) \times Y_{\text{BUTA}}(t)/100)
\]

\[
Y_{\text{BUTA}}(t) = \left[ (w_1 \times N_d) + (w_2 \times H_d) - 1 \right] \times 100
\]

where

- BUTA = Exhaust 1,3-butadiene emissions in terms of milligrams/mile
- \(Y_{\text{BUTA}}(t)\) = 1,3-butadiene performance of target fuel in terms of percentage change from baseline
- \(\text{BUTA}(b)\) = Baseline 1,3-butadiene emissions as defined in paragraph (b)(2) of this section for the appropriate phase and season
- \(N_d = \exp d_1(t)/\exp d_1(b)\)
- \(H_d = \exp d_2(t)/\exp d_2(b)\)
- \(w_1\) =ighting factor for normal emitters as defined in paragraph (b)(1) of this section for the appropriate phase
- \(w_2\) = Weighting factor for higher emitters as defined in paragraph (b)(1) of this section for the appropriate Phase.

\(d_1(t)\) = Normal emitter 1,3-butadiene equation as defined in paragraph (e)(7)(i) of this section, evaluated using the target fuel’s properties, subject to paragraph (e)(7)(ii) of this section.

\(d_1(b)\) = Normal emitter 1,3-butadiene equation as defined in paragraph (e)(7)(i) of this section, evaluated for the base fuel’s properties.

\(d_2(b)\) = Higher emitter 1,3-butadiene equation as defined in paragraph (e)(7)(ii) of this section, evaluated for the base fuel’s properties.

(i) Consolidated equation for normal emitters.

\[
d_1 = \left[ -0.001552 \times \text{SUL} \right] + \left[ 0.00753 \times E200 \right] + \left[ -0.014986 \times E300 \right] + \left[ -0.03996 \times \text{ARO} \right] + \left[ 0.028235 \times \text{OLE} \right]
\]

(ii) Equation for higher emitters.

\[
d_2 = \left[ -0.06771 \times \text{OXY} \right] + \left[ 0.0731 \times E200 \right] + \left[ 0.08058 \times E300 \right] + \left[ -0.004005 \times \text{ARO} \right] + \left[ 0.043696 \times \text{OLE} \right]
\]

(iii) If the aromatics value of the target fuel is less than 10 volume percent, then an aromatics value of 10 volume percent shall be used when evaluating the equations given in paragraphs (e)(7)(i) and (ii) of this section. If the E300 value of the target fuel is greater than 95 volume percent, then an E300 value of 95 volume percent shall be used when evaluating the equations given in paragraphs (e)(7)(i) and (ii) of this section.

(8) Polycyclic organic matter mass emissions shall be given by the following equation:

\[
POM = 0.003355 \times \text{VOCE}
\]

\[
\text{POC} = \text{Polycyclic organic matter emissions in terms of milligrams per mile}
\]

\[
\text{VOCE} = \text{Non-methane, non-ethane exhaust emissions of volatile organic compounds in grams per mile}
\]

(9) Nonexhaust benzene emissions in VOC Control Region 1 shall be given by the following equations for both Phase I and Phase II:

\[
\text{NBERZ1} = \text{DIBZ1} + \text{HSBZ1} + \text{RLBZ1} + \text{RFBZ1}
\]

\[
\text{DIBZ1} = 0 \times \text{BEN} \times \text{VOCCH1} \times \left[ (-0.0342 \times \text{MTB}) + (-0.080274 \times \text{RVP}) + 1.4448 \right]
\]

\[
\text{HSBZ1} = 10 \times \text{BEN} \times \text{VOCCH1} \times \left[ 0.0342 \times \text{MTB} \right] + (-0.080274 \times \text{RVP}) + 1.3758
\]

\[
\text{RLBZ1} = 10 \times \text{BEN} \times \text{VORCFI1} \times \left[ (-0.0342 \times \text{MTB}) + (-0.080274 \times \text{RVP}) + 1.4448 \right]
\]

\[
\text{RFBZ1} = 10 \times \text{BEN} \times \text{VORCFI1} \times \left[ (-0.0296 \times \text{MTB}) + (-0.081507 \times \text{RVP}) + 1.3972 \right]
\]

where

\[
\text{NBERZ1} = \text{Nonexhaust emissions of volatile organic compounds in VOC Control Region 1 in milligrams per mile}
\]

676
DIBZ2 = Diurnal emissions of volatile organic compounds in VOC Control Region 1 in milligrams per mile.
HSBZ2 = Hot soak emissions of volatile organic compounds in VOC Control Region 1 in milligrams per mile.
RLBZ2 = Running loss emissions of volatile organic compounds in VOC Control Region 1 in milligrams per mile.
RFBZ2 = Refueling emissions of volatile organic compounds in VOC Control Region 1 in grams per mile.

VOCDI1 = Diurnal emissions of volatile organic compounds in VOC Control Region 1 in milligrams per mile.
VOCHS1 = Hot soak emissions of volatile organic compounds in VOC Control Region 1 in milligrams per mile.
VOCRL1 = Running loss emissions of volatile organic compounds in VOC Control Region 1 in milligrams per mile.
VORFB1 = Refueling emissions of volatile organic compounds in VOC Control Region 1 in milligrams per mile.

(10) Nonexhaust benzene emissions in VOC Control Region 2 shall be given by the following equations for both Phase I and Phase II:

NEBZ2 = DIBZ2 + HSBZ2 + RLBZ2 + RFBZ2

where

NEBZ2 = Nonexhaust emissions of volatile organic compounds in VOC Control Region 2 in milligrams per mile.

VOCDI2 = Diurnal emissions of volatile organic compounds in VOC Control Region 2 in milligrams per mile.
VOCHS2 = Hot soak emissions of volatile organic compounds in VOC Control Region 2 in milligrams per mile.
VOCRL2 = Running loss emissions of volatile organic compounds in VOC Control Region 2 in milligrams per mile.

(f) Limits of the model. (1) The equations described in paragraphs (c), (d), and (e) of this section shall be valid only for fuels with fuel properties that fall in the following ranges for reformulated gasolines:

<table>
<thead>
<tr>
<th>Fuel property</th>
<th>Acceptable range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>0.0–4.0 weight percent.</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.0–500.0 parts per million by weight.</td>
</tr>
<tr>
<td>RVP</td>
<td>64–10.0 pounds per square inch.</td>
</tr>
<tr>
<td>E200</td>
<td>30.0–70.0 percent evaporated.</td>
</tr>
<tr>
<td>E300</td>
<td>70.0–100.0 percent evaporated.</td>
</tr>
<tr>
<td>Aromatics</td>
<td>0.0–50.0 volume percent.</td>
</tr>
<tr>
<td>Olefins</td>
<td>0.0–25.0 volume percent.</td>
</tr>
<tr>
<td>Benzene</td>
<td>0.0–2.0 volume percent.</td>
</tr>
</tbody>
</table>

(2) Fuels with one or more properties that do not fall within the ranges described in above shall not be certified or evaluated for their emissions performance using the complex emissions model described in paragraphs (c), (d), and (e) of this section.