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N = Total number of regeneration emission tests.

(Subscript ‘s’ refers to standard test schedule)

5. Refer to table I and determine t₀ at (N₀ – 2)₀₀₀ degrees of freedom and t at (N – 2)₀₀₀ degrees of freedom.

6. If \((A₀₀₀)^{1/2} ≥ t₀ / t\) the proposed plan is acceptable.

<table>
<thead>
<tr>
<th>Table I TO APPENDIX XV</th>
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<tbody>
<tr>
<td>Degrees of freedom (N–2)</td>
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</table>

(82 FR 31264, June 6, 1997)

APPENDIX XVI TO PART 86—POLLUTANT MASS EMISSIONS CALCULATION PROCEDURE FOR GASEOUS-FUELED VEHICLES AND FOR VEHICLES EQUIPPED WITH PERIODICALLY REGENERATING TRAP OXIDIZER SYSTEMS CERTIFYING TO THE PROVISIONS OF PART 86, SUBPART R

(a) Gaseous-Fueled Vehicle Pollutant Mass Emission Calculation Procedure.

(1) For all TLEVs, LEVs, and ULEVs, the calculation procedures specified in Chapter 5 of the California Regulatory Requirements Applicable to the National Low Emission Vehicle Program (October, 1996) shall apply. These procedures are incorporated by reference (see §86.1).


(1) Exhaust Emissions. (i) The provisions of §86.1777 apply to vehicles equipped with periodically regenerating trap oxidizer systems, except that the following shall apply instead of the requirements in §86.144–94(a):

(ii) The final reported test results shall be computed by the use of the following formula:

\[ Y_{em} = 0.43 \left( \frac{Y_{ct} + Y_{s}}{D_{ct} + D_{s}} \right) + 0.57 \left( \frac{Y_{ht} + Y_{s}}{D_{ht} + D_{s}} \right) \]

(iii) For light-duty vehicles and light-duty trucks:

\[ Y_{em} = 0.43 \left( \frac{Y_{ct} + Y_{s}}{D_{ct} + D_{s}} \right) + 0.57 \left( \frac{Y_{ht} + Y_{s}}{D_{ht} + D_{s}} \right) \]

(iv) For purposes of adjusting emissions for regeneration:

\[ Re = (Y_{r1} - Y_{ct}) + (Y_{r2} - Y_{s}) + (Y_{r3} - Y_{ht}) / (D_{ct} + D_{s} + D_{ht}). \]

Where:

\[ Y_{wm} = \text{Weighted mass emissions of each pollutant}, \ i.e., \ HC, \ CO, \ NO_x \text{ or CO}, \ \text{in grams per vehicle mile}. \]

\[ Y_{ct} = \text{Mass emissions as calculated from the “transient” phase of the cold start test, in grams per test phase.} \]

\[ Y_{ht} = \text{Mass emissions as calculated from the “transient” phase of the hot start test in grams per test phase.} \]

\[ Y_{r1} = \text{Mass emissions, during a regeneration emission test, as calculated from the “transient” phase of the cold start test, in grams per test phase.} \]

\[ Y_{r2} = \text{Mass emissions, during a regeneration emission test, as calculated from the “stabilized” phase of the cold start test, in grams per test phase.} \]

\[ Y_{r3} = \text{Mass emissions, during a regeneration emission test, as calculated from the “transient” phase of the hot start test in grams per test phase.} \]

(2) Particulate Emissions. (i) The provisions of §86.1778 apply to vehicles equipped with periodically regenerating trap oxidizer systems, except that the following shall apply instead of the requirements §86.145–92(a):

(ii) The final reported test results for the mass particulate (Mp) in grams/mile shall be computed as follows.

(iii) For purposes of adjusting emissions for regeneration:

\[ Mp = 0.43(M_{p1} + M_{p2}) / (D_{ct} + D_{s}) + 0.57(M_{p3} + M_{p2}) / (D_{ht} + D_{s}). \]

\[ Re = (M_{p1} - M_{p2}) + (M_{p2} - M_{p3}) + (M_{p3} - M_{p3}) / (D_{ct} + D_{s} + D_{ht}). \]

\[ M_{pr} = M_{p} + Re \]

Where:

\[ (M_{p1}) = \text{Mass of particulate determined from the “transient” phase of the cold start test, in grams per test phase.} \]

\[ (M_{p2}) = \text{Mass of particulate determined from the “transient” phase of the hot start test, in grams per test phase.} \]

See §86.110–94(d)(1) for determination.)
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(2) $\text{Mp}_2 = \text{Mass of particulate determined from the "stabilized" phase of the cold start test, in grams per test phase. (See §86.110-94(d)(1) for determination.)}$

(3) $\text{Mp}_3 = \text{Mass of particulate determined from the "transient" phase of the cold start test, in grams per test phase. (See §86.110-94(d)(1) for determination.)}$

(4) $\text{Dct} = \text{The measured driving distance from the "transient" phase of the cold start test, in miles.}$

(5) $\text{Ds} = \text{The measured driving distance from the "stabilized" phase of the cold start test, in miles.}$

(6) $\text{Dht} = \text{The measured driving distance from the "transient" phase of the hot start test, in miles.}$

(7) $\text{Mpr} = \text{Regeneration emission test}$

(8) $\text{Re} = \text{Mass of particulate attributable to regeneration in grams/mile.}$

(9) $\text{Mpr}_1 = \text{Mass of particulate determined, during a regeneration emission test, from the "transient" phase of the cold start test in grams per test phase. (See §86.110-94(d)(1) for determination.)}$

(10) $\text{Mpr}_2 = \text{Mass of particulate determined, during a regeneration emission test, from the "stabilized" phase of the cold start test, in grams per test phase. (See §86.110-94(d)(1) for determination.)}$

(11) $\text{Mpr}_3 = \text{Mass of particulate determined, during a regeneration emission test, from the "transient" phase of the hot start test, in grams per test phase. (See §86.110-94(d)(1) for determination.)}$

(c) Fuel Economy Calculations for Gaseous Fuels Based on the Cold Start CVS–1975 Federal Test Procedure.

(1) Assume the fuel meets HD–5 specifications ($95\% C_3H_8, 5\% nC_4H_{10}$, by volume).

(ii) Density of the HD–5 fuel:

\[
(0.95 \times 4.235) + (0.05 \times 4.868) = 4.267 \text{ lb/gal @ 60 °F}
\]

(iii) Molecular Weights:

(A)

\[
\begin{array}{|c|c|c|}
\hline
\text{Species} & \text{Mol. Wt.} & \text{Sp. Gr.} \\
\hline
\text{C} & 12.01115 & 0.429 \\
\text{H} & 1.00797 & 0.508 \\
\text{O} & 15.9994 & 0.584 \\
\text{CO} & 28.01055 & 4.235 \\
\text{CO}_2 & 44.00995 & 4.868 \\
\text{CH}_{2.658} & 14.6903 & 0.95 \\
\hline
\end{array}
\]

*Average ratio of Hydrogen to carbon atoms in HD–5 fuel.

(B)

\[
\begin{array}{|c|c|c|}
\hline
\text{Species} & \text{Mol. Wt.} & \text{Sp. Gr.} \\
\hline
\text{C}_{3}H_8 & 44.094 & 4.0233 \\
\text{nC}_{4}H_{10} & 58.12 & 0.2434 \\
\hline
\end{array}
\]

(iv) Weight of Carbon in:

\[
\text{CO} = \text{wt. of CO} \times (12.01115 / 28.01055) = \text{wt. CO} \times (0.429)
\]

\[
\text{CO}_2 = \text{wt. of CO}_2 \times (12.01115 / 44.00995) \text{ wt. CO}_2 \times (0.273)
\]

\[
\text{CH}_{2.658} = \text{wt. of CH}_{2.658} \times (12.01115 / 14.6903) = \text{wt. CH}_{2.658} \times (0.818)
\]

(v) Weight of Carbon per gallon of LPG:

\[
\text{wt. of carbon} = 4.2667 \text{ lb/gal} \times 453.59 \text{ gms/lb} \times 0.818 = 1583 \text{ grams C/gal HD–5}
\]

(vi) Fuel economy:

\[
\text{LPG} = \frac{1583 \text{ gms C/gal}}{(0.818)(\text{HC}) + (0.429)(\text{CO}) + (0.273)(\text{CO}_2)}
\]

Where:

\[
\begin{align*}
\text{HC} &= \text{CVS HC in grams/mile} \\
\text{CO} &= \text{CVS CO in grams/mile} \\
\text{CO}_2 &= \text{CVS CO}_2 in grams/mile
\end{align*}
\]

For gasoline:

\[
= \frac{2421} {((0.866)(\text{HC}) + (0.429)(\text{CO}) + (0.273)(\text{CO}_2))}
\]

For Natural Gas:

\[
= \frac{1535} {((0.759)(\text{HC}) + (0.429)(\text{CO}) + (0.273)(\text{CO}_2))}
\]