California Environmental Protection Agency
AIR RESOURCES BOARD

CALIFORNIA NON-METHANE ORGANIC GAS TEST PROCEDURES

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NOTE: Mention of any trade name or commercial product does not constitute endorsement or recommendation of this product by the Air Resources Board. Note: The proposed amendments to this document are shown in underline to indicate additions and strikeout to indicate deletions compared to the test procedures as last amended March 22, 2012. [No change] indicates proposed federal provisions that are also proposed for incorporation herein without change. Existing intervening text that is not amended in this rulemaking is indicated by "* * * *".

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PART B

DETERMINATION OF NON-METHANE HYDROCARBON MASS EMISSIONS BY FLAME IONIZATION DETECTION

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5. NMHC MASS EMISSION PER TEST PHASE

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5.2 All Vehicles

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5.2.5 The density of the NMHC is determined using the carbon:hydrogen ratio of the fuel, $C_xH_yO_z$, according to the following equation:

$$NMHC_{dens} = (x * 12.01115 + y * 1.00797)(g/mole) * \left(\frac{28.316847\ \text{liter/ft3}}{24.055\ \text{liter/mole}} \right)$$

where: 12.01115 = atomic weight of carbon
1.00797 = atomic weight of hydrogen

<u>except when using any gasoline-based fuel, including Phase 2 gasoline and E85 fuel, for which the $NMHC_{dens}$ is defined as 16.33.</u>

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7. SAMPLE CALCULATIONS

7.1 Given the following data for a gasoline vehicle operated on phase 2 certification fuel, $CH_{1.964}O_{0.0182}$, calculate the weighted NMHC mass emission.

Test Phase	FID THC_e (ppmC)	FID THC_d (ppmC)	CH_{4e} (ppmC)	CH_{4d} (ppmC)	CO_{em} (ppm)	CO_{2e} (%)	VMIX (ft^3)	$D_{phase\ n}$ (mile)
1	21.928	3.557	3.667	2.545	94.758	0.9581	2745	3.610
2	3.826	3.533	2.694	2.490	16.516	0.5925	4700	3.876
3	4.242	3.386	2.769	2.414	11.524	0.8225	2738	3.611

For Phase 1:

$NMHC_e$ = FID THC_e - (r_{CH_4} * CH_{4e})
= 21.928 ppmC - (1.15 * 3.667 ppmC)
= 17.711 ppmC

$NMHC_d$ = FID THC_d - (r_{CH_4} * CH_{4d})
= 3.557 ppmC - (1.15 * 2.545 ppmC)
= 0.630 ppmC

The numerator of the DF
= 100 * (x / (x + y/2 + 3.76 * (x + y/4 – z/2))
= 100 * (1 / 1 + 1.964 / 2 + 3.76 * (1 + 1.964 / 4 – 0.0182 / 2)
= 13.2381

DF = 13.2381 ÷ [CO_{2e} + ($NMHC_e$ + CH_{4e} + CO_e) * 10^{-4}]

$$DF = \frac{13.2381}{0.9581 + (17.711\,\text{ppmC} + 3.667\,\text{ppmC} + 94.758\,\text{ppmC}) * 10^{-4}}$$

= 13.653

$NMHC_{conc}$ = $NMHC_e$ - $NMHC_d$ * [1 - (1 ÷ DF)]
= 17.711 ppmC – 0.630 ppmC * [1 - (1 ÷ 13.653)]
= 17.127 ppmC

~~$NMHC_{dens} = (x * 12.01115 + y * 1.00797)(g/mole) * \left(\frac{28.316847\text{liter/ft3}}{24.0547\text{liter/mole}}\right)$~~

$NMHC_{dens}$ = 16.33 g/ft^3 ~~(1 * 12.01115 + 1.964 *1.00797)* (28.316847/24.055)~~
~~= 16.470 g/ft^3~~

$NMHC_{mass\ n}$ = $NMHC_{conc}$ * $NMHC_{dens}$ * VMIX * 10^{-6}
= 17.127 ppmC * 16.33~~47~~ g/ft^3 * 2745 ft^3 * 10^{-6}

$NMHC_{mass\ 1}$ = 0.770~~43~~ g

Similarly, for Phase 2: $NMHC_{mass\ 2}$ = 0.0068 g
and for Phase 3: $NMHC_{mass\ 3}$ = 0.0217~~9~~ g

Therefore,

$$NMHC_{wm} = 0.43 * \left(\frac{NMHC_{mass1} + NMHC_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{NMHC_{mass3} + NMHC_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

~~$$NMHC_{wm} = 0.43 * \left(\frac{0.768\text{ g} + 0.0068\text{ g}}{3.610\text{ miles} + 3.876\text{ miles}} \right) + 0.57 * \left(\frac{0.0217\text{ g} + 0.0068\text{ g}}{3.611\text{ miles} + 3.876\text{ miles}} \right)$$~~

$$NMHC_{wm} = 0.43 * \left(\frac{0.770\text{ g} + 0.0068\text{ g}}{3.610\text{ miles} + 3.876\text{ miles}} \right) + 0.57 * \left(\frac{0.0217\text{ g} + 0.0068\text{ g}}{3.611\text{ miles} + 3.876\text{ miles}} \right)$$

$NMHC_{wm}$ = 0.047 g/mile

7.2 Given the following data for a vehicle operating on 10% ethanol and 90% gasoline (E10) CH$_{1.8784}$~~$_{2.7841}$~~O$_{0.0338}$~~$_{0.3835}$~~, calculate the weighted NMHC mass emission.

Test Phase	FID THC_e (ppmC)	FID THC_d (ppmC)	CH_{4e} (ppmC)	CH_{4d} (ppmC)	CO_{em} (ppm)	CO_{2e} (%)	VMIX (ft^3)	$D_{phase\ n}$ (mile)
1	14.398	2.971	3.639	2.125	97.83	0.9203	3508	3.590
2	2.882	2.830	2.176	2.010	12.25	0.5935	6010	3.858
3	3.976	2.642	2.621	2.058	19.86	0.7624	3502	3.581

For Phase 1:

$NMHC_e$ = FID THC_e - (r_{CH_4} * CH_{4e})
= 14.398 ppmC - (1.15 * 2.215 ppmC)
= 10.213 ppmC

$NMHC_d$ = FID THC_d - (r_{CH_4} * CH_{4d})
= 2.971 ppmC - (1.15 * 2.125 ppmC)
= 0.527 ppmC

The numerator of the DF
= 100 * (x / (x + y/2 + 3.76 * (x + y/4 – z/2)))
= 100 * (1 / (1 + 1.8784 / 2 + 3.76 * (1 + 1.8784 / 4 – 0.0338 / 2)))
= 13.511

DF = $13.511 \div [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$

$$= \frac{13.511}{0.9203 + (10.213\,\text{ppmC} + 3.639\,\text{ppmC} + 97.83\,\text{ppmC}) * 10^{-4}}$$

= 14.505

$NMHC_{conc}$ = $NMHC_e$ - $NMHC_d$ * [1 - (1 / DF)]
= 10.213 ppmC – 0.527 ppmC * [1 - (1 / 14.505)]
= 9.722 ppmC

$NMHC_{mass\ n}$ = $NMHC_{conc}$ * $NMHC_{dens}$ * VMIX * 10^{-6}

$NMHC_{mass\ 1}$ = 0.557~~8~~ g

Similarly, Phase 2: $NMHC_{mass\ 2}$ = 0.0 g
and for Phase 3: $NMHC_{mass\ 3}$ = 0.040 g

Therefore,

$$NMHC_{wm} = 0.43 * \left(\frac{NMHC_{mass1} + NMHC_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{NMHC_{mass3} + NMHC_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

~~$$NMHC_{wm} = 0.43 * \left(\frac{0.558\,\text{g} + 0.00\,\text{g}}{3.590\ \text{miles} + 3.858\ \text{miles}} \right) + 0.57 * \left(\frac{0.040\,\text{g} + 0.00\,\text{g}}{3.581\ \text{miles} + 3.858\ \text{miles}} \right)$$~~

$$NMHC_{wm} = 0.43 * \left(\frac{0.557\,\text{g} + 0.00\,\text{g}}{3.590\ \text{miles} + 3.858\ \text{miles}} \right) + 0.57 * \left(\frac{0.040\,\text{g} + 0.00\,\text{g}}{3.581\ \text{miles} + 3.858\ \text{miles}} \right)$$

$NMHC_{wm}$ = 0.035 g/mile

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As Amended: December 6, 2012
Date of Hearing: November 15, 2012

Part D

DETERMINATION OF C_2 TO C_5 HYDROCARBONS IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1002

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2. METHOD SUMMARY

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2.2 The samples are received by the laboratory in Tedlar®, Kynar®, or Solef® bags, which are sub-sampled into a GC for separation and analysis.

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4. INSTRUMENTS AND APPARATUS

4.1 ~~Kynar® (polyvinylidene fluoride)~~ Sample collection bags, ~~4 mil in thickness,~~ nominally 5 to 10 liters in capacity and equipped with quick-connect fittings, are typically used to contain the samples. Sample collection bags may be made of Tedlar® (polyvinylfloride, or PVF), 2 mil in thickness, or of Kynar® or Solef® (polyvinylidenefloride, or PVDF), each 4 mil in thickness. Other sample bag material or sample collection containers, such ~~as bags made of Tedlar® (polyvinyl fluoride) film or~~ nickel-coated stainless steel canisters, may be used, provided they are made of non-reactive material and do not cause sample loss or contamination.

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Part E

DETERMINATION OF C_6 TO C_{12} HYDROCARBONS IN AUTOMOTIVE SOURCE SAMPLES BY GAS CHROMATOGRAPHY

METHOD NO. 1003

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2. METHOD SUMMARY

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2.2 The samples are received by the laboratory in Tedlar®, Kynar®, or Solef® bags, which are sub-sampled into a GC for separation and analysis.

*   *   *   *

4. INSTRUMENTATION AND APPARATUS

4.1 ~~Kynar® (polyvinylidene fluoride)~~ Sample collection bags, ~~4 mil in thickness,~~ nominally 5 to 10 liters in capacity and equipped with quick-connect fittings, are typically used to contain the samples. Sample collection bags may be made of Tedlar® (polyvinylfloride, or PVF), 2 mil in thickness, or of Kynar® or Solef® (polyvinylidenefloride, or PVDF), each 4 mil in thickness. Other sample bag material or sample collection containers, such ~~as bags made of Tedlar® (polyvinyl fluoride) film or~~ nickel-coated stainless steel canisters, may be used, provided they are made of non-reactive material and do not cause sample loss or contamination.

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Part F

DETERMINATION OF ALDEHYDE AND KETONE COMPOUNDS IN AUTOMOTIVE SOURCE SAMPLES BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

METHOD NO. 1004

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7. CALCULATIONS

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7.3 For tolualdehyde, the sum of all isomers present is reported as m-tolualdehyde. —

Under the conditions of the system described in Section 6.6, the isomers coelute. The m-tolualdehyde response factor is applied to the single tolualdehyde peak. This concentration is reported as m-tolualdehyde.

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Part G
DETERMINATION OF NMOG MASS EMISSIONS

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3. DILUTION FACTOR AND NMHC MASS EMISSION CALCULATION

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3.2 The density of the NMHC is determined using the carbon:hydrogen ratio of the fuel, $C_xH_yO_z$, according to the following equation:

$$NMHC_{dens} = (x * 12.01115 + y * 1.00797)(g/mole) * \left(\frac{28.316847\text{liter/ft3}}{24.0547\text{liter/mole}}\right)$$

where: 12.01115 = atomic weight of carbon
1.00797 = atomic weight of hydrogen

except when using any gasoline-based fuel, including Phase 2 gasoline and E85 fuel, for which the $NMHC_{dens}$ is defined as 16.33.

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b) For Phase 2 gasoline, $CH_{1.94}O_{0.017}$, where x = 1, y = 1.94 and z = 0.017,
DF = $13.295 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
$NMHC_{dens}$ = 16.33 ~~16.44~~

* * * *

e) For E85, $CH_{2.7841}O_{0.3835}$, ~~W~~where x = 1, y = 2.7841, and z = 0.3835:
DF = $12.4253 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
$NMHC_{dens}$ = 16.33 ~~17.44~~

3.3 Sample Calculation

A flex-fuel vehicle using E85 fuel $CH_{2.7841}O_{0.3835}$, where x = 1, y = 2.7841, and z = 0.3835:

Test Phase	FID THC_e (ppmC)	CH_{4e} (ppmC)	CO_{2e} (%)	CO_e (ppm)	FID THC_d (ppmC)	CH_{4d} (ppmC)	CO_{2d} (%)	CO_d (ppm)	VMIX (ft^3)	$D_{phase\ n}$ (mile)
1	27.230	6.918	0.8564	117.801	3.532	2.261	0.0438	0.5224	3495	3.591
2	3.5459	2.357	0.5595	10.8229	3.476	2.247	0.4446	0.3322	5799	3.846
3	3.8510	2.590	0.7163	5.1538	3.396	2.188	0.4507	0.6752	3484	3.591

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FID response factor of methane is experimentally determined for each individual FID. The value of 1.15 used here is for example only.

For phase 1:

$NMHC_e$ = FID $THC_e - r_{CH_4} * CH_{4e}$
= 27.230 – 1.15 * 6.918
= 19.274 ppmC

DF = $12.4253 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
= $12.4253 / [0.8564 + (19.274 + 6.918 + 117.801) * 10^{-4}]$
= 14.2688 ppmC

$NMHC_d$ = FID $THC_d - r_{CH_4} * CH_{4d}$
= 3.532 – 1.15 * 2.261
= 0.9319 ppmC

$NMHC_{conc}$ = $NMHC_e - NMHC_{d*} (1 - 1/DF)$
= 19.274 – 0.9319*(1 – 1 / 14.2688)
= 18.407 ppmC

$NMHC_{mass1}$ = $NMHC_{conc} * NMHC_{dens} * VMIX_1 * 10^{-6}$

= 18.407 * 16.33 ~~17.44~~ * 3495 * 10^{-6}
= 1.0506 ~~1.1220~~ g

Similarly, for Phase 2, DF = 22.152 and $NMHC_{mass2}$ = 0

Similarly, for Phase 3, DF = 17.326~~32~~ and $NMHC_{mass2}$ = 0.0025~~6~~ g

4. SPECIATED HYDROCARBON MASS EMISSIONS CALCULATION

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4.4. SAMPLE CALCULATION

4.4.1 Exhaust emissions from a gasoline vehicle are collected in three dilute exhaust sample bags and one dilution air (background) sample bag during the FTP. Gas chromatography is used to determine the benzene concentration of each bag sample. Calculate the weighted benzene mass emissions based on the following data:

Test Phase	HC_e (ppbC)	HC_d (ppbC)	FID THC_e (ppmC)	CH_{4e} (ppmC)	CO_{2e} (%)	CO_{em} (ppm)	R_a (%)	VMIX (ft^3)	$D_{phase\ n}$ (mile)
1	500	25	98	6	1.20	280	28	2846	3.584
2	100	25	22	4	0.95	87	25	4854	3.842
3	120	25	29	5	1.07	101	24	2840	3.586

For Phase 1:

DF = $13.47 / [CO_{2e} + (NMHC_e + CH_{4e} + CO_e) * 10^{-4}]$
(see section 3, DF Calc.)

$NMHC_e$ = FID THC_e - (r_{CH_4} * CH_{4e})
= 98 ppmC - (1.04 * 6 ppmC)
= 92 ppmC

CO = $(1 - (0.01 + 0.005 * HCR) * CO_{2e} - 0.000323 * R_a) * CO_{em}$
NOTE: If a CO instrument which meets the criteria specified in CFR 40, 86.111 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e.
= (1 - (0.01925) * 1.2% - 0.000323 * 28%) * 280 ppm
= 271 ppm

DF = 13.47 / [1.2% + (92 ppmC + 6 ppmC + 271 ppm) * 10^{-4}]
= 10.89

HC_{conc} = HC_e - (HC_d * (1 - (1 / DF)))
= 500 ppbC - (25 ppbC * (1 - (1 / 10.89)))
= 477 ppbC

Mol. Wt. of C_6H_6 = (6 * 12.01115) + (6 * 1.00797)
= 78.11472 g/mole

HC_{dens} = (Mol. Wt. * conversion of liter to ft^3) / (Mol. Vol.)
= (78.11472 g/mole * 28.316 liter/ft^3) / 24.055 liter/mole
= 91.952 g/ft^3

$HC_{mass\ n}$ = (HC_{conc} * HC_{dens} * VMIX * 10^{-6}) / (Carbon No.)

$HC_{mass\ 1}$ = (477 ppbC * 91.952 g/ft^3 * 2846 ft^3 * 10^{-6}) / 6
= 20.8 mg

Similarly, for Phase 2: $HCe_{mass\ 2}$ = 5.7 mg and for Phase 3: $H\underline{C}{\not c}_{mass\ \underline{3}}$ = 4.2 mg

Therefore,

$$HC_{wm} = 0.43 * \left(\frac{HC_{mass1} + HC_{mass2}}{D_{phase1} + D_{phase2}} \right) + 0.57 * \left(\frac{HC_{mass3} + HC_{mass2}}{D_{phase3} + D_{phase2}} \right)$$

$$HC_{wm} = 0.43 * \left(\frac{20.8\,mg + 5.7\,mg}{3.584\text{ miles} + 3.842\text{ miles}} \right) + 0.57 * \left(\frac{4.2\,mg + 5.7\,mg}{3.586\text{ miles} + 3.842\text{ miles}} \right)$$

HC_{wm} = 2.3 mg/mile (benzene weighted mass emissions)

5. ALCOHOL MASS EMISSIONS CALCULATION

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5.4 SAMPLE CALCULATION

5.4.1 Alcohol emissions from an E85 fueled vehicle are collected in three sets of dilute exhaust impingers and one set of dilution air impingers during the FTP. Gas chromatography is used to determine the alcohol concentration in each impinger. This is the same vehicle test as the example in section 3.3. Calculate the weighted ethanol mass emissions based on the following data, along with the data presented in section 3.3:

Test Phase	$Ivol_r$ (mL)	$Iconc_{e1}$ (µg/mL)	$Iconc_{e2}$ (µg/mL)	$Ivol_{em}$ (liter)	$Iconc_{d1}$ (µg/mL)	$Iconc_{d2}$ (µg/mL)	$Ivol_{dm}$ (liter)	$Itemp_e$ (°K)	$Itemp_d$ (°K)
1	15	4.984	0.106	8.18	0	0	31.16	294.26	294.26
2	15	0	0	14.65	0	0	31.16	294.26	294.26
3	15	0	0	8.67	0	0	31.16	294.26	294.26

Test Phase	$D_{phase\ n}$ (mile)	DF	P_B (mm HG)	VMIX (ft^3~~3~~)
1	3.591	14.27	760	3495
2	3.846	22.15	760	5799
3	3.591	17.33	760	3484

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6. CARBONYL MASS EMISSIONS CALCULATIONS

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6.4. SAMPLE CALCULATION

6.4.1 Carbonyl emissions from an E85 vehicle are collected in three sets of dilute exhaust impingers and one set of dilution air impingers during the FTP. HPLC is used to determine the carbonyl mass in each impinger. This is the same vehicle test as the example in section 3.3. Calculate the weighted formaldehyde and acetaldehyde mass emissions based on the following data, along with the data presented in section 3.3:

Test Phase	$Ivol_c$ (mL~~l~~)	Formaldehyde		$Ivol_{em}$ (liter)	Acetaldehyde		$Ivol_{dm}$ (liter)	$Itemp_e$ (°K)	$Itemp_d$ (°K)
		$Iconc_{ce}$ (μg/mL)	$Iconc_{cd}$ (μg/mL)		$Iconc_{ce}$ (μg/mL)	$Iconc_{cd}$ (μg/mL)			
1	4.4	0.387	0.006	8.47	4.114	0.006	8.23	294.26	294.26
2	4.4	0.048	0.016	15.35	0.013	0.009	13.88	294.26	294.26
3	4.4	0.016	0.006	9.01	0.012	0.005	8.16	294.26	294.26

Test Phase	$D_{phase\ n}$ (mile)	DF	P_B (mm HG)	VMIX (ft^3~~3~~)
1	3.591	14.27	760	3495
2	3.846	22.15	760	5799
3	3.591	17.33	760	3484

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7 NONMHC MASS EMISIONS CALCULATION

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7.3 Sample Calculation

Continuing from the same E85 test used in the alcohol and carbonyl calculations:

Test Phase	$NMHC_{mass\ n}$ (g)	$Ethanol_{mass\ n}$ (g)	$Formaldehyde_{massn}$ (g)	$Acetaldehyde_{mass\ n}$ (g)
1	1.0506 ~~1.1220~~	0.09271	0.0197	0.212
2	0	0	0.001457	0.000165
3	0.0025~~6~~	0	0.000472	0.000329

and

$NMHC_{dens}$ = 16.33 ~~17.44~~ g/ft^3

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$$NONMHC_{mass1} = NMHC_{mass1} - NMHC_{dens} * \sum\left(\frac{ROH_{mass1}}{ROH_{dens}}\right) * r_{ROH} - NMHC_{dens} * \sum\left(\frac{RHO_{mass1}}{RHO_{dens}}\right) * r_{RHO}$$

$NONMHC_{mass1}$ = 1.0506 ~~1.1220~~ – 16.33 ~~17.44~~ g/ft^3 * (0.9271 g / 27.116 (g/ft^3)) * 0.756
– 16.33 ~~17.44~~ g/ft^3 * (0.0197 g / 35.350 (g/ft^3)) * 0
– 16.33 ~~17.44~~ g/ft^3 * (0.212 g / 25.929 (g/ft^3)) * 0.5
= 1.0506 ~~1.1220~~ – 0.4221 ~~0.4508~~ – 0 – 0.0668 ~~0.0713~~
= 0.5617 ~~0.5999~~ g

$NONMHC_{mass2}$ = 0 – 16.33 ~~17.44~~ g/ft^3 * (0 g / 27.116 (g/ft^3)) * 0.756
– 16.33 ~~17.44~~ g/ft^3 * (0.001457 g / 35.350 (g/ft^3)) * 0
– 16.33 ~~17.44~~ g/ft^3 * (0.000165 g / 25.929 (g/ft^3)) * 0.5
= 0 – 0 – 0 – 0.000052~~5~~
= 0 g

Note: Results that are less than zero are reported as zero.

$NONMHC_{mass3}$ = 0.0025~~6~~ – 16.33 ~~17.44~~ g/ft^3 * (0 g / 27.116 (g/ft^3)) * 0.756
– 16.33 ~~17.44~~ g/ft^3 * (0.000472 g / 35.350 (g/ft^3)) * 0
– 16.33 ~~17.44~~ g/ft^3 * (0.000329 g / 25.929 (g/ft^3)) * 0.5
= 0.0025~~6~~ – 0 – 0 – 0.0001~~11~~
= 0.0024~~9~~ g

8 WEIGHTED HYDROCARBON MASS EMISSIONS CALCULATION

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8.2 Sample calculation

Continuing from the previous example:

Test Phase	$NONMHC_{mass\ n}$ (g)	$Ethanol_{mass\ n}$ (g)	$Formaldehyde_{mass\ n}$ (g)	$Acetaldehyde_{mass\ n}$ (g)	Distance (mile)
1	~~0.5999~~ 0.5617	0.9271	0.019718	0.212	3.591
2	0	0	0.001457	0.000165	3.846
3	0.0024~~9~~	0	0.000472	0.000329	3.591

~~$NONMHC_{wm} = 0.43 * \left(\frac{0.5999\text{ g} + 0\text{ g}}{3.591\text{ miles} + 3.846\text{ miles}}\right) + 0.57 * \left(\frac{0.00249\text{ g} + 0\text{ g}}{3.591\text{ miles} + 3.846\text{ miles}}\right)$~~

$$NONMHC_{wm} = 0.43 * \left(\frac{0.5617\text{ g} + 0\text{ g}}{3.591\text{ miles} + 3.846\text{ miles}}\right) + 0.57 * \left(\frac{0.0024\text{ g} + 0\text{ g}}{3.591\text{ miles} + 3.846\text{ miles}}\right)$$

$NONMHC_{wm}$ = 0.03266 ~~0.03488~~ g/mile
Similarly, $Ethanol_{wm}$ = 0.05360 g/mile
Similarly, $Formaldehyde_{wm}$ = 0.00137 g/mile
Similarly, $Acetaldehyde_{wm}$ = 0.01231 g/mile

With all the above information, the weighted mass emissions of non-methane organic gas can be calculated:

$$\text{NMOG}_{\text{wm}} = \sum \text{NONMHC}_{\text{wm}} + \sum \text{ROH}_{\text{wm}} + \sum \text{RHO}_{\text{wm}}$$

$NMOG_{wm}$ = 0.03266 ~~0.03488~~ g/mile + 0.05360 g/mile + 0.00137 g/mile + 0.01231 g/mile
= 0.09994 ~~0.102~~ g/mile

APPENDIX 1

LIST OF COMPOUNDS

CAS #	COMPOUND	MIR

* * * *

Light End and Mid-Range Hydrocarbons
(Listed in approximate elution order)

* * * *

03404-61-3	3-methyl-1-hexene	~~4.56~~4.41

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