

# §86.144 Calculations; exhaust emissions

## Read Input Data

$i := 1 \dots 54$        $\text{input}_i := \text{READ}(\text{ftpinput})$

Testnumber :=  $\text{input}_1$

Numeric test identifier

Testnumber = 199701

Procedure :=  $\text{input}_2$

Procedure = 2

Numeric Test Procedure

## §86.144-94(e)

For Phase II California fueled vehicle with measured fuel composition of  $\text{C}_x\text{H}_y\text{O}_z$ :

$x := \text{input}_{49}$

$x = 1$

Carbon-to-carbon ratio as measured for the fuel used.

$y := \text{input}_{50}$

$y = 3.97$

Hydrogen-to-carbon ratio as measured for the fuel used.

$y_{\text{HC}} := y$

$y_{\text{HC}} = 3.97$

Hydrogen-to-carbon ratio as measured for the fuel used.

$y_{\text{NMHC}} := \text{input}_{52}$

$y_{\text{NMHC}} = 2.596$

Non-Methane Hydrocarbon Hydrogen-to-carbon ratio as measured for the Non-Methane Hydrocarbon components of the fuel used.

$z := \text{input}_{53}$

$z = 0$

Oxygen-to-carbon ratio as measured for the fuel used.

## FID response to methane

$r_{\text{CH4.ct}} := \text{input}_7$

$r_{\text{CH4.ct}} = 1.114$

FID response to methane.

$r_{\text{CH4.s}} := \text{input}_8$

$r_{\text{CH4.s}} = 1.114$

FID response to methane.

$r_{\text{CH4.ht}} := \text{input}_9$

$r_{\text{CH4.ht}} = 1.114$

FID response to methane.

## §86.144 Calculations; exhaust emissions

Testnumber = 199701

For the "transient" phase of the cold-start test, the analyzer concentrations were as follows:

$FIDHC_{ct.e} := input_{10}$	$FIDHC_{ct.e} = 71.917$	Concentration of hydrocarbon plus methane in dilute exhaust as measured by the FID, ppm carbon equivalent.
$NOx_{ct.e} := input_{11}$	$NOx_{ct.e} = 20.859$	Oxides of nitrogen concentration of the dilute exhaust sample as measured, in ppm.
$CO_{ct.e} := input_{12}$	$CO_{ct.e} = 120.853$	Carbon monoxide concentration of the dilute exhaust sample as measured, in ppm.
$CO2_{ct.e} := input_{13}$	$CO2_{ct.e} = 1.504$	Carbon dioxide concentration of the dilute exhaust sample as measured, in percent.
$CH4_{ct.e} := input_{14}$	$CH4_{ct.e} = 59.328$	Concentration of methane in dilute exhaust sample as measured, ppm carbon equivalent.
$FIDHC_{ct.d} := input_{15}$	$FIDHC_{ct.d} = 3.434$	Concentration of hydrocarbon plus methane in dilution air as measured by the FID, ppm carbon equivalent.
$NOx_{ct.d} := input_{16}$	$NOx_{ct.d} = 0.153$	Oxides of nitrogen concentration of the dilution air sample as measured, in ppm.
$CO_{ct.d} := input_{17}$	$CO_{ct.d} = 0$	Carbon monoxide concentration of the dilution air sample as measured, in ppm.
$CO2_{ct.d} := input_{18}$	$CO2_{ct.d} = 0.041$	Carbon dioxide concentration of the dilution air as measured, in percent.
$CH4_{ct.d} := input_{19}$	$CH4_{ct.d} = 1.52$	Concentration of methane in dilution air as measured, ppm carbon equivalent.
$D_{ct} := input_{20}$	$D_{ct} = 3.602$	The measured driving distance from the "transient" phase of the cold start test, in miles.
$V_{mix.ct} := input_{21}$	$V_{mix.ct} = 2790$	Volume of dilute exhaust collected during the transient phase of the cold-start test, in scf.
$K_{H.ct} := input_{22}$	$K_{H.ct} = 0.867$	NOx Humidity Correction Factor

## §86.144 Calculations; exhaust emissions

Testnumber = 199701

For the "stabilized" portion of the test, the analyzer concentrations were as follows:

FIDHC <sub>s,e</sub> := input <sub>23</sub>	FIDHC <sub>s,e</sub> = 20.257	Concentration of hydrocarbon plus methane in dilute exhaust as measured by the FID, ppm carbon equivalent.
NOx <sub>s,e</sub> := input <sub>24</sub>	NOx <sub>s,e</sub> = 6.869	Oxides of nitrogen concentration of the dilute exhaust sample as measured, in ppm.
CO <sub>s,e</sub> := input <sub>25</sub>	CO <sub>s,e</sub> = 16.543	Carbon monoxide concentration of the dilute exhaust sample as measured, in ppm.
CO2 <sub>s,e</sub> := input <sub>26</sub>	CO2 <sub>s,e</sub> = 0.979	Carbon dioxide concentration of the dilute exhaust sample as measured, in percent.
CH4 <sub>s,e</sub> := input <sub>27</sub>	CH4 <sub>s,e</sub> = 16.709	Concentration of methane in dilute exhaust sample as measured, ppm carbon equivalent.
FIDHC <sub>s,d</sub> := input <sub>28</sub>	FIDHC <sub>s,d</sub> = 3.21	Concentration of hydrocarbon plus methane in dilution air as measured by the FID, ppm carbon equivalent.
NOx <sub>s,d</sub> := input <sub>29</sub>	NOx <sub>s,d</sub> = 0.102	Oxides of nitrogen concentration of the dilution air sample as measured, in ppm.
CO <sub>s,d</sub> := input <sub>30</sub>	CO <sub>s,d</sub> = 0	Carbon monoxide concentration of the dilution air sample as measured, in ppm.
CO2 <sub>s,d</sub> := input <sub>31</sub>	CO2 <sub>s,d</sub> = 0.042	Carbon dioxide concentration of the dilution air as measured, in percent.
CH4 <sub>s,d</sub> := input <sub>32</sub>	CH4 <sub>s,d</sub> = 1.52	Concentration of methane in dilution air as measured, ppm carbon equivalent.
D <sub>s</sub> := input <sub>33</sub>	D <sub>s</sub> = 3.872	The measured driving distance from the "transient" phase of the cold start test, in miles.
V <sub>mix,s</sub> := input <sub>34</sub>	V <sub>mix,s</sub> = 4738	Volume of dilute exhaust collected during the transient phase of the cold-start test, in scf.
K <sub>H,s</sub> := input <sub>35</sub>	K <sub>H,s</sub> = 0.867	NOx Humidity Correction Factor

## §86.144 Calculations; exhaust emissions

Testnumber = 199701

For the "transient" portion of the hot-start test, the analyzer concentrations were as follows:

FIDHC <sub>ht.e</sub> := input <sub>36</sub>	FIDHC <sub>ht.e</sub> = 45.516	Concentration of hydrocarbon plus methane in dilute exhaust as measured by the FID, ppm carbon equivalent.
NOx <sub>ht.e</sub> := input <sub>37</sub>	NOx <sub>ht.e</sub> = 14.714	Oxides of nitrogen concentration of the dilute exhaust sample as measured, in ppm.
CO <sub>ht.e</sub> := input <sub>38</sub>	CO <sub>ht.e</sub> = 15.39	Carbon monoxide concentration of the dilute exhaust sample as measured, in ppm.
CO2 <sub>ht.e</sub> := input <sub>39</sub>	CO2 <sub>ht.e</sub> = 1.319	Carbon dioxide concentration of the dilute exhaust sample as measured, in percent.
CH4 <sub>ht.e</sub> := input <sub>40</sub>	CH4 <sub>ht.e</sub> = 39.687	Concentration of methane in dilute exhaust sample as measured, ppm carbon equivalent.
FIDHC <sub>ht.d</sub> := input <sub>41</sub>	FIDHC <sub>ht.d</sub> = 3.21	Concentration of hydrocarbon plus methane in dilution air as measured by the FID, ppm carbon equivalent.
NOx <sub>ht.d</sub> := input <sub>42</sub>	NOx <sub>ht.d</sub> = 0.102	Oxides of nitrogen concentration of the dilution air sample as measured, in ppm.
CO <sub>ht.d</sub> := input <sub>43</sub>	CO <sub>ht.d</sub> = 0	Carbon monoxide concentration of the dilution air sample as measured, in ppm.
CO2 <sub>ht.d</sub> := input <sub>44</sub>	CO2 <sub>ht.d</sub> = 0.042	Carbon dioxide concentration of the dilution air as measured, in percent.
CH4 <sub>ht.d</sub> := input <sub>45</sub>	CH4 <sub>ht.d</sub> = 1.52	Concentration of methane in dilution air as measured, ppm carbon equivalent.
D <sub>ht</sub> := input <sub>46</sub>	D <sub>ht</sub> = 3.608	The measured driving distance from the "transient" phase of the cold start test, in miles.
V <sub>mix.ht</sub> := input <sub>47</sub>	V <sub>mix.ht</sub> = 2753	Volume of dilute exhaust collected during the transient phase of the cold-start test, in scf.
K <sub>H.ht</sub> := input <sub>48</sub>	K <sub>H.ht</sub> = 0.867	NOx Humidity Correction Factor

# §86.144 Calculations; exhaust emissions

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## CONSTANTS

Density HC := 16.33	Density is grams per cubic foot, at 68iF and 760 mm Hg pressure.
Density THC := 16.33	Density is grams per cubic foot, at 68iF and 760 mm Hg pressure.
Density NMHC := 16.33	Density is grams per cubic foot, at 68iF and 760 mm Hg pressure.
Density CH4 := 18.89	Density is grams per cubic foot, at 68iF and 760 mm Hg pressure.
Density NOx := 54.16	Density is grams per cubic foot, at 68iF and 760 mm Hg pressure.
Density CO := 32.97	Density is grams per cubic foot, at 68iF and 760 mm Hg pressure.
Density CO2 := 51.81	Density is grams per cubic foot, at 68iF and 760 mm Hg pressure.

## DERIVED DENSITIES

$$\text{Density HC} := 1.1771 \cdot (12.011 + y_{\text{HC}} \cdot 1.008) \qquad \text{Density HC} = 18.849$$

$$\text{Density NMHC} := 1.1771 \cdot (12.011 + y_{\text{NMHC}} \cdot 1.008) \qquad \text{Density NMHC} = 17.218$$

## §86.144 Calculations; exhaust emissions

Testnumber = 199701

EPA and CARB - Non-methane hydrocarbon concentration of the dilute exhaust sample as measured, in ppm carbon equivalent.

$$\text{NMHC}_{\text{ct,e}} := \text{FIDHC}_{\text{ct,e}} - r_{\text{CH4.ct}} \cdot \text{CH4}_{\text{ct,e}}$$

$$\text{NMHC}_{\text{ct,e}} = 5.826$$

$$\text{NMHC}_{\text{s,e}} := \text{FIDHC}_{\text{s,e}} - r_{\text{CH4.s}} \cdot \text{CH4}_{\text{s,e}}$$

$$\text{NMHC}_{\text{s,e}} = 1.643$$

$$\text{NMHC}_{\text{ht,e}} := \text{FIDHC}_{\text{ht,e}} - r_{\text{CH4.ht}} \cdot \text{CH4}_{\text{ht,e}}$$

$$\text{NMHC}_{\text{ht,e}} = 1.305$$

EPA and CARB - Non-methane hydrocarbon concentration of the dilution air as measured, in ppm carbon equivalent.

$$\text{NMHC}_{\text{ct,d}} := \text{FIDHC}_{\text{ct,d}} - r_{\text{CH4.ct}} \cdot \text{CH4}_{\text{ct,d}}$$

$$\text{NMHC}_{\text{ct,d}} = 1.74$$

$$\text{NMHC}_{\text{s,d}} := \text{FIDHC}_{\text{s,d}} - r_{\text{CH4.s}} \cdot \text{CH4}_{\text{s,d}}$$

$$\text{NMHC}_{\text{s,d}} = 1.516$$

$$\text{NMHC}_{\text{ht,d}} := \text{FIDHC}_{\text{ht,d}} - r_{\text{CH4.ht}} \cdot \text{CH4}_{\text{ht,d}}$$

$$\text{NMHC}_{\text{ht,d}} = 1.516$$

Total hydrocarbon (non-methanol) concentration of the dilute exhaust sample as measured, ppm carbon equivalent, i.e., equivalent propane X 3.

$$\text{HC}_{\text{ct,e}} := \text{FIDHC}_{\text{ct,e}}$$

$$\text{HC}_{\text{ct,e}} = 71.917$$

$$\text{HC}_{\text{s,e}} := \text{FIDHC}_{\text{s,e}}$$

$$\text{HC}_{\text{s,e}} = 20.257$$

$$\text{HC}_{\text{ht,e}} := \text{FIDHC}_{\text{ht,e}}$$

$$\text{HC}_{\text{ht,e}} = 45.516$$

Total hydrocarbon (non-methanol) concentration of the dilution air as measured, in ppm carbon equivalent.

$$\text{HC}_{\text{ct,d}} := \text{FIDHC}_{\text{ct,d}}$$

$$\text{HC}_{\text{ct,d}} = 3.434$$

$$\text{HC}_{\text{s,d}} := \text{FIDHC}_{\text{s,d}}$$

$$\text{HC}_{\text{s,d}} = 3.21$$

$$\text{HC}_{\text{ht,d}} := \text{FIDHC}_{\text{ht,d}}$$

$$\text{HC}_{\text{ht,d}} = 3.21$$

# §86.144 Calculations; exhaust emissions

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Dilution factor for Natural Gas fueled vehicles where fuel composition is CxHyOz as measured for the fuel used.

$$DF_{ct} := \frac{100 \cdot \left[ \frac{x}{x + \frac{y}{2} + 3.76 \cdot \left[ x + \frac{y}{4} \right]} \right]}{CO2_{ct,e} + (NMHC_{ct,e} + CH4_{ct,e} + CO_{ct,e}) \cdot 10^{-4}} \quad DF_{ct} = 6.268$$

$$DF_s := \frac{100 \cdot \left[ \frac{x}{x + \frac{y}{2} + 3.76 \cdot \left[ x + \frac{y}{4} \right]} \right]}{CO2_{s,e} + (NMHC_{s,e} + CH4_{s,e} + CO_{s,e}) \cdot 10^{-4}} \quad DF_s = 9.714$$

$$DF_{ht} := \frac{100 \cdot \left[ \frac{x}{x + \frac{y}{2} + 3.76 \cdot \left[ x + \frac{y}{4} \right]} \right]}{CO2_{ht,e} + (NMHC_{ht,e} + CH4_{ht,e} + CO_{ht,e}) \cdot 10^{-4}} \quad DF_{ht} = 7.207$$

Non-methane concentration of the dilute exhaust sample corrected for background, in ppm carbon equivalent.

$$NMHC_{ct,conc} := NMHC_{ct,e} - NMHC_{ct,d} \cdot \left[ 1 - \frac{1}{DF_{ct}} \right] \quad NMHC_{ct,conc} = 4.36$$

$$NMHC_{s,conc} := NMHC_{s,e} - NMHC_{s,d} \cdot \left[ 1 - \frac{1}{DF_s} \right] \quad NMHC_{s,conc} = 0.28$$

$$NMHC_{ht,conc} := NMHC_{ht,e} - NMHC_{ht,d} \cdot \left[ 1 - \frac{1}{DF_{ht}} \right] \quad NMHC_{ht,conc} = -5.29 \cdot 10^{-4}$$

Non-methane hydrocarbon mass, in grams per test phase.

$$NMHC_{ct,mass} := \frac{V_{mix,ct} \cdot \text{Density}_{NMHC} \cdot NMHC_{ct,conc}}{10^6} \quad NMHC_{ct,mass} = 0.21$$

$$NMHC_{s,mass} := \frac{V_{mix,s} \cdot \text{Density}_{NMHC} \cdot NMHC_{s,conc}}{10^6} \quad NMHC_{s,mass} = 0.023$$

$$NMHC_{ht,mass} := \frac{V_{mix,ht} \cdot \text{Density}_{NMHC} \cdot NMHC_{ht,conc}}{10^6} \quad NMHC_{ht,mass} = 0$$

## §86.144 Calculations; exhaust emissions

Testnumber = 199701

Methane concentration of the dilute exhaust sample corrected for background, in ppm carbon equivalent.

$$\text{CH4}_{\text{ct.conc}} := \text{CH4}_{\text{ct.e}} - \text{CH4}_{\text{ct.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ct}}} \right] \quad \text{CH4}_{\text{ct.conc}} = 58.05$$

$$\text{CH4}_{\text{s.conc}} := \text{CH4}_{\text{s.e}} - \text{CH4}_{\text{s.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{s}}} \right] \quad \text{CH4}_{\text{s.conc}} = 15.34$$

$$\text{CH4}_{\text{ht.conc}} := \text{CH4}_{\text{ht.e}} - \text{CH4}_{\text{ht.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ht}}} \right] \quad \text{CH4}_{\text{ht.conc}} = 38.38$$

Methane hydrocarbon mass, in grams per test phase.

$$\text{CH4}_{\text{ct.mass}} := \frac{\text{V}_{\text{mix.ct}} \cdot \text{Density}_{\text{CH4}} \cdot \text{CH4}_{\text{ct.conc}}}{10^6} \quad \text{CH4}_{\text{ct.mass}} = 3.059$$

$$\text{CH4}_{\text{s.mass}} := \frac{\text{V}_{\text{mix.s}} \cdot \text{Density}_{\text{CH4}} \cdot \text{CH4}_{\text{s.conc}}}{10^6} \quad \text{CH4}_{\text{s.mass}} = 1.373$$

$$\text{CH4}_{\text{ht.mass}} := \frac{\text{V}_{\text{mix.ht}} \cdot \text{Density}_{\text{CH4}} \cdot \text{CH4}_{\text{ht.conc}}}{10^6} \quad \text{CH4}_{\text{ht.mass}} = 1.996$$

Hydrocarbon concentration of the dilute exhaust sample, in ppm carbon equivalent.

$$\text{HC}_{\text{ct.conc}} := \text{HC}_{\text{ct.e}} - \text{HC}_{\text{ct.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ct}}} \right] \quad \text{HC}_{\text{ct.conc}} = 69.031$$

$$\text{HC}_{\text{s.conc}} := \text{HC}_{\text{s.e}} - \text{HC}_{\text{s.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{s}}} \right] \quad \text{HC}_{\text{s.conc}} = 17.378$$

$$\text{HC}_{\text{ht.conc}} := \text{HC}_{\text{ht.e}} - \text{HC}_{\text{ht.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ht}}} \right] \quad \text{HC}_{\text{ht.conc}} = 42.752$$

Total hydrocarbon emissions, in grams per test phase.

$$\text{HC}_{\text{ct.mass}} := \frac{\text{V}_{\text{mix.ct}} \cdot \text{Density}_{\text{HC}} \cdot \text{HC}_{\text{ct.conc}}}{10^6} \quad \text{HC}_{\text{ct.mass}} = 3.63$$

$$\text{HC}_{\text{s.mass}} := \frac{\text{V}_{\text{mix.s}} \cdot \text{Density}_{\text{HC}} \cdot \text{HC}_{\text{s.conc}}}{10^6} \quad \text{HC}_{\text{s.mass}} = 1.552$$

$$\text{HC}_{\text{ht.mass}} := \frac{\text{V}_{\text{mix.ht}} \cdot \text{Density}_{\text{HC}} \cdot \text{HC}_{\text{ht.conc}}}{10^6} \quad \text{HC}_{\text{ht.mass}} = 2.218$$

## §86.144 Calculations; exhaust emissions

Testnumber = 199701

Oxides of nitrogen concentration of the dilute exhaust sample corrected for background, ppm.

$$\text{NOx}_{\text{ct.conc}} := \text{NOx}_{\text{ct.e}} - \text{NOx}_{\text{ct.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ct}}} \right]$$

$\text{NOx}_{\text{ct.conc}} = 20.73$

$$\text{NOx}_{\text{s.conc}} := \text{NOx}_{\text{s.e}} - \text{NOx}_{\text{s.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{s}}} \right]$$

$\text{NOx}_{\text{s.conc}} = 6.78$

$$\text{NOx}_{\text{ht.conc}} := \text{NOx}_{\text{ht.e}} - \text{NOx}_{\text{ht.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ht}}} \right]$$

$\text{NOx}_{\text{ht.conc}} = 14.63$

Oxides of nitrogen emissions, in grams per test phase.

$$\text{NOx}_{\text{ct.mass}} := \frac{V_{\text{mix.ct}} \cdot \text{Density}_{\text{NOx}} \cdot K_{\text{H.ct}} \cdot \text{NOx}_{\text{ct.conc}}}{10^6}$$

$\text{NOx}_{\text{ct.mass}} = 2.716$

$$\text{NOx}_{\text{s.mass}} := \frac{V_{\text{mix.s}} \cdot \text{Density}_{\text{NOx}} \cdot K_{\text{H.s}} \cdot \text{NOx}_{\text{s.conc}}}{10^6}$$

$\text{NOx}_{\text{s.mass}} = 1.508$

$$\text{NOx}_{\text{ht.mass}} := \frac{V_{\text{mix.ht}} \cdot \text{Density}_{\text{NOx}} \cdot K_{\text{H.ht}} \cdot \text{NOx}_{\text{ht.conc}}}{10^6}$$

$\text{NOx}_{\text{ht.mass}} = 1.891$

Carbon monoxide concentration of the dilute exhaust sample corrected for background, ppm.

$$\text{CO}_{\text{ct.conc}} := \text{CO}_{\text{ct.e}} - \text{CO}_{\text{ct.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ct}}} \right]$$

$\text{CO}_{\text{ct.conc}} = 120.85$

$$\text{CO}_{\text{s.conc}} := \text{CO}_{\text{s.e}} - \text{CO}_{\text{s.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{s}}} \right]$$

$\text{CO}_{\text{s.conc}} = 16.54$

$$\text{CO}_{\text{ht.conc}} := \text{CO}_{\text{ht.e}} - \text{CO}_{\text{ht.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ht}}} \right]$$

$\text{CO}_{\text{ht.conc}} = 15.39$

Carbon monoxide emissions, in grams per test phase.

$$\text{CO}_{\text{ct.mass}} := \frac{V_{\text{mix.ct}} \cdot \text{Density}_{\text{CO}} \cdot \text{CO}_{\text{ct.conc}}}{10^6}$$

$\text{CO}_{\text{ct.mass}} = 11.12$

$$\text{CO}_{\text{s.mass}} := \frac{V_{\text{mix.s}} \cdot \text{Density}_{\text{CO}} \cdot \text{CO}_{\text{s.conc}}}{10^6}$$

$\text{CO}_{\text{s.mass}} = 2.58$

$$\text{CO}_{\text{ht.mass}} := \frac{V_{\text{mix.ht}} \cdot \text{Density}_{\text{CO}} \cdot \text{CO}_{\text{ht.conc}}}{10^6}$$

$\text{CO}_{\text{ht.mass}} = 1.4$

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Carbon dioxide concentration of the dilute exhaust sample corrected for background, percent.

$$\text{CO2}_{\text{ct.conc}} := \text{CO2}_{\text{ct.e}} - \text{CO2}_{\text{ct.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ct}}} \right] \quad \text{CO2}_{\text{ct.conc}} = 1.469$$

$$\text{CO2}_{\text{s.conc}} := \text{CO2}_{\text{s.e}} - \text{CO2}_{\text{s.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{s}}} \right] \quad \text{CO2}_{\text{s.conc}} = 0.941$$

$$\text{CO2}_{\text{ht.conc}} := \text{CO2}_{\text{ht.e}} - \text{CO2}_{\text{ht.d}} \cdot \left[ 1 - \frac{1}{\text{DF}_{\text{ht}}} \right] \quad \text{CO2}_{\text{ht.conc}} = 1.282$$

Carbon dioxide emissions, in grams per test phase.

$$\text{CO2}_{\text{ct.mass}} := \frac{V_{\text{mix.ct}} \cdot \text{Density}_{\text{CO2}} \cdot \text{CO2}_{\text{ct.conc}}}{10^2} \quad \text{CO2}_{\text{ct.mass}} = 2124$$

$$\text{CO2}_{\text{s.mass}} := \frac{V_{\text{mix.s}} \cdot \text{Density}_{\text{CO2}} \cdot \text{CO2}_{\text{s.conc}}}{10^2} \quad \text{CO2}_{\text{s.mass}} = 2310$$

$$\text{CO2}_{\text{ht.mass}} := \frac{V_{\text{mix.ht}} \cdot \text{Density}_{\text{CO2}} \cdot \text{CO2}_{\text{ht.conc}}}{10^2} \quad \text{CO2}_{\text{ht.mass}} = 1829$$

## §86.144 Calculations; exhaust emissions

Testnumber = 199701

(1) For the "transient" portion of the cold start test the above calculations resulted in the following:

$HC_{ct} = HC_{ct.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$HC_{ct} = 3.63$
$CH4_{ct} = CH4_{ct.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$CH4_{ct} = 3.059$
$NMHC_{ct} = NMHC_{ct.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$NMHC_{ct} = 0.21$
$NOx_{ct} = NOx_{ct.mass}$	Oxides of nitrogen, in grams per test phase.	$NOx_{ct} = 2.716$
$CO_{ct} = CO_{ct.mass}$	Carbon monoxide, in grams per test phase.	$CO_{ct} = 11.117$
$CO2_{ct} = CO2_{ct.mass}$	Carbon dioxide in grams per test phase.	$CO2_{ct} = 2124$

(2) For the stabilized portion of the cold start test similar calculations resulted in the following:

$HC_s = HC_{s.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$HC_s = 1.552$
$CH4_s = CH4_{s.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$CH4_s = 1.373$
$NMHC_s = NMHC_{s.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$NMHC_s = 0.023$
$NOx_s = NOx_{s.mass}$	Oxides of nitrogen, in grams per test phase.	$NOx_s = 1.508$
$CO_s = CO_{s.mass}$	Carbon monoxide, in grams per test phase.	$CO_s = 2.584$
$CO2_s = CO2_{s.mass}$	Carbon dioxide in grams per test phase.	$CO2_s = 2310$

(3) For the "transient" portion of the hot start similar calculations resulted in the following:

$HC_{ht} = HC_{ht.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$HC_{ht} = 2.218$
$CH4_{ht} = CH4_{ht.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$CH4_{ht} = 1.996$
$NMHC_{ht} = NMHC_{ht.mass}$	Total hydrocarbon equivalent, in grams per test phase.	$NMHC_{ht} = 0$
$NOx_{ht} = NOx_{ht.mass}$	Oxides of nitrogen, in grams per test phase.	$NOx_{ht} = 1.891$
$CO_{ht} = CO_{ht.mass}$	Carbon monoxide, in grams per test phase.	$CO_{ht} = 1.397$
$CO2_{ht} = CO2_{ht.mass}$	Carbon dioxide in grams per test phase.	$CO2_{ht} = 1829$

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(4) Weighted emission results:

Total hydrocarbon, in grams per vehicle mile.

$$\text{HC}_{\text{wm}} := 0.43 \cdot \left[ \frac{\text{HC}_{\text{ct}} + \text{HC}_{\text{s}}}{D_{\text{ct}} + D_{\text{s}}} \right] + 0.57 \cdot \left[ \frac{\text{HC}_{\text{ht}} + \text{HC}_{\text{s}}}{D_{\text{ht}} + D_{\text{s}}} \right] \quad \text{HC}_{\text{wm}} = 0.5854$$

Methane hydrocarbon, in grams per vehicle mile.

$$\text{CH4}_{\text{wm}} := 0.43 \cdot \left[ \frac{\text{CH4}_{\text{ct}} + \text{CH4}_{\text{s}}}{D_{\text{ct}} + D_{\text{s}}} \right] + 0.57 \cdot \left[ \frac{\text{CH4}_{\text{ht}} + \text{CH4}_{\text{s}}}{D_{\text{ht}} + D_{\text{s}}} \right] \quad \text{CH4}_{\text{wm}} = 0.5118$$

Non-methane hydrocarbon, in grams per vehicle mile.

$$\text{NMHC}_{\text{wm}} := 0.43 \cdot \left[ \frac{\text{NMHC}_{\text{ct}} + \text{NMHC}_{\text{s}}}{D_{\text{ct}} + D_{\text{s}}} \right] + 0.57 \cdot \left[ \frac{\text{NMHC}_{\text{ht}} + \text{NMHC}_{\text{s}}}{D_{\text{ht}} + D_{\text{s}}} \right] \quad \text{NMHC}_{\text{wm}} = 0.0152$$

Oxides of nitrogen, in grams per vehicle mile.

$$\text{NOx}_{\text{wm}} := 0.43 \cdot \left[ \frac{\text{NOx}_{\text{ct}} + \text{NOx}_{\text{s}}}{D_{\text{ct}} + D_{\text{s}}} \right] + 0.57 \cdot \left[ \frac{\text{NOx}_{\text{ht}} + \text{NOx}_{\text{s}}}{D_{\text{ht}} + D_{\text{s}}} \right] \quad \text{NOx}_{\text{wm}} = 0.5019$$

Carbon monoxide, in grams per vehicle mile.

$$\text{CO}_{\text{wm}} := 0.43 \cdot \left[ \frac{\text{CO}_{\text{ct}} + \text{CO}_{\text{s}}}{D_{\text{ct}} + D_{\text{s}}} \right] + 0.57 \cdot \left[ \frac{\text{CO}_{\text{ht}} + \text{CO}_{\text{s}}}{D_{\text{ht}} + D_{\text{s}}} \right] \quad \text{CO}_{\text{wm}} = 1.0916$$

Carbon dioxide, in grams per vehicle mile.

$$\text{CO2}_{\text{wm}} := 0.43 \cdot \left[ \frac{\text{CO2}_{\text{ct}} + \text{CO2}_{\text{s}}}{D_{\text{ct}} + D_{\text{s}}} \right] + 0.57 \cdot \left[ \frac{\text{CO2}_{\text{ht}} + \text{CO2}_{\text{s}}}{D_{\text{ht}} + D_{\text{s}}} \right] \quad \text{CO2}_{\text{wm}} = 570.4742$$