§CFR 600.113-93(h) EPA Natural Gas Fuel Economy

Read Input Data

$i := 1 .. 62$ $input_i := READ(hwyinput)$

$Testnumber := input_1$	Testnumber = 199702	Numeric test identifier	Testnumber = 199702
$Procedure := input_2$	Procedure = 3	Numeric test procedure identifier	

§538.7 - DOT Gallon Equivalents for Gaseous Fuels

The gallon equivalent of gaseous fuels, for purposes of calculations.

$gegf_{CNG} := 0.823$		Compressed Natural Gas Gallon Equivalent Measurement
$gegf_{LNG} := 0.823$		Liquified Natural Gas Gallon Equivalent Measurement

Natural Gas Fuel Property Determination

$x := input_{49}$	x = 1	Carbon-to-carbon ratio as measured for the fuel used.
$y_{THC} := input_{50}$	y_{THC} = 3.97	Hydrogen-to-carbon ratio as measured for the fuel used.
$y_{NMHC} := input_{52}$	y_{NMHC} = 2.596	Hydrogen-to-carbon ratio as measured for the fuel used.
$z := input_{53}$	z = 0	Oxygen-to-carbon ratio as measured for the fuel used.
$CWF_{NG} := input_{54}$	CWF_{NG} = 0.72	Carbon weight fraction of the gaseous fuel
$CWF_{HCNG} := input_{55}$	CWF_{HCNG} = 0.703	Carbon weight fraction derived from the weight of carbon in HC constituents divided by the total weight of the fuel
$WF_{CO2} := input_{56}$	WF_{CO2} = 0.063	Carbon Dioxide Weight Fraction
$NHV_{B.t.u.per.lb} := input_{57}$	$NHV_{B.t.u.per.lb}$ = 20432	Net (lower) heating value of the fuel per ASTM D-3588, B.t.u. per pound
$SG_{fuel.AIR} := input_{58}$	$SG_{fuel.AIR}$ = 0.584	Specific gravity of the fue per ASTM D-3588, relative to Air.

Weighted Mass Emissions, Grams per Mile

$CH_4 := input_{59}$	CH_4 = 0	Methane, grams per mile
$NMHC := input_{60}$	NMHC = 0.158	Non-MethaneHydrocarbon, grams per mile
$CO := input_{61}$	CO = 0.198	Carbon Monoxide, grams per mile
$CO_2 := input_{62}$	CO_2 = 358	Carbon Dioxide, grams per mile

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Natural Gas Fuel Property Derivation

Testnumber = 199702

Density HC in NG, grams per cubic foot

$D_{HC} := 1.1771 \cdot (12.011 + y_{THC} \cdot 1.008)$

$D_{HC} = 18.849$

Density NMHC in NG, grams per cubic foot

$D_{NMHC} := 1.1771 \cdot (12.011 + y_{NMHC} \cdot 1.008)$

$D_{NMHC} = 17.218$

Carbon Weight Graction of the NMHC in the NG

$CWF_{NMHC} := \frac{12.011}{(y_{NMHC} \cdot 1.008 + 12.011)}$

$CWF_{NMHC} = 0.821$

Density of Natural Gas @ 60°F and 1 atm, grams per cubic foot Note: @ 68°F & 1 atm
28.316847 is liters per cu ft
1.2047 is Density Air, gr per liter

$D_{NG.1} := SG_{fuel.AIR} \cdot 28.316847 \cdot 1.2047$

$D_{NG.1} = 19.922$

Cubic feet of natural gas fuel consumed per mile.

$FC_{NG} := \frac{0.749 \cdot CH_4 + CWF_{NMHC} \cdot NMHC + 0.429 \cdot CO + 0.273 \cdot CO_2}{CWF_{NG} \cdot D_{NG.1}}$

$FC_{NG} = 6.829$

Grams of Carbon Dioxide in natural gas fuel consumed per mile of travel.

$CO_{2.NG} := FC_{NG} \cdot D_{NG.1} \cdot WF_{CO2}$

$CO_{2.NG} = 8.571$

§CFR 600.113-93(h) EPA Natural Gas Fuel economy, mile per gallon equivalent

$mpg_{e.NG} := \frac{CWF_{HCNG} \cdot D_{NG.1} \cdot 121.5}{0.749 \cdot CH_4 + CWF_{NMHC} \cdot NMHC + 0.429 \cdot CO + 0.273 \cdot (CO_2 - CO_{2.NG})}$

$mpg_{e.NG} = 17.798$

Note: $\frac{100}{gegf_{CNG}} = 121.5$ and $\frac{100}{gegf_{LNG}} = 121.5$

§CFR 600.510-93 Alternative Fuel Energy Efficiency

Net Heating Value of the Fuel, B.t.u.'s per pound

$NHV_{fuel} := NHV_{B.t.u.per.lb}$

$NHV_{fuel} = 20432$

Density of the Natural Gas Fuel, lbs per 100 cubic feet

$D_{NG.100} := 100 \cdot \left[\frac{D_{NG.1}}{453.6}\right]$

$D_{NG.100} = 4.392$

Natural Gas Fuel Economy while operated on the alternative fuel, miles per gallon

$FE_{alt} := mpg_{e.NG}$

$FE_{alt} = 17.798$

Density of the alternative fuel, pounds per gallon

$D_{alt} := D_{NG.100}$

$D_{alt} = 4.392$

Energy Efficiency while operating on alternative fuel, miles per million B.t.u.

$E_{alt} := \left[\frac{FE_{alt}}{NHV_{fuel} \cdot D_{alt}}\right] \cdot 10^6$

$E_{alt} = 198.33$