Subpart C IVT Equation Inputs Summary

This page lists the variables used in each Inputs Verifier Tool (IVT) equation in subpart C. This information is intended primarily for XML uploaders to enable them to understand how each IVT equation is calculated and to identify sources for the constants, default values, and lookup values needed to solve the equations.

Click the links for the equations below to view the variables used in the IVT calculations:

Equation C-1: Annual CO_2 Mass Emissions for the Specific Fuel Type for Tier 1

Equation C-1 calculates annual CO2 mass emissions for the specific fuel type for Tier 1

$$CO_2 = 1 \times 10^{-3} * Fuel * HHV * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CO_2	Annual CO_2 mass emissions for the specific fuel type	metric tons	Output
Fuel	Mass or volume of fuel combusted per year, from company records as defined in §98.6	short tons for solid fuel volume in standard cubic feet for gaseous fuel volume in gallons for liquid fuel	User input
HHV	Default high heat value of the fuel, from Table C-1 of this subpart	mmBtu per mass or mmBtu per volume, as applicable	Table C-1
EF	Fuel-specific default CO_2 emission factor, from Table C-1 of this subpart	kg CO_2/mmBtu	Table C-1
1×10^3	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-1a: Annual CO_2 Mass Emissions from Natural Gas Combustion for Tier 1 - Therms

Equation C-1a calculates annual CO_2 mass emissions from natural gas combustion when natural gas consumption in billing records is expressed in therms.

$$CO_2 = 1 x 10^{-3} [0.1 * Gas * EF]$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CO_2	Annual CO_2 mass emissions from natural gas combustion	metric tons	Output
Gas	Annual natural gas usage, from billing records	therms	User input
EF	Fuel-specific default CO_2 emission factor for natural gas, from Table C-1 of this subpart	kg CO_2/mmBtu	Table C-1
0.1	Conversion factor from therms to mmBtu	mmBtu/therm	0.1
1×10^3	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-1b: Annual CO_2 Mass Emissions from Natural Gas Combustion for Tier 1 - mmBtu

Equation C-1b calculates annual CO_2 mass emissions from natural gas combustion when natural gas consumption in billing records is expressed in mmBtu.

$$CO_2 = 1 \times 10^{-3} * Gas * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CO_2	Annual CO_2 mass emissions from natural gas combustion	metric tons	Output
Gas	Annual natural gas usage, from billing records	mmBtu	User input
EF	Fuel-specific default CO_2 emission factor for natural gas, from Table C-1 of this subpart	kg CO_2/mmBtu	Table C-1
1×10^3	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-2a: Annual CO_2 mass emissions for a specific fuel type for Tier 2

Equation C-2a calculates annual CO_2 mass emissions for a specific fuel type for Tier 2.

$$CO_2 = 1 x 10^{-3} * Fuel * HHV * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CO_2	Annual CO_2 mass emissions for a specific fuel type	metric tons	Output
Fuel	Mass or volume of the fuel combusted during the year, from company records as defined in §98.6	short tons for solid fuel volume in standard cubic feet for gaseous fuel volume in gallons for liquid fuel	User input
HHV	Annual average high heat value of the fuel	mmBtu per mass or volume. The average HHV shall be calculated according to the requirements of paragraph (a)(2)(ii) of this section	User input

EF	Fuel-specific default CO_2 emission factor, from Table C-1 of this subpart	kg CO_2/mmBtu	Table C-1
1 × 103	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-2b: Weighted Annual Average High Heat Value of the Fuel

Equation C-2b calculates the weighted annual average high heat value of the fuel.

$$(HHV)_{annual} = \frac{\sum_{i=1}^{n} (HHV)_i * (Fuel)_i}{\sum_{i=1}^{n} (Fuel)_i}$$

The table below defines the parameters in this equation. Equation C-2b does not include constants, default values, or lookup values.

Parameter	Description	Units of Measure	Value or Source
$(HHV)_{annual}$	Weighted annual average high heat value of the fuel	mmBtu per mass or volume	Output
$(HHV)_I$	Measured high heat value of the fuel, for month "i" (which may be the arithmetic average of multiple determinations), or, if applicable, an appropriate substitute data value	mmBtu per mass or volume	User input
$(Fuel)_I$	Mass or volume of the fuel combusted during month "i," from company records	short tons for solid fuel volume in standard cubic feet for gaseous fuel volume in gallons for liquid fuel	User input
n	Number of months in the year that the fuel is burned in the unit	-	1-12

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Equation C-2c: Annual CO2 Mass Emissions from MSW or Solid Fuel Combustion

Equation C-2c calculates annual CO_2 mass emissions from MSW or solid fuel combustion.

$$CO_2 = 1 \times 10^{-3} * Steam * B * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CO_2	Annual CO_2 mass emissions from MSW or solid fuel combustion	metric tons	Output
Steam	Total mass of steam generated by MSW or solid fuel combustion during the reporting year	lb steam	User input
B	Ratio of the boiler's maximum rated heat input capacity to its design rated steam output capacity	mmBtu/lb steam	User input
EF	Fuel-specific default CO_2 emission factor, from Table C-1 of this subpart	kg CO_2/mmBtu	Table C-1
1 × 103	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-3: Annual CO_2 Mass Emissions from the Combustion of the Specific Solid Fuel for Tier 3

Equation C-3 calculates annual CO_2 mass emissions from the combustion of the specific solid fuel.

$$CO_2 = \frac{44}{12} * Fuel * CC * 0.91$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CO_2	Annual CO_2 mass emissions from the combustion of the specific solid fuel	metric tons	Output
Fuel	Annual mass of the solid fuel combusted, from company records as defined in §98.6	short tons	User input
CC	Annual average carbon content of the solid fuel	percent by weight, expressed as a decimal fraction, e.g., 95% = 0.95	User input
44/12	Ratio of molecular weights, CO_2 to carbon	-	44/12
0.91	Conversion factor from short tons to metric tons	-	0.91

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Equation C-4: Annual CO_2 Mass Emissions from the Combustion of the Specific Liquid Fuel for Tier 3

Equation C-4 calculates annual CO_2 mass emissions from the combustion of the specific liquid fuel.

$$CO_2 = \frac{44}{12} * Fuel * CC * 0.001$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CO_2	Annual CO_2 mass emissions from the combustion of the specific liquid fuel	metric tons	Output
Fuel	Annual volume of the liquid fuel combusted	gallons	User input
CC	Annual average carbon content of the liquid fuel	kg C per gallon of fuel	User input
44/12	Ratio of molecular weights, CO_2 to carbon	-	44/12
0.001	Conversion factor from kg to metric tons	-	0.001

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Equation C-5: Annual CO_2 Mass Emissions from the Combustion of the Specific Gaseous Fuel for Tier 3

Equation C-5 calculates annual CO_2 mass emissions from combustion of the specific gaseous fuel.

$$CO_2 = \frac{44}{12} * Fuel * CC * \frac{MW}{MVC} * 0.001$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CO_2	Annual CO_2 mass emissions from combustion of the specific gaseous fuel	metric tons	Output
Fuel	Annual volume of the gaseous fuel combusted	scf	User input
CC	Annual average carbon content of the gaseous fuel	kg C per kg of fuel	User input
MW	Annual average molecular weight of the gaseous fuel	kg/kg-mole	User input
MVC	Molar volume conversion factor at standard conditions, as defined in §98.6	scf per kg mole	849.5 @ 68°F, or 836.6 @ 60 °F
44/12	Ratio of molecular weights, CO_2 to carbon	-	44/12
0.001	Conversion factor from kg to metric tons	-	0.001

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Equation C-8: Annual CH_4 or N_2O Emissions from the Combustion of a Particular Type of Fuel for which Tier 1 or Tier 3 Is Used to Calculate CO_2 Emissions

Equation C-8 calculates annual CH_4 or N_2O emissions from the combustion of a particular type of fuel for which Tier 1 or Tier 3 Is Used to Calculate CO_2 Emissions

$$CH_4 \text{ or } N_2O = 1 x 10^{-3} * Fuel * HHV * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CH_4 or N_2O	Annual CH_4 or N_2O emissions from the combustion of a particular type of fuel	metric tons	Output
Fuel	Mass or volume of the fuel combusted, either from company records or directly measured by a fuel flow meter, as applicable	mass or volume per year	User Input
HHV	Default high heat value of the fuel from Table C-1 of this subpart; alternatively, for Tier 3, if actual HHV data are available for the reporting year, you may average these data using the procedures specified in paragraph (a)(2)(ii) of this section, and use the average value in Equation C-8	mmBtu per mass or volume	Table C-1 or calculated per §98.33(a)(2)(ii)
EF	Fuel-specific default emission factor for CH_4 or N_2O, from Table C-2 of this subpart	kg CH_4 or N_2O per mmBtu	Table C-2
1×10^3	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-8a: Annual CH_4 or N_2O Emissions from the Combustion of Natural Gas - Therms

Equation C-8a calculates the annual CH_4 or N_2O emissions from the combustion of natural gas when natural gas consumption in billing records is expressed in therms.

$$CH_4 \text{ or } N_2O = 1 x 10^{-3} * Fuel * 0.1 * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CH_4 or N_2O	Annual CH_4 or N_2O emissions from the combustion of natural gas	metric tons	Output
Fuel	Annual natural gas usage, from gas billing records	therms	User input
EF	Fuel-specific default emission factor for CH_4 or N_2O, from Table C-2 of this subpart	kg CH_4 or N_2O per mmBtu	Table C-2
0.1	Conversion factor from therms to mmBtu	-	0.1
1×10^3	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-8b: Annual CH_4 or N_2O Emissions from the Combustion of Natural Gas - mmBtu

Equation C-8b calculates the annual CH_4 or N_2O emissions from the combustion of natural gas when natural gas consumption in billing records is expressed in mmBtu.

$$CH_4 \text{ or } N_2O = 1 \times 10^{-3} * Fuel * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CH_4 or N_2O	Annual CH_4 or N_2O emissions from the combustion of natural gas	metric tons	Output
Fuel	Annual natural gas usage, from gas billing records	mmBtu	User input
EF	Fuel-specific default emission factor for CH_4 or N_2O, from Table C-2 of this subpart	kg CH_4 or N_2O per mmBtu	Table C-2
1×10^3	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-9a: Annual CH_4 or N_2O Emissions from the Combustion of a Particular Type of Fuel for which Tier 2 Is Used to Calculate CO_2 Emissions

Equation C-9a calculates annual CH_4 or N_2O emissions from the combustion of a particular type of fuel for which Tier 2 is used to calculate CO_2 emissions.

$$CH_4 \text{ or } N_2O = 1 \times 10^{-3} * HHV * EF * Fuel$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CH_4 or N_2O	Annual CH_4 or N_2O emissions from the combustion of a particular type of fuel	metric tons	Output
Fuel	Mass or volume of the fuel combusted during the reporting year	short tons for solid fuel volume in standard cubic feet for gaseous fuel volume in gallons for liquid fuel	User input
HHV	High heat value of the fuel, averaged for all valid measurements for the reporting year	mmBtu per mass or volume	User input
EF	Fuel-specific default emission factor for CH_4 or N_2O, from Table C-2 of this subpart	kg CH_4 or N_2O per mmBtu	Table C-2
1×10^3	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-9b: Annual CH_4 or N_2O emissions from the combustion of a solid fuel for which Equation C-2b Is Used to Calculate CO_2 Emissions

Equation C-9b calculates annual CH_4 or N_2O emissions from the combustion of a solid fuel for which Equation C-2b Is Used to Calculate CO_2 Emissions.

$$CH_4 \text{ or } N_2O = 1 \times 10^{-3} * Steam * B * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CH_4 or N_2O	Annual CH_4 or N_2O emissions from the combustion of a solid fuel	metric tons	Output
Steam	Total mass of steam generated by solid fuel combustion during the reporting year	lb steam	User input
B	Ratio of the boiler's maximum rated heat input capacity to its design rated steam output	mmBtu/lb steam	User input
EF	Fuel-specific emission factor for CH_4 or N_2O, from Table C-2 of this subpart	kg CH_4 or N_2O per mmBtu	Table C-2
1 × 103	Conversion factor from kilograms to metric tons	-	0.001

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Equation C-10: Annual CH_4 or N_2O Emissions from the Combustion of a Particular Type of Fuel for which Tier 4 Is Used to Calculate CO_2 Emissions

Equation C-10 calculates annual CH_4 or N_2O emissions from the combustion of a particular type of fuel for which Tier 4 is used to calculate CO_2 emissions.

$$CH_4 \text{ or } N_2O = 0.001 * (HI)_A * EF$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source
CH_4 or N_2O	Annual CH_4 or N_2O emissions from the combustion of a particular type of fuel	metric tons	
$(HI)_A$	Cumulative annual heat input from combustion of the fuel	mmBtu	
EF	Fuel-specific emission factor for CH_4 or N_2O, from Table C-2 of this section	kg CH_4 or N_2O per mmBtu)	
0.001	Conversion factor from kg to metric tons	-	

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Equation C-13: Annual Volume of CO_2 Emitted from Combustion of a Particular Fossil Fuel

Equation C-13 calculates annual volume of CO_2 emitted from combustion of a particular fossil fuel.

$$V_{ff} = \frac{Fuel * F_c * HHV}{10^6}$$

The table below defines the parameters in this equation and provides the values or sources of any constants, default values, and lookup values.

Parameter	Description	Units of Measure	Value or Source

V_{ff}	Annual volume of CO_2 emitted from combustion of a particular fossil fuel	scf	Output
Fuel	Total quantity of the fossil fuel combusted in the reporting year, from company records, as defined in §98.6	lb for solid fuel gallons for liquid fuel scf for gaseous fuel	User input
F_c	Fuel-specific carbon based F-factor, either a default value from Table 1 in section 3.3.5 of appendix F to 40 CFR part 75, or a site-specific value determined under section 3.3.6 of appendix F to 40 CFR part 75	scf CO_2/mmBtu	Table 1 in Appendix F in 40 CFR 75 or Section 3.3.6 of Appendix F to 40 CFR 75
HHV	Annual average high heat value of the fossil fuel, from fuel sampling and analysis (Sampled as specified (e.g., monthly, quarterly, semi-annually, or by lot in §98.34(a)(2). The average HHV shall be calculated according to the requirements of paragraph (a)(2)(ii) of this section.)	Btu/lb for solid fuel Btu/gal for liquid fuel Btu/scf for gaseous fuel	User input
10^6	Conversion factor, Btu per mmBtu	-	1000000

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