# 40 C.F.R. § 98.253

## Calculating GHG emissions.

(a) Calculate GHG emissions required to be reported in § 98.252(b) through (i) using the applicable methods in paragraphs (b) through (n) of this section.

(b) For flares, calculate GHG emissions according to the requirements in paragraphs (b)(1) through (3) of this section. All gas discharged through the flare stack must be included in the flare GHG emissions calculations with the exception of gas used for the flare pilots, which may be excluded.

(1) Calculate the $CO_2$ emissions according to the applicable requirements in paragraphs (b)(1)(i) through (b)(1)(iii) of this section.

(i) *Flow measurement.* If you have a continuous flow monitor on the flare, you must use the measured flow rates when the monitor is operational and the flow rate is within the calibrated range of the measurement device to calculate the flare gas flow. If you do not have a continuous flow monitor on the flare and for periods when the monitor is not operational or the flow rate is outside the calibrated range of the measurement device, you must use engineering calculations, company records, or similar estimates of volumetric flare gas flow.

(ii) *Heat value or carbon content measurement.* If you have a continuous higher heating value monitor or gas composition monitor on the flare or if you monitor these parameters at least weekly, you must use the measured heat value or carbon content value in calculating the $CO_2$ emissions from the flare using the applicable methods in paragraphs (b)(1)(ii)(A) and (b)(1)(ii)(B).

(A) If you monitor gas composition, calculate the $CO_2$ emissions from the flare using either Equation Y-1a or Equation Y-1b of this section. If daily or more frequent measurement data are available, you must use daily values when using Equation Y-1a or Equation Y-1b of this section; otherwise, use weekly values.

$$CO_2 = 0.98 \times 0.001 \times \left( \sum_{p=1}^{n} \left[ \frac{44}{12} \times (Flare)_p \times \frac{(MW)_p}{MVC} \times (CC)_p \right] \right) \qquad (Eq.Y-1a)$$

where:

$CO_2$ = Annual $CO_2$ emissions for a specific fuel type (metric tons/year). 0.98 = Assumed combustion efficiency of a flare. 0.001 = Unit conversion factor (metric tons per kilogram, mt/kg). n = Number of measurement periods. The minimum value for n is 52 (for weekly measurements); the maximum value for n is 366 (for daily measurements during a leap year). p = Measurement period index. 44 = Molecular weight of $CO_2$ (kg/kg-mole). 12 = Atomic weight of C (kg/kg-mole). $(Flare)_p$ = Volume of flare gas combusted during measurement period (standard cubic feet per period, scf/period). If a mass flow meter is used, measure flare gas flow rate in kg/period and replace the term "$(MW)_p/MVC$" with "1". $(MW)_p$ = Average molecular weight of the flare gas combusted during measurement period (kg/kg-mole). If measurements are taken more frequently than daily, use the

arithmetic average of measurement values within the day to calculate a daily average. MVC = Molar volume conversion factor (849.5 scf/kg-mole at 68 °F and 14.7 pounds per square inch absolute (psia) or 836.6 scf/kg-mole at 60 °F and 14.7 psia). $(CC)_p$ = Average carbon content of the flare gas combusted during measurement period (kg C per kg flare gas). If measurements are taken more frequently than daily, use the arithmetic average of measurement values within the day to calculate a daily average.

$$CO_2 = \sum_{p=1}^{n}\left[(Flare)_p \times \frac{44}{MVC} \times 0.001 \times \left(\frac{(\%CO_2)_p}{100\%} + \sum_{x=1}^{y}\left\{0.98 \times \frac{(\%C_x)_p}{100\%} \times CMN_x\right\}\right)\right]$$

(Eq.Y-1b)

where:

$CO_2$ = Annual $CO_2$ emissions for a specific fuel type (metric tons/year). n = Number of measurement periods. The minimum value for n is 52 (for weekly measurements); the maximum value for n is 366 (for daily measurements during a leap year). p = Measurement period index. $(Flare)_p$ = Volume of flare gas combusted during measurement period (standard cubic feet per period, scf/period). If a mass flow meter is used, you must determine the average molecular weight of the flare gas during the measurement period and convert the mass flow to a volumetric flow. 44 = Molecular weight of $CO_2$ (kg/kg-mole). MVC = Molar volume conversion factor (849.5 scf/kg-mole at 68 °F and 14.7 psia or 836.6 scf/kg-mole at 60 °F and 14.7 psia). 0.001 = Unit conversion factor (metric tons per kilogram, mt/kg). $(\%CO_2)_p$ = Mole percent $CO_2$ concentration in the flare gas stream during the measurement period (mole percent = percent by volume). y = Number of carbon-containing compounds other than $CO_2$ in the flare gas stream. x = Index for carbon-containing compounds other than $CO_2$. 0.98 = Assumed combustion efficiency of a flare (mole $CO_2$ per mole carbon). $(\%C_X)_p$ = Mole percent concentration of compound "x" in the flare gas stream during the measurement period (mole percent = percent by volume) $CMN_X$ = Carbon mole number of compound "x" in the flare gas stream (mole carbon atoms per mole compound). E.g., CMN for ethane ($C_2H_6$) is 2; CMN for propane ($C_3H_8$) is 3.

(B) If you monitor heat content but do not monitor gas composition, calculate the $CO_2$ emissions from the flare using Equation Y-2 of this section. If daily or more frequent measurement data are available, you must use daily values when using Equation Y-2 of this section; otherwise, use weekly values.

$$CO_2 = 0.98 \times 0.001 \times \sum_{p=1}^{n}\left[(Flare)_p \times (HHV)_p \times EmF\right]$$

(Eq. Y-2)

Where:

$CO_2$ = Annual $CO_2$ emissions for a specific fuel type (metric tons/year). 0.98 = Assumed combustion efficiency of a flare. 0.001 = Unit conversion factor (metric tons per kilogram, mt/kg). n = Number of measurement periods. The minimum value for n is 52 (for weekly measurements); the maximum value for n is 366 (for daily measurements during a leap year). p = Measurement period index. $(Flare)_p$ = Volume of flare gas combusted during measurement period (million (MM) scf/period). If a mass flow meter is used, you must also measure molecular weight and convert the mass flow to a volumetric flow as follows: Flare[MMscf] = 0.000001 × Flare[kg] × MVC/$(MW)_p$, where MVC is the molar volume conversion factor [849.5 scf/kg-mole at 68 °F and 14.7 psia or 836.6 scf/kg-mole at 60 °F and 14.7 psia depending on the standard conditions used when determining $(HHV)_p$] and $(MW)_p$ is the average molecular weight of the flare gas combusted during measurement period (kg/kg-mole). $(HHV)_p$ = Higher heating value for the flare gas combusted during measurement period (British thermal

units per scf, Btu/scf = MMBtu/MMscf). If measurements are taken more frequently than daily, use the arithmetic average of measurement values within the day to calculate a daily average. EmF = Default $CO_2$ emission factor of 60 kilograms $CO_2$/MMBtu (HHV basis).

(iii) *Alternative to heat value or carbon content measurements.* If you do not measure the higher heating value or carbon content of the flare gas at least weekly, determine the quantity of gas discharged to the flare separately for periods of routine flare operation and for periods of start-up, shutdown, or malfunction, and calculate the $CO_2$ emissions as specified in paragraphs (b)(1)(iii)(A) through (b)(1)(iii)(C) of this section.

(A) For periods of start-up, shutdown, or malfunction, use engineering calculations and process knowledge to estimate the carbon content of the flared gas for each start-up, shutdown, or malfunction event exceeding 500,000 scf/day.

(B) For periods of normal operation, use the average higher heating value measured for the fuel gas used as flare sweep or purge gas for the higher heating value of the flare gas. If higher heating value of the fuel gas is not measured, the higher heating value of the flare gas under normal operations may be estimated from historic data or engineering calculations.

(C) Calculate the $CO_2$ emissions using Equation Y-3 of this section.

$$CO_2 = 0.98 \times 0.001 \times \left( Flare_{Norm} \times HHV \times EmF + \sum_{p=1}^{n} \left[ \frac{44}{12} \times (Flare_{SSM})_p \times \frac{(MW)_p}{MVC} \times (CC)_p \right] \right) \quad \text{(Eq. Y-3)}$$

Where:

$CO_2$ = Annual $CO_2$ emissions for a specific fuel type (metric tons/year). 0.98 = Assumed combustion efficiency of a flare. 0.001 = Unit conversion factor (metric tons per kilogram, mt/kg). $Flare_{Norm}$ = Annual volume of flare gas combusted during normal operations from company records, (million (MM) standard cubic feet per year, MMscf/year). HHV = Higher heating value for fuel gas or flare gas from company records (British thermal units per scf, Btu/scf = MMBtu/MMscf). EmF = Default $CO_2$ emission factor for flare gas of 60 kilograms $CO_2$/MMBtu (HHV basis). n = Number of start-up, shutdown, and malfunction events during the reporting year exceeding 500,000 scf/day. p = Start-up, shutdown, and malfunction event index. 44 = Molecular weight of $CO_2$ (kg/kg-mole). 12 = Atomic weight of C (kg/kg-mole). $(Flare_{SSM})_p$ = Volume of flare gas combusted during indexed start-up, shutdown, or malfunction event from engineering calculations, (scf/event). $(MW)_p$ = Average molecular weight of the flare gas, from the analysis results or engineering calculations for the event (kg/kg-mole). MVC = Molar volume conversion factor (849.5 scf/kg-mole at 68 °F and 14.7 psia or 836.6 scf/kg-mole at 60 °F and 14.7 psia). $(CC)_p$ = Average carbon content of the flare gas, from analysis results or engineering calculations for the event (kg C per kg flare gas).

(2) Calculate $CH_4$ using Equation Y-4 of this section.

$$CH_4 = \left( CO_2 \times \frac{EmF_{CH4}}{EmF} \right) + CO_2 \times \frac{0.02}{0.98} \times \frac{16}{44} \times f_{CH4} \quad \text{(Eq. Y-4)}$$

Where:

$CH_4$ = Annual methane emissions from flared gas (metric tons $CH_4$/year). $CO_2$ = Emission rate of $CO_2$ from flared

gas calculated in paragraph (b)(1) of this section (metric tons/year). $EmF_{CH4}$ = Default $CH_4$ emission factor for "Fuel Gas" from Table C–2 of subpart C of this part (General Stationary Fuel Combustion Sources) (kg $CH_4$/MMBtu). EmF = Default $CO_2$ emission factor for flare gas of 60 kg $CO_2$/MMBtu (HHV basis). 0.02/0.98 = Correction factor for flare combustion efficiency. 16/44 = Correction factor ratio of the molecular weight of $CH_4$ to $CO_2$. $f_{CH4}$ = Weight fraction of carbon in the flare gas prior to combustion that is contributed by methane from measurement values or engineering calculations (kg C in methane in flare gas/kg C in flare gas); default is 0.4.