Process Name: Gathering and boosting flaring

Reference Flow: 1 kg of natural gas

Brief Description: Flaring of natural gas at natural gas gathering sites

Section I: Meta Data

Geographical Coverage: United States **Region:** 14 U.S. production regions

Year Data Best Represents: 2016

Process Type: Extraction Process (EP)

Process Scope: Cradle-to-Gate Process (CG)

Allocation Applied: No

Completeness: All Relevant Flows Captured

Flows Aggregated in Data Set:

☒ Process ☐ Energy Use ☐ Energy P&D ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☐ Greenhouse Gases	☐ Criteria Air Pollutants	☐ Other
Releases to Water:	☐ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

2_FLARE_CH4

[tonnes] Mass of CH_4 emitted by gathering and boosting flaring

2_NG_sent

[Mcf] Natural gas resource input, including what ends up as marketed produced and what is combusted by flaring

Tracked Input Flows:

Natural Gas [intermediate flow]

Natural gas resource input, including what ends up as marketed product and what is combusted and venting by flaring at gathering and boosting.

*Tr***acked Output Flows:**

Natural Gas [intermediate flow]

Reference flow

Flare [to venting and flaring]

Natural gas flared per unit of natural gas gathered and boosted

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_NG_GandB Flaring_2018.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with the flaring of natural gas at natural gas gathering and boosting facilities.

Boundary and Description

This unit process provides a summary of relevant input and output flows associated with the flaring of natural gas at natural gas gathering and boosting facilities. The reference flow of this unit process is 1 kg of natural gas.

Flaring is an environmental control measure. At natural gas gathering and boosting facilities, flaring is used to combust methane and other natural gas components that cannot be sent to the natural gas product stream.

Figure 1 shows input and output flows of the unit process. The reference flow is 1 kg of gathered and boosted natural gas.

Figure 1: Unit Process Scope and Boundary

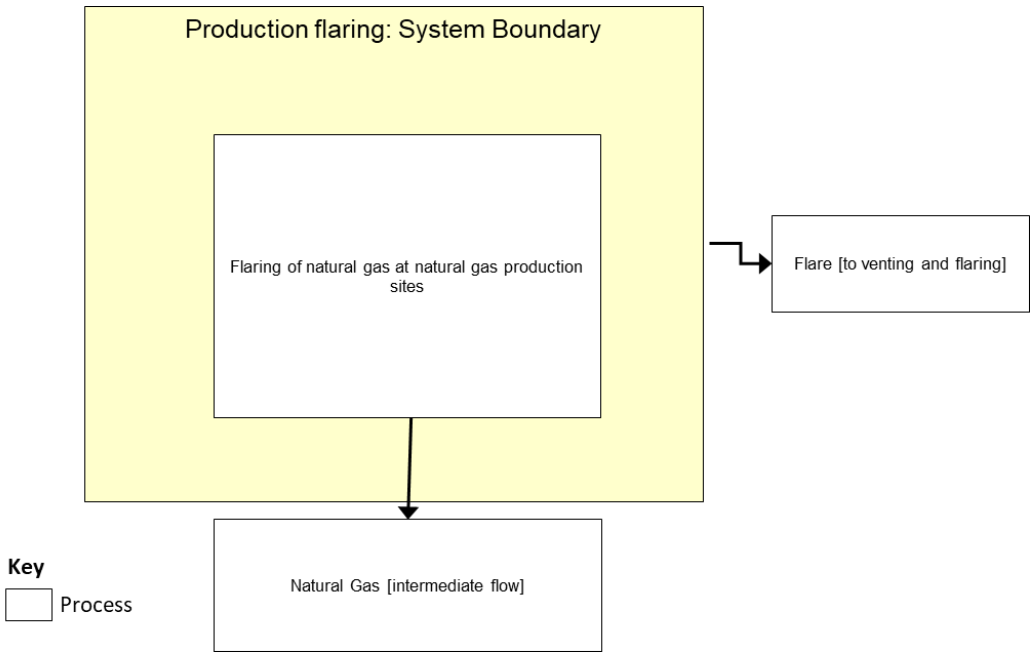

Table 1 shows the input parameters, which include the mass of CH4 emitted by flaring and volume of natural gas gathered and boosted. The mass of CH_4 emitted by gathering and boosting flaring is based on data reported by the Greenhouse Gas Reporting Program (EPA, 2018). These data were stratified by NETL into 14 onshore production basins based on basin data from DI Desktop (DI Desktop, 2018). The variability in the flaring data accounts for the 95 percent confidence interval in the mean flaring emission rate of CH_4, which was obtained by statistical bootstrapping (which simulates the production-weighted average in the flaring volumes). The volume of natural gas flared was calculated by dividing the CH_4 emission rate by 98 percent (the destruction efficiency of flaring equipment) and then converting to a volume basis using a natural gas density of 0.042 pounds (lb) per standard cubic foot (scf). The annual production rates for natural gas wells are based on data from DI Desktop, which are also stratified by basin and extraction technology (DI Desktop, 2018).

Table 1 shows parameters for the Appalachian Shale production scenario; the DS file holds data for Appalachian Shale production as well as 26 other onshore production scenarios. The full scenario list is as follows:

- Quantity of natural gas flared at natural gas gathering and boosting facilities in Appalachia - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Gulf - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Gulf - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Gulf - Tight
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Arkla - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Arkla - Shale

- Quantity of natural gas flared at natural gas gathering and boosting facilities in Arkla - Tight
- Quantity of natural gas flared at natural gas gathering and boosting facilities in East Texas - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in East Texas - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in East Texas - Tight
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Arkoma - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Arkoma - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in South Oklahoma - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Anadarko - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Anadarko - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Anadarko - Tight
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Strawn - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Fort Worth - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Permian - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Permian - Shale
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Green River - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Green River - Tight
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Uinta - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Uinta - Tight
- Quantity of natural gas flared at natural gas gathering and boosting facilities in San Juan - CBM
- Quantity of natural gas flared at natural gas gathering and boosting facilities in San Juan - Conventional
- Quantity of natural gas flared at natural gas gathering and boosting facilities in Piceance – Tight

Table 2 shows the values for natural gas resource inputs and flaring ouput for Appalachian gathering and boosting scenario. The DS File can compute the output for all 27 onshore scenarios. The input flow of natural gas product accounts for the total amount of natural gas production from production sites that exits to gathering and boosting as a product natural gas (the reference flow of 1 kg) and

the flared natural gas; this allows the model to account for the total amount of natural gas produced per unit of natural gas gathered and boosted. The flared output ("Flare [to venting and flaring]") shows the quantity of natural gas sent to a separate instance of NETL's "venting and flaring" unit processes wherein combustion chemistry and flaring effectiveness are used to convert the whole natural gas stream into speciated hydrocarbons and other components that are emitted to the atmosphere.

Table 1: Input Parameters

Parameter	Expected Value	Low	High	Units	Description
Flaring activity					
2_FLARE_CH4	3.71E+01	1.90E+01	5.51E+01	tonnes	Mass of CH4 emitted by gathering and boosting flaring
Natural gas production rates					
2_NG_sent	9.13E+08	6.27E+08	1.23E+09	Mcf	Volume of natural gas gathered and boosted

Table 2: Unit Process Input and Output Flows

Flow Name	Expected Value	Minimum	Maximum	Units (Per Reference Flow)
Inputs				
Natural gas [intermediate flow]	1.000107E+00	1.000079E+00	1.000118E+00	kg NG
Outputs				
Natural Gas [intermediate flow]	1	1	1	kg NG
Flare [to venting and flaring]	1.067E-04	7.944E-05	1.176E-04	kg NG

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Note: Inventory items not included are assumed to be zero based on best engineering judgment or assumed to be zero because no data was available to categorize them for this unit process at the time of its creation.

Embedded Unit Processes

None.

References

EPA. 2016. Greenhouse Gas Reporting Program. Environmental Protection Agency. https://www.epa.gov/enviro/greenhouse-gas-customized-search. Accessed August 22, 2018

DrillingInfo. 2018. DI Data & Insights.

Section III: Document Control Information

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