NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Storage Venting

Reference Flow: 1 kg of natural gas

Brief Description: Venting of natural gas from natural gas storage operations

Section I: Meta Data

Geographical Coverage: United States **Region:** United States

Year Data Best Represents: 2016

Process Type: Basic Process (BP)

Process Scope: Gate-to-Gate Process (GG)

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:

5_PDhb_hrs

[hours] operating hours for high bleed devices

5_PDhb_count

[count] number of high bleed devices

5_PDhb_EF

[scf/hr-device] emission factor for high bleed devices

5_PDib_hrs

[hours] operating hours for intermittent bleed devices

5_PDib_count

[count] number of intermittent bleed devices

5_PDib_EF

[scf/hr-device] emission factor for intermittent bleed devices

5_PDlb_hrs

[hours] operating hours for low bleed devices

5_PDlb_count

[count] number of low bleed devices

5_PDlb_EF

[scf/hr-device] emission factor for low bleed devices

5_DEHY_EF

[kg CH4/MMcf dehydrated] emission factor for dehydrator venting

5_DEHY_AF

[MMcf dehydrated] activity factor for dehydrator venting

5_STATION_EF

[kg/station] emission factor for storage station venting

5_STATION_AF

[stations] activity factor for storage station venting

5_storcap_v

[Mcf] Annual production, volume

5_storcap_m

[kg] Annual production, mass

5_vCH4

[fraction] volume fraction of CH4

5_HBkgCH4_EF

[kg/hr-device] mass emission factor for high bleed device

5_IBkgCH4_EF

[kg/hr-device] mass emission factor for intermittent bleed device

5_LBkgCH4_EF

[kg/hr-device] mass emission factor for low bleed device

nat_mCH4

[dimensionless] Mass fraction of CH4 in natural gas.

Vent_PDhb

[kg NG/kg NG] Venting of NG from high bleed pneumatic devices per unit of natural gas stored

Vent_PDib

[kg NG/kg NG] Venting of NG from intermittent bleed pneumatic devices per unit of natural gas stored

Vent_PDlb

[kg NG/kg NG] Venting of NG from low bleed pneumatic devices per unit of natural gas stored

Vent_DEHY

[kg NG/kg NG] Venting of NG from dehydrators blowdowns per unit of natural gas stored

Vent_STATION

[kg NG/kg NG] Venting of NG from storage station vents per unit of natural gas stored

Tracked Input Flows:

Tracked Output Flows:

Natural Gas [intermediate flow]

Reference flow

Vent_PDhb [to venting and flaring]

[kg NG/kg NG] Venting of NG from high bleed pneumatic devices per unit of natural gas stored

Vent_PDib [to venting and flaring]

[kg NG/kg NG] Venting of NG from intermittent bleed pneumatic devices per unit of natural gas stored

Vent_PDlb [to venting and flaring]

[kg NG/kg NG] Venting of NG from low bleed pneumatic devices per unit of natural gas stored

Vent_DEHY [to venting and flaring]

[kg NG/kg NG] Venting of NG from dehydrators blowdowns per unit of natural gas stored

Vent_STATION [to venting and flaring]

[kg NG/kg NG] Venting of NG from storage station vents per unit of natural gas stored

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_NG_Storage_Venting_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 venting from natural gas storage operations. It accounts for vented emission sources from 5 specific emitters that are comprised of 3 types of pneumatic devices, 1 type of dehydrator, and 1 type of storage station. The outputs of this unit process are the reference flow of natural gas, and 5 intermediate flows of vented streams that are to be connected to the venting and flaring unit process for speciation of whole natural gas into its hydrocarbon and other components. The reference flow of this unit process is: 1 kg of natural gas

Boundary and Description

This unit process provides a summary of relevant input and output flows associated with venting from natural gas storage operations. It accounts for vented emission sources from 5 specific emitters that are comprised of 3 types of pneumatic devices, 1 type of dehydrator, and 1 type of storage station. The outputs of this unit process are the reference flow of natural gas, and 5 intermediate flows of vented streams that are to be connected to the venting and flaring unit process for speciation of whole natural gas into its hydrocarbon and other components. The reference flow of this unit process is: 1 kg of natural gas

This unit process provides a summary of relevant input and output flows associated with venting from natural gas transmission facility operations. It accounts for vented emission sources from 11 specific emitters that are comprised of 3 types of pneumatic devices, 1 type of dehydrator, and 7 types of blowdowns. The outputs of this unit process are the reference flow of natural gas, and 11 intermediate flows of vented streams that are to be connected to the venting and flaring unit process

for speciation of whole natural gas into its hydrocarbon and other components. The reference flow of this unit process is: 1 kg of natural gas

Vented emissions are intentional releases to the atmosphere and can be a part of well development activities, routine activities, or maintenance events.

Figure 1 shows input and output flows of the unit process. The reference flow is 1 kg of stored natural gas. Outputs include 5 instances of natural gas sent to another unit process where they are speciated into specific hydrocarbons and other gas components and then released as air emissions. For simplicity, **Figure 1** shows only one output to the downstream venting unit process; when implemented in a life cycle model, there are 5 instances of these intermediate flows that are connected to unique instantiations of venting unit processes.

Figure 1: Unit Process Scope and Boundary

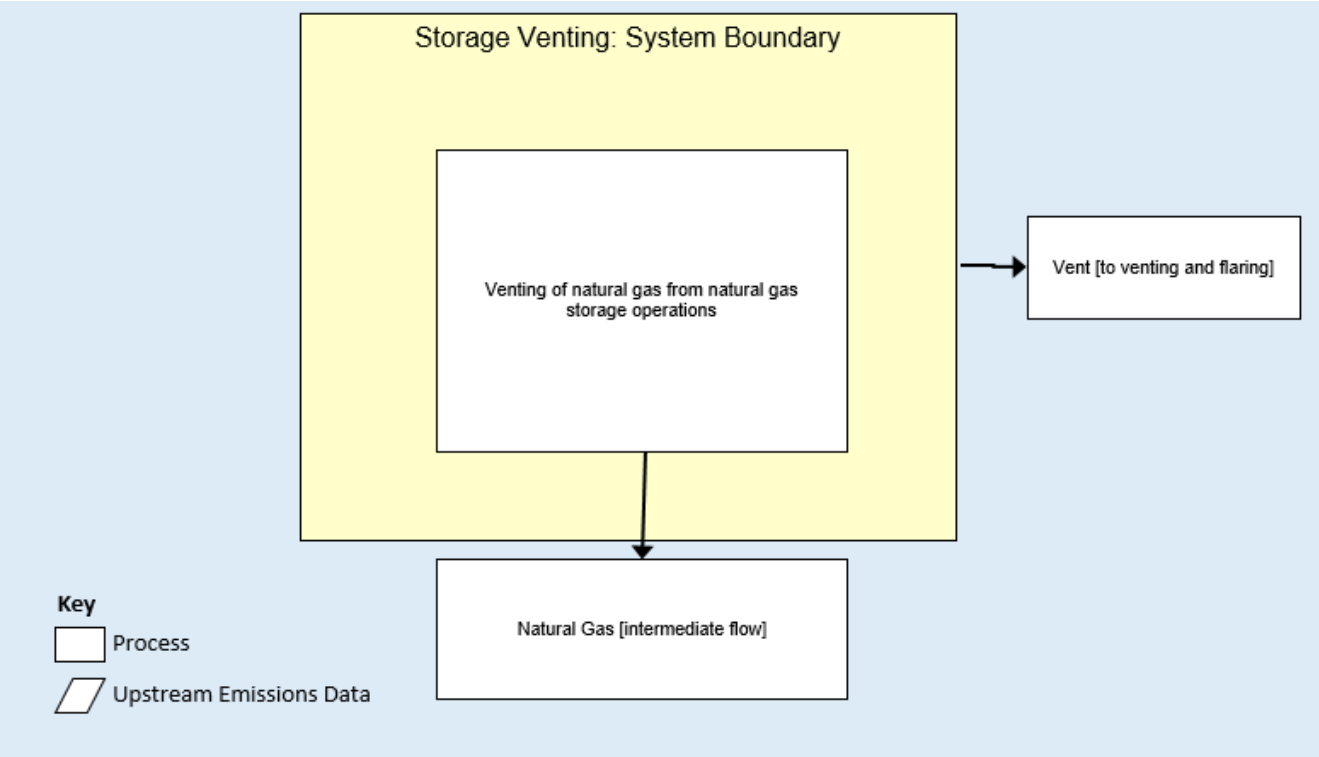

Table 1 shows the input parameters, which include emission factors and activity factors for each venting emission source. The emission and activity factors are based on EPA's Greenhouse Gas Reporting Program (GHGRP) (EPA, 2016a) and EPA's Greenhouse Gas Inventory (GHGI) (EPA, 2018). The low, expected, and high bounds represent the variability in the underlying data and were developed via throughput-weighted statistical bootstrapping. The bootstrapping technique allows computation of the confidence intervals around average activity factors. The DS file has a parameter scenario (PS) worksheet with 27 scenarios that match the scenarios for the onshore production unit

processes, but at this stage in the supply chain, the average U.S. is the only supply chain scenario that is modeled. After natural gas is gathered, the remaining supply chain stages model it as a commodity for which the energy requirements and emissions are the same for all sources of natural gas.

Table 2 shows the output values for natural gas resource and venting flows for Appalachian production scenario. The natural gas resource flow accounts for the total amount of input natural gas resource that goes to product (the reference flow of 1 kg) and total venting; this allows the model to account for the total amount of natural gas resource extraction associated with this process. The 5 vented outputs show the quantity of natural gas to be sent to separate instances of NETL's "venting and flaring" unit processes wherein the vented flows are speciated into hydrocarbons and other gas components and emitted to the atmosphere.

Table 1: Input Parameters

Parameter	Expected Value	Low	High	Units	Description
5_PDhb_hrs	3.26E+03	2.15E+03	4.47E+03	hours	operating hours for high bleed devices
5_PDhb_count	2.57E+01	9.62E+00	4.54E+01	count	number of high bleed devices
5_PDhb_EF	2.59E+01	2.59E+01	2.59E+01	scf/hr-device	emission factor for high bleed devices
5_PDib_hrs	5.95E+03	4.80E+03	6.96E+03	hours	operating hours for intermittent bleed devices
5_PDib_count	4.95E+01	3.56E+01	6.43E+01	count	number of intermittent bleed devices
5_PDib_EF	9.10E+00	9.10E+00	9.10E+00	scf/hr-device	emission factor for intermittent bleed devices
5_PDlb_hrs	3.55E+03	2.48E+03	4.80E+03	hours	operating hours for low bleed devices
5_PDlb_count	7.31E+00	3.40E+00	1.22E+01	count	number of low bleed devices
5_PDlb_EF	9.50E-01	9.50E-01	9.50E-01	scf/hr-device	emission factor for low bleed devices
5_DEHY_EF	2.26E+00	2.26E+00	2.26E+00	kg CH4/MMcf dehydrated	emission factor for dehydrator venting
5_DEHY_AF	1.85E+06	1.85E+06	1.85E+06	MMcf dehydrated	activity factor for dehydrator venting
5_STATION_EF	8.40E+04	8.40E+04	8.40E+04	kg/station	emission factor for storage station venting
5_STATION_AF	1.00E+00	1.00E+00	1.00E+00	stations	activity factor for storage station venting
5_storcap_v	1.07E+08	9.32E+07	1.20E+08	Mcf	Annual production, volume
5_vCH4	0.934	0.934	0.934	fraction	volume fraction of CH4
nat_mCH4	7.34E-01	7.31E-01	7.38E-01	dimensionless	Mass fraction of CH4 in natural gas

Table 2: Unit Process Input and Output Flows

Flow Name	Expected Value	Low	High	Units (Per Reference Flow)
Inputs				
Outputs				
Natural Gas [intermediate flow]	1.00	1.00	1.00	kg NG
Vent_PDhb [to venting and flaring]	2.74E-05	7.81E-06	5.92E-05	kg NG
Vent_PDib [to venting and flaring]	3.38E-05	2.26E-05	4.57E-05	kg NG
Vent_PDlb [to venting and flaring]	3.11E-07	1.17E-07	6.25E-07	kg NG
Vent_DEHY [to venting and flaring]	4.18E+06	4.18E+06	4.18E+06	kg NG
Vent_STATION [to venting and flaring]	8.40E+04	8.40E+04	8.40E+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. 2016a. Greenhouse Gas Reporting Program. Environmental Protection Agency. https://www.epa.gov/enviro/greenhouse-gas-customized-search. Accessed August 22, 2018.

EPA. 2018. Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2016. EPA 430-R-18-003. Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2016. https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf Accessed August 20, 2018.

Section III: Document Control Information

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