NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Transmission Facility Venting

Reference Flow: 1 kg of natural gas

Brief Description: Venting of natural gas from natural gas transmission facility 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:

4_PDhb_count

[count] Number of high-bleed pneumatic devices.

4_PDhb_EF

[kg/controller-yr] Emission factor for high-bleed pneumatic devices.

4_PDib_count

[count] Number of intermittent-bleed pneumatic devices.

4_PDib_EF

[kg/controller-yr] Emission factor for intermittent-bleed pneumatic devices.

4_PDlb_count

[count] Number of low-bleed pneumatic devices.

4_PDlb_EF

[kg/controller-yr] Emission factor for low-bleed pneumatic devices.

4_BDother_CH4

[metric tonnes CH4/yr] Emission mass for other blowdowns

4_BDcomp_CH4

[metric tonnes CH4/yr] Emission mass for compressor blowdowns

4_BDesd_CH4

[metric tonnes CH4/yr] Emission mass for ESD blowdowns

4_BDfacpip_CH4

[metric tonnes CH4/yr] Emission mass for facility piping blowdowns

4_BDpig_CH4

[metric tonnes CH4/yr] Emission mass for pig blowdowns

4_BDpipe_CH4

[metric tonnes CH4/yr] Emission mass for pipeline venting blowdowns

4_BDscrub_CH4

[metric tonnes CH4/yr] Emission mass for scrubbers/strainers blowdowns

4_DEHY_EF

[kg CH4/MMcf] Emission factor for dehydrator vents

4_DEHY_thru

[MMcf] throughput volume for dehydrator vents

4_NG_trans_v

[Mcf] Annual production, volume

NG_tran_m

[kg] Annual production, mass

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 through transmission facility

Vent_Pdib

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

Vent_PDlb

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

Vent_BDother

[kg NG/kg NG] Venting of NG from other blowdowns per unit of natural gas through transmission facility

Vent_BDcomp

[kg NG/kg NG] Venting of NG from compressor blowdowns per unit of natural gas through transmission facility

Vent_BDesd

[kg NG/kg NG] Venting of NG from ESD blowdowns per unit of natural gas through transmission facility

Vent_BDfacpip

[kg NG/kg NG] Venting of NG from facility piping blowdowns per unit of natural gas through transmission facility

Vent_BDpig

[kg NG/kg NG] Venting of NG from pig blowdowns per unit of natural gas through transmission facility

Vent_BDpipe

[kg NG/kg NG] Venting of NG from pipeline venting blowdowns per unit of natural gas through transmission facility

Vent_BDscrub

[kg NG/kg NG] Venting of NG from scrubbers/strainers blowdowns per unit of natural gas through transmission facility

Vent_DEHY

[kg NG/kg NG] Venting of NG fromdehydrator vents per unit of natural gas through transmission facility

NG_processing

[kg] Natural gas input from processing; equals transmission output plus natural gas that is vented

Tracked Input Flows:

Natural gas [from a processing facility]

[intermediate flow] Natural gas from a processing facility, including what exits transmission and what is vented at the transmission facility

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 through transmission facility

Vent_PDib [to venting and flaring]

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

Vent_PDlb [to venting and flaring]

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

Vent_BDother [to venting and flaring]

[kg NG/kg NG] Venting of NG from other blowdowns per unit of natural gas through transmission facility

Vent_BDcomp [to venting and flaring]

[kg NG/kg NG] Venting of NG from compressor blowdowns per unit of natural gas through transmission facility

Vent_BDesd [to venting and flaring]

[kg NG/kg NG] Venting of NG from ESD blowdowns per unit of natural gas through transmission facility

Vent_BDfacpip [to venting and flaring]

[kg NG/kg NG] Venting of NG from facility piping blowdowns per unit of natural gas through transmission facility

Vent_BDpig [to venting and flaring]

[kg NG/kg NG] Venting of NG from pig blowdowns per unit of natural gas through transmission facility

Vent_BDpipe [to venting and flaring]

[kg NG/kg NG] Venting of NG from pipeline venting blowdowns per unit of natural gas through transmission facility

Vent_BDscrub [to venting and flaring]

[kg NG/kg NG] Venting of NG from scrubbers/strainers blowdowns per unit of natural gas through transmission facility

Vent_DEHY [to venting and flaring]

[kg NG/kg NG] Venting of NG fromdehydrator vents per unit of natural gas through transmission facility

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_NG_Transmission_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 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

Boundary and Description

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 transmitted natural gas. Outputs include 11 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 11 instances of these intermediate flows that are connected to unique instantiations of venting unit processes.

Figure 1: Unit Process Scope and Boundary

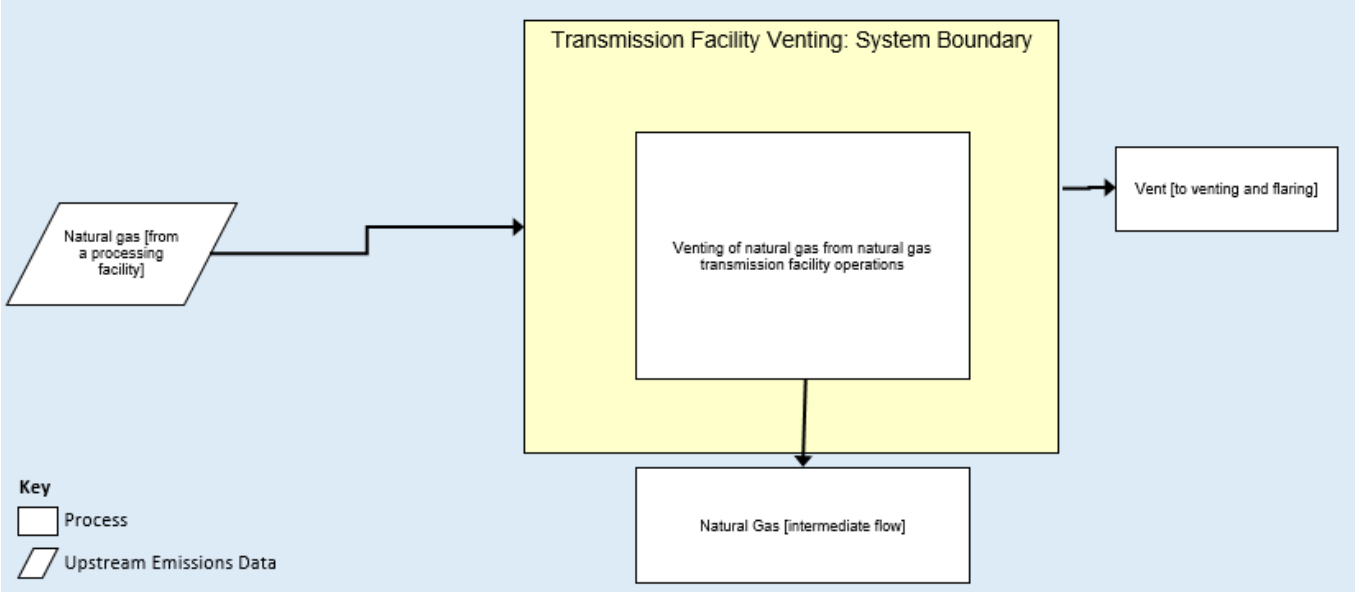

Table 1 shows the input parameters, which include emission factors and activity factors for each venting emission source. The emission and activity factors are based on EPA's Greenhouse Gas Reporting Program (GHGRP) (EPA, 2016a) and EPA's Greenhouse Gas Inventory (GHGI) (EPA, 2018). The low, expected, 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 11 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
4_PDhb_count	1.52E+00	1.19E+00	1.89E+00	count	Number of high-bleed pneumatic devices.
4_PDhb_EF	8.41E+02	7.25E+02	9.58E+02	kg CH4/ controller-yr	Emission factor for high-bleed pneumatic devices.
4_PDib_count	2.48E+01	2.12E+01	2.85E+01	count	Number of intermittent-bleed pneumatic devices.
4_PDib_EF	2.23E+02	1.86E+02	2.72E+02	kg CH4/ controller-yr	Emission factor for intermittent-bleed pneumatic devices.
4_PDlb_count	1.72E+00	1.34E+00	2.18E+00	count	Number of low-bleed pneumatic devices.
4_PDlb_EF	6.55E+01	5.55E+01	7.70E+01	kg CH4/ controller-yr	Emission factor for low-bleed pneumatic devices.
4_BDother_CH4	1.25E+01	5.73E+00	2.05E+01	metric tonnes CH4/yr	Emission mass for other blowdowns
4_BDcomp_CH4	5.67E+01	5.02E+01	6.37E+01	metric tonnes CH4/yr	Emission mass for compressor blowdowns
4_BDesd_CH4	8.60E+00	4.94E+00	1.63E+01	metric tonnes CH4/yr	Emission mass for ESD blowdowns
4_BDfacpip_CH4	2.28E+01	1.59E+01	3.09E+01	metric tonnes CH4/yr	Emission mass for facility piping blowdowns
4_BDpig_CH4	9.35E-01	2.54E-01	2.78E+00	metric tonnes CH4/yr	Emission mass for pig blowdowns
4_BDpipe_CH4	2.29E+01	1.27E+01	3.45E+01	metric tonnes CH4/yr	Emission mass for pipeline venting blowdowns
4_BDscrub_CH4	9.80E-01	5.87E-01	1.46E+00	metric tonnes CH4/yr	Emission mass for scrubbers/strainers blowdowns
4_DEHY_EF	1.81E+00	1.81E+00	1.81E+00	kg CH4/MMcf	Emission factor for dehydrator vents
4_DEHY_thru	1.19E+06	1.19E+06	1.19E+06	MMcf	throughput volume for dehydrator vents
4_NG_trans_v	1.24E+08	9.54E+07	1.59E+08	Mcf	Annual production, volume
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				
Natural gas [Resource]	1.0012	1.0016	1.0010	kg NG
Outputs				
Natural Gas [intermediate flow]	1.00	1.00	1.00	kg NG
Vent_PDhb [to venting and flaring]	7.36E-07	6.52E-07	8.08E-07	kg NG
Vent_PDib [to venting and flaring]	3.18E-06	2.96E-06	3.47E-06	kg NG
Vent_PDlb [to venting and flaring]	6.46E-08	5.60E-08	7.52E-08	kg NG
Vent_BDother [to venting and flaring]	7.18E-09	3.30E-09	1.18E-08	kg NG
Vent_BDcomp [to venting and flaring]	3.26E-08	2.89E-08	3.66E-08	kg NG
Vent_BDesd [to venting and flaring]	4.94E-09	2.84E-09	9.36E-09	kg NG
Vent_BDfacpip [to venting and flaring]	1.31E-08	9.12E-09	1.78E-08	kg NG
Vent_BDpig [to venting and flaring]	5.37E-10	1.46E-10	1.60E-09	kg NG
Vent_BDpipe [to venting and flaring]	1.32E-08	7.31E-09	1.98E-08	kg NG
Vent_BDscrub [to venting and flaring]	5.63E-10	3.37E-10	8.39E-10	kg NG
Vent_DEHY [to venting and flaring]	1.23E-03	1.61E-03	9.59E-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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Revision History:

Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2018). NETL Life Cycle Inventory Data – Unit Process: Transmission Facility Venting. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: October 2018 (version 01). www.netl.doe.gov/LCA (http://www.netl.doe.gov/LCA)

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