



NETL Life Cycle Inventory Data

Process Documentation File

Process Name: Transmission Pipeline Venting
Reference Flow: 1 kg of natural gas
Brief Description: Venting of natural gas from natural gas through transmission pipeline

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:

6_overview_mi

[miles] miles of transmission pipeline

6_transfer

[MCF] quantity of natural gas transferred to third parties such as LDCs or other transmission pipelines

6_transfer_kg

[kg] mass of natural gas transferred to third parties

nat_mCH4

[mass fraction CH4] methane content in the natural gas

6_OTHER_CH4

[metric tonnes] annual emissions from all other pipeline segments with a physical volume greater than or equal to 50 cubic feet

6_ESD_CH4

[metric tonnes] annual emissions from emergency shutdowns

6_REPAIR_CH4

[metric tonnes] annual emissions from equipment replacement or repair

6_CONSTRUCT_CH4

[metric tonnes] annual emissions from new construction or modification of pipelines including commissioning and change of service

6_CAUTION_CH4

[metric tonnes] annual emissions from operational precaution during activities

6_INTEGRITY_CH4

[metric tonnes] annual emissions from pipeline integrity work

6_MAINT_CH4

[metric tonnes] annual emissions from traditional operations or pipeline maintenance

Vent_OTHER

[kg NG/kg NG] Venting of NG from other sources per unit of natural gas through transmission pipeline

Vent_ESD

[kg NG/kg NG] Venting of NG from emergency shutdowns per unit of natural gas through transmission pipeline

Vent_REPAIR

[kg NG/kg NG] Venting of NG from replacement or repair per unit of natural gas through transmission pipeline

Vent_CONSTRUCT

[kg NG/kg NG] Venting of NG from new construction or modification per unit of natural gas through transmission pipeline

Vent_CAUTION

[kg NG/kg NG] Venting of NG from operational precaution per unit of natural gas through transmission pipeline

Vent_INTEGRITY

[kg NG/kg NG] Venting of NG from pipeline integrity work per unit of natural gas through transmission pipeline

Vent_MAINT

[kg NG/kg NG] Venting of NG from pipeline maintenance per unit of natural gas through transmission pipeline

NG_transmission

[kg] Natural gas product input plus natural gas that is vented

Tracked Input Flows:**Natural gas [from pipeline transmission facility]**

[intermediate flow] Natural gas from transmission facility input, including what ends up going through pipeline transmission and what is vented at pipeline transmission

Tracked Output Flows:**Natural Gas [intermediate flow]**

Reference flow

Vent_PDhb [to venting and flaring]

[kg NG/kg NG] Venting of NG from other sources per unit of natural gas through transmission pipeline

Vent_PDib [to venting and flaring]

[kg NG/kg NG] Venting of NG from emergency shutdowns per unit of natural gas through transmission pipeline

Vent_PDlb [to venting and flaring]

[kg NG/kg NG] Venting of NG from replacement or repair per unit of natural gas through transmission pipeline

Vent_BDother [to venting and flaring]

[kg NG/kg NG] Venting of NG from new construction or modification per unit of natural gas through transmission pipeline

Vent_BDcomp [to venting and flaring]

[kg NG/kg NG] Venting of NG from operational precaution per unit of natural gas through transmission pipeline

Vent_BDesd [to venting and flaring]

[kg NG/kg NG] Venting of NG from pipeline integrity work per unit of natural gas through transmission pipeline

Vent_BDfacpip [to venting and flaring]

[kg NG/kg NG] Venting of NG from pipeline maintenance per unit of natural gas through transmission pipeline

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_NG_Pipeline_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 pipeline operations. It accounts for vented emission sources from 7 specific emitters that are comprised of emergency shutdowns, equipment repair and replacement, new construction or modification, operational precaution, pipeline integrity work, traditional operations, and other sources. The outputs of this unit process are the reference flow of natural gas, and 7 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 pipeline operations. It accounts for vented emission sources from 7 specific emitters that are comprised of emergency shutdowns, equipment repair and replacement, new construction or modification, operational precaution, pipeline integrity work, traditional operations, and other sources. The outputs of this unit process are the reference flow of natural gas, and 7 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 7 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 7 instances of these intermediate flows that are connected to unique instantiations of venting unit processes.

Figure 1: Unit Process Scope and Boundary

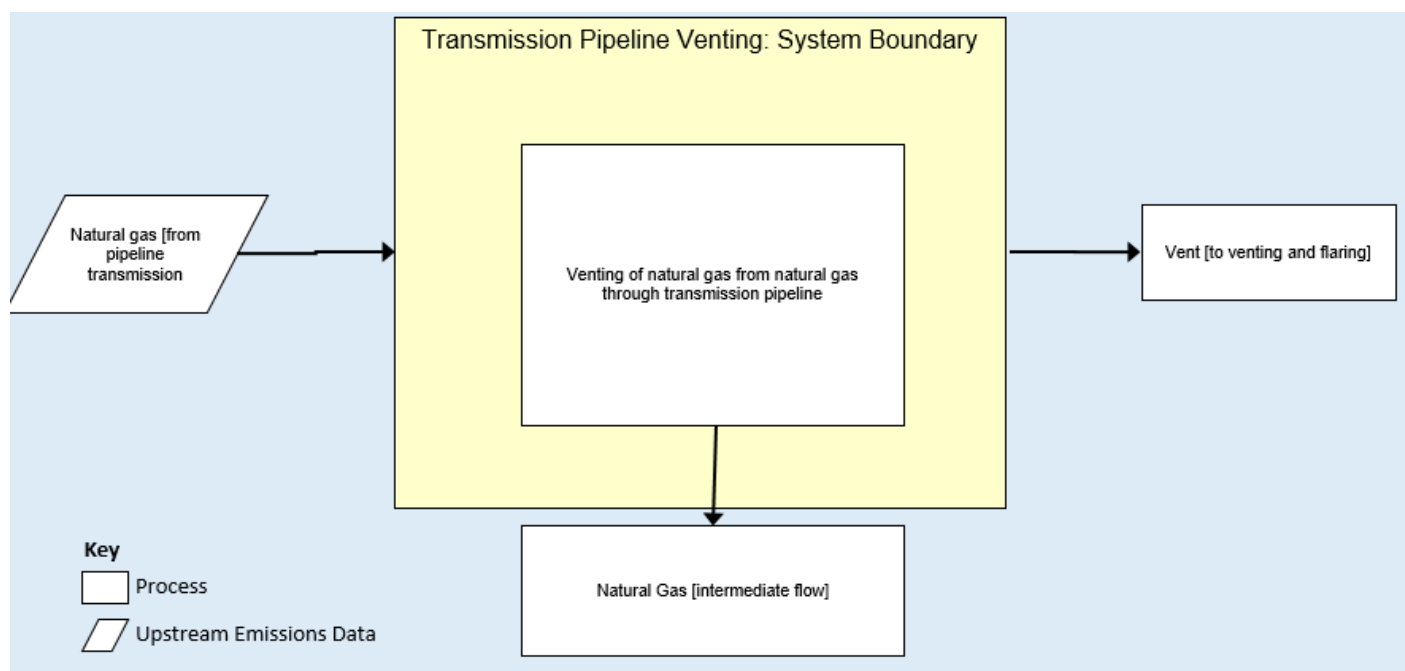


Table 1 shows the input parameters, which include emission factors and activity factors for each venting emission source. The emission and activity factors are based on EPA's Greenhouse Gas Reporting Program (GHGRP) (EPA, 2016a) and EPA's Greenhouse Gas Inventory (GHGI) (EPA, 2018). The low, expected, 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 7 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
6_overview_mi	8.28E+03	6.86E+03	9.63E+03	miles	miles of transmission pipeline
6_transfer	1.33E+09	8.70E+08	1.88E+09	MCF	quantity of natural gas transferred to third parties such as LDCs or other transmission pipelines
nat_mCH4	7.34E-01	7.31E-01	7.38E-01	mass fraction CH4	methane content in the natural gas
6_OTHER_CH4	1.43E+03	3.14E+02	3.28E+03	metric tonnes	annual emissions from all other pipeline segments with a physical volume greater than or equal to 50 cubic feet
6_ESD_CH4	4.95E+01	1.52E-02	1.71E+02	metric tonnes	annual emissions from emergency shutdowns
6_REPAIR_CH4	3.31E+02	1.84E+02	5.09E+02	metric tonnes	annual emissions from equipment replacement or repair
6_CONSTRUCT_CH4	9.66E+02	4.29E+02	1.73E+03	metric tonnes	annual emissions from new construction or modification of pipelines including commissioning and change of service
6_CAUTION_CH4	9.01E+01	2.53E+01	1.82E+02	metric tonnes	annual emissions from operational precaution during activities
6_INTEGRITY_CH4	5.47E+01	2.89E+01	9.29E+01	metric tonnes	annual emissions from pipeline integrity work
6_MAINT_CH4	1.46E+03	5.33E+02	4.57E+03	metric tonnes	annual emissions from traditional operations or pipeline maintenance

Table 2: Unit Process Input and Output Flows

Flow Name	Expected Value	Low	High	Units (Per Reference Flow)
Inputs				
Natural gas [from pipeline transmission facility]	1.00E+00	1.00E+00	1.00E+00	kg NG
Outputs				
Natural Gas [intermediate flow]	1.00	1.00	1.00	kg NG
Vent_PDhb [to venting and flaring]	9.32E-09	3.79E-09	1.29E-08	kg NG
Vent_PDib [to venting and flaring]	3.22E-10	1.83E-13	6.76E-10	kg NG
Vent_PDlb [to venting and flaring]	2.15E-09	2.22E-09	2.01E-09	kg NG
Vent_BDother [to venting and flaring]	6.29E-09	5.17E-09	6.81E-09	kg NG
Vent_BDcomp [to venting and flaring]	5.86E-10	3.04E-10	7.16E-10	kg NG
Vent_BDesd [to venting and flaring]	3.56E-10	3.48E-10	3.66E-10	kg NG
Vent_BDfacpip [to venting and flaring]	9.50E-09	6.42E-09	1.80E-08	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

Date Created: January 14, 2019

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