NETL Life Cycle Inventory Data
Process Documentation File

Process Name:	Distribution Fugitives
Reference Flow:	1 kg of natural gas
Brief Description:	Fugitive emissions of natural gas from natural gas distribution

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:

7_TD_CH4

[tonnes] Leaks from transmission-distribution transfer stations

7_MAINS_CH4

[tonnes] Leaks from above grade metering-regulating stations that are not above grade T-D transfer stations

7_BELOW_CH4

[tonnes] Leaks from below grade T-D station and distribution mains & services

7_METERres_AF

[meters/kg NG] Activity factor for leaks from residential customer meters

7_METERres_EF

[kg CH4/meter] Emission factor for leaks from residential customer meters

7_METERcom_AF

[meters/kg NG] Activity factor for leaks from commercial and industrial customer meters

7_METERcom_EF

[kg CH4/meter] Emission factor for leaks from commercial and industrial customer meters

nat_mCH4

[dimensionless] Mass fraction of CH4 in natural gas.

7_NG_deliv

[Mcf] Natural gas distributed, volume

7_NG_deliv_kg

[kg] Natural gas distributed, mass

Fugitive_TD

[kg NG/kg NG] Fugitive emissions from transmission-distribution transfer stations per unit of distributed natural gas

Fugitive_MAINS

[kg NG/kg NG] Fugitive emissions from above grade metering-regulating stations that are not above grade T-D transfer stations per unit of distributed natural gas

Fugitive_BELOW

[kg NG/kg NG] Fugitive emissions from below grade T-D station and distribution mains & services per unit of distributed natural gas

Fugitive_METERres

[kg NG/kg NG] Fugitive emissions from residential meters per unit of distributed natural gas

Fugitive_METERcom

[kg NG/kg NG] Fugitive emissions from commercial and industrial meters per unit of distributed natural gas

NG_transpipeline

[kg] Natural gas input (from a transmission pipeline); equals the natural gas delivered to the consumer via distribution plus natural gas that is emitted as fugitives during distribution.

DF_NG_Distribution_Fugitives_2018.01.docx

Tracked Input Flows:

Natural gas [from transmission pipeline]

[intermediate flow] Natural gas received from a transmission pipeline.

Tracked Output Flows:

Natural Gas [intermediate flow]

Reference flow

Fugitive_TD [to venting and flaring]

[kg] Fugitive emissions from transmission-distribution transfer stations per unit of distributed natural gas

Fugitive_MAINS [to venting and flaring]

[kg] Fugitive emissions from above grade metering-regulating stations that are not above grade T-D transfer stations per unit of distributed natural gas

Fugitive_BELOW [to venting and flaring]

[kg] Fugitive emissions from below grade T-D station and distribution mains & services per unit of distributed natural gas

Fugitive_METERres [to venting and flaring]

[kg] Fugitive emissions from residential meters per unit of distributed natural gas

Fugitive_METERcom [to venting and flaring]

[kg] Fugitive emissions from commercial and industrial meters per unit of distributed natural gas

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Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_NG_Distribution_Fugitives_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 fugitive emissions from natural gas distribution. It accounts for fugitive emissions from 5 specific sources: transfer stations, above grade metering-regulating stations, below grade transmission-distribution stations and distribution mains and services, residential customer meters, and commercial and industrial customer meters. The outputs of this unit process are the reference flow of natural gas, and 5 intermediate flows of fugitive emission streams that are to be connected to NETL's 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 fugitive emissions from natural gas distribution. It accounts for fugitive emissions from 5 specific sources: transfer stations, above grade metering-regulating stations, below grade transmission-distribution stations and distribution mains and services, residential customer meters, and commercial and industrial customer meters. The outputs of this unit process are the reference flow of natural gas, and 5 intermediate flows of fugitive emission streams that are to be connected to NETL's 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

Fugitive emissions are unintentional releases to the atmosphere. They are leaks that occur during routine natural gas operations.

Figure 1 shows input and output flows of the unit process. The reference flow is 1 kg of distributed 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 and flaring" 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 and flaring" unit processes.

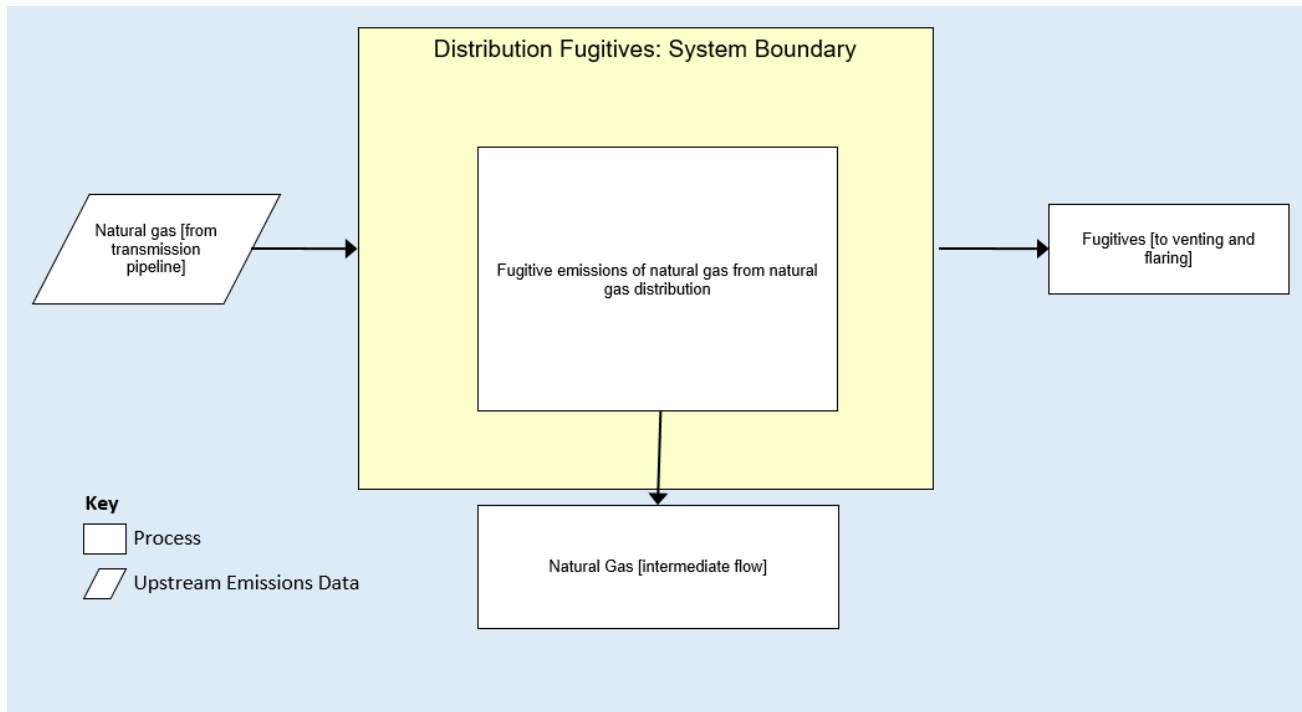## Figure 1: Unit Process Scope and Boundary

Table 1 shows the input parameters, which include emission factors and activity factors for each fugitive 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 fugitive 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 fugitive emissions; this allows the model to account for the total amount of natural gas resource extraction associated with this process. The 5 fugitive 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
7_TD_CH4	1.28E+01	6.82E+00	2.06E+01	tonnes	Leaks from transmission-distribution transfer stations
7_MAINS_CH4	1.01E+04	7.97E+03	1.22E+04	tonnes	Leaks from above grade metering-regulating stations that are not above grade T-D transfer stations
7_BELOW_CH4	3.87E+01	2.84E+01	4.92E+01	tonnes	Leaks from below grade T-D station and distribution mains & services
7_METERres_AF	2.06E-04	2.06E-04	2.06E-04	meters/kg NG	Activity factor for leaks from residential customer meters
7_METERres_EF	1.49E+00	1.49E+00	1.49E+00	kg CH4/meter	Emission factor for leaks from residential customer meters
7_METERcom_AF	2.14E-05	2.14E-05	2.14E-05	meters/kg NG	Activity factor for leaks from commercial and industrial customer meters
7_METERcom_EF	9.73E+00	9.73E+00	9.73E+00	kg CH4/meter	Emission factor for leaks from commercial and industrial customer meters
nat_mCH4	7.34E-01	7.31E-01	7.38E-01	dimensionless	Mass fraction of CH4 in natural gas.
7_NG_deliv	2.47E+08	2.12E+08	2.80E+08	Mcf	Natural gas distributed, volume

Table 2: Unit Process Input and Output Flows

Flow Name	Expected	Low	High	Units (Per Reference Flow)
Inputs				
Natural gas [from transmission pipeline]	1.0029	1.0027	1.0031	kg NG
Outputs				
Natural Gas [intermediate flow]	1.00	1.00	1.00	kg NG
Fugitive_TD [to venting and flaring]	3.69E-06	2.31E-06	5.23E-06	kg NG
Fugitive_MAINS [to venting and flaring]	2.91E-03	2.70E-03	3.10E-03	kg NG
Fugitive_BELOW [to venting and flaring]	1.12E-05	9.62E-06	1.25E-05	kg NG
Fugitive_METERres [to venting and flaring]	8.85E-14	1.04E-13	7.78E-14	kg NG
Fugitive_METERcom [to venting and flaring]	6.04E-14	7.07E-14	5.30E-14	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.

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

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

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