NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Natural Gas Extraction Fugitive Emissions - Flanges

Reference Flow: 1 kg of Natural Gas Conserved

Brief Description: This unit process quantifies the amount of gas emitted to the atmosphere during natural gas production from fugitive losses during flange operation

Section I: Meta Data

Geographical Coverage: U.S. **Region:** Various U.S. Basins

Year Data Best Represents: 2011

Process Type: Extraction Process (EP)

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	☐ Other
Releases to Water:	☐ Inorganic	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

Avg_NG_Prod	*[MCF/YR] Regional production rate used for scaling emission factors*
NG_Dens	*[kg/MCF] Calculated density of natural gas at atmospheric conditions*
C_Flange	*[Count] Number of flanges at extraction site*
MW_Gas	*[g/mol] Molecular weight of leaked gas*

OP_HR	*[HR/YR] Hours of operation in a year for fugitive components*
NG_Flange	*[kg/comp-HR] Fugitive mass leak rate of natural gas from a flange*
NG_Vented_Flange	*[kg/kg] Fugitive mass leak rate of natural gas per natural gas produced*

Tracked Input Flows:

Tracked Output Flows:

Natural Gas [intermediate flow]	*Reference Flow*
Natural Gas Vented, Fugitives [Intermediate flow]	*Intermediate flow*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_NG_Extraction_Fugitive_Flange_2015.01.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 natural gas well fugitive losses from flange operation. Default parameter values presented are regional averages for the Appalachian Basin and values are available for conventional natural gas wells and coal bed methane production. Regional averages are also available for other U.S. regions in the Parameter Scenario (PS) tab of the data sheet (DS) document. The reference flow of this unit process is: 1 kg of Natural gas conserved.

Boundary and Description

he onsite construction of natural gas production equipment requires that there be numerous line or pipe connections. It is not uncommon for these connections to have some fugitive losses of natural gas while gas is passed through them.

This unit process utilizes the Environmental Protection Agency's (EPA) Oil and Gas Emission Estimation Tool (O&G Tool). This tool exists as a Microsoft® Access® database

containing county level data on natural gas production, well counts, device counts, and various device characteristics. The O&G Tool was developed by compiling data from 49 sources including state and basin level sampling studies, federal reports and expert correspondences. Where better data were not available, the regional boundaries of suitable sources were extended to cover the missing area. In regions with no data coverage that could not be suitably extrapolated by the extension of a single data source, source averages were used to complete the coverage (ENVIRON, 2012).

The county level data were aggregated to generate basin level averages for the 11 onshore basins of the 13 shown in **Figure 1**. The relevant parameters pertaining to conventional gas well and coal bed methane production were aggregated weighted by the county level well count. Average, minimum and maximum values are available in the associated *DS_Stage1_O_NG_Extraction_Fugitive_Flange_2014.01.xlsx* document. These basin and well type specific parameters are selected through the Parameter Scenario worksheet (PS). Due to the source limitations in the O&G database the minimum and maximum parameters should not be considered as an uncertainty range but an expected range of possible values. The reasoning behind this being that regions with fewer, extrapolated, or averaged data sources will tend to have more agreement in parameter values between counties without providing any more certainty in the data.

The regionally averaged parameter values are used in equations provided in the 2011 Oil and Gas Emission Inventory Enhancement Project for CenSARA States report produced by ENVIRON and Eastern Research Group (ERG) in order to determine the average emission rate per well-year from connections. These emission rates were then obtained per-mass natural gas produced by dividing by the average well production rate and density of natural gas. There are data available within the O&G Tool to determine the emission rates of carbon dioxide (CO_2), methane (CH_4), hydrogen sulfide (H_2S), and volatile organic compounds (VOC). The summation of total organic compounds weight fractions does not reach unity so the remainder was defined as nitrogen and ethane in a ratio determined from a 2011 memorandum utilized in the development of the O&G Tool (Pring, 2014) (Brown, 2011). The weight fractions originally presented as a ratio to total organic compounds were normalized to be on a basis of total natural gas emitted. Additionally, the molecular weight of the emitted gas that is used to determine the gas density is calculated using the extended gas composition rather than using the one provided in the O&G Tool. Minimal speciation of C6+ VOC compounds is provided in the O&G Tool so the VOC weight fraction was further speciated using the SPECIATE database. **Figure 2** illustrates the unit process scope and boundary.

While the natural gas composition is calculated in this unit process, this information is only used to calculate the density of the natural gas in order to determine the total mass of natural gas emitted. This tracked output is intended to be connected to the Stage1_O_NG_Flaring UP which contains regionally and device specific gas

compositions as parameter scenarios and accounts for the specific gas species being emitted to the atmosphere.

Figure 1: U.S. Basin Map

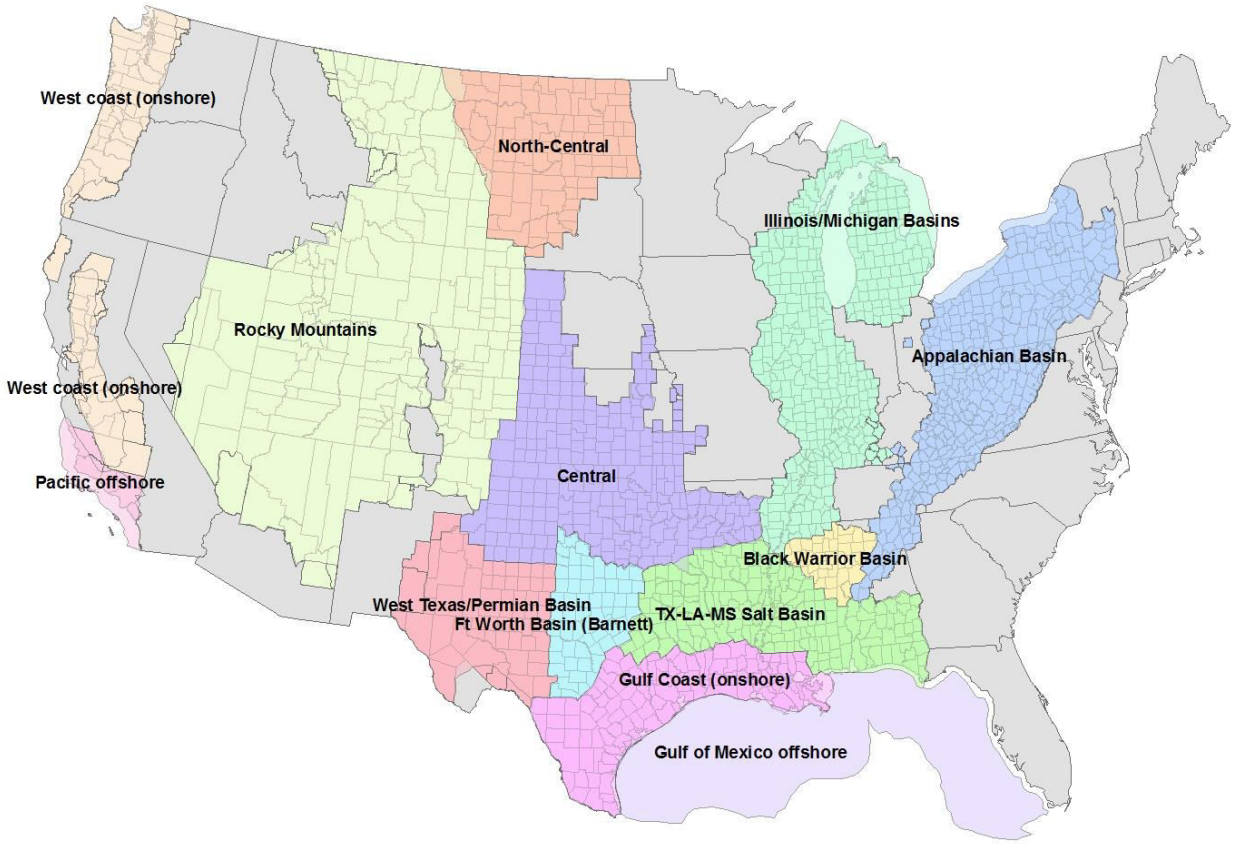

Figure 2: Unit Process Scope and Boundary

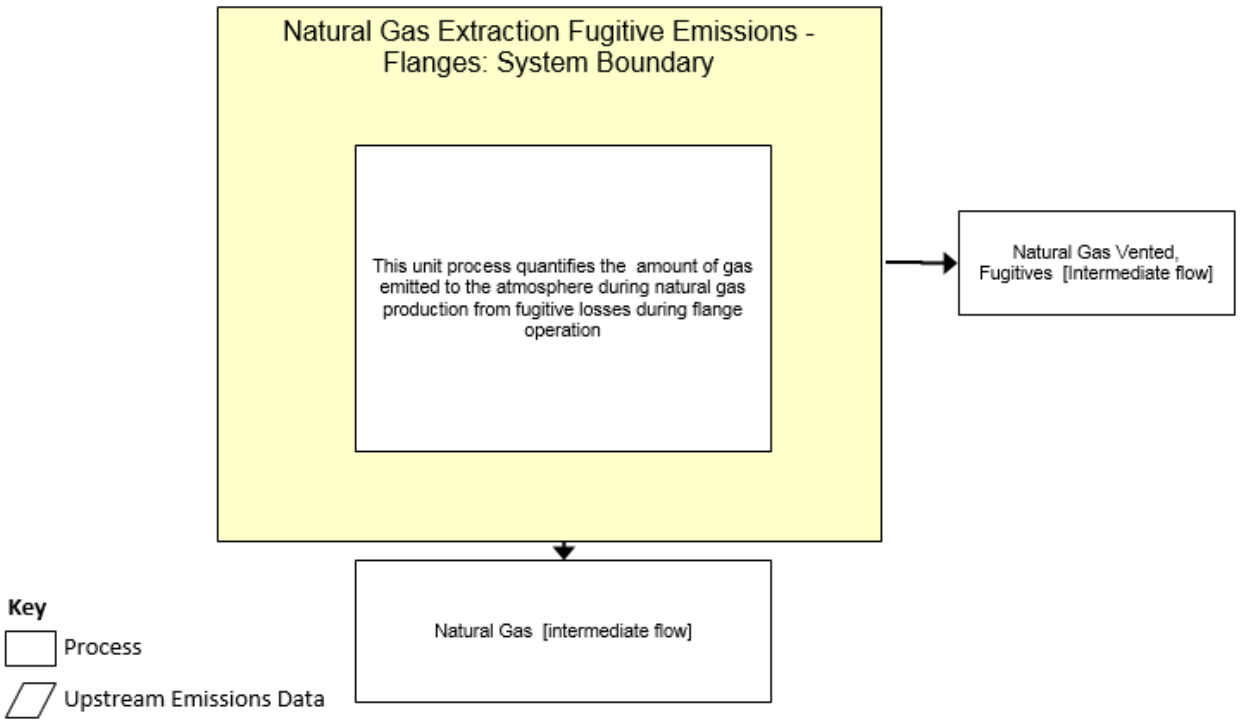

Table 1: Adjustable Parameters – Appalachian Basin – Gas Well

Parameter Name	Value	Min. Value	Max. Value	Units
AVG_NG_Prod	1.38E+04	1.00E+00	1.81E+06	MCF/YR
C_Flange	1.88E+01	0.00E+00	2.17E+01	count
MW_Gas	1.99E+01			g/mol
OP_HR	7.62E+03	2.60E+02	8.76E+03	HR/YR
NG_Flange	4.03E-04			kg/comp-HR

Table 2: Unit Process Input and Output Flows – Appalachian Basin – Gas Well

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Outputs		
Natural Gas [Intermediate flow]	1.00E+00	kg
Natural Gas Vented, Fugitives [Intermediate flow]	1.81E-04	kg

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

Embedded Unit Processes

None.

References

Brown, 2011 — Brown, Heather P. 2011. Composition of Natural Gas for use in the Oil and Natural Gas Sector Rulemaking. ECR Incorporated.

ENVIRON, 2012 — ENVIRON, Eastern Research Group (ERG). 2012. 2011 Oil and Gas Emission Inventory Enhancement Project for CenSARA States. Retrieved from www.censara.org/filedepot_download/56064/14 on August 8, 2014.

EPA, 2013 — Environmental Protection Agency (EPA). 2013. Oil and Gas Emission Estimation Tool. Retrieved from http://www.epa.gov/ttn/chief/net/2011inventory.html on August 8, 2014.

Pring, 2014 — Pring, Mike. 2014. Email Correspondence with ERG. August 26, 2014.

Section III: Document Control Information

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