



NETL Life Cycle Inventory Data

Process Documentation File

Process Name: Crude Production Associated Gas Emissions Composition
Reference Flow: 1 kg of associated gas
Brief Description: Unit process specific associated gas species composition

Section I: Meta Data

Geographical Coverage: USA **Region:** N/A
Year Data Best Represents: 2010
Process Type: Basic Process (BP)
Process Scope: Gate-to-Gate Process (GG)
Allocation Applied: No
Completeness: Individual 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:

CO2 *[dimensionless] Mole fraction of carbon dioxide in associated natural gas stream*
C1 *[dimensionless] Mole fraction of methane in associated natural gas stream*
C2 *[dimensionless] Mole fraction of ethane in associated natural gas stream*

C3	<i>[dimensionless] Mole fraction of propane in associated natural gas stream</i>
C4_plus	<i>[dimensionless] Mole fraction of butane and higher hydrocarbons in associated natural gas stream</i>
H2S	<i>[dimensionless] Mole fraction of hydrogen sulfide in associated natural gas stream</i>

Tracked Input Flows:

None.

Tracked Output Flows:

Active well and cellar emissions	<i>[Intermediate Product] Emissions of associated gas from active wells and well cellars</i>
Cleanup venting	<i>[Intermediate Product] Release of associated gas from cleanups</i>
Compressor emissions	<i>[Intermediate Product] Emissions of associated gas from compressors</i>
Dehydrator emissions	<i>[Intermediate Product] Emissions of associated gas from dehydrator</i>
Gathering pipeline emissions	<i>[Intermediate Product] Emissions of associated gas from gathering pipelines</i>
Separator emissions	<i>[Intermediate Product] Emissions of associated gas from separator</i>
Vented associated gas	<i>[Intermediate Product] Venting of associated gas from petroleum extraction</i>
Workover venting	<i>[Intermediate Product] Release of associated gas from workovers</i>

AGR emissions	<i>[Intermediate Product] Emissions of associated gas from acid gas remover</i>
Liquid storage tank emissions	<i>[Intermediate Product] Emissions of associated gas from storage tank flash</i>
Heater treater emissions	<i>[Intermediate Product] Emissions of associated gas from heater treater</i>

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_associated_gas_species_2014.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

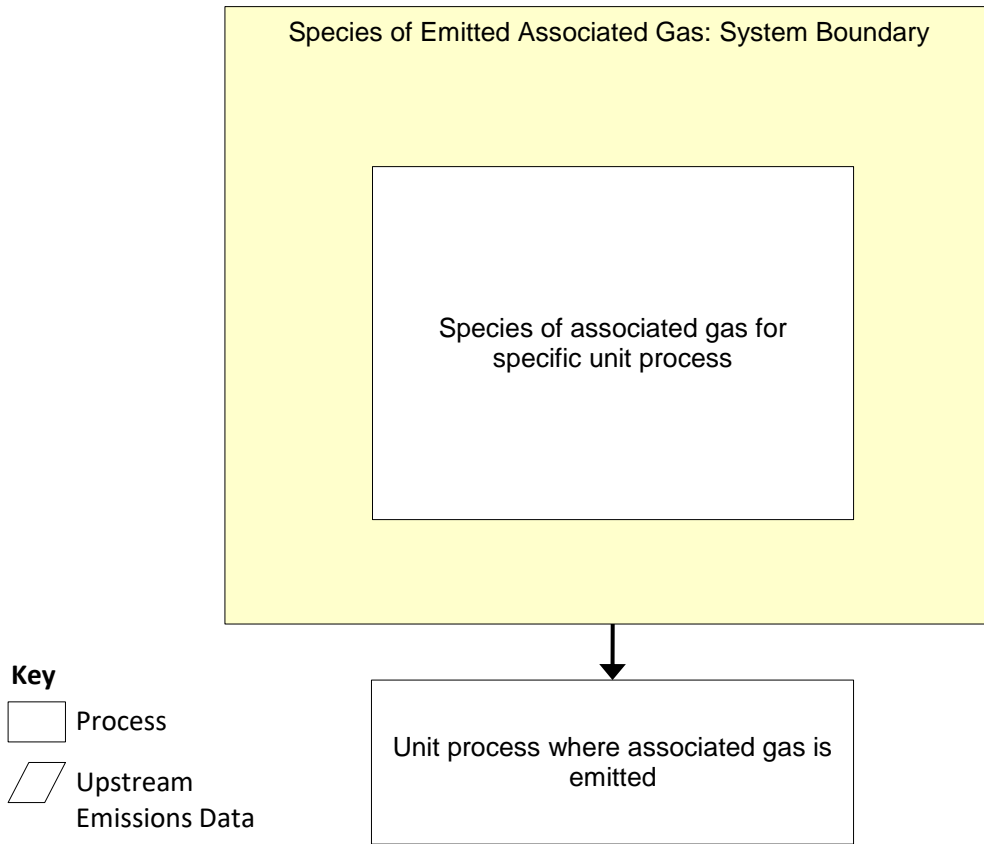
Goal and Scope

This unit process provides a summary of relevant output flows related to the emissions of unit process specific associated gas. Outputs are specific species emissions to air per kg of associated gas emitted. Default values for different unit processes are provided in the scenarios. The reference flow of this unit process is: 1 kg of emitted associated gas.

Boundary and Description

Figure 1 provides an overview of the boundary of this process. There are no inputs to this process because the process is expected to be called by production unit processes that emit associated gas as part of the crude production process.

Figure 1: Unit Process Scope and Boundary



This unit process provides the species composition of eleven Parameter Scenarios specific associated gas emissions to air. The unit process modeled is selected by Scenario ID in the 'PS tab' of the DS. **Table 1** lists seven adjustable parameters that define the mole fraction composition of the associated gas and the default values.

Table 1: Adjustable Parameters

Parameter	Default Mole Fraction
Nitrogen	0.02
Carbon Dioxide	0.06
Methane	0.84
Ethane	0.04
Propane	0.02
C4+	0.01
Hydrogen Sulfide	0.01

There is a Secondary Condition qualifier in the 'PS' tab of the DS that selects an alternative species dataset when applicable to the Parameter Scenarios. The values and effect of the qualifier are listed in **Table 2**. The C4+ component is broken down into specific species with data from the Environmental Protection Agency's SPECIATE 4.3 Database (EPA, 2011) with the exception of the produced water tank flash gas species which comes from a 2010 Texas Commission on Environmental Quality study. (TCEQ, 2010). The database does not contain species datasets specific to every unit process considered in this model so some datasets were appropriated to multiple unit processes. **Table 2** lists all the unit processes covered and the corresponding SPECIATE dataset depending on the qualifier selected.

Table 2: Unit Processes and SPECIATE Datasets

Unit Process	Qualifier	SPECIATE Dataset
Active Well & Cellar Vented Associated Gas Workover Venting	0 = Primary	Oil Field - Well
	1 = Gas Drive	Crude Oil Production – Well Heads (Gas Drive)
	2 = Water Flood	Crude Oil Production – Well Heads (Water Flood)
Cleanup Venting Gathering Pipeline	3 = Produce Water	Oil Field - Tank
	0 = Crude	Produced Water Tank (TCEQ)
Storage Tank Flash Losses*		
Acid Gas Remover Separator Dehydrator	N/A	Oil Field - Separator
Heater Treater	N/A	Oil Field – Dehydration Tank
Compressor	N/A	Oil Field – Compressor – Vapor Recovery

*Crude storage Tank Flash Losses are an average of Tank and Separator Species

Table 3 shows the model results for 1 kg of associated gas for the eleven scenarios. The values in **Table 3** represent a primary well and crude oil flow (i.e. a value of zero as the Secondary Condition parameter in the 'PS' tab of the DS).

Table 3: Unit Process Input and Output Flows

Flow Name†	Active Well & Cellar	Cleanup Venting	Compressor	Dehydrator	Gathering Pipeline	Separator	Vented Assoc. Gas	Workover Venting	Acid Gas Remover	Storage Tank Flash Losses	Heater Treater	Units (Per Reference Flow)
Inputs												
Outputs												
Active well and cellar emissions [Intermediate products]	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Cleanup venting [Intermediate products]	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Compressor emissions [Intermediate products]	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Dehydrator emissions [Intermediate products]	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Gathering pipeline emissions [Intermediate products]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Separator emissions [Intermediate products]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Vented associated gas [Intermediate products]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Workover venting [Intermediate products]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
AGR emissions [Intermediate products]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	kg
Liquid storage tank emissions [Intermediate products]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	kg
Heater treater emissions [Intermediate products]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	kg
Nitrogen (atmospheric nitrogen) [Inorganic emissions to air]	2.79E-02	2.82E-02	2.82E-02	2.82E-02	2.82E-02	2.82E-02	2.79E-02	2.79E-02	2.82E-02	2.82E-02	2.79E-02	kg
Carbon dioxide [Inorganic emissions to air]	1.32E-01	1.33E-01	1.33E-01	1.33E-01	1.33E-01	1.33E-01	1.32E-01	1.32E-01	1.33E-01	1.33E-01	1.32E-01	kg
Methane [Organic emissions to air (group VOC)]	6.72E-01	6.78E-01	6.78E-01	6.79E-01	6.78E-01	6.79E-01	6.72E-01	6.72E-01	6.79E-01	6.79E-01	6.72E-01	kg
Ethane [Group NMVOC to air]	6.00E-02	6.05E-02	6.06E-02	6.06E-02	6.05E-02	6.06E-02	6.00E-02	6.00E-02	6.06E-02	6.06E-02	6.00E-02	kg
Propane [Group NMVOC to air]	4.40E-02	4.44E-02	4.44E-02	4.45E-02	4.44E-02	4.45E-02	4.40E-02	4.40E-02	4.45E-02	4.44E-02	4.40E-02	kg
Hydrogen sulphide [Inorganic emissions to air]	1.70E-02	1.71E-02	1.72E-02	1.72E-02	1.71E-02	1.72E-02	1.70E-02	1.70E-02	1.72E-02	1.72E-02	1.70E-02	kg
1,2,3-Trimethylbenzene [Group NMVOC to air]	1.58E-04	1.04E-05	0.00E+00	0.00E+00	1.04E-05	0.00E+00	1.58E-04	1.58E-04	0.00E+00	0.00E+00	0.00E+00	kg
1,2,4-Trimethylbenzene [Group NMVOC to air]	1.79E-04	1.12E-05	0.00E+00	1.66E-06	1.12E-05	1.66E-06	1.79E-04	1.79E-04	1.66E-06	6.35E-06	2.61E-04	kg



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1,3,5-Trimethylbenzene [Group NMVOC to air]	1.17E-04	1.29E-05	0.00E+00	2.77E-06	1.29E-05	2.77E-06	1.17E-04	1.17E-04	2.77E-06	7.72E-06	0.00E+00	kg
ortho-Ethyltoluene [Group NMVOC to air]	1.38E-04	1.28E-05	9.34E-06	4.61E-06	1.28E-05	4.61E-06	1.38E-04	1.38E-04	4.61E-06	8.63E-06	9.20E-05	kg
meta-Ethyltoluene [Group NMVOC to air]	1.33E-04	1.07E-05	1.03E-05	4.31E-06	1.07E-05	4.31E-06	1.33E-04	1.33E-04	4.31E-06	7.47E-06	1.58E-04	kg
2,2,4-Trimethylpentane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
2,2-Dimethylbutane [Group NMVOC to air]	2.13E-04	0.00E+00	1.90E-04	1.40E-04	0.00E+00	1.40E-04	2.13E-04	2.13E-04	1.40E-04	7.20E-05	1.36E-04	kg
Neopentane [Group NMVOC to air]	1.24E-04	9.63E-05	1.13E-04	8.39E-05	9.63E-05	8.39E-05	1.24E-04	1.24E-04	8.39E-05	9.03E-05	1.13E-04	kg
2,3,4-Trimethylpentane [Group NMVOC to air]	1.88E-04	2.17E-04	0.00E+00	1.30E-04	2.17E-04	1.30E-04	1.88E-04	1.88E-04	1.30E-04	1.73E-04	2.00E-04	kg
2,3-Dimethylbutane [Group NMVOC to air]	7.65E-04	2.24E-04	0.00E+00	0.00E+00	2.24E-04	0.00E+00	7.65E-04	7.65E-04	0.00E+00	0.00E+00	0.00E+00	kg
2,3-Dimethylhexane [Group NMVOC to air]	5.88E-05	2.92E-05	3.11E-05	1.42E-05	2.92E-05	1.42E-05	5.88E-05	5.88E-05	1.42E-05	2.16E-05	1.09E-04	kg
2,3 Dimethylpentane [Group NMVOC to air]	3.80E-04	2.42E-04	2.51E-04	1.86E-04	2.42E-04	1.86E-04	3.80E-04	3.80E-04	1.86E-04	2.14E-04	5.17E-04	kg
2,4-Dimethylhexane [Group NMVOC to air]	1.64E-04	6.59E-05	0.00E+00	3.91E-05	6.59E-05	3.91E-05	1.64E-04	1.64E-04	3.91E-05	5.24E-05	1.30E-04	kg
2,4-Dimethylpentane [Group NMVOC to air]	1.56E-04	7.84E-05	1.17E-04	8.57E-05	7.84E-05	8.57E-05	1.56E-04	1.56E-04	8.57E-05	8.25E-05	1.28E-04	kg
2-Methylheptane [Group NMVOC to air]	2.13E-04	1.17E-04	1.36E-04	9.10E-05	1.17E-04	9.10E-05	2.13E-04	2.13E-04	9.10E-05	1.04E-04	4.06E-04	kg
2-Methylhexane [Group NMVOC to air]	3.31E-04	2.98E-04	2.53E-04	2.44E-04	2.98E-04	2.44E-04	3.31E-04	3.31E-04	2.44E-04	2.72E-04	3.57E-04	kg
2-Methylpentane [Group NMVOC to air]	7.91E-04	9.18E-04	1.11E-03	9.60E-04	9.18E-04	9.60E-04	7.91E-04	7.91E-04	9.60E-04	9.43E-04	1.16E-03	kg
3-Methylheptane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
3-Methylhexane [Group NMVOC to air]	3.10E-04	3.33E-04	3.44E-04	3.01E-04	3.33E-04	3.01E-04	3.10E-04	3.10E-04	3.01E-04	3.18E-04	5.07E-04	kg
3-Methylpentane [Group NMVOC to air]	6.91E-04	7.15E-04	7.51E-04	6.74E-04	7.15E-04	6.74E-04	6.91E-04	6.91E-04	6.74E-04	6.96E-04	7.70E-04	kg
Benzene [Group NMVOC to air]	3.51E-04	2.42E-04	8.78E-05	1.31E-04	2.42E-04	1.31E-04	3.51E-04	3.51E-04	1.31E-04	1.86E-04	1.46E-04	kg
Cyclohexane (hexahydro benzene) [Group NMVOC to air]	7.78E-05	1.82E-05	2.96E-05	2.09E-05	1.82E-05	2.09E-05	7.78E-05	7.78E-05	2.09E-05	1.96E-05	0.00E+00	kg
Cyclopentane [Group NMVOC to air]	1.21E-04	1.52E-04	4.57E-04	3.46E-04	1.52E-04	3.46E-04	1.21E-04	1.21E-04	3.46E-04	2.53E-04	3.58E-04	kg
Ethyl benzene [Group NMVOC to air]	4.32E-04	1.19E-04	1.17E-04	5.52E-05	1.19E-04	5.52E-05	4.32E-04	4.32E-04	5.52E-05	8.66E-05	5.95E-04	kg
Ethyl cyclohexane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
iso-Butane [Group NMVOC to air]	2.88E-03	3.21E-03	3.27E-03	3.72E-03	3.21E-03	3.72E-03	2.88E-03	2.88E-03	3.72E-03	3.48E-03	1.15E-03	kg
sec-Butyl benzene [Group NMVOC to air]	1.26E-04	1.72E-06	6.93E-06	0.00E+00	1.72E-06	0.00E+00	1.26E-04	1.26E-04	0.00E+00	0.00E+00	4.79E-05	kg
iso-Pentane [Group NMVOC to air]	2.91E-03	3.35E-03	1.47E-03	3.47E-03	3.35E-03	3.47E-03	2.91E-03	2.91E-03	3.47E-03	3.42E-03	2.93E-03	kg
Cumene (isopropylbenzene) [Group NMVOC to air]	7.82E-05	3.95E-06	0.00E+00	2.38E-06	3.95E-06	2.38E-06	7.82E-05	7.82E-05	2.38E-06	3.16E-06	4.05E-05	kg
Xylene (dimethyl benzene) [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg

m-Xylene [unspecified]	2.12E-04	7.57E-05	3.21E-05	2.94E-05	7.57E-05	2.94E-05	2.12E-04	2.12E-04	2.94E-05	5.21E-05	2.58E-04	kg
Methyl cyclohexane [Group NMVOC to air]	4.63E-04	5.13E-04	1.12E-03	8.80E-04	5.13E-04	8.80E-04	4.63E-04	4.63E-04	8.80E-04	7.04E-04	2.52E-04	kg
Methyl cyclopentane [Group NMVOC to air]	8.03E-04	1.46E-03	1.84E-03	1.73E-03	1.46E-03	1.73E-03	8.03E-04	8.03E-04	1.73E-03	1.60E-03	1.40E-03	kg
2-Methyl-1-pentene [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Butane (n-butane) [Group NMVOC to air]	6.72E-03	8.74E-03	6.49E-03	1.07E-02	8.74E-03	1.07E-02	6.72E-03	6.72E-03	1.07E-02	9.77E-03	3.61E-03	kg
Decane [Group NMVOC to air]	7.71E-05	1.73E-05	9.05E-06	3.16E-06	1.73E-05	3.16E-06	7.71E-05	7.71E-05	3.16E-06	1.01E-05	3.26E-05	kg
Heptane (isomers) [Group NMVOC to air]	4.22E-04	5.43E-04	4.21E-04	3.93E-04	5.43E-04	3.93E-04	4.22E-04	4.22E-04	3.93E-04	4.68E-04	7.41E-04	kg
Hexane (isomers) [Group NMVOC to air]	8.86E-04	1.40E-03	1.22E-03	1.31E-03	1.40E-03	1.31E-03	8.86E-04	8.86E-04	1.31E-03	1.36E-03	1.26E-03	kg
Nonane [Group NMVOC to air]	3.52E-04	5.96E-05	2.32E-05	2.04E-05	5.96E-05	2.04E-05	3.52E-04	3.52E-04	2.04E-05	3.97E-05	1.20E-04	kg
Octane [Group NMVOC to air]	6.65E-04	2.13E-04	2.98E-04	1.59E-04	2.13E-04	1.59E-04	6.65E-04	6.65E-04	1.59E-04	1.86E-04	7.45E-04	kg
Pentane (n-pentane) [Group NMVOC to air]	2.20E-03	3.20E-03	1.37E-03	2.98E-03	3.20E-03	2.98E-03	2.20E-03	2.20E-03	2.98E-03	3.10E-03	2.37E-03	kg
1-Propylbenzene [Group NMVOC to air]	1.62E-04	1.99E-05	1.33E-05	7.08E-06	1.99E-05	7.08E-06	1.62E-04	1.62E-04	7.08E-06	1.34E-05	2.18E-04	kg
1-Undecane [Group NMVOC to air]	1.48E-04	3.83E-06	0.00E+00	2.77E-06	3.83E-06	2.77E-06	1.48E-04	1.48E-04	2.77E-06	3.30E-06	5.44E-05	kg
o-Xylene [unspecified]	2.56E-04	4.94E-05	3.64E-05	1.81E-05	4.94E-05	1.81E-05	2.56E-04	2.56E-04	1.81E-05	3.35E-05	1.52E-04	kg
Xylene (para-Xylene; 1,4-Dimethylbenzene) [Group NMVOC to air]	8.59E-05	8.09E-05	5.25E-05	2.19E-05	8.09E-05	2.19E-05	8.59E-05	8.59E-05	2.19E-05	5.08E-05	1.51E-04	kg
Propene (propylene) [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Toluene (methyl benzene) [Group NMVOC to air]	4.67E-04	2.13E-04	1.33E-04	1.23E-04	2.13E-04	1.23E-04	4.67E-04	4.67E-04	1.23E-04	1.68E-04	2.67E-04	kg
1-Butylbenzene [Group NMVOC to air]	6.27E-05	4.20E-06	0.00E+00	0.00E+00	4.20E-06	0.00E+00	6.27E-05	6.27E-05	0.00E+00	0.00E+00	0.00E+00	kg
iso-Pentane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
NMVOC (unspecified) [Group NMVOC to air]	2.11E-02	1.19E-02	1.64E-02	7.97E-03	1.19E-02	7.97E-03	2.11E-02	2.11E-02	7.97E-03	9.93E-03	2.56E-02	kg
Hexane (isomers) [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Heptane (isomers) [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg

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

† Some flow names may be repeated as a more broadly defined flow may apply to more specific parameters defined by parameter names not listed here.

Embedded Unit Processes

None.

References

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Section III: Document Control Information

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