NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Onshore Pipeline, Installation/Deinstallation

Reference Flow: 1 mile of Onshore Pipeline

Brief Description: Emissions from underground pipeline laying and construction: heavy construction equipment exhaust emissions, emissions from transport of pipes and associated materials (200 miles round-trip), and fugitive dust.

Section I: Meta Data

Geographical Coverage: US **Region:** Not Applicable

Year Data Best Represents: 2001

Process Type: Installation Process (IP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: Individual Relevant Flows Recorded

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:

Deinstallation Intensity	*Proportion of pipeline installation emissions that are assumed to result from pipeline deinstallation*

Tracked Input Flows:

Diesel Fuel (NETL) [Crude oil products]	*Diesel used to fuel heavy machinery used for installation and deinstallation*

Tracked Output Flows:

Onshore Pipeline [Installation]	*Reference flow*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1,2,3,4_I_Onshore_Pipeline_Installation_Deinstallation_2010.01.xls*, which provides additional details regarding calculations, data quality, and references as relevant.

Goal and Scope

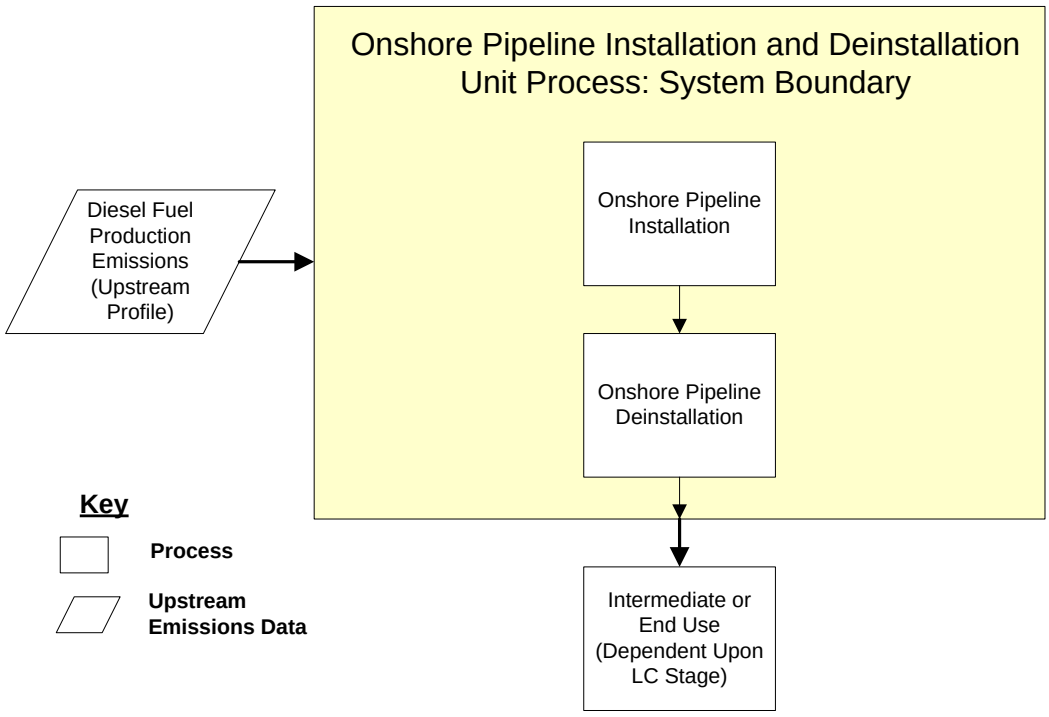
This process estimates the emissions consistent with underground pipeline installation and deinstallation. The process includes heavy construction equipment exhaust emissions, emissions from transport of pipes and associated materials (200 miles round-trip), and fugitive dust. The reference flow of this process is 1 mile of onshore pipeline (installed).

This process is used in lifecycle (LC) stage #3, but may also be used in LC Stages #1, #2, and #4, for installation and deinstallation of pipelines used to distribute gas, liquid products, or fuels to their point of use. For instance, this unit process is used in the Petroleum LCA LC Stage #1 for transport of foreign extracted crude oil to foreign ports, and in Stage #3 for the transport of captured CO_2 to geologic sequestration sites under cases using carbon capture sequestration (CCS). This onshore pipeline installation process is distinguished from an offshore pipeline installation process, as the two processes are significantly different in content and emissions.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. Rectangular boxes represent relevant sub-processes, while trapezoidal boxes indicate upstream data that are outside of the boundary of this unit process. Emissions from the manufacture of equipment are not considered within this unit process, while emissions associated with the production of raw materials used to construct machinery are accounted for in separate unit processes. Construction of equipment used in support of pipeline installation and deinstallation is not considered within the boundary of this study, since it is assumed that such equipment would be used for several pipeline installation/deinstallation projects, and would not be constructed solely for this pipeline.

Figure 1: Unit Process Scope and Boundary



By default, deinstallation emissions are assumed to be 10 percent of installation emissions. In the event that updated data are identified regarding the intensity of emissions for deinstallation, this value can be updated by varying the adjustable process parameter included in this unit process, as relevant. According to the Environmental Impact Report describing a proposed pipeline installation for Billiton Cabrillo Port Liquefied Natural Gas Deepwater Port in California (California State Lands Commission, 2007), decommissioned pipelines are abandoned in-place, cleaned to remove any liquids, filled with an inert gas, and sealed. This decommissioning process generates no solid waste to be inventoried.

Particulate matter (PM), nitrogen oxides (NOx), sulfur oxides (SOx), carbon monoxide (CO), and volatile organic carbon (VOC) emissions were estimated for pipeline installation based on the installation of a natural gas pipeline (SMUD 2001). Emissions were placed on a per-mile-installed basis. Diesel consumption was also estimated from this source.

The emissions of four other pollutants: methane, nitrous oxide, ammonia, and mercury, were calculated using different sources in conjunction with the estimated diesel consumption (SMUD 2001). The emissions factors for methane and nitrous oxide were taken from Appendix H of a report from the US Department of Energy (2006). These emission factors were 0.58 g/gallon of diesel for methane and 0.26 g/gallon for nitrous oxide (DOE 2006). The emission factor for ammonia for the combustion of diesel from mobile sources was given as 0.11 kg/1000 L of diesel (Battye et al. 1994).

Air pollutant species of interest, including hydrogen chloride and lead, were taken from the 22.4 mile onshore pipeline installation of Billiton Cabrillo Port Liquefied Natural Gas Deepwater Port in California (California State Lands Commission, 2007). These emissions were provided in terms of mass emitted per hour of installation, and were adjusted to reflect emissions per mile of installed pipeline. Although all heavy metals are reported independently, it is not clear whether the PM emissions reported by the Sacramento Municipal Utility District included heavy metals emissions with fugitive dust. Thus it is possible that some of these air emissions are duplicative. Due to the low level of significance of the heavy metal emissions calculated, this is considered an acceptable data limitation.

Water usage for pipeline hydrotesting is ignored because water is assumed to be returned to its source after use. Drilling fluid used for horizontal directional boring is composed of 2 to 5 percent bentonite clay and 95 to 98 percent groundwater, all of which is assumed to be reabsorbed by the geologic formation, resulting in zero net groundwater use (BHP, 2005). Additives may be applied to increase circulation of the drilling fluid, but are limited to inert, non-toxic materials and as such are not considered as solid waste (BHP, 2005). Likewise, this source provides evidence that minimal emissions to water occur during the installation of the pipeline, as no water emissions species are injected at the site of horizontal boring. An additional assumption is made that, in the case of CO_2 pipeline installation for injection into oil or gas fields for enhanced recovery, no gaseous or liquid leakage of hydrocarbons is incurred.

Table 1: Key Properties of Pipeline Installation/Deinstallation

Total Weight of Single Tail Drive	Weight	Reference
Diesel Fuel Usage, Installation Only, gal/mi (L/km)	2,429 (5,715)	NETL Engineering Calculation
Proportion of Installation Emissions Assumed for Deinstallation (unitless)	0.1	NETL Engineering Judgment

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Diesel Fuel (NETL) [Crude oil products]	1.01E+04	L
Outputs		
Carbon dioxide [Inorganic emissions to air]	3.43E+04	kg
VOC (unspecified) [Organic emissions to air (group VOC)]	2.58E+01	kg
Nitrogen oxides [Inorganic emissions to air]	3.51E+02	kg
Sulphur dioxide [Inorganic emissions to air]	1.19E+01	kg
Particulate Matter, unspecified [Other emissions to air]	6.95E+01	kg
Carbon monoxide [Inorganic emissions to air]	1.22E+02	kg
Methane [Organic emissions to air (group VOC)]	1.55E+00	kg
Nitrous oxide (laughing gas) [Inorganic emissions to air]	6.95E-01	kg
Ammonia [Inorganic emissions to air]	1.11E+00	kg
Mercury (+II) [Heavy metals to air]	1.20E-02	kg
Hydrogen chloride [Inorganic emissions to air]	1.12E+00	kg
Arsenic (+V) [Heavy metals to air]	9.63E-03	kg
Cadmium (+II) [Heavy metals to air]	9.03E-03	kg
Chromium (All but +VI) [Heavy metals to air]	3.61E-03	kg
Chromium (+VI) [Heavy metals to air]	6.02E-04	kg
Copper (+II) [Heavy metals to air]	2.47E-02	kg
Lead (+II) [Heavy metals to air]	5.00E-02	kg
Manganese (+II) [Heavy metals to air]	1.87E-02	kg
Nickel (+II) [Heavy metals to air]	2.35E-02	kg
Selenium [Heavy metals to air]	1.32E-02	kg
Zinc (+II) [Heavy metals to air]	1.35E-01	kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows. Upstream environmental flows were added during the modeling process using GaBi modeling software, as shown in Figure 1.

Embedded Unit Processes

None.

External References

Battye et al 1994 — Battye, R., Battye, W., Overcash, C., Fudge, S. 1994. *Development and Selection of Ammonia Emissions Factors, Final Report*. US EPA, Washington, D.C.

CSLC 2007 — California State Lands Commission. 2007. *Final Environmental Impact Statement/Environmental*

Impact Report for the Cabrillo Port Liquefied Natural Gas Deepwater Port License Application. California State Lands Commission, Division of Environmental Planning and Management. USCG-2004-16887. http://www.slc.ca.gov/Division_Pages/DEPM/DEPM_Programs_and_Reports/BHP_Deep_Water_Port/BHP_Final_EIR.html (accessed December 17, 2009).

DOE 2006 — Department of Energy. 2006. *Form EIA-1605 Long Form for Voluntary Reporting of Greenhouse Gases: Instructions. Appendix H: Fuel Emissions Factors*. March, 2006. OMB No. 1905-0194. http://www.eia.doe.gov/oiaf/1605/excel/Fuel%20Emission%20Factors.xls (Accessed December 17, 2009).

OTAQ 2005 — Office of Transportation and Air Quality. 2005. *Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel*. EPA420-F-05-001. U.S. Environmental Protection Agency. http://www.epa.gov/OMS/climate/420f05001.pdf (Accessed December 17, 2009).

SMUD 2001. — Sacramento Municipal Utility District. 2001. *Application for Certification: Consumnes Power Plant, Volume 1 - Appendix 8.1A: Construction Phase Impacts*.

Section III: Document Control Information

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