# NETL Life Cycle Inventory Data
# Process Documentation File

**Process Name:** $CO_2$ Pipeline Operation

**Reference Flow:** 1 kg of carbon dioxide

**Brief Description:** The $CO_2$ emissions from the operation of a $CO_2$ pipeline.

## Section I: Meta Data

**Geographical Coverage:** United States **Region:** N/A

**Year Data Best Represents:** 2012

**Process Type:** Transport Process

**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:**

| | |
|---|---|
| CO2_EF | *Fraction of $CO_2$ lost during pipeline operation* |
| Pipe_L | *Length of $CO_2$ pipeline* |
| CO2_thru | *Throughput of $CO_2$* |

**Tracked Input Flows:**

| | |
|---|---|
| Carbon Dioxide | *$CO_2$ from $CO_2$ recovery operations at an ECF* |

**Tracked Output Flows:**

| | |
|---|---|
| Carbon Dioxide | *$CO_2$ for enhanced oil recovery or sequestration* |

## Section II: Process Description

### Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_O_CO2_Pipeline_2012.02.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 the operation of a carbon dioxide pipeline that is used for the conveyance of carbon dioxide captured at an energy conversion facility, to a site for sequestration or other use, as relevant. The key emission of this unit process is $CO_2$ that leaks from the pipeline. Compression needed to drive pressurized $CO_2$ through the pipeline is provided by the energy conversion facility, under a separate unit process. Boost pressurization along the pipeline, and the $CO_2$ emissions from boost pressurization, are also accounted for in another unit process.

The only tracked input is $CO_2$, and the key output is $CO_2$ emissions. The reference flow of this unit process is the delivery of one kilogram of $CO_2$ as described below and shown in **Figure 1**. This unit process is used within Life Cycle (LC) Stage #3 of NETL's energy conversion models.

### Boundary and Description

This unit process provides a summary of relevant input and output flows associated with the operation of a carbon dioxide pipeline that is used for the conveyance of carbon dioxide captured at an energy conversion facility, to a site for sequestration or other use, as relevant. The only tracked input is $CO_2$, and the key output is $CO_2$ emissions. The reference flow of this unit process is the delivery of one kilogram of $CO_2$.

This unit process uses IPCC (Intergovernmental Panel on Climate Change) emission factors to calculate $CO_2$ emissions (Holloway, 2006). The IPCC factors are pipeline only (not compressor emissions) and were calculated by multiplying methane emissions from NG transmission pipelines by 0.60 (the square root of ratio of gas densities) (Holloway, 2006). It should be noted that the IPCC documentation incorrectly calculated the inverse of this ratio instead, resulting in a value of 1.66. Since the factor is used to approximate $CO_2$ pipeline operations, the ratio should be based on the density ratio of $CO_2$ to natural gas. The IPCC emission factor does not specify the flow rate of total $CO_2$ through a pipeline, so this unit process uses a flow rate of 10,000 tons of $CO_2$ per day, which is comparable to the $CO_2$ captured by a 550 $MW_{net}$ coal fired power plant with 90 percent $CO_2$ capture.

**Figure 1** provides an overview of the boundary of this unit process. There is one input to this unit process, $CO_2$ that has been captured and compressed at an energy conversion facility. The capture and compression of $CO_2$ is not included in this unit

process. The fugitive emission of $CO_2$ is accounted for in this unit process. There is one tracked output for this unit process: 1 kg of $CO_2$.

**Figure 1: Unit Process Scope and Boundary**

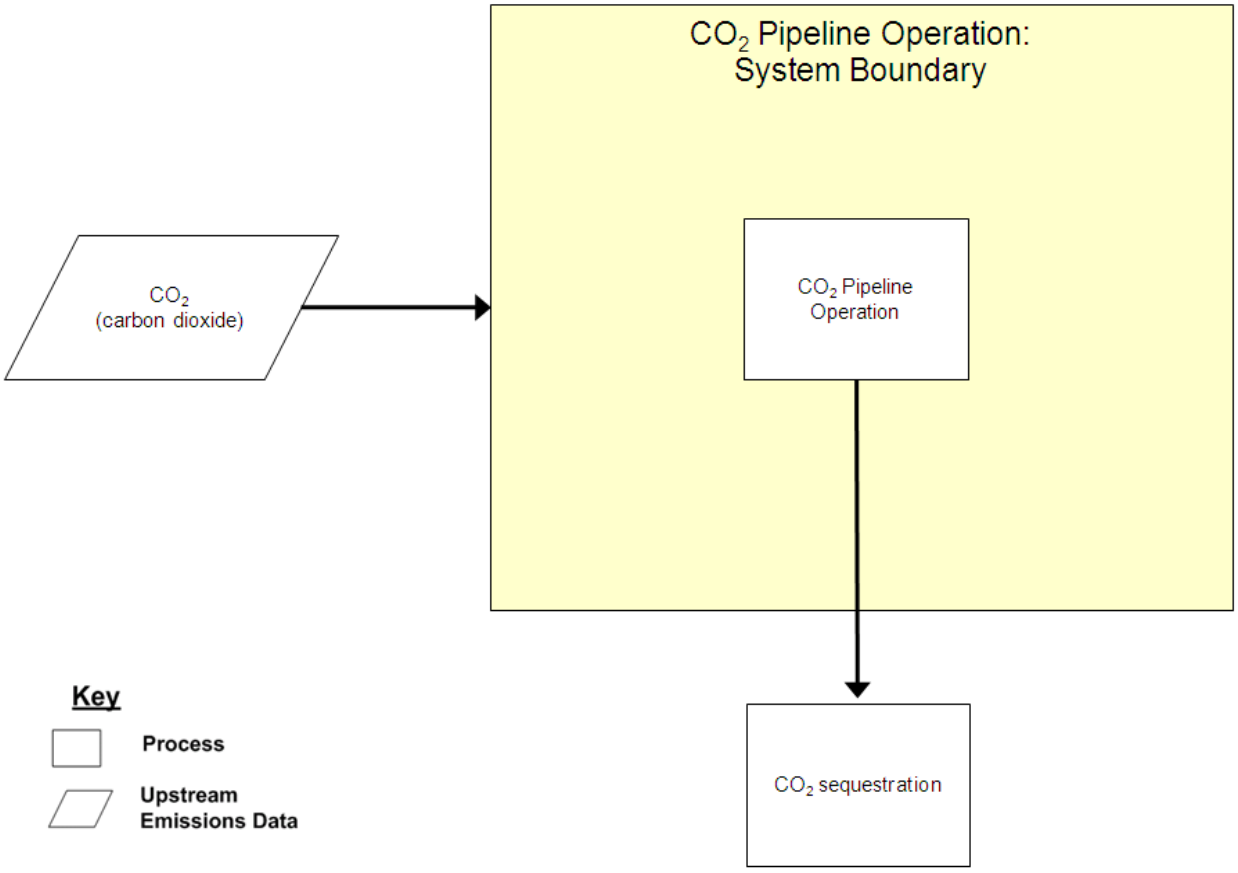


**Table 1** summarizes airborne emission factors and other parameters that are relevant to this unit process. **Table 2** provides a summary of modeled input and output flows and shows all inputs and outputs on the basis of the reference flow (the pipeline transport of one kilogram of $CO_2$). Additional detail regarding input and output flows, including calculation methods, is contained in the associated DS.

**Table 1: Emission Factors and Other Relevant Parameters**

| Parameter | Value | Units |
|---|---|---|
| $CO_2$ emission factor | 3.84E+03 | kg/(mi-yr) |
| Throughput of $CO_2$ pipeline | 1.00E+04 | tons/day |
| Pipeline distance | 100 | mi |

### Table 2: Unit Process Input and Output Flows

| Flow Name | Value | Units (Per Reference Flow) |
|---|---|---|
| **Inputs** | | |
| **Carbon dioxide** | **1.000116** | **kg** |
| **Outputs** | | |
| **Carbon dioxide** | **1.00** | **kg** |
| Carbon dioxide [Inorganic emissions to air] | 1.16E-04 | 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.

## References

Holloway, 2006 — Holloway, S., 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 5: Carbon Dioxide Transport, Injection, and Geological Storage, Intergovernmental Panel on Climate Change (IPCC). Accessed on July 25, 2012 at http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_5_Ch5_CCS.pdf.

## Section III: Document Control Information

**Date Created:** July 30, 2012

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

**Revision History:**

7MAY2014 Updated leak factor to correct an error in one of the conversion factors from the IPCC documentation which was used to convert the pipeline process fluid from natural gas to carbon dioxide (0.60 instead of 1.66)

**How to Cite This Document:** This document should be cited as:

NETL (2012). *NETL Life Cycle Inventory Data – Unit Process: $CO_2$ Pipeline Operation.* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: April 2014 (version 02). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

## Section IV: Disclaimer

Neither the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) nor any person acting on behalf of these organizations:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights; or

B. Assumes any liability with this report as to its use, or damages resulting from the use of any information, apparatus, method, or process disclosed in this document.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by NETL. The views and opinions of the authors expressed herein do not necessarily state or reflect those of NETL.