NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Coal Unit Train Assembly, 100 Railcars, Construction

Reference Flow: 1 piece (pcs) of Coal Unit Train Assembly, 100 Railcars, per kg Coal Transported

Brief Description: Calculates the number of locomotives and railcars needed to haul coal from the coal mine to the power plant over the lifetime of the plant. Assumes one locomotive can pull 20 capacity-laden railcars with 100 railcars per unit train.

Section I: Meta Data

Geographical Coverage: US **Region:** N/A

Year Data Best Represents: 2007

Process Type: Auxillary Process (AP)

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 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:

Round-Trip Distance	*Round-trip distance that the train travels from coal mine to energy conversion facility and back, in miles*
Train Travel Speed	*Average travel speed of the unit train, in miles per hour*

Tracked Input Flows:

Diesel Locomotive, 4400 Horsepower [Installation]	*Total number of locomotives needed over the lifetime of the energy conversion facility (plant), normalized to the reference flow*
Coal Railcar, 244000 lbs Net Capacity [Installation]	*Total number of railcars needed over the lifetime of the energy conversion facility (plant), normalized to the reference flow*

Tracked Output Flows:

Coal Unit Train Assembly, 100 Railcars, per kg Coal Transported [Installation]

Construction of a single 100 railcar coal unit train used to carry coal from the coal mine to the plant, per kg coal transported over the study period (reference flow)

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage2_C_Assembly_Coal_Unit_Train_100_Cars_2010.02.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process covers the elements required for the construction of a single unit train used to haul coal under Life Cycle (LC) Stage #2, from the coal mine (LC Stage #1) to the power plant (LC Stage #3) over the 30-year study period, as described below and in **Figure 1**. Coal railcars and diesel locomotives are the sole input flows for the construction of a single unit train. This unit process assumes one locomotive can pull 20 capacity-laden railcars with 100 railcars per unit train, and calculates the fraction of a railcar and a locomotive needed as inputs to haul 1 kg of generic coal over the lifetime of the plant, based on these parameters. This process applies to a generic type of coal, and can be used for the transport of various coal types.

Construction data, including the mass of raw materials required to construct a single coal railcar and a single diesel locomotive, are calculated in separate unit processes. Therefore, the following unit processes are considered to be

embedded in this assembly unit process: DF_Stage2_C_Coal_Railcar_244000_lbs_Net_Capacity_2009.01.doc, and DF_Stage2_C_Diesel_Locomotive_4400_HP_2009.01.doc. For a discussion of environmental emissions associated with the manufacture of raw materials used in the construction of unit train components, as well as other pertinent information, please refer to these separate unit processes.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. The total weight of a single, empty railcar was taken from an average of two different railcar models (FreightCar 2008; Trinity Rail 2008), consistent with the railcar construction unit process. The average weight of coal in one fully-laden railcar (FreightCar 2008) was then added to the average railcar weight and converted to tons per 100 railcars. The horsepower required to pull 100 railcars is calculated based on the weight of 100 railcars and their payload when full, and the number of locomotives was derived based on the horsepower needed to pull that amount, as provided by a published source (GE 2008).

The total weight of a single, loaded railcar is 120.925 tons, with 100 railcars weighing 12,092.50 tons. Since a single locomotive has 4,400 HP (GE 2008), calculations show that one locomotive can pull up to 20 capacity-laden railcars. Therefore, assuming a power plant lifetime of 30 years, an estimated locomotive lifetime of 20 years (GE 2009), and an estimated railcar lifetime of 30 years (Dept. for Transport 2005), replacement rates of 1.5 locomotives (NETL 2007; GE 2009) and 1.0 railcars (NETL 2007; Dept. for Transport 2005) over the lifetime of the plant are required.

The average round-trip load/unload dwell time for the unit train is 46.2 hours, which was taken from the average of six different railway dwell times (BNSF 2009), as detailed in the DS associated with this unit process. The amount of coal delivered over the lifetime of the plant was calculated based on the average speed and terminal dwell time (loading and unloading) of a unit train over the 30-year span.

The round-trip distance adjustable parameter indicates the total round-trip distance that is traveled by the train from the coal mine to the energy conversion facility, and back. The default value for this parameter is 1,170 miles, equivalent to the round-trip distance from an Illinois No. 6 Bituminous coal mine, located in Saline County, IL, to the energy conversion facility, located in central Iowa, along existing major rail lines. This variable can be adjusted as needed to reflect assumptions regarding facility placement.

The train travel speed adjustable parameter indicates the average speed of the unit train as it travels from the coal mine to the energy conversion facility. Calculation of the default value for the average train travel speed is discussed previously. The average coal train speed of 19.5 mph is based on an average of train transport speeds from six different railways (BNSF 2009).

Relevant properties of a single unit train used for the calculation of input and output flows for this unit process are shown in **Table 1**. **Table 2** provides a summary of modeled input and output flows. Additional details showing calculation methods for input and output flows, and other relevant information, are contained in the associated DS.

Figure 1: Unit Process Scope and Boundary

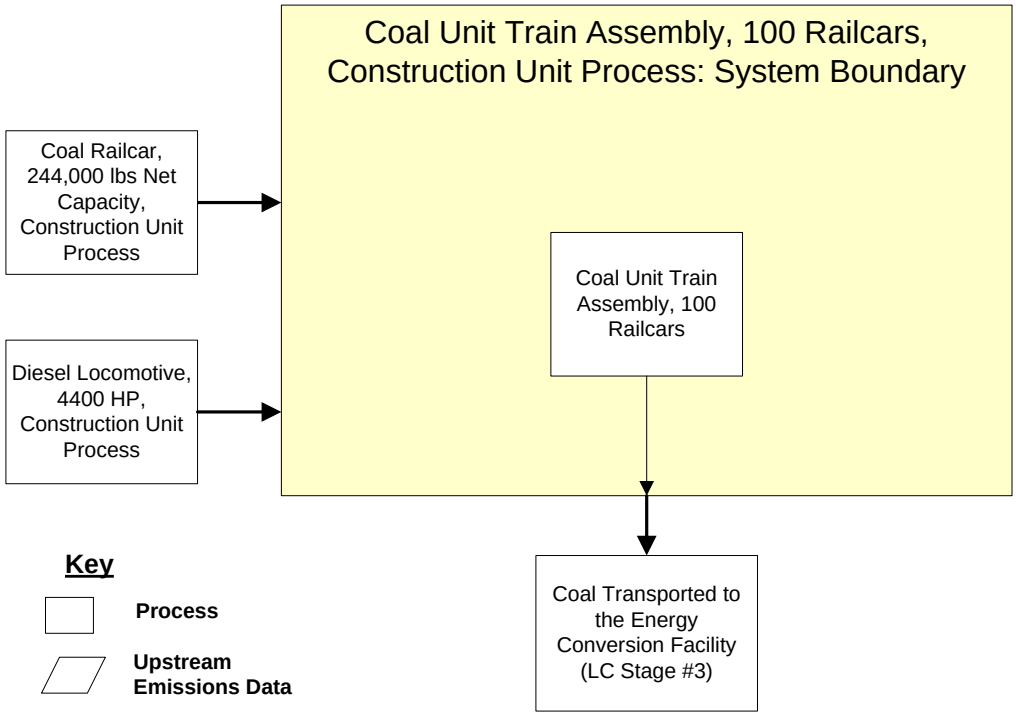

Table 1: Properties of a Single Unit Train

Construction and Travel Properties		
Property	**Value**	**Units**
Railcars in Unit Train	100	
Locomotives in Unit Train	5	
Railcar Capacity	90,718.48	kg
Unit Train Capacity	9,071,848	kg
Round-Trip Distance	1,170	miles
Avg. Total Load/Unload Time	48	hrs
Avg. Unit Train Speed	20	mph
Avg. Round-Trip Time	106.50	hrs
Plant Lifetime	30	yr
Locomotive Replacement Rate	1.5	locomotives
Railcar Replacement Rate	1.0	railcars
Total Amount of Coal to be Transported Over Plant Lifetime	22,385,743,234	kg

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Diesel Locomotive, 4400 Horsepower [Installation]	**3.23875E-10**	**locomotives**
Coal Railcar, 244000 lbs Net Capacity [Installation]	**4.45810E-09**	**railcars**
Outputs		
Coal Unit Train Assembly, 100 Railcars, per kg Coal Transported [Installation]	1	pcs/kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows. See also the documentation for embedded unit processes, as shown below.

Embedded Unit Processes

DF_Stage2_C_Coal_Railcar_244000_lbs_Net_Capacity_2009.01.doc;
DF_Stage2_C_Diesel_Locomotive_4400_HP_2009.01.doc

References

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NETL 2007 — National Energy Technology Laboratory. 2007. *Cost and Performance Baseline for Fossil Energy Plants*. DOE/NETL-2007/1281. U.S. Department of Energy.

BNSF 2009 — BNSF Railway Company, Canadian Pacific Railway, CSX Transportation, Kansas City Southern, Norfolk Southern, Union Pacific Railroad. 2009. *Railroad Performance Measures*. Railroad Performance Measures. http://www.railroadpm.org/home/rpm.aspx (Accessed March 24, 2009).

Section III: Document Control Information

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