NETL Life Cycle Inventory Data
Process Documentation File

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

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

Brief Description: Calculates the number of locomotives and tanker railcars needed to carry fuel from a loading point to the plant/refinery 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: 2008

Process Type: Auxiliary 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:

Locomotive Lifetime	*Expected lifetime of a single locomotive, in years*
Tanker Railcar Lifetime	*Expected lifetime of a single tanker railcar, in years*
Study Period	*Assumed temporal boundary of the study, in years*
Round-Trip Distance	*Round-trip distance that the train travels from loading point mine to energy conversion facility (plant) and back, in miles*
Train Travel Speed	*Average travel speed of the unit train, in miles per hour*
Train Load Time	*Estimated time for the unit train to be loaded at the loading point and have any maintenance performed*
Train Unload Time	*Estimated time for the unit train to be unloaded at the plant and have any maintenance performed*

Tracked Input Flows:

4400-HP Diesel Locomotive [Installation]	*Total number of locomotives needed over the study period, including replacements, per kg fuel transported*
Tanker Railcar, 26,470 Gal Net Capacity [Installation]	*Total number of tanker railcars needed over the study period, including replacements, per kg fuel transported*

Tracked Output Flows:

Tanker Unit Train Assembly, 100 Railcars, per kg Fuel Transported [Installation]	*Construction of a single 100 railcar tanker unit train used to carry fuel from a loading point to the plant, per kg fuel 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_Tanker_Unit_Train_100_Railcars_2010.01.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 tanker unit train needed to carry liquid fuel under Life Cycle (LC) Stage #2, from a loading point (under LC Stage #2) to the plant (LC Stage #3) over the study period, as described below and in **Figure 1**. Tanker railcars and locomotives are the sole input flows for the construction of a single tanker unit train. This unit process assumes the unit train consists of 100 tanker railcars, and calculates the fraction of a tanker railcar and a locomotive needed as inputs to haul 1 kg of fuel, based on these parameters.

Construction data, including the mass of raw materials required to construct a single tanker railcar and a single 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_Tanker_Railcar_26470_Gal_Net_Capacity_2010.01.doc, and DF_Stage2_C_Locomotive_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 tanker railcar was taken from manufacturer specifications for a 26,470 gallon net capacity railcar model (Trinity Rail 2009), consistent with the tanker railcar construction unit process. The average weight of fuel in one fully-laden tanker railcar, 84,969 kg (Trinity Rail 2009; NETL 2008) was then added to the weight of a railcar for a total weight of 114,225 kg. 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 100 fully loaded railcars is 12,591 short tons. Since a single locomotive has 4,400 HP (GE 2008), calculations show that one locomotive can pull up to 20 capacity-laden railcars (5 locomotives for 100 loaded tanker railcars). Therefore, assuming a study period of 1 year, an estimated locomotive

lifetime of 20 years (GE 2009), and an estimated railcar lifetime of 30 years (Dept. for Transport 2005), replacement rates of 0.050 locomotives and 0.033 railcars are required over the study period.

The average load or unload dwell time for the unit train is estimated at 24.0 hours, which was taken from the average of 6 different railway dwell times (BNSF 2009), as detailed in the DS associated with this unit process. An average estimated unit train speed of 23.5 mph was also determined using data from the same source (BNSF 2009). Combined with a default round-trip transportation distance of 400 miles, it was estimated that the tanker unit train would take 65.0 hours to load, travel to the plant, unload, and return to the loading point, on average. The amount of fuel transported over the study period was calculated based on the average speed and terminal dwell time (loading and unloading) of a single tanker unit train over the same period.

The locomotive lifetime adjustable parameter is the expected lifetime of a single 4,400 HP locomotive. The tanker railcar lifetime indicates the expected lifetime of a single 26,470 gallon net capacity railcar. The default values for these variables are 20 and 30 years, respectively. The lifetimes of each piece of equipment can be adjusted as required to account for various life spans. The study period adjustable parameter indicates the temporal boundary of the study, in this case the default value is a single year. This variable can be adjusted to reflect longer or shorter study periods based on plant life expectancy.

The round-trip distance adjustable parameter indicates the total round-trip distance that is traveled by the unit train from the loading point to the energy conversion facility and back. The default value for this parameter is assumed to be 400 miles. 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 loading point to the energy conversion facility and back. Calculation of the default value for the average train travel speed was discussed previously. The average coal train speed of 23.5 mph is based on an average of train transport speeds from six different railways (BNSF 2009). The train load and unload adjustable parameters indicate the average length of time the train spends either loading fuel at the loading point or unloading fuel at the energy conversion facility. The calculation of the default value for the load/unload time was discussed previously. The average load and unload time of 24.0 hours is based on an approximation of the average dwell times from six different railways (BNSF 2009).

Relevant properties of a single tanker 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

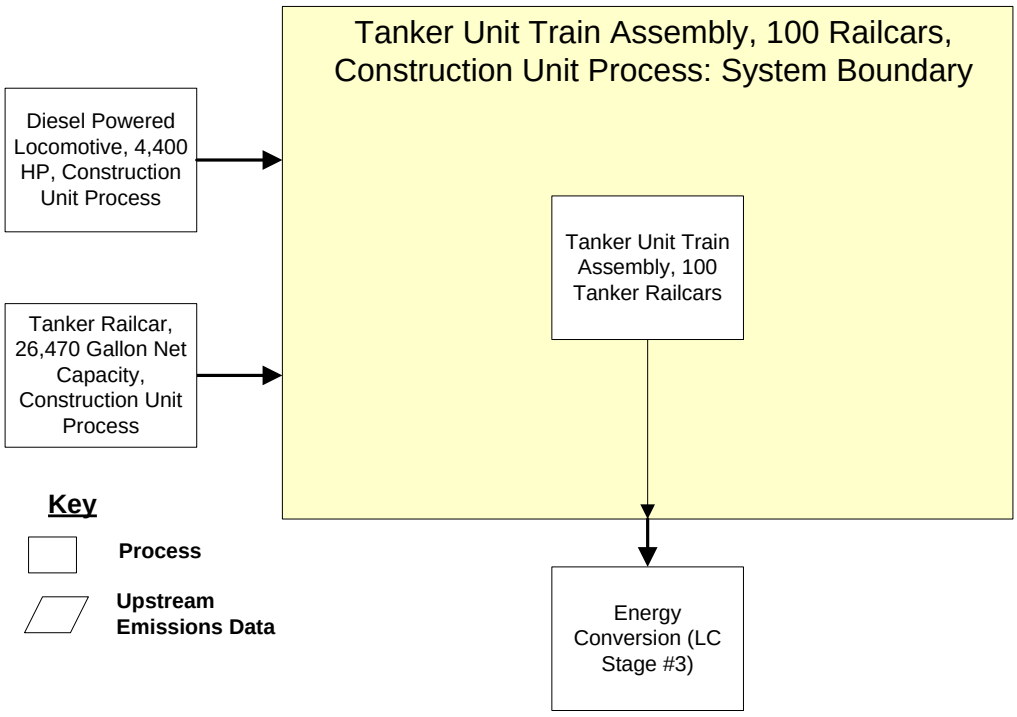

Table 1: Properties of a Single Tanker Unit Train

Construction and Travel Properties		
Property	**Value**	**Units**
Locomotive Lifetime	20	years
Tanker Railcar Lifetime	30	years
Study Period	1	years
Locomotive Replacement Rate	0.050	locomotives
Tanker Railcar Replacement Rate	0.033	tanker railcars
Round-Trip Distance	400	miles
Locomotives in Unit Train	5	locomotives
Tanker Railcars in Unit Train	100	tanker railcars
Tanker Railcar Capacity	84,968.7	kg
Unit Train Capacity	8,496,870.0	kg
Avg. Unit Train Speed	23.5	mph
Avg. Dwell/Load Time	24.0	hours
Avg. Dwell/Unload Time	24.0	hours
Total Round-Trip Time	65.0	hours
Total Amount of Fuel to be Transported Over Study Period	1,144,741,923	kg

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
4,400-HP Diesel Locomotive [Installation]	**2.175E-10**	**locomotives**
Tanker Railcar, 26,470 Gal Net Capacity [Installation]	**2.912E-09**	**tanker railcars**
Outputs		
Tanker Unit Train Assembly, 100 Railcars, per kg Fuel Transported [Installation]	1	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

DF_Stage2_C_Tanker_Railcar_26470_Gal_Net_Capacity_2010.01.doc;
DF_Stage2_C_Locomotive_2009.01.doc

References

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).

Department for Transport 2005 — Department for Transport. 2005. *Regulatory Impact Assessment on NRMM*. Department for Transport. http://www.dft.gov.uk/consultations/aboutria/ria/nrmmemissions?page=2#a1008 (Accessed March 24, 2009).

GE 2008 — GE Transportation. 2008. *The Evolution Series Locomotives*. General Electric Company. http://www.getransportation.com/na/en/docs/806527_20020%20-%20B%20Evo[1][1].Series.lores.pdf (Accessed March 24, 2009).

GE 2009 — GE Transportation. 2009. *Locomotive Facts & History*. General Electric Company. http://www.getransportation.com/na/en/locofacts.html (Accessed March 24, 2009).

NETL 2008	NETL. 2008. *Development of Baseline Data and Analysis of Life Cycle Greenhouse Gas Emissions of Petroleum-Based Fuels*. DOE/NETL-2009/1346. U.S. Department of Energy, National Energy Technology Laboratory. Pittsburgh, PA.
Trinity Rail 2009	Trinity Rail. 2009. *26,470 Gallon Non-Coiled and Non-Insulated Tank Car*. Trinity Industries, Inc. http://www.trinityrailcar.com/railcars/tank/pdfs/tank_26470.pdf (Accessed December 18, 2009).

Section III: Document Control Information

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