NETL Life Cycle Inventory Data
Process Documentation File

Process Name: LLW disposition

Reference Flow: 1 kg of low level waste

Brief Description: The energy and material requirements for constructing a long term disposal facility for low level waste (LLW) from the nuclear fuel cycle.

Section I: Meta Data

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

Year Data Best Represents: 2005

Process Type: Waste Treatment Process (WT)

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:

none

Tracked Input Flows:

Low level waste	*Reference flow, LLW received from a nuclear power plant*
Stainless Steel Cold Roll, 431 [Metals]	*Stainless steel used for construction and LLW containment*
Concrete, ready mix, R-5-0 [Concrete_Cement]	*Concrete used for construction*
Power [Electric power]	*Electricity used for construction*
Diesel [Crude oil products]	*Diesel used for construction*

Tracked Output Flows:

none

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_C_LLW_Disposition _2011.01.xls*, 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 construction of a long term disposal facility for low level waste (LLW) from the nuclear fuel cycle. Low level waste includes contaminated minerals and metals from steady-state nuclear operations as well as from the decommissioning of nuclear power plants. Key inputs to this unit process include the construction materials and installation energy requirements for a LLW disposition facility. The calculations presented for this unit process are based on the reference flow of 1 kg of input LLW, as described below and shown in **Figure 1**. This unit process is used within Life Cycle (LC) Stage #3 of NETL's model of nuclear power.

Boundary and Description

This unit process accounts for the energy and material requirements for constructing a long term disposal facility for LLW from the nuclear fuel cycle. LLW includes contaminated minerals and metals from steady-state nuclear operations as well as from the decommissioning of nuclear power plants. Key inputs to this unit process include the construction materials and installation energy requirements for a LLW disposition facility. The reference flow of this unit process is the disposition of one kilogram of LLW.

The key materials for constructing a low level waste (LLW) repository include stainless steel, concrete, and cement (Lenzen, 2008). The construction of an LLW facility requires 500 tonnes of stainless steel, 24,100 tonnes of concrete, and 8,300 tonnes of cement (Lenzen, 2008). These construction requirements are representative of a LLW facility with a capacity of 43,100 tonnes of waste.

The energy requirements for the construction of an LLW facility include thermal energy and electricity. Thermal energy is assumed to be comprised mostly of diesel combusted in heavy equipment; the construction of the facility requires 47 GWh of thermal energy. Electricity requirements for the construction of an LLW facility are 1,051 GWh. These energy requirements are representative of a LLW facility with a capacity of 43.1 million kilograms of waste.

The volume of LLW from spent fuel is 1,300 m^3/year for a 1,000 MW reactor; this is 52,000 m^3 during the 40-year life of a reactor. The volume of LLW from plant decommissioning is 17,900 m^3.

To translate all flows to the reference flow of one kilogram of disposed LLW, the material and energy requirements are divided by the lifetime capacity of the LLW facility. The above material and energy requirements are representative of a LLW facility with a capacity of 43.1 million kilograms of waste (Lenzen, 2008).

The following table shows the energy and material requirements for the construction of a LLW facility. All flows are scaled to the basis of the reference flow (one kilogram of waste).

Figure 1 provides an overview of the boundary of this unit process. As shown, LLW that is produced by upstream processes of the nuclear fuel cycle enter the system. Electricity and diesel are used for installation of the LLW facility; the environmental burdens for the production and delivery of electricity and diesel are accounted for by upstream processes that are outside the scope of this unit process. Steel plate and concrete are key materials of construction; the environmental burden for the production and delivery of construction materials are accounted for by upstream processes that are outside the scope of this unit process. The air emissions from this unit process are due to the combustion of diesel during the installation of the facility. This unit process does not have any tracked flows that are inputs to subsequent, downstream unit processes.

Figure 1: Unit Process Scope and Boundary

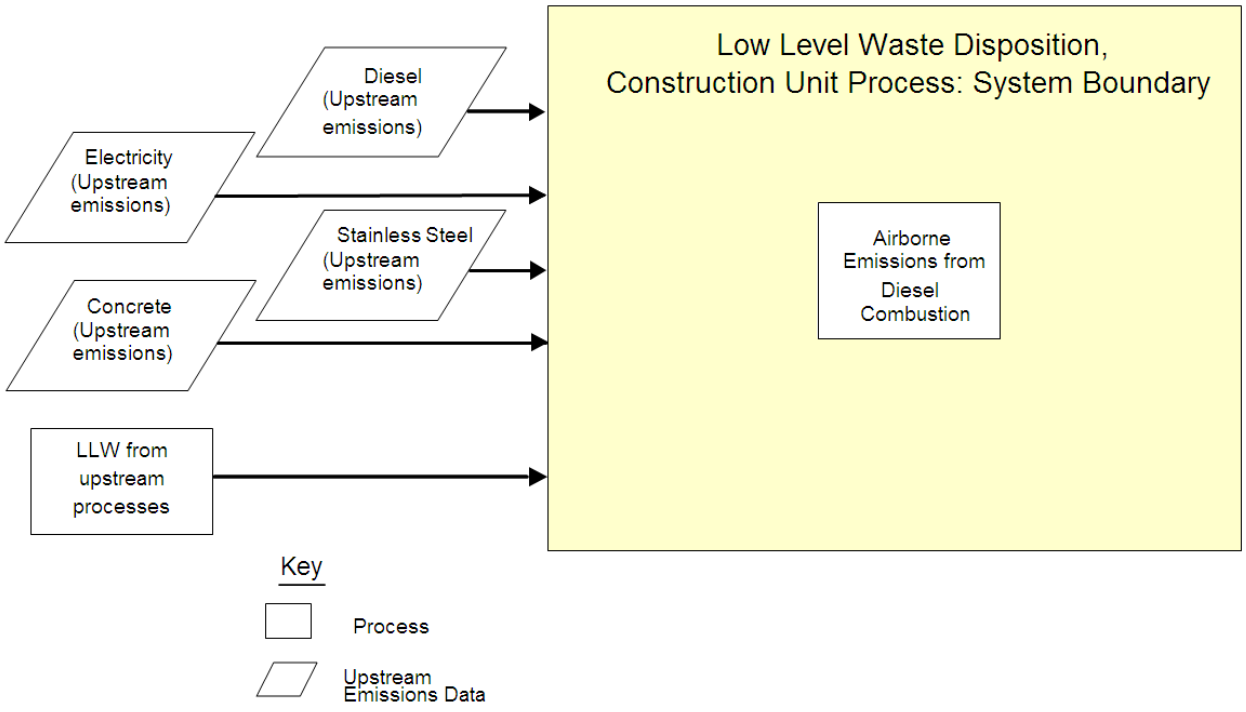

Table 1 summarizes airborne emissions factors and energy inputs and outputs that are applied within this unit process. **Table 2** provides a summary of modeled input and output flows. Additional detail regarding input and output flows, including calculation methods, is contained in the associated DS.

Table 1: Relevant Emission Factors

Flow Name	Value	Units
NOx	7.19E-02	kg/kg diesel
CO	1.55E-02	kg/kg diesel
SOx	4.73E-03	kg/kg diesel
PM10	5.05E-03	kg/kg diesel
CO_2	2.67E+00	kg/kg diesel
NMVOC	5.87E-03	kg/kg diesel

Table 2: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Low level waste	1.00	kg
Stainless Steel Cold Roll, 431 [Metals]	1.16E-02	kg
Concrete, ready mix, R-5-0 [Concrete_Cement]	7.52E-01	kg
Power [Electric power]	86.40	MJ
Diesel [Crude oil products]	9.49E-02	kg
Outputs		
Carbon dioxide [Inorganic emissions to air]	2.54E-01	kg
Nitrogen oxides [Inorganic emissions to air]	6.83E-03	kg
Sulphur dioxide [Inorganic emissions to air]	4.49E-04	kg
Carbon monoxide [Inorganic emissions to air]	1.47E-03	kg
NMVOC (unspecified) [Group NMVOC to air]	5.57E-04	kg
Dust (PM10) [Particles to air]	4.80E-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

EPA 1995 — EPA (1995). AP 42, Fifth Edition, Volume I, Chapter 1: External Combustion Sources. http://www.epa.gov/ttnchie1/ap42/ch01/final/c01s04.pdf (Accessed June 22, 2011)

Lenzen 2008 — Lenzen, Manfred (2008). *Life cycle energy and greenhouse gas emissions of nuclear energy.* Sydney, Australia: Energy Conversion and Management, 2008, Vol. 49, pp. 2178-2199.

Section III: Document Control Information

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