NETL Life Cycle Inventory Data
Process Documentation File

Process Name: HLW disposition

Reference Flow: 1 kg of high level waste

Brief Description: The energy and material requirements for constructing a long term disposal facility for high level waste (HLW) 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:

High level waste	*Reference flow, HLW received from a nuclear power plant or reprocessing facility*
Steel plate, BF (85% Recovery Rate) [Metals]	*Carbon steel used for construction*
Concrete, ready mix, R-5-0 [Concrete_Cement]	*Concrete used for construction*
Coppersheet [Metals]	*Copper 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_HLW_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 high level waste (HLW) from the nuclear fuel cycle. High 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 HLW disposition facility. The calculations presented for this unit process are based on the reference flow of 1 kg of input HLW, 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 HLW from the nuclear fuel cycle. HLW includes spent fuel from the operation of a nuclear power plant, including spent fuel that has been stockpiled in temporary storage. Key inputs to this unit process include the construction materials and installation energy requirements for a HLW disposition facility.

The key materials for constructing a HLW repository include reinforced steel, concrete, and copper (Lenzen, 2008). The construction of an HLW facility requires 5,200 tonnes of reinforced steel, 372,600 tonnes of concrete, and 3,200 tonnes of copper (Lenzen, 2008).

The energy requirements for the construction of an HLW facility include thermal energy and electricity. Thermal energy is assumed to be provided by diesel that is combusted in heavy equipment; the construction of the facility requires 119 GWh of thermal energy. Electricity requirements for the construction of an HLW facility are 1,184 GWh.

To translate all flows to the reference flow of one kilogram of disposed HLW, the material and energy requirements are divided by the lifetime capacity of the HLW facility. The above material and energy requirements are representative of a HLW facility with a capacity of 3.19 million kilograms of waste (Lenzen, 2008).

The following table shows the energy and material requirements for the construction of a HLW 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, HLW that is produced by upstream processes of the nuclear fuel cycle enter the system. Electricity and diesel are used for installation of the HLW 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, concrete, and copper sheet 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

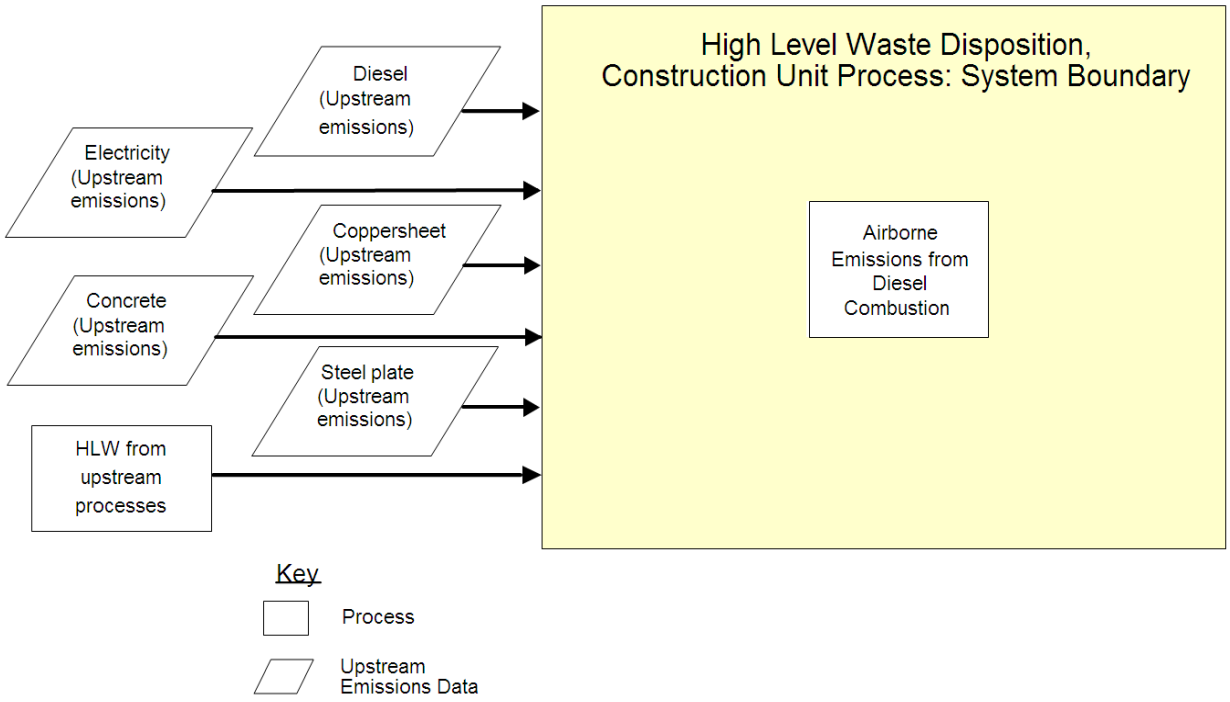

Table 1 summarizes airborne emissions factors and energy inputs and outputs that are applied within this unit process. **Table 2** provides a summary of modeled input and output flows. Additional detail regarding input and output flows, including calculation methods, is contained in the associated DS.

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		
High level waste	1	kg
Steel plate, BF (85% Recovery Rate) [Metals]	1.629	kg
Concrete, ready mix	116.7	kg
Coppersheet	1.003	kg
Electricity	1184	MJ
Diesel	11.30	kg
Outputs		
Carbon dioxide [Inorganic emissions to air]	30.2	kg
Nitrogen oxides [Inorganic emissions to air]	8.12E-01	kg
Sulphur dioxide [Inorganic emissions to air]	5.34E-02	kg
Carbon monoxide [Inorganic emissions to air]	1.75E-01	kg
NMVOC (unspecified) [Group NMVOC to air]	6.63E-02	kg
Dust (PM10) [Particles to air]	5.71E-02	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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