NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Gen II PWR Plant, 1000 MW, Construction

Reference Flow: 1 piece of Gen II Plant, 1000 MW

Brief Description: This process inventories the materials and energy required to construct and install a generation II PWR nuclear plant.

Section I: Meta Data

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

Year Data Best Represents: 1998

Process Type: Manufacturing Process (MP)

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:

Plant Cost	*The total cost of the plant, used to determine diesel needs for the construction*
Diesel Cost	*The cost of diesel, used to determine the diesel needs for the construction*
Cost Ratio	*The ratio of the total cost of the plant to that of the diesel needed for the installation of the plant*

Tracked Input Flows:

Concrete, ready mix, R-5-0 [Concrete_Cement]	*Concrete mix used for the construction of the Generation II nuclear plant*
Stainless Steel Cold Roll, 431 [Metals]	*Stainless steel used to help construction of the Generation II nuclear plant*
Steel plate, BF (85% Recovery Rate) [Metals]	*Steel plate used to help construction of the Generation II nuclear plant, assumes 85% recycled steel*
Diesel [Crude oil products]	*Diesel used to construct the Generation II nuclear plant*
Aluminum [Metals]	*Aluminum used to construct the Generation II nuclear plant*
Coppersheet [Metals]	*Copper sheeting used to construct the Generation II nuclear plant*
Polyurethane flexible foam (PU) [Plastics]	*Polyurethane flexible foam used to construct the Generation II nuclear plant*
Lead [Metals]	*Lead used to construct the Generation II nuclear plant*
Manganese ore [Non renewable resources]	*Manganese ore used to construct the Generation II nuclear plant*
Nickel (99.95%; electrolyte nickel) [Metals]	*Nickel used to construct the Generation II nuclear plant*
Silver [Metals]	*Silver used to construct the Generation II nuclear plant*

Tracked Output Flows:

Gen II PWR Plant, 1000 MW [Construction]	*Construction of a Generation II power plant*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_O_GenerationII_Power_Plant_2010.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process encompasses the material and energy inputs necessary to construct a Generation II nuclear power plant. The process is based on a reference flow of one nuclear power plant, as described below and shown in **Figure 1**. This process is used during LC Stage #3 to construct a facility to produce electricity. It will be combined with other construction (storage for spent fuel rods) and operation processes for LC Stage #3.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. Emissions related to the physical assembly of the Generation II nuclear power plant, aside from the diesel combustion (e.g., particle matter that is created while putting together the components of the power plant, including all transportation emissions of these components), are not included in this study. Upstream emissions from the production of raw materials used for the construction of the power plant (e.g., concrete) are calculated outside the boundary of this unit process, based on proprietary profiles available within the GaBi model.

The construction of the Generation II nuclear power plant is based on a study conducted at Oak Ridge National Laboratory in 1974. Estimated quantities of the materials and their constituents are presented in detail for each portion of the power plant. Scott White at the University of Wisconsin used this data to compare construction material quantities required by multiple types of power plants normalized to 1000 MW(e) (White 1998). The power plant is constructed of concrete ready-mix, stainless steel, steel plate, aluminum, copper sheeting, polyurethane, lead, manganese ore, nickel, silver, and diesel. Other materials are assumed to be negligible. In inventorying these materials, an assumption was made that PWR and BWR require similar quantities of aluminum. It was also assumed that insulation consists primarily of polyurethane foam.

Diesel combusted in heavy equipment accounts for majority of fuel combusted during construction of the power plant. No primary data was available to determine the

amount of diesel needed for the installation of the power plant: a significant data limitation. This quantity was estimated from the cost of diesel fuel relative to total plant construction cost. Plant construction cost ranges from 1100 to 6000 $/kWe, depending on the referenced source. The midpoint between these costs is used as the default value for this analysis with each extreme suggested for adjustment in sensitivity analysis. The cost of diesel is assumed to range between 2 and 4 dollars per gallon. The default value of the cost of diesel is 3 dollars per gallon. The cost ratio between the cost of the power plant and the cost of the diesel is assumed to be between 1 and 5 percent. The default value is assumed to be 3 percent.

Table 1 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 sheet.

Figure 1. Unit Process Scope and Boundary

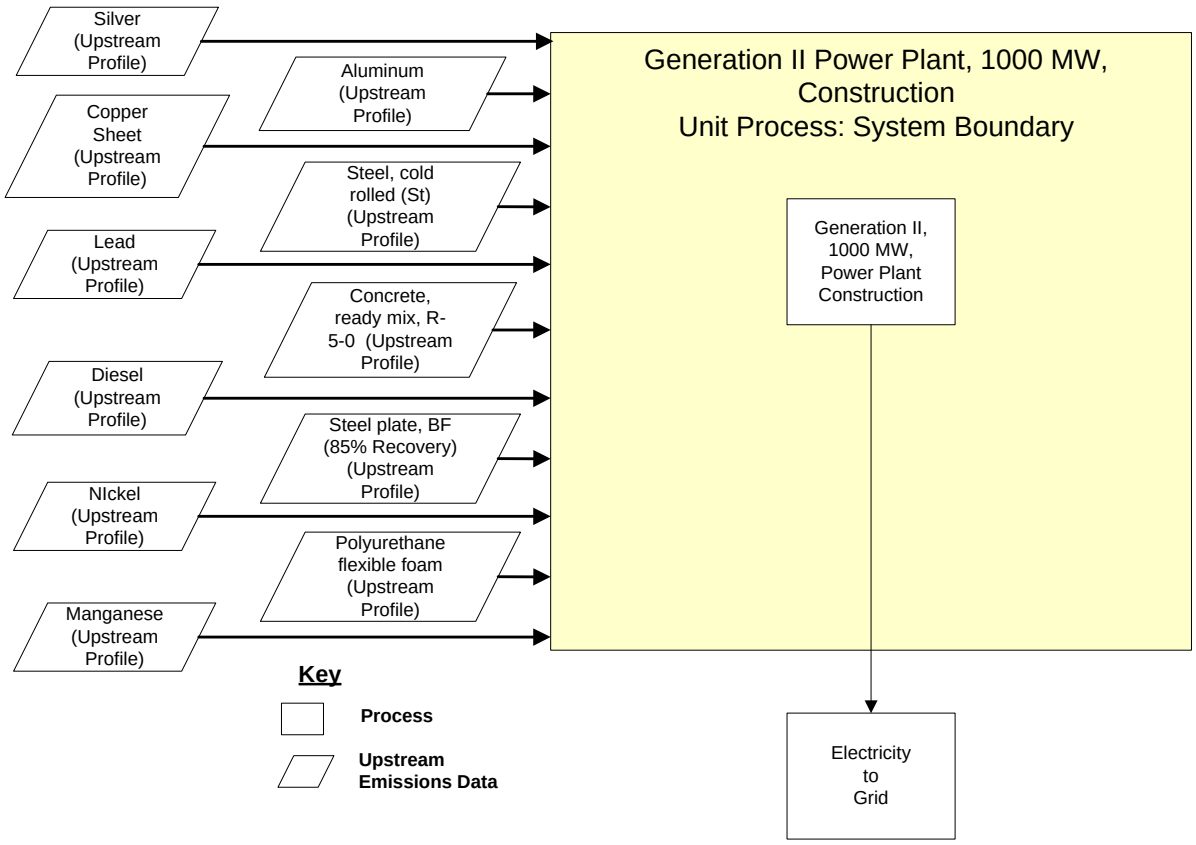

Table 1: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Diesel [Crude oil products]	**1.14E+08**	**kg/1000 MW plant**
Aluminum [Metals]	**1.80E+04**	**kg/1000 MW plant**
Concrete, ready mix, R-5-0 [Concrete_Cement]	**1.80E+08**	**kg/1000 MW plant**
Coppersheet [Metals]	**7.29E+05**	**kg/1000 MW plant**
Polyurethane flexible foam (PU) [Plastics]	**9.22E+05**	**kg/1000 MW plant**
Lead [Metals]	**4.60E+04**	**kg/1000 MW plant**
Manganese ore [Non renewable resources]	**4.34E+05**	**kg/1000 MW plant**
Nickel (99.95%; electrolyte nickel) [Metals]	**1.25E+05**	**kg/1000 MW plant**
Silver [Metals]	**5.00E+02**	**kg/1000 MW plant**
Steel plate, BF (85% Recovery Rate) [Metals]	**3.40E+07**	**kg/1000 MW plant**
Stainless Steel Cold Roll, 431 [Metals]	**2.08E+06**	**kg/1000 MW plant**
Outputs		
Gen II PWR Plant, 1000 MW [construction processes]	1.00	piece
Carbon dioxide [Inorganic emissions to air]	3.61E+08	kg/1000 MW plant
Carbon monoxide [Inorganic emissions to air]	2.09E+06	kg/1000 MW plant
Dust (PM10) [Particles to air]	1.99E+06	kg/1000 MW plant
Nitrogen dioxide [Inorganic emissions to air]	9.70E+06	kg/1000 MW plant
Sulphur dioxide [Inorganic emissions to air]	6.38E+05	kg/1000 MW plant
VOC (unspecified) [Organic emissions to air (group VOC)]	7.92E+05	kg/1000 MW plant

* **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

White, Scott W. and Kulcinski, Gerald L.: "Birth to Death" Analysis of the Energy Payback Ratio and CO2 Gas Emission Rates from Coal, Fission, Wind, and DT Fusion Electric Power Plants; 1998 http://www.colorado.edu/physics/phys3070/phys3070_sp05/docs/wisc1998.pdf

Section III: Document Control Information

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