NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Generation III+ Nuclear Power Plant, Construction

Reference Flow: 1 piece of Generation III+ Power Plant

Brief Description: This unit process includes the materials and energy sources needed for the construction of a Generation III+ Nuclear Power Plant.

Section I: Meta Data

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

Year Data Best Represents: 2010

Process Type: Installation Process (IP)

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 III+ nuclear plant*
Stainless steel, 316 2B, 80% Recycled [Metals]	*Stainless steel used to help construction of the Generation III+ nuclear plant, assumes 80% recycled steel*
Steel, pipe welded, BF (85% Recovery Rate) [Metals]	S*teel pipe used to help construction of the Generation III+ nuclear plant, assumes 85% recycled steel*
Steel plate, BF (85% Recovery Rate) [Metals]	S*teel plate used to help construction of the Generation III+ nuclear plant, assumes 85% recycled steel*
Diesel [Crude oil products]	*Diesel used to construct the Generation III+ nuclear plant*

Tracked Output Flows:

Generation III+ Power Plant [Installation]	*Construction of a Generation III+ power plant*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_C_Nuclear_Spent_Fuel_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 III+ 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 III+ 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.

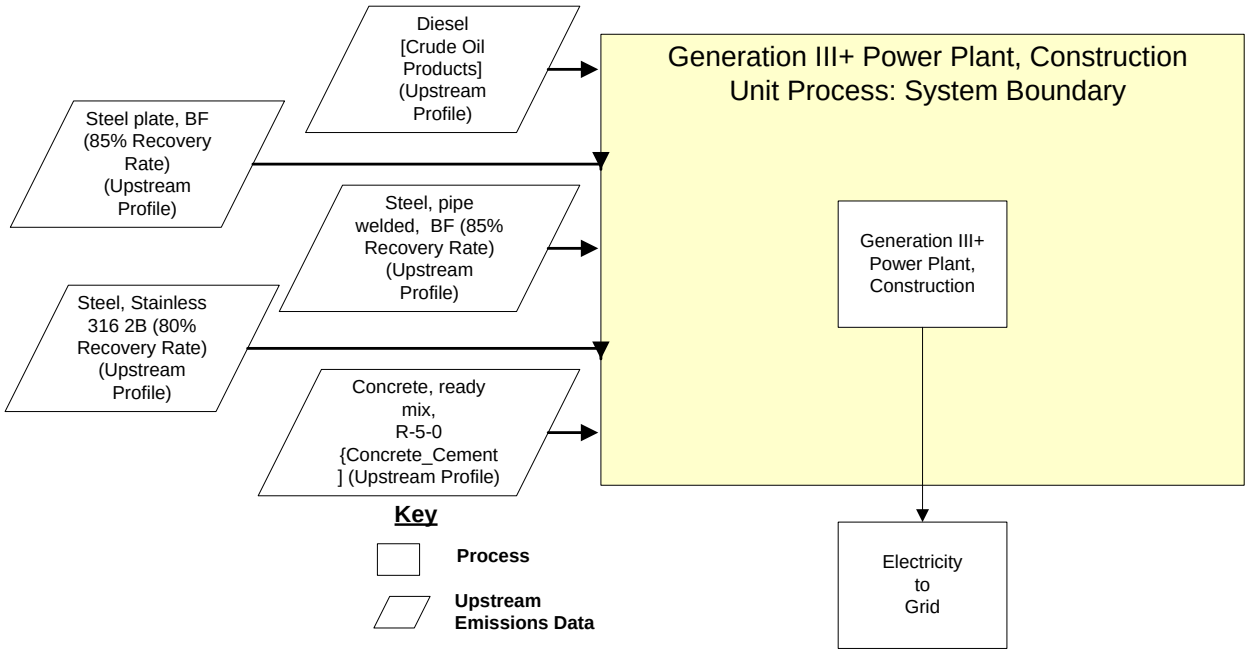

Figure 1. Unit Process Scope and Boundary

The construction of the Generation III+ nuclear power plant is based on the "DOE NP2010 Nuclear Power Plant Construction Infrastructure Assessment" report. The document assesses the adequacy of current infrastructure to construct a new fleet of nuclear power plants in the United States between 2010 and 2017. Included in the assessment are material resource requirements: reinforced steel and embedded parts, structural steel, large- and small-bore pipe, cable, and concrete. From these part lists and estimates of raw material requirements for each of the components, a raw material input list was calculated. It was assumed that reinforcing and embedded parts are 50% carbon steel, 50% stainless steel. It was also assumed that structural steel, miscellaneous steel, and decking is 75% carbon steel and 25% stainless steel. Pipe

weights and raw material requirements came from ANSI Schedule 40 (Engineering Toolbox 2005).

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 shows relevant properties and assumptions used to calculate the amount of steels and concrete in one Generation III+ nuclear power plant. **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 sheet.

Table 1: Properties of Process

Material Composition and Weights		
Material	**Weight (kg)**	**Reference**
Weight of Concrete	757,721,199	DOE 2005
Weight of Carbon Steel	38,388,883	DOE 2005
Weight of Carbon Steel Pipe	10,074,774	DOE 2005
Weight of Stainless Steel	29,893,412	DOE 2005

Table 2: 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**
Steel plate, BF (85% Recovery Rate) [Metals]	**3.84E+07**	**kg/1000 MW plant**
Steel, pipe welded, BF (85% Recovery Rate) [Metals]	**1.01E+07**	**kg/1000 MW plant**
Steel, Stainless, 316 2B (80% Recycled) [Metals]	**2.99E+07**	**kg/1000 MW plant**
Concrete, ready mix, R-5-0 [Concrete_Cement]	**7.58E+08**	**kg/1000 MW plant**
Outputs		
Generation III+ Power Plant [construction]	1.00	piece (1000 MW plant)
Nitrogen oxides [Inorganic emissions to air]	9.70E+06	kg/1000 MW plant
Carbon monoxide [Inorganic emissions to air]	2.09E+06	kg/1000 MW plant
Sulphur oxides [Inorganic emissions to air]	6.38E+05	kg/1000 MW plant
Dust (PM10) [Particles to air]	6.82E+05	kg/1000 MW plant
Carbon dioxide [Inorganic emissions to air]	3.61E+08	kg/1000 MW plant
NMVOC (unspecified) [Group NMVOC to air]	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

DOE 2005 — R. D'Olier. 2005. DOE NP2010 Nuclear Power Plant Construction Infrastructure Assessment. US Department of Energy. Washington, DC. 2010. http://nuclear.energy.gov/np2010/reports/mpr2776Rev0102105.pdf (Accessed July 20, 2010)

Engineering Toolbox 2005 — The Engineering ToolBox. 2005. Steel Pipes Dimensions - ANSI Schedule 40. 2005. http://www.engineeringtoolbox.com/ansi-steel-pipes-d_305.html (Accessed July 20, 2010)

Section III: Document Control Information

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