NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Multipurpose Nuclear Spent Fuel Cask, Construction

Reference Flow: 1 piece of Spent Fuel Cask

Brief Description: This process builds a cask to store the nuclear spent fuel. It is designed to both store the spent fuel with the option of moving the spent fuel within the cask. The cask is constructed of concrete and steel.

Section I: Meta Data

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

Year Data Best Represents: 2010

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:

Tracked Input Flows:

Concrete, ready mix, R-5-0 [Concrete_Cement]	*Concrete mix used for the construction of the spent fuel cylinder to stop radiation releases*
Stainless steel, 316 2B, 80% Recycled [Metals]	*Stainless steel used to help reduce the radiation releases, assumes 80% recycled steel*

Spent fuel [Energy carrier]	*Spent fuel rods from the nuclear reactor*

Tracked Output Flows:

Spent Fuel Cask [Installation]	*Construction of a concrete and steel spent fuel cask for nuclear fuel*

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 materials and weights of those materials necessary to construct a single spent fuel cask, to be used for the storage of spent nuclear fuel rods. The process is based on the reference flow of 1 piece of spent fuel storage, as described below and shown in **Figure 1**. The spent storage cask is assumed to be constructed of concrete ready-mix and stainless steel. Other materials are assumed negligible.

This process is used during LC Stage #3 to storage the spent fuel rods after they have had time to cool off in a cooling pool for several years. It will be combined with other construction processes for LC Stage #3. The number of casks will be determined based on the weight of spent fuel being stored. This process creates only one.

Boundary and Description

Terminal end-of-life for nuclear spent fuel is undetermined at this time, therefore, no transport or permanent storage preparation/ construction is included in this process or in the study. The constructed spent fuel cask is used to store spent fuel rods after they have been cooled in a storage pool for several years. Construction of the spent fuel cask is based on manufacturer specifications for a MAGNASTOR storage system produced by NAC International (NAC International 2010). It is assumed there is no leakage from the cask to cause any operating factors.

Figure 1 provides an overview of the boundary of this unit process. Emissions related to the physical assembly of the spent storage cask (e.g., that are emitted while putting together the components of the cask, including transportation of these components) are not included in this study. Upstream emissions from the production of raw materials used for the construction of the storage cask (e.g., concrete) are calculated outside the boundary of this unit process, based on proprietary profiles available within the GaBi model. As shown in Figure 1 and discussed above, the storage cask constructed in this unit process is to be used with any type of operations process for nuclear power production.

The total weight of a spent fuel storage cask was readily available but reliable data for the material breakdown of storage cask subcomponents were not. Diagrams and cask measurements were used to calculate the quantity of materials needed for both the concrete and steel portions (Concrete, ready mix, R-5-0 [Concrete_Cement] and Stainless steel, 316 2B, 80% Recycled [Metals]). The mass of the spent fuel which could be stored in the cask was calculated by subtracting the mass of the materials from the maximum weight which a crane can lift.

Several assumptions were made in interpreting the available specifications for storage casks:

- It is assumed that the internal cavity dimensions provided by NAC International are descriptive of the interior space within the steel wall. Thus the described canister shell thickness is the thickness of the steel wall.
- It is assumed that the canister has a cap and bottom made of steel.
- It is assumed that two-thirds of the empty space in the canister is concrete (one-third above and one-third below the fuel rods) and one-third is void of material for fuel rod storage.
- It is assumed that the maximum weight will not exceed 114 tons which is the combined weight of the cask and PWR fuel assembles to be moved by a crane.

Table 1 shows relevant properties and assumptions used to calculate the amount of stainless steel and concrete in one spent storage cask. Total weight for one cask is estimated to be approximately 81,330 kg (179,301 lb) (NAC International 2010). Based on the volume of the materials needed, 80,663 kg (177,830 lb) is assumed to be stainless steel and 666 kg (1,468 lb) is assumed to be concrete. **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.

Figure 1. Unit Process Scope and Boundary

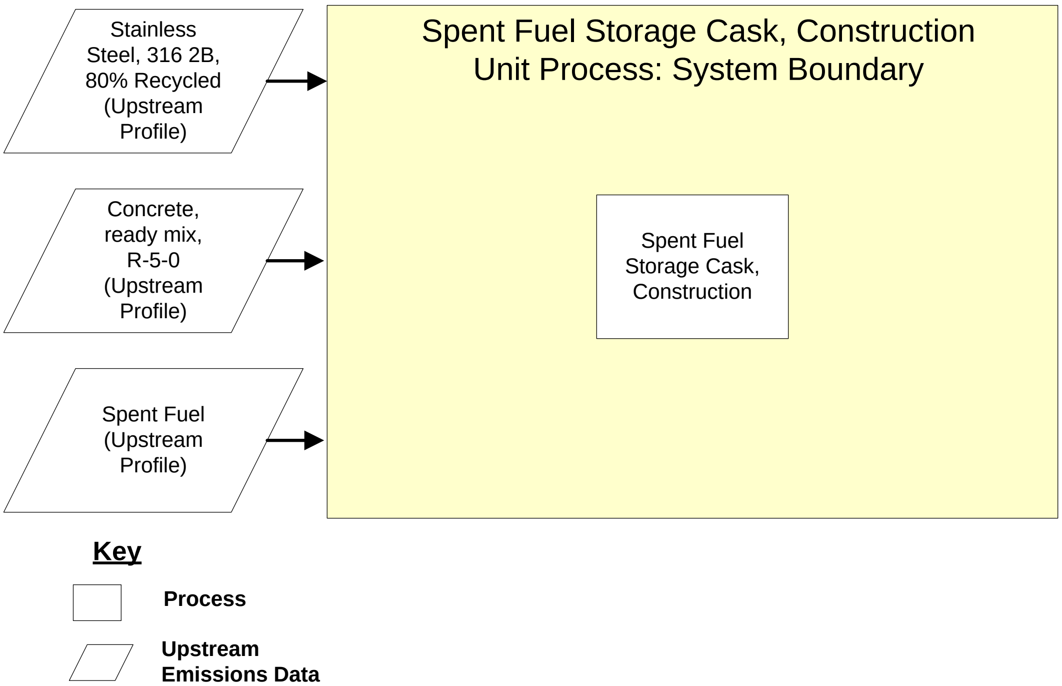
Spent Fuel Storage Cask, Construction
Unit Process: System Boundary
Stainless Steel, 316 2B, 80% Recycled (Upstream Profile)
Concrete, ready mix, R-5-0 (Upstream Profile)
Spent Fuel (Upstream Profile)
Spent Fuel Storage Cask, Construction
Key
Process
Upstream Emissions Data

Table 1: Properties of Process

Material Composition and Weights		
Material	**Value**	**Reference**
Volume of Concrete	40.13 m^3	NAC International
Weight of Concrete	80,663 kg	Calculated
Volume of Steel	0.33 m^3	NAC International
Weight of Steel	666 kg	Calculated

Table 2: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Concrete, ready mix, R-5-0 [Concrete_Cement]	**80,663**	**kg**
Stainless steel, 316 2B, 80% Recycled [Metals]	**666**	**kg**
Spent fuel [Energy carrier	**22,090**	**kg**
Outputs		
Spent Fuel Cask [Installation]	1	piece

* **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

NAC International 2010 — NAC International. 2010. The MAGNASTOR System: The new Genreation in Multipurpose Storage. NAC International. 2010. http://www.nacintl.com/magnastor (Accessed 12, 2010).

Section III: Document Control Information

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