NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Fuel Assembly Facility, Operation

Reference Flow: 1 kg of UO_2 (Fuel Assembly)

Brief Description: This unit process estimates input and output flows for assembling enriched UF_6 into UO_2 fuel assemblies for loading into nuclear reactors, including electricity, natural gas, and water use; air, water, solid waste, and radionuclide emissions.

Section I: Meta Data

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

Year Data Best Represents: 1983

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	☑ Other
Releases to Water:	☑ Inorganic	☐ Organic Emissions	☑ Other
Water Usage:	☑ Water Consumption	☑ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☑ Other

Adjustable Process Parameters:

grnd_water_f	*[L/ kg UO_2] Amount of groundwater required for operation of the fuel assembly facility*

EF_w_Ammonia	*[L/ kg UO_2] Emission to water*
EF_w_Nitrate	*[L/ kg UO_2] Emission to water*
EF_w_Fluoride	*[L/ kg UO_2] Emission to water*
EF_w_Uranium	*[L/ kg UO_2] Emission to water*
EF_w_Th234	*[L/ kg UO_2] Emission to water*
water_discharge	*[L/ kg UO_2] Amount of groundwater discharged from the fuel assembly facility based on Assumption [1]*

Tracked Input Flows:

Natural gas USA [Natural gas (resource)]	*[Technosphere] Amount of natural gas to operate the fuel assembly facility*
Power [Electric power]	*[Technosphere] Amount of electricity to operate the fuel assembly facility*
UF6 (enriched) [Intermediate products]	*[Technosphere] Amount of enriched uranium to operate the fuel assembly facility*

Tracked Output Flows:

UO_2 (fuel assembly) [Intermediate products]	*Reference flow*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_Fuel_Fabrication_Facility_2010.02.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 operate a fuel fabrication facility, to assemble uranium fuel rods into the form needed for use in nuclear power plants. The process is based on the reference flow of 1 kg of UO_2 (fuel assembly), as described below and shown in **Figure 1**. Usage of electricity, natural gas, and water are quantified.

Boundary and Description

Fuel fabrication begins with receipt of uranium hexafluoride (UF_6) from an enrichment plant. The UF_6 is transported in solid form to the fuel fabrication facility, where it is heated to a gas and chemically processed to form uranium dioxide (UO_2) powder. The UO_2 powder is then pelletized, sintered into ceramic form, loaded into tubes, and constructed into fuel assemblies.

The constructed fuel assembly has differing dimensions and contains different quantities of fuel rods depending on the reactor in which it is used. This diversity is not captured in the modeled fuel assembly process. Rather, operation of a generic fuel assembly plant is based on inputs and outputs provided in the “Energy Technology Characterizations Handbook” (ETCH 1983). These data include energy demands during operation of the facility, chemical inputs and emissions from the use of the energy and the chemical transformations.

Figure 1 provides an overview of the boundary of this unit process. Rectangular boxes represent relevant sub-processes and upstream unit processes that are documented separately, while trapezoidal boxes indicate upstream data that are outside of the boundary of this unit process. As shown, upstream emissions associated with the production and delivery of electricity and natural gas are accounted for outside of the boundary of this unit process, based on proprietary profiles available within the GaBi model.

Table 1 shows relevant production values of the entire facility. **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

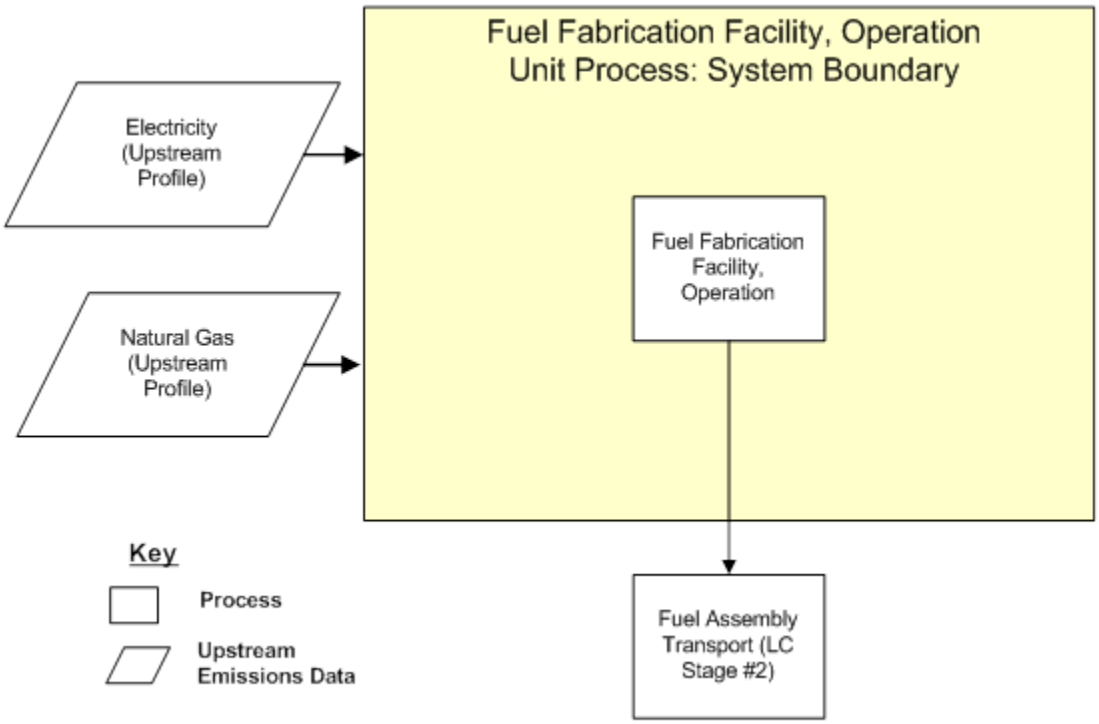

Table 1: Properties of Process

Material	Value	Reference
Uranium Dioxide Annual Output	900,000 kg	ETCH 1983
Enriched Uranium Hexafluoride Annual Input	3,080,000 kg	ETCH 1983
Electricity Annual Input	44,000 MWh	ETCH 1983
Natural Gas Annual Input	2,600,000 m^3	ETCH 1983

Table 2: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Natural gas USA [Natural gas (resource)]	2.89E+00	m^3/ $kgUO_2$
Power [Electric power]	4.89E-02	MWh/ $kgUO_2$
UF6 (enriched) [Intermediate products]	3.42E+00	kg/ $kgUO_2$
Water (ground water) [Water]	5.67E+02	L/ $kgUO_2$
Outputs		
UO_2 (fuel assembly) [Intermediate products]	**1.00E+00**	**kg**
Ammonia [Inorganic emissions to fresh water]	2.89E-04	kg/ $kgUO_2$
Calcium Fluoride [Emissions to industrial soil]	7.49E-01	kg/ $kgUO_2$
Carbon monoxide [Inorganic emissions to air]	6.22E-06	kg/ $kgUO_2$
Fluoride [Inorganic emissions to fresh water]	1.22E-04	kg/ $kgUO_2$
Nitrate [Inorganic emissions to fresh water]	6.87E-04	kg/ $kgUO_2$
Nitrogen oxides [Inorganic emissions to air]	1.78E-04	kg/ $kgUO_2$
Sulphur dioxide [Inorganic emissions to air]	6.87E-04	kg/ $kgUO_2$
Thorium (Th234) [Radioactive emissions to fresh water]	1.07E-08	Bq/ $kgUO_2$
Uranium [Radioactive emissions to fresh water]	2.10E-08	Bq/ $kgUO_2$
Uranium [Radioactive emissions to industrial soil]	2.43E-07	Bq/ $kgUO_2$
Uranium (U235) [Radioactive emissions to air]	2.10E-08	Bq/ $kgUO_2$
Water (wastewater) [Water]	5.67E+02	L/ $kgUO_2$

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Embedded Unit Processes

None.

References

ETCH 1983 — The Aerospace Corporation and Mueller Associates, Inc. 1983. Energy Technology Characterizations Handbook. Department of Energy. Washington, D.C.

Section III: Document Control Information

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