



NETL Life Cycle Inventory Data

Process Documentation File

Process Name: Gaseous Diffusion Uranium Enrichment, Operations

Reference Flow: 1 kg of Enriched UF₆

Brief Description: This process receives UF₆ from a conversion facility and enriches the percent composition of uranium-235 in the fuel. This process includes energy consumption, air emissions, water use, water emissions, and solid waste.

Section I: Meta Data

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

Year Data Best Represents: 2010

Process Type: Energy Conversion (EC)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: Individual Relevant Flows Recorded

Flows Aggregated in Data Set:

- Process
 Energy Use
 Energy P&D
 Material P&D

Relevant Output Flows Included in Data Set:

- | | | | |
|--------------------|--|--|---|
| Releases to Air: | <input type="checkbox"/> Greenhouse Gases | <input type="checkbox"/> Criteria Air Pollutants | <input checked="" type="checkbox"/> Other |
| Releases to Water: | <input type="checkbox"/> Inorganic Emissions | <input type="checkbox"/> Organic Emissions | <input type="checkbox"/> Other |
| Water Usage: | <input type="checkbox"/> Water Consumption | <input type="checkbox"/> Water Demand (throughput) | |
| Releases to Soil: | <input type="checkbox"/> Inorganic Releases | <input type="checkbox"/> Organic Releases | <input type="checkbox"/> Other |

Adjustable Process Parameters:

Tracked Input Flows:

UF ₆ (natural) [Energy carrier]	<i>Quantity of natural uranium hexafluoride entering the enrichment facility, in kg</i>
Power [Electric Power]	<i>Coal fired electricity profile, in kilowatt hours</i>

Tracked Output Flows:

UF ₆ (enriched) [Energy carrier]	<i>Reference Flow</i>
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Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_Diffusion_Enrichment_2010.01.xls*, which provides additional details regarding relevant, calculations, data quality, and references.

Goal and Scope

This unit process describes the operation of a gaseous diffusion enrichment facility. The enrichment operations process receives natural uranium fluoride (UF_6) from the conversion facility and separates uranium isotopes to increase the concentration of uranium-235 in the fuel. Enriched uranium from the facility is then transported to the fuel fabrication facility. All steps are contained within lifecycle Stage #1 of the uranium life cycle.

Boundary and Description

This gaseous diffusion enrichment process is used to increase the concentration of uranium-235 in UF_6 for effective use of the fuel. Natural concentrations of uranium-235 are less than one weight percent. For optimal light water nuclear fission in a commercial power plant, the uranium-235 concentration must be above 3 weight percent.

Gaseous diffusion is the only type of enrichment process used in the United States. Operations take place at a single plant in Paducah, Kentucky. A similar plant in Piketon, Ohio was shut down in March 2001.

The diffusion enrichment process filters UF_6 gas through porous membranes to separate heavier uranium-238 isotopes from lighter uranium-235 isotopes. The fuel goes through many hundreds of these barriers before the concentration is high enough for commercial fuel use. (NRC 2010)

Inputs to the unit process, as shown in **Figure 1**, include electricity and natural UF_6 . A dedicated power plant, the Joppa Steam plant, provides the Paducah facility 1600 MW of power. Electric Energy, Inc. provides a maximum capacity of 3400 MW for use by the enrichment facility. (WNA 2010)

A public health assessment completed by the Agency for Toxic Substances and Disease Registry provided toxic and radioactive air emissions and water quality data for this inventory (ATSDR 2001). Water use data was taken from the final environmental impact statement for the Paducah facility (DOE 2004).

Figure 1: Unit Process Boundary and Scope

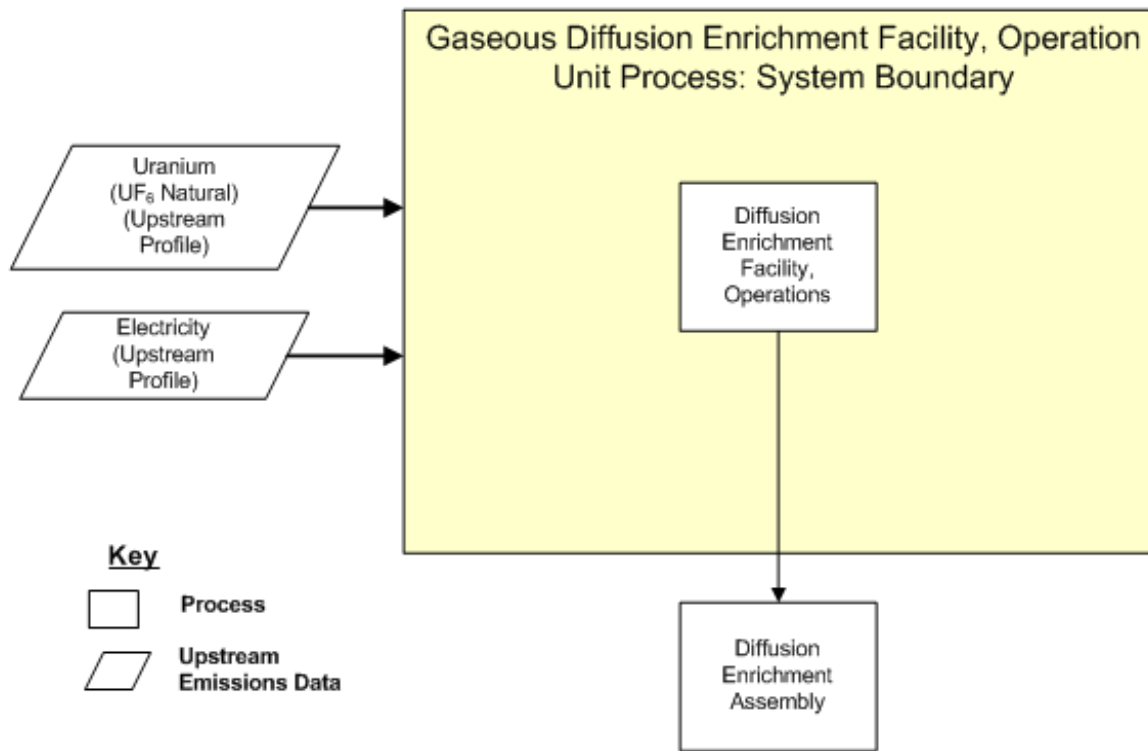


Table 1 shows the plant parameters for the diffusion enrichment process. **Table 2** provides a summary of modeled input and output flows. Additional details regarding input and output flows, including calculation methods, are contained in the associated DS.

Table 1: Plant Parameters

Property	Value	Units	Reference
Purchased electric power: electrical need	1,600	MW	WNA 2010
Purchased electric power: maximum capacity	3,400	MW	WNA 2010
Annual Enrichment Capacity	1.13E+07	SWU/yr	Laughter 2009
SWU per kg of Enriched UF ₆	7.9	SWU/kg	WNA 2010, Spurgeon 2008

Table 2: Unit Process Input and Output Flows

Flow Name*	Value E10	Units (Per Reference Flow)
Inputs		
UF ₆ (natural) [Energy carrier]	10.40	kg/ kg UF ₆
Power [Electric power]	8.0	MWh/ kg UF ₆
Water (surface water) [Water]	14488	kg/ kg UF ₆
Outputs		
UF ₆ (enriched) [Energy carrier]	1.00	kg
Chromium (unspecified) [Heavy metals to air]	1.00E-03	kg/ kg UF ₆
Hydrogen fluoride [Inorganic emissions to air]	3.85E-03	kg/ kg UF ₆
NMVOOC (unspecified) [Group NMVOOC to air]	2.24E-02	kg/ kg UF ₆
Radionuclides (unspecified) [Radioactive emissions to air]	7.11E+02	Bq/ kg UF ₆
Heavy metals to water (unspecified) [Heavy metals to fresh water]	1.06E-01	kg/ kg UF ₆
Nitrate [Inorganic emissions to fresh water]	9.63E-03	m ³ / kg UF ₆
Fluoride [Inorganic emissions to fresh water]	4.04E-03	m ³ / kg UF ₆
Chlorinated hydrocarbons (unspecified) [Halogenated organic emissions to fresh water]	3.67E-05	kg/ kg UF ₆
Sulphate [Inorganic emissions to fresh water]	4.18E-01	kg/ kg UF ₆
Water (river water) [Water]	3863	kg/ kg UF ₆
Radioactive tailings [Radioactive waste]	9.40	kg/ kg UF ₆

* **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 2004 U.S. Department of Energy. (2004). Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site. <http://nepa.energy.gov/finalEIS-0359.htm> (Accessed August 26, 2010) Laughter 2009 M.D. Laughter. (2009). Profile of World Uranium Enrichment Programs--2009. http://apps.ornl.gov/~pts/prod/pubs/ldoc15166_profile_of_world_uranium_enrichment_programs_2009_final_draft_4_24.pdf (Accessed August 26, 2010)
- NRC 2010 Nuclear Regulatory Commission. (2010) Uranium Enrichment. <http://www.nrc.gov/materials/fuel-cycle-fac/ur-enrichment.html> (Accessed August 26, 2010)

Spurgeon 2008	Statement of Dennis R. Spurgeon, Assistant Secretary for Nuclear Energy, Before the Subcommittee on Oversight and Investigations Committee on Energy and Commerce. U.S. House of Representatives. April 3, 2008.
WNA 2010	World Nuclear Association. (2010). Uranium Enrichment. http://www.world-nuclear.org/info/inf28.html (Accessed July 9, 2010)
ATSDR 2001	Agency for Toxic Substances and Disease Registry. (2001). Public Health Assessment: Paducah Gaseous Diffusion (USDOE). http://www.atsdr.cdc.gov/hac/pha/pha.asp?docid=791&pg=1 (Accessed August 26, 2010)

Section III: Document Control Information

Date Created:	November 9, 2010
Point of Contact:	Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV
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